VOLUME 4 (Part VI)

Semiconductor Devices

thyristors
thyristor stacks

Issued by
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SILICON CONTROLLED SWITCH

BRY39

The BRY39 is a silicon planar p-n-p-n controlled switch designed for switching applications, primarily as a driver of numerical indicator tubes.

Each semiconductor region is accessible, giving good design flexibility. TO-72 outline with the Anode Gate connected to the envelope.

QUICK REFERENCE DATA

	P-N-P transistor		
$-V_{EBO}$	Max. emitter-base voltage (open collector)	70	V
	N-P-N transistor		
V_{CBO}	Max. collector-base voltage (open emitter)	70	V
$-I_{EM}$	Emitter current (peak value)	500	mA
P_{tot}	Max. total dissipation ($T_{amb} \leq 25^{o}C$)	250	mW
T_j	Max. operating junction temperature	150	^{o}C
V_{AE}	Forward voltage $I_A = 50mA$, $I_C = 0$, $R_{BE} = 10k\Omega$	<1.4	V
I_H	Holding current $I_C = 10mA$, $-V_{BB} = 2.0V$, $R_{BE} = 10k\Omega$	<1.0	mA
t_{on}	Turn-on time	<0.25	µs
t_q	Turn-off time	<5.0	µs

OUTLINE AND DIMENSIONS

Conforming to J.E.D.E.C. TO-72
B.S. 3934 SO-12A/SB4-3

For complete data see under

Transistors in Volume 4 part II

TENTATIVE DATA

The BT101 and BT102 series are ranges of p-gate reverse blocking thyristors intended for use in domestic and light industrial equipment. The device is stud mounted and is similar in outline to SO-35A.

QUICK REFERENCE DATA

	BT101-	300R	500R	
	BT102-	300R	500R	
V_{BO} min.		300	500	V
V_{RRM} max.		300	500	V
$I_{T(AV)}$ max.				
$T_{mb} \leq 85^{o}C$		6.5		A
$I_{T(RMS)}$ max.		15		A
T_j max.		125		^{o}C

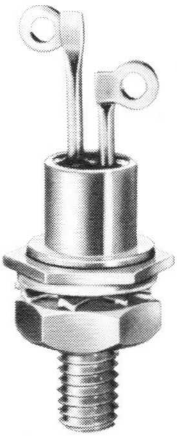
Unless otherwise stated data is applicable to all types in both series

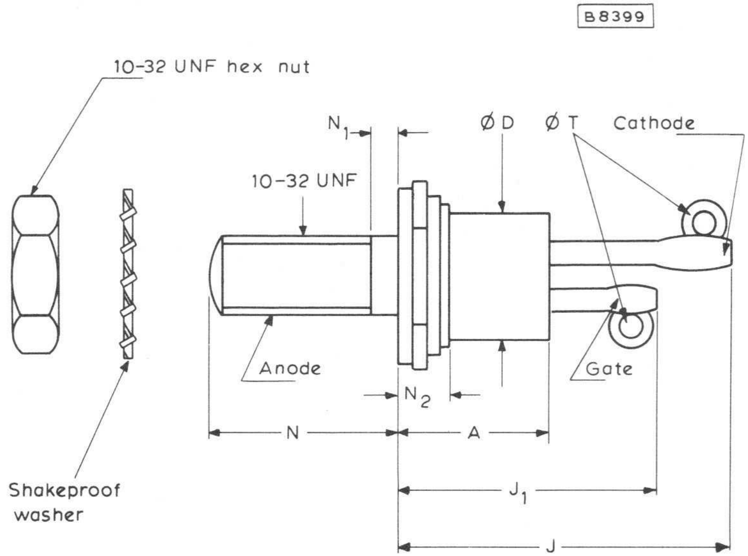
OUTLINE AND DIMENSIONS

Similar to J.E.D.E.C. TO-64

B.S. 3934 SO-35A

For details see page 2





Inch dimensions derived from millimetre originals

	Millimetres			Inches			Note
Ref.	Min.	Nom.	Max.	Min.	Nom.	Max.	
A	-	-	10.1	-	-	0.398	
ØD	-	-	9.5	-	-	0.374	
J	-	-	21.7	-	-	0.854	
J_1	-	-	17	-	-	0.669	
N	10.72	-	11.51	0.423	-	0.453	
N_1	-	-	1.98	-	-	0.078	
N_2	-	-	3.2	-	-	0.126	1
ØT	1.6	-	1.9	0.063	-	0.075	

NOTE

1. This zone includes a 7/16in hexagon, across flats dimension 0.423in (10.75mm) minimum, 0.438in (11.12mm) maximum.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

		BT101- 300R	BT101- 500R	
Voltage (see note)		BT102- 300R	BT102- 500R	
V_{RWM}	Crest working reverse voltage	200	400	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	300	500	V
V_{RSM}	Non-repetitive peak reverse voltage (≤ 10ms)	300	500	V
V_{DWM}	Crest working off-state voltage	200	400	V
V_{DRM}	Repetitive peak off-state voltage (1% duty cycle at 50Hz)	300	500	V
V_{DSM}	Non-repetitive peak off-state voltage (≤ 10ms)	300	500	V

Current

$I_{T(AV)}$	Mean on-state current (180° conduction, $T_{mb} \leq 85°C$, see graph on page 7 for higher T_{mb})	6.5	A
$I_{T(RMS)}$	R.M.S. on-state current	15	A
I_{TRM}	Repetitive peak on-state current	50	A
I_{TSM}	Non-repetitive peak on-state current (10ms, half sine-wave, following any rated load condition)	55	A
I_{start}	Starting current	see graph on page 8	
$\frac{di}{dt}$	Rate of rise of on-state current	50	A/µs

NOTE

These ratings do not apply when the gate is positive with respect to cathode.

GATE TO CATHODE

$P_{G(AV)}$	Average gate power (forward and reverse) (averaged over any 20ms period)	0.5	W

RATINGS (cont'd)

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

$R_{th(j-mb)}$	Maximum thermal resistance junction to mounting base	3.0	degC/W
$R_{th(i)}$	Maximum contact thermal resistance for a torque of 9 kg cm on the nut	0.5	degC/W
$R_{th(j-amb)}$	Maximum thermal resistance junction to ambient with nut and washer	40	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

			BT101- BT102-	300R 300R	500R 500R	
V_{BO}	Min. forward breakover voltage			300	500	V
V_T	Max. instantaneous on-state voltage at $I_T = 20A$, $T_j = 25^oC$				2.3	V
i_D	Max. off-state leakage current at V_{DWM}				1.5	mA
i_R	Max. reverse leakage current at V_{RWM}				1.5	mA
V_{GT}	Min. instantaneous trigger voltage to initiate turn-on	at $T_j = 25^oC$	BT101		2.0	V
			BT102		2.5	V
		at $T_j = -10^oC$	BT101		2.1	V
			BT102		2.8	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on	at $T_j = 25^oC$	BT101		10	mA
			BT102		50	mA
		at $T_j = -10^oC$	BT101		13	mA
			BT102		65	mA
V_{GD}	Max. continuous gate voltage which will not initiate turn-on				250	mV
V_{RG}	Max. reverse gate voltage for negligible reverse gate dissipation				5.0	V

MECHANICAL DATA

Maximum torque on hexagon or nut	17kg cm	1.3lb ft
Minimum torque on hexagon or nut	9kg cm	0.6lb ft
Recommended diameter of hole in heatsink	5.2mm	0.205in

OPERATING NOTES

1. Thyristors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

2. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below.

Junction temperature

$R_{th(j-mb)} = 3.0\text{degC/W}$

Mounting base temperature

$R_{th(i)} = 0.5\text{degC/W}$

Heatsink temperature

$R_{th(h)}$

Ambient temperature

The method of using the graph on page 7 is as follows:-

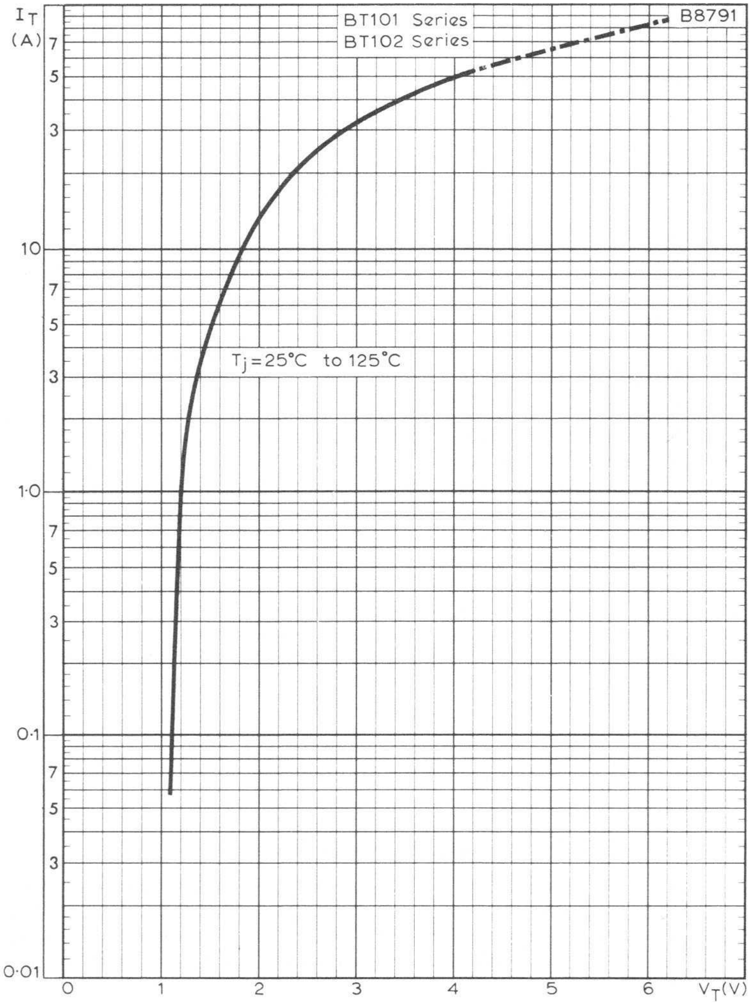
Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate heatsink curve is reached. Finally trace downwards to determine the maximum ambient temperature. (Note that these curves are for the whole thermal system i.e. the 20degC/W curve is in fact, 20 ($R_{th(h)}$) + 0.5 ($R_{th(i)}$) + 3 ($R_{th(j-mb)}$) = 23.5degC/W.
$R_{th(i)}$ is the contact thermal resistance for minimum torque, as given on page 4. $R_{th(h)}$ is the thermal resistance of the heatsink used.
Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page 7. Thus, knowing the maximum ambient temperature the maximum value of $R_{th(h)}$ is given by:-

$$R_{th(h)} = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - R_{th(i)}$$

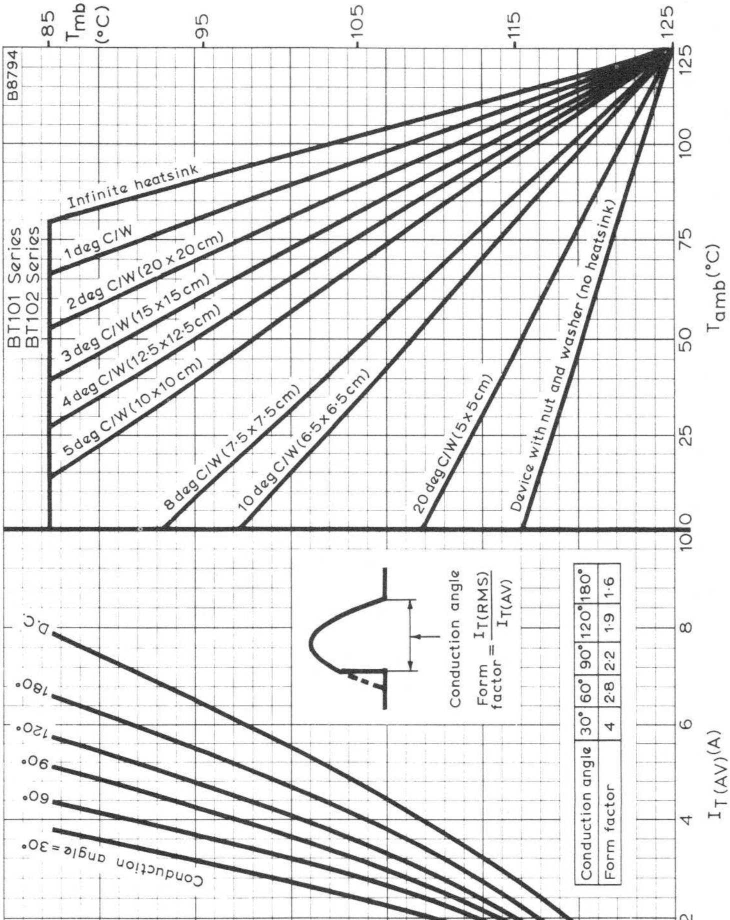
3. Overload conditions

The method of using the graph on page 9 is as follows:-

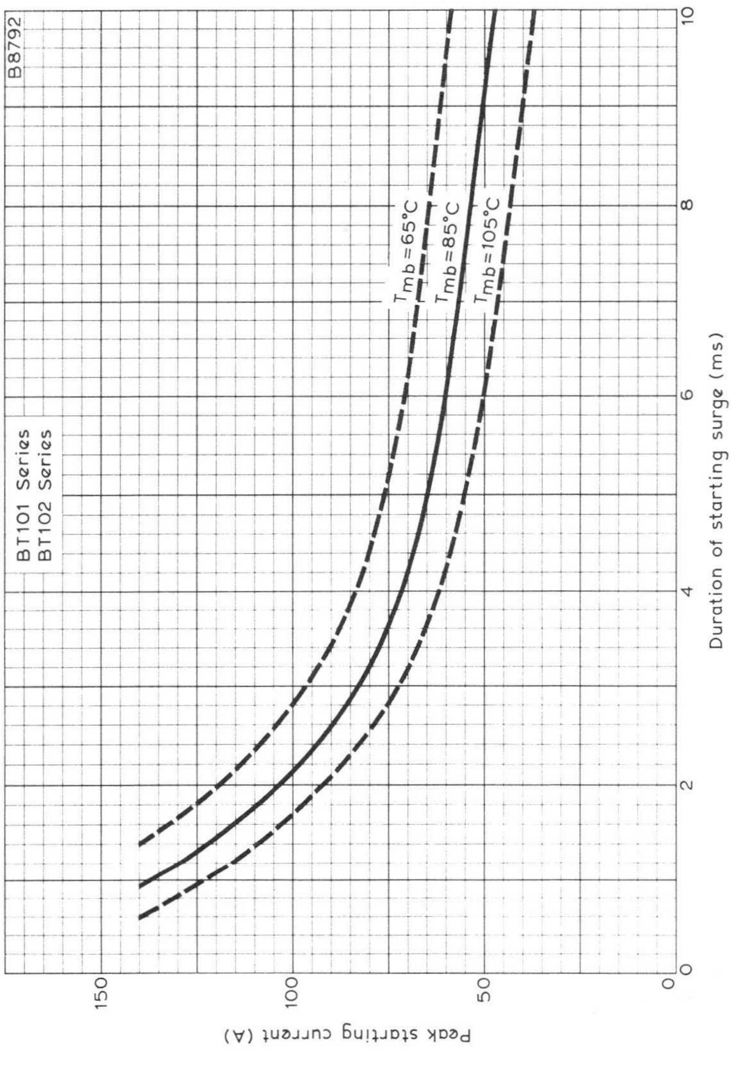
Starting with the curve of maximum dissipation as a function of mean on-state overload current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate heatsink curve is reached. Finally trace downwards to determine the permitted overload time.
After the permitted overload time the device must revert to normal operation as derived from the graph on page 7.



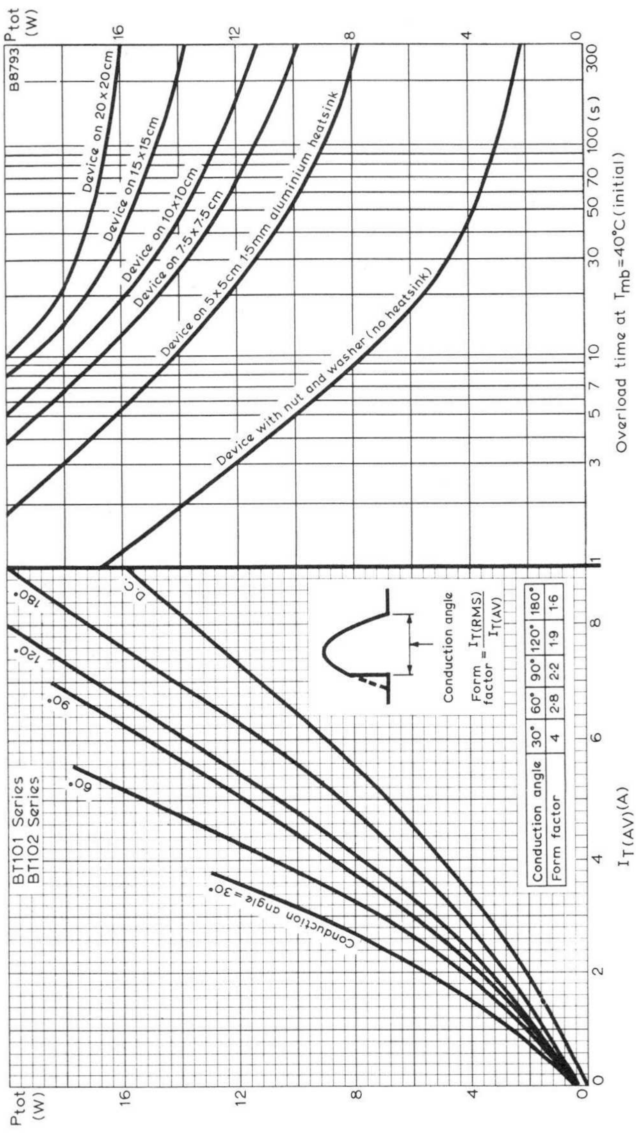
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURE FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE. DEVICE MOUNTED ON 1.5mm BRIGHT ALUMINIUM SHEET



PEAK STARTING CURRENT PLOTTED AGAINST DURATION OF STARTING SURGE



MAXIMUM TOTAL DISSIPATION PLOTTED AGAINST MEAN ON-STATE CURRENT AND OVERLOAD TIME. FOR INFORMATION ON THE USE OF THESE CURVES SEE PAGE 5

THYRISTORS

BTX18 Series

TENTATIVE DATA

The BTX18 series is a range of p-gate reverse blocking thyristors, in the J.E.D.E.C. TO-5 outline, intended for use in general low power applications up to 1.0A mean on-state current.

QUICK REFERENCE DATA

BTX18-	100	200	300	400	500	
$^*V_D$	100	200	300	400	500	V
V_{RSM}	120	240	350	500	600	V
V_{RWM}	100	200	300	400	500	V
$I_{T(AV)}$ max.						
$T_{case} = 105^\circ C$			1.0			A
$T_{amb} = 60^\circ C$, in free air			250			mA
T_j max.			125			$^\circ C$
$R_{th(j-case)}$			10			degC/W
$R_{th(j-amb)}$			200			degC/W

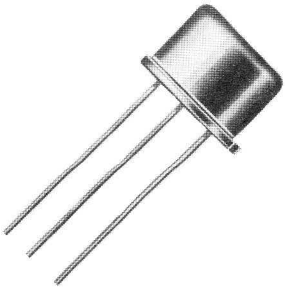
*Rating applies when 1kΩ resistor is connected between gate and cathode

Unless otherwise stated data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-5
B.S. 3934 SO-3/SB3-3A

For details see page 5



RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous applications of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX18-	100	200	300	400	500	
V_R	Continuous reverse voltage	100	200	300	400	500	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	120	240	350	500	600	V
V_{RSM}	Non-repetitive peak reverse voltage ($t \leq 10ms$)	120	240	350	500	600	V
V_D	Continuous off-state voltage	100	200	300	400	500	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	V
V_{DRM}	Repetitive peak off-state voltage (1% duty cycle at 50Hz)	120	240	350	500	600	V
V_{DSM}	Non-repetitive peak off-state voltage ($t \leq 10ms$)	120	240	350	500	600	V
$\frac{dV}{dt}$	Rate of rise of voltage not to trigger the device			See page 11			

NOTE

1. These ratings apply for zero or negative bias on the gate with respect to the cathode, and when a 1kΩ resistor is connected between gate and cathode.

Current

I_T	Continuous on-state current ($T_{case} = 100^oC$)	1.6	A
$I_{T(AV)}$	Mean on-state current (see page 7)	1.0	A
$I_{T(RMS)}$	R.M.S. on-state current	1.6	A
I_{TRM}	Repetitive peak on-state current	10	A
I_{TSM}	Non-repetitive peak on-state current (t = 10ms, half sinewave)	10	A

GATE TO CATHODE (with 1.0kΩ resistor connected between gate and cathode)

Voltage

V_{FGM}	Peak forward gate voltage	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward gate current	0.2	A

Power

P_{GM}	Peak gate power	0.5	W
$P_{G(AV)}$	Average gate power	0.05	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

$R_{th(j-case)}$	Thermal resistance from junction to case	10	degC/W
$R_{th(j-amb)}$	Thermal resistance from junction to ambient	200	degC/W

ELECTRICAL CHARACTERISTICS (with 1kΩ resistor between gate and cathode)

Measured at $T_j = 125^{o}C$ unless otherwise stated

Symbol	Parameter	BTX18-100	BTX18-200	BTX18-300	BTX18-400	BTX18-500	Unit
V_{BO}	Minimum forward breakover voltage (see note 2)	120	240	350	500	600	V
V_T	Maximum instantaneous on-state voltage at $I_T = 1.0A$, $T_j = 25^{o}C$ (see note 4)					1.5	V
i_D	Maximum off-state leakage current at V_{DWM}	800	400	275	200	160	μA
i_R	Maximum reverse leakage current at V_{RWM}	800	400	275	200	160	μA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$					2.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$					5.0	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on					200	mV
I_H	Maximum holding current at $T_j = 25^{o}C$ (see note 3)					5.0	mA
I_L	Typical latching current					10	mA
t_q	Turn-off time at $I_T = 300mA$, $I_R = 175mA$		See page 12				

NOTES

2. The device is not suitable for operation in the forward breakover mode.
3. Measured under the following conditions

   Anode supply voltage = +6.0V

   Initial on-state current after gate triggering = 50mA

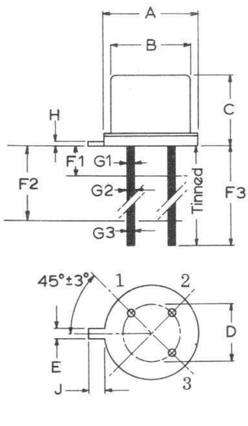
   The current is reduced until the device turns off.
4. V_T is measured along the leads at 1cm from the case.

SOLDERING AND WIRING RECOMMENDATIONS

1. When using a soldering iron the thyristor may be soldered directly into the circuit, but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Thyristors may be dip soldered at a solder temperature of 245^{o}C, for a maximum soldering time of 5 seconds. The case temperature during dip soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a thyristor mounted flush on a board with punched-through holes, or spaced 1.5mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS

Conforming to B.S.3934 SO-3/SB3-3A
J.E.D.E.C. TO-5

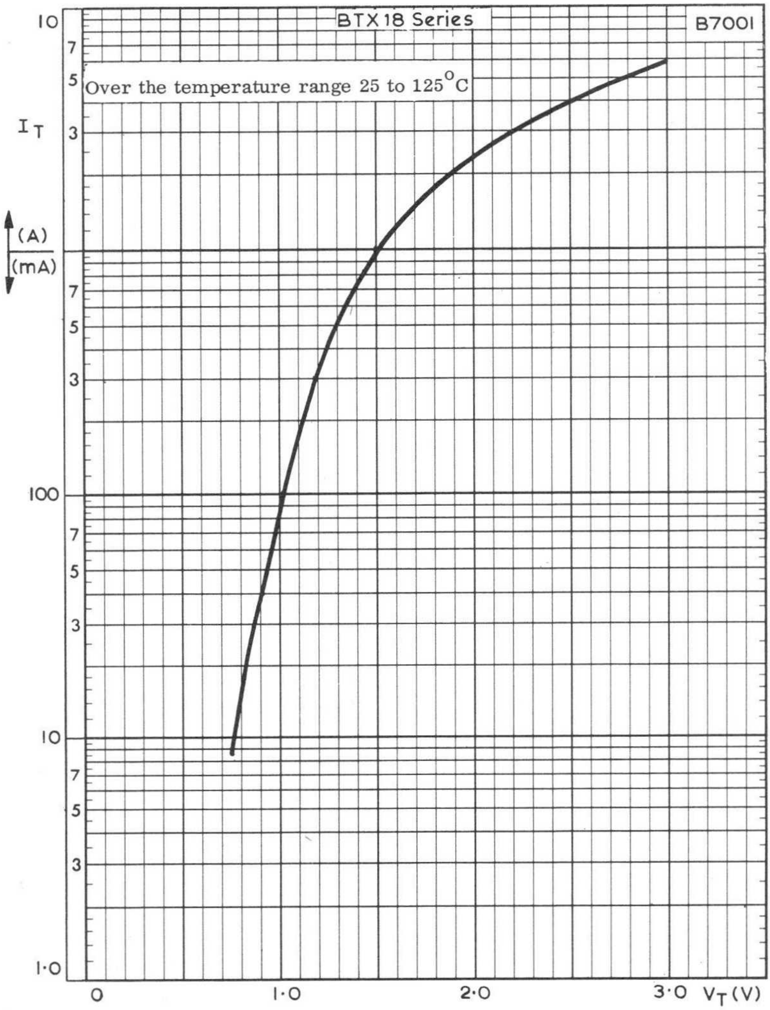


1. Cathode
2. Gate
3. Anode

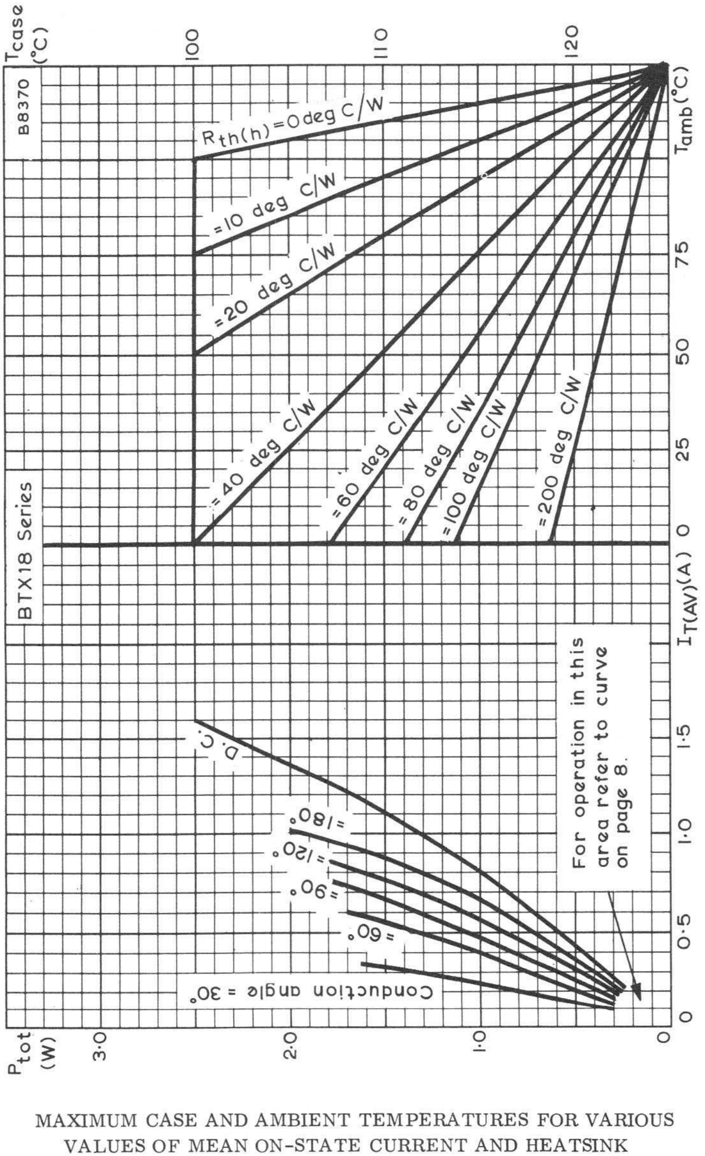
anode connected to case

Millimetres

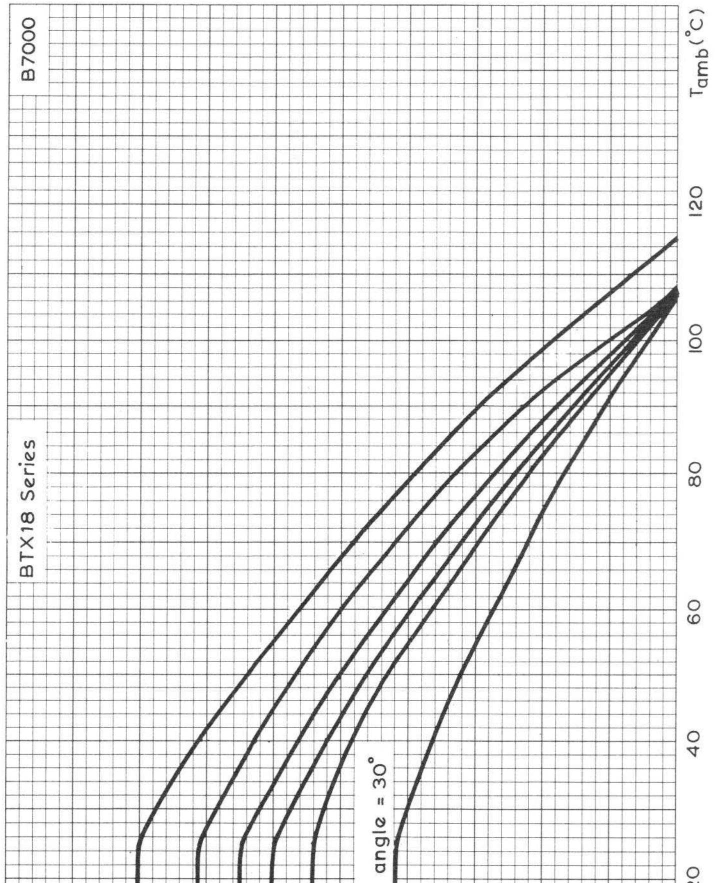
	Min.	Nom.	Max.
A	9.10	-	9.39
B	8.20	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01



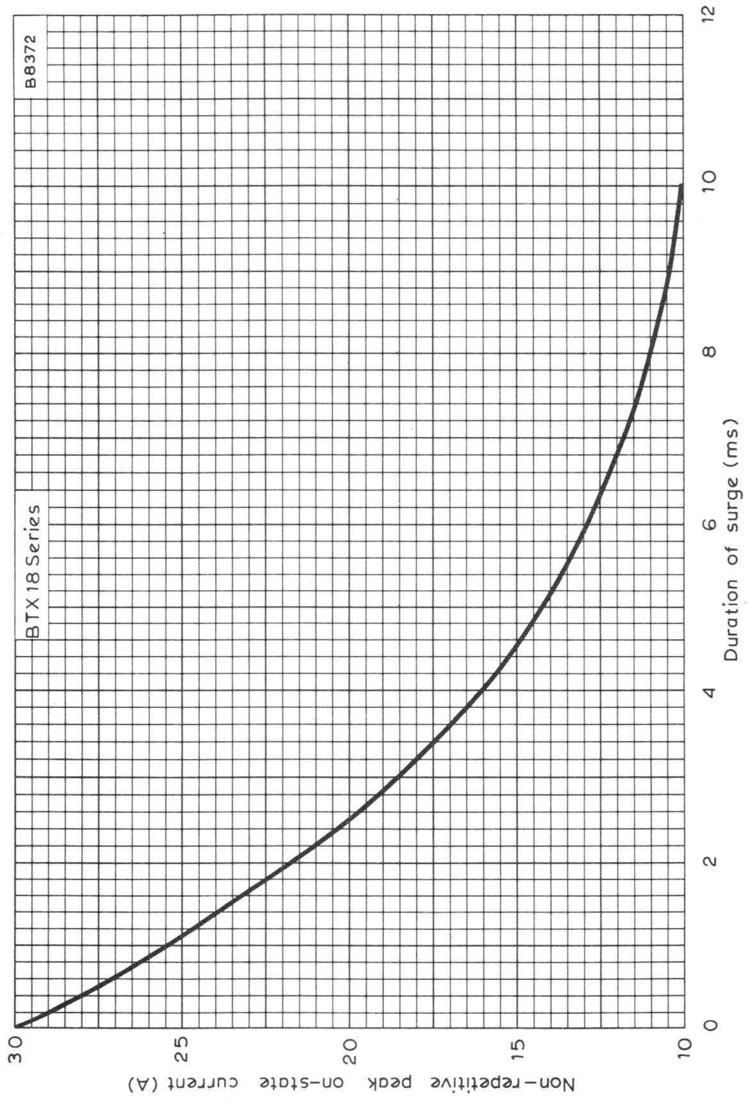
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



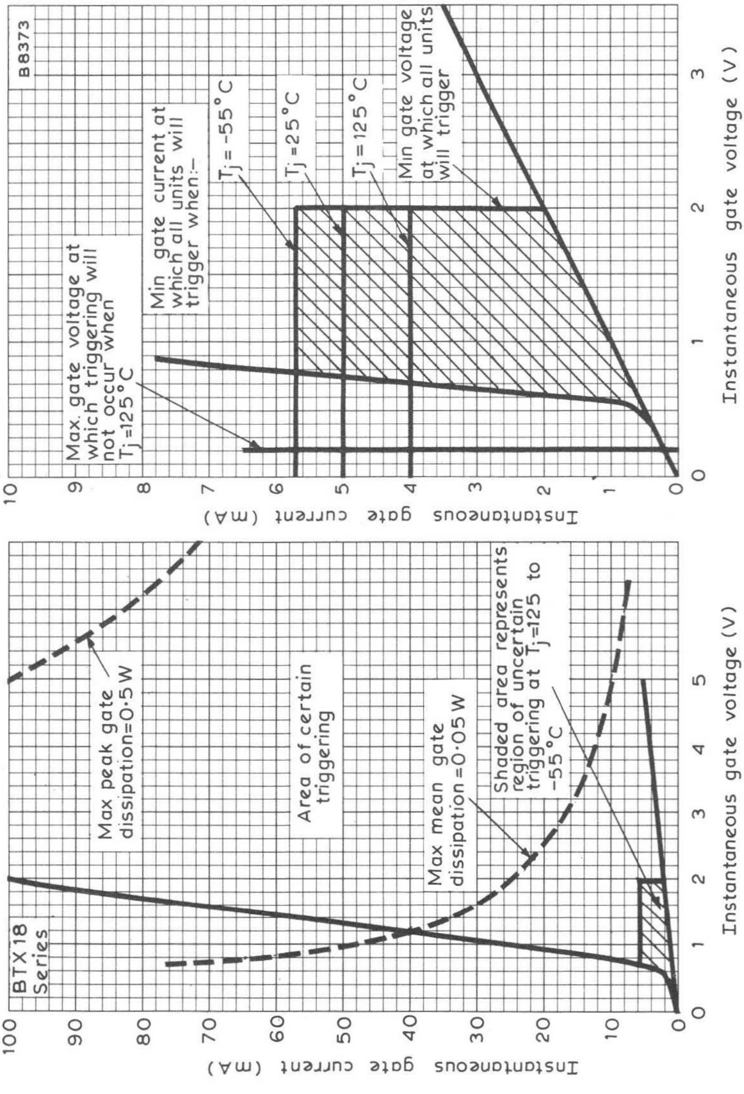
MAXIMUM CASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



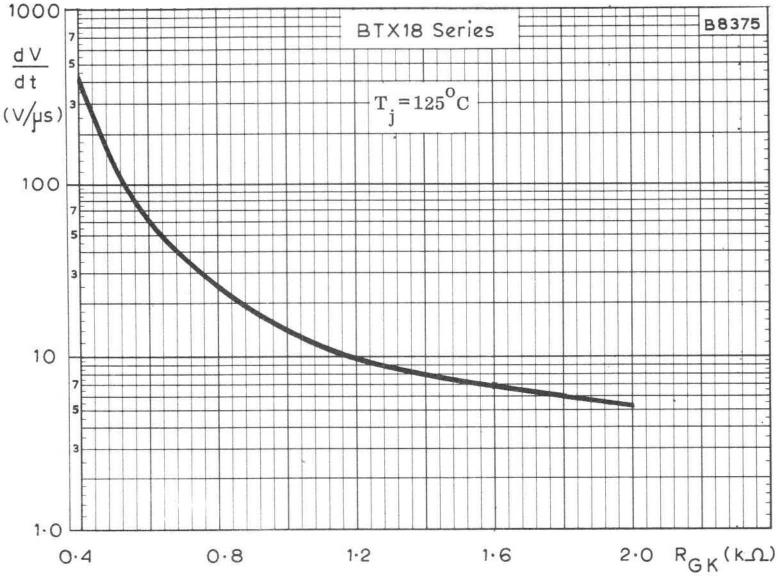
DERATING CURVE FOR A DEVICE OPERATING IN FREE AIR
WITHOUT A HEATSINK

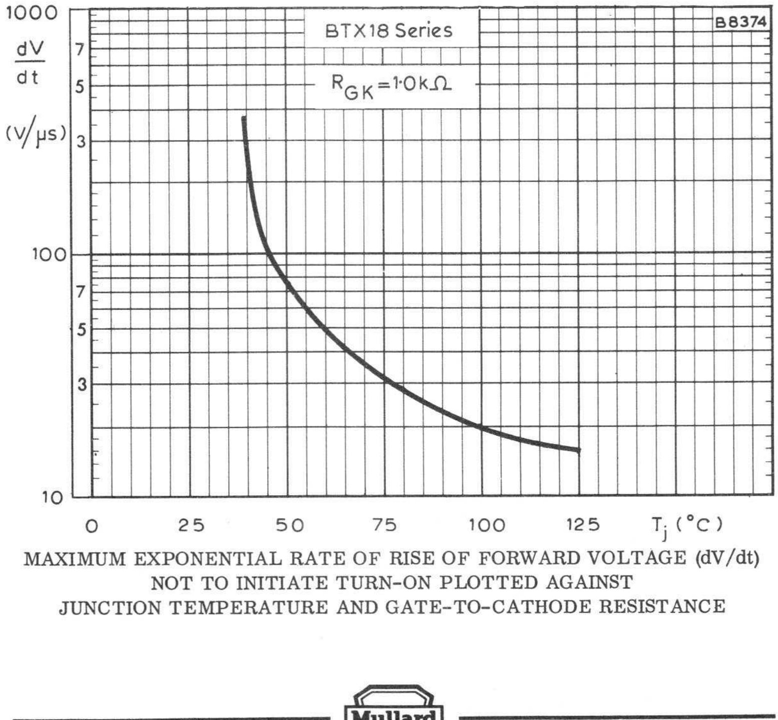


MAXIMUM NON-REPETITIVE PEAK ON-STATE CURRENT PLOTTED AGAINST DURATION OF SURGE FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)

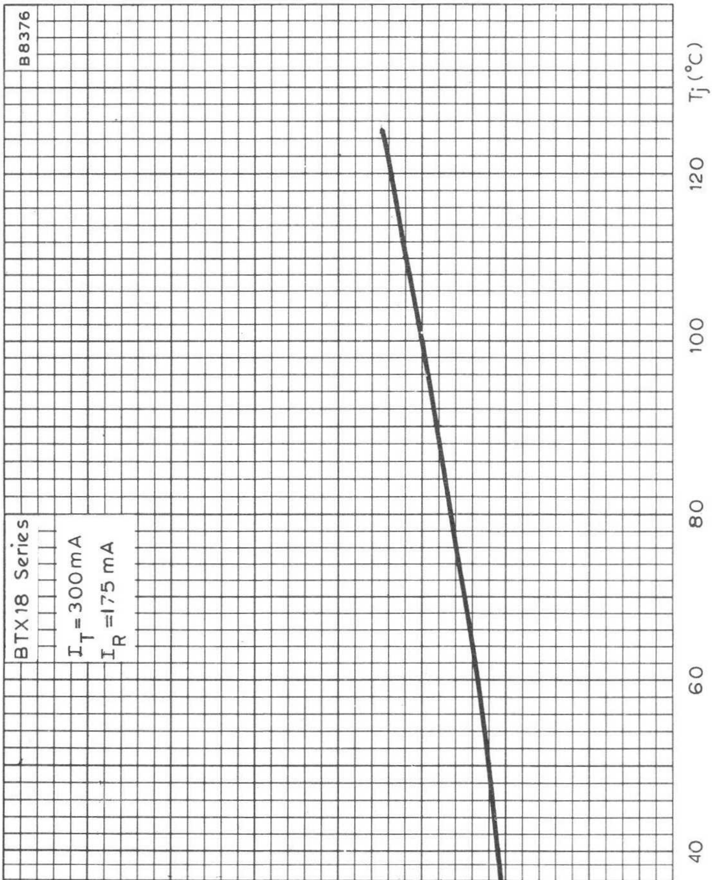


THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN





MAXIMUM EXPONENTIAL RATE OF RISE OF FORWARD VOLTAGE (dV/dt)
NOT TO INITIATE TURN-ON PLOTTED AGAINST
JUNCTION TEMPERATURE AND GATE-TO-CATHODE RESISTANCE



TYPICAL TURN-OFF TIME PLOTTED AGAINST JUNCTION TEMPERATURE

THYRISTORS

BTX30 Series

TENTATIVE DATA

The BTX30 series is a range of p-gate reverse blocking thyristors, in the J.E.D.E.C. TO-5 outline, intended for use in general low power applications up to 1.0A mean on-state current.

QUICK REFERENCE DATA

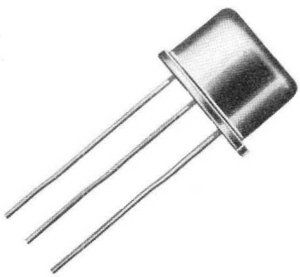
BTX30-	100	200	300	400	500	
V_{DWM}	100	200	300	400	500	V
V_{RWM}	100	200	300	400	500	V
V_{RSM}	150	300	400	500	600	V
$I_{T(AV)}$ max.						
$T_{case} = 85^oC$					1.0	A
$T_{amb} = 60^oC$, in free air					150	mA
T_j max.					125	^oC
$R_{th(j-case)}$					20	degC/W
$R_{th(j-amb)}$					250	degC/W

Unless otherwise stated data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-5
B.S. 3934 SO-3/SB3-3A

For details see page 5



RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX30-	100	200	300	400	500	
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	500	V
V_{RSM}	Non-repetitive peak reverse voltage ($t \leq 5ms$)	150	300	400	500	600	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	V
V_{DRM}	Repetitive peak off-state voltage	100	200	300	400	500	V

NOTE

1. These ratings apply for zero or negative bias on the gate with respect to cathode.

Current

I_T	Continuous on-state current ($T_{case} = 85^oC$)	1.2	A
	for other temperatures see pages 7 and 8		
$I_{T(AV)}$	Mean on-state current ($T_{case} = 85^oC$)	1.0	A
	for other temperatures see pages 7 and 8		
I_{TRM}	Repetitive peak on-state current	10	A
I_{TSM}	Non-repetitive peak on-state current ($t = 10ms$, half sine-wave)	15	A

RATINGS (cont'd)

GATE TO CATHODE

Voltage

V_{RGM}	Peak reverse gate voltage	6.0	V
V_{FGM}	Peak forward gate voltage	10	V

Current

I_{FGM}	Peak forward gate current	0.1	A

Power

P_{GM}	Peak gate power	0.1	W
$P_{G(AV)}$	Average gate power	0.05	W

Temperature

T_{stg} min.	Storage temperature min.	-65	^{o}C
T_{stg} max.	Storage temperature max.	125	^{o}C
T_j max.	Junction temperature max.	125	^{o}C

THERMAL CHARACTERISTICS

$R_{th(j-case)}$	Thermal resistance from junction to case	20	degC/W
$R_{th(j-amb)}$	Thermal resistance from junction to ambient	250	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

	BTX30-	100	200	300	400	500	
V_{BO}	Minimum forward break-over voltage (see note 2)	100	200	300	400	500	V
V_T	Maximum instantaneous on-state voltage at $I_T = 1.0A$, $T_j = 25^oC$ (see note 4)					1.6	V
i_D	Maximum off-state leakage current at V_{DWM}					1.0	mA
i_R	Maximum reverse leakage current at V_{RWM}					1.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$					3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$					10	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on					200	mV
I_H	Maximum holding current at $T_j = 25^oC$ (see note 3)					25	mA
I_L	Maximum latching current					25	mA

NOTES

2. The device is not suitable for operation in the forward break-over mode.

3. Measured under the following conditions:-

   Anode supply voltage = +6.0V

   Initial on-state current after gate triggering = 50mA

   The current is reduced until the device turns off.

4. V_T is measured along the leads at 1cm from the case.

SOLDERING AND WIRING RECOMMENDATIONS

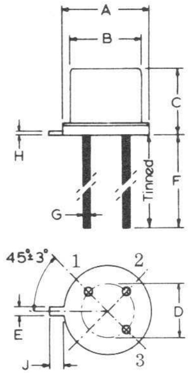
1. When using a soldering iron the thyristor may be soldered directly into the circuit, but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

2. Thyristors may be dip-soldered at a solder temperature of 245°C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a thyristor mounted flush on a board with punched-through holes, or spaced at least 1.5mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5mm from the seal.

OUTLINE AND DIMENSIONS

Conforming to B.S.3934 SO-3/SB3-3A
J.E.D.E.C. TO-5



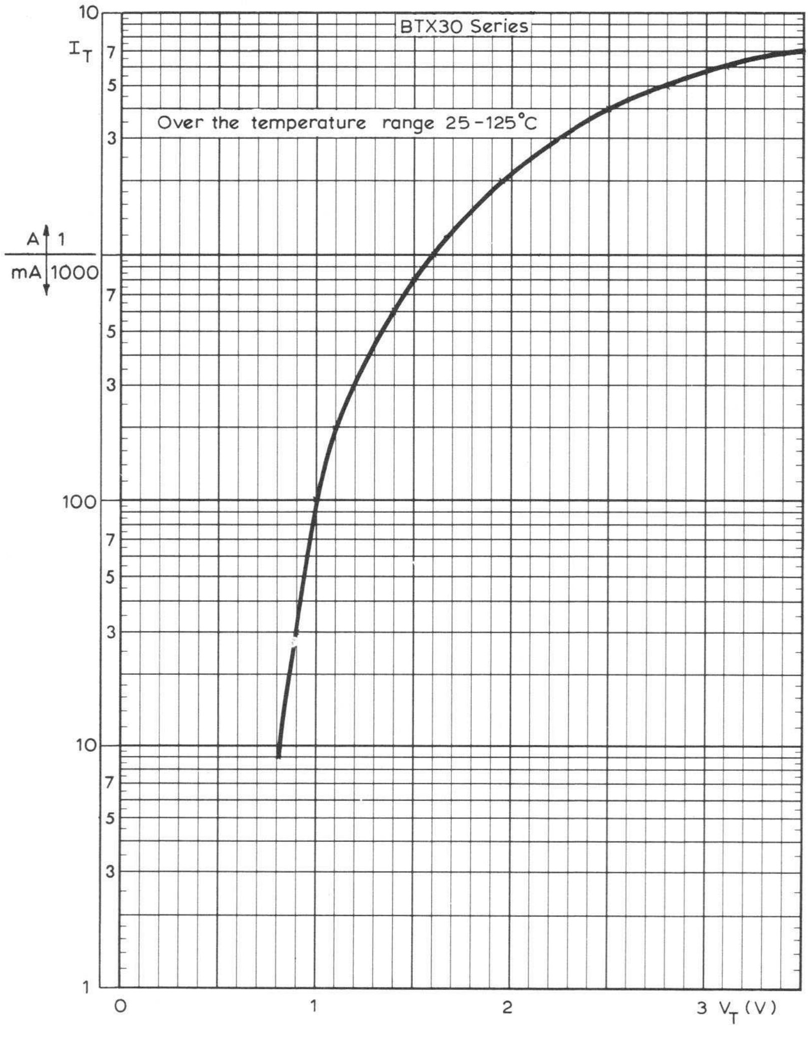
Millimetres

	Min.	Nom.	Max.
A	9.10	-	9.39
B	8.20	-	8.50
C	6.15	-	6.60
D	-	5.08	-
E	0.71	-	0.86
F1	-	-	0.51
F2	12.7	-	-
F3	38.1	-	41.3
G1	-	-	1.01
G2	0.41	-	0.48
G3	-	-	0.53
H	-	0.4	-
J	0.74	-	1.01

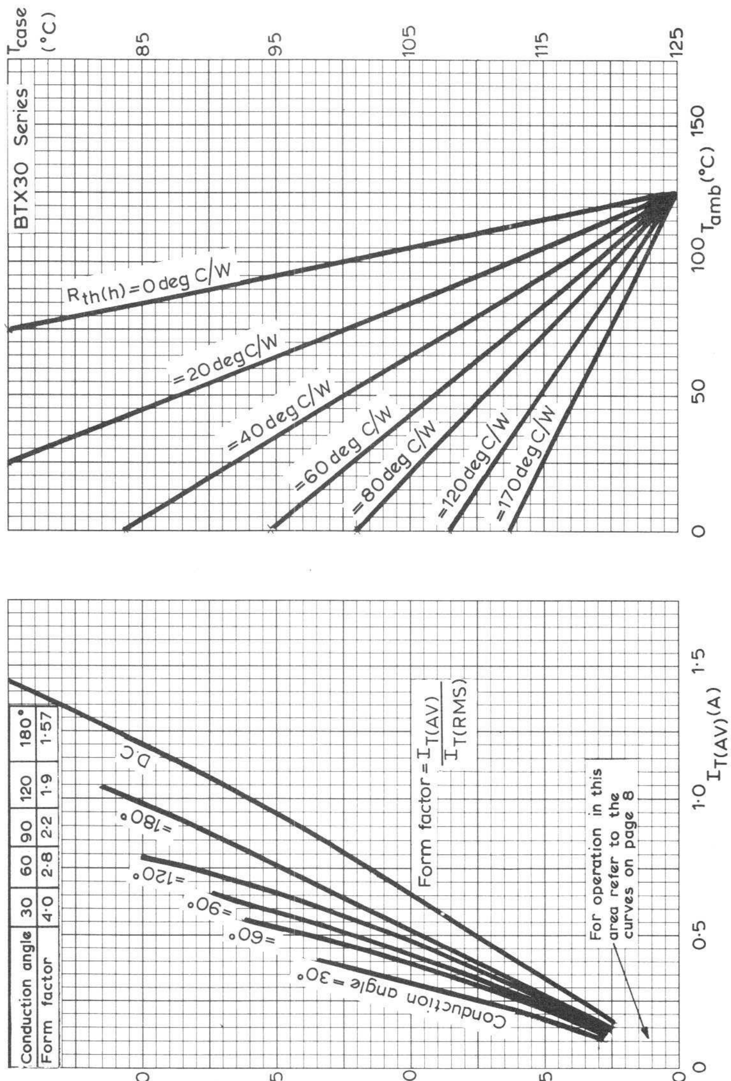
Connections

1. Cathode
2. Gate
3. Anode

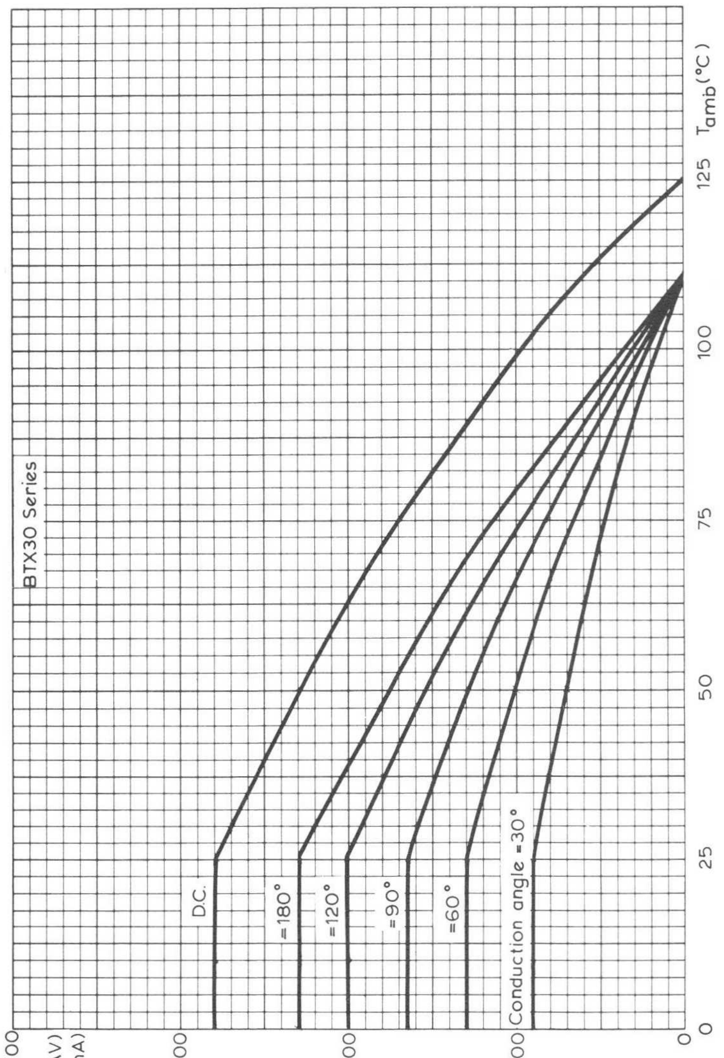
Anode connected to case



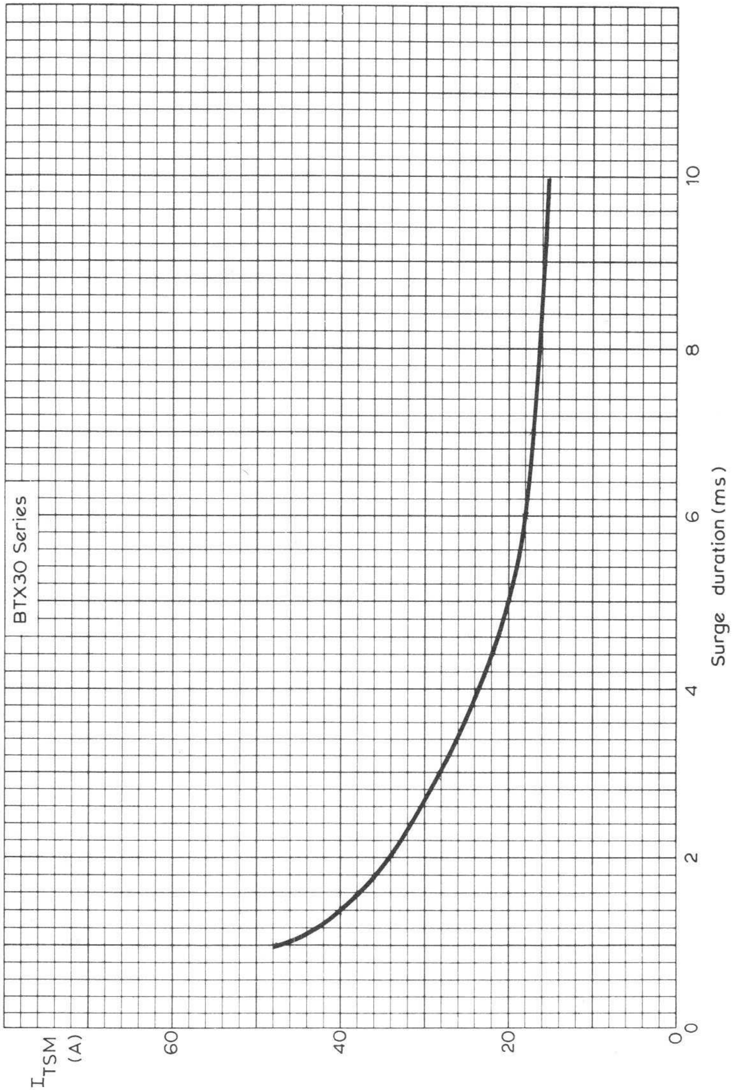
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



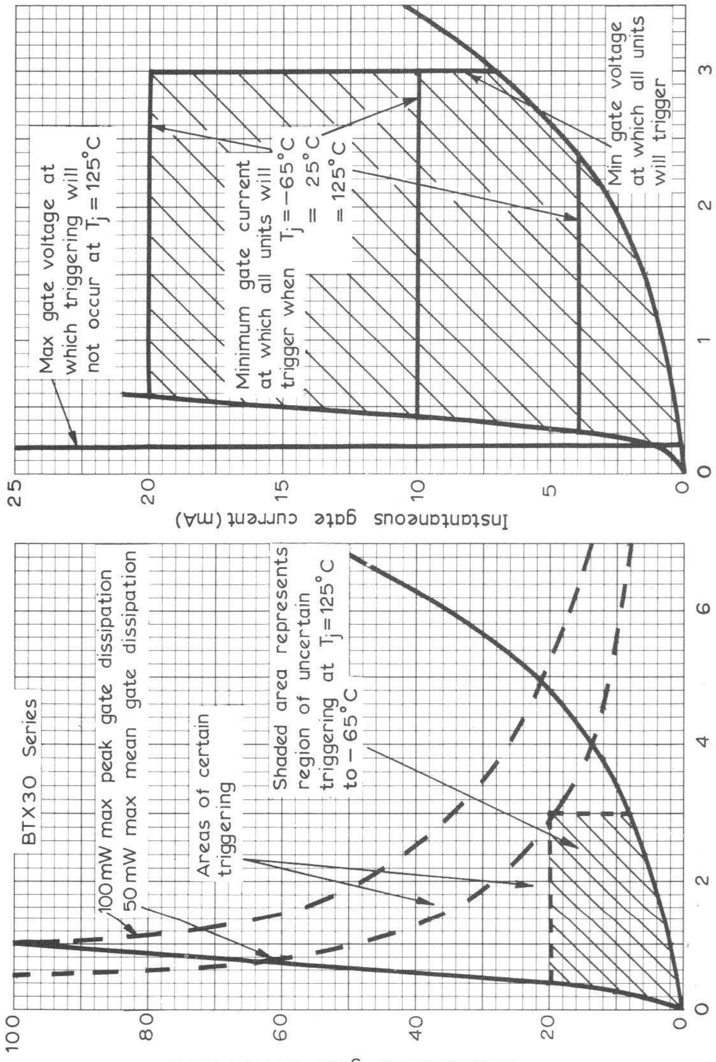
MAXIMUM CASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



DERATING CURVES FOR A DEVICE OPERATING IN FREE AIR
WITHOUT A HEATSINK



MAXIMUM NON-REPETITIVE PEAK ON-STATE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)



THYRISTOR GATE CHARACTERISTIC
THE RIGHT-HAND GRAPH IS AN ENLARGEMENT OF THE SHADED PORTION OF THE LEFT-HAND GRAPH

TENTATIVE DATA

The BTX35 series is a range of p-gate reverse blocking thyristors with controlled avalanche characteristics for use in power control circuits. This range of thyristors is capable of absorbing transient energy within the rectifier circuit without damage.

Unless otherwise shown data is applicable to all types in the series

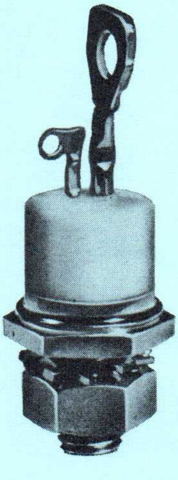
QUICK REFERENCE DATA

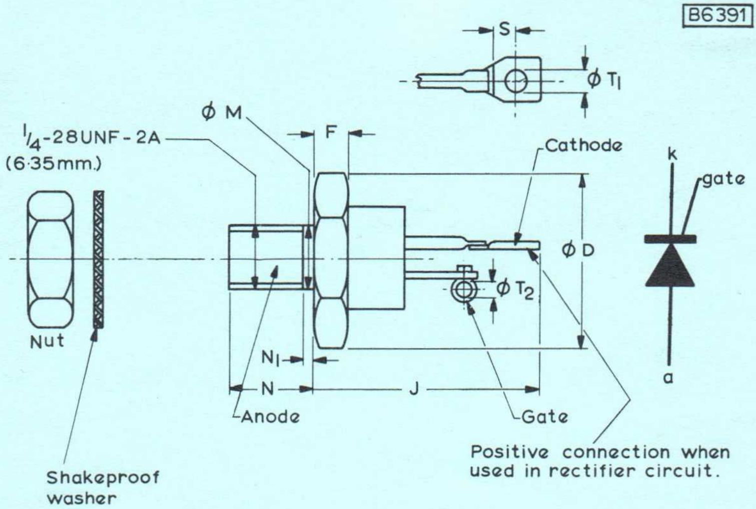
Type BTX35-	500R	600R	700R	800R	
V_{BO} min.	550	660	770	880	V
V_{RA} min.	550	660	770	880	V
$I_{F(AV)}$				12	A
Reverse power surge (non-repetitive)					
10μs, $T_j = 25^{o}C$				18	kW
10μs, $T_j = 125^{o}C$				7.5	kW

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-48
B.S. 3934 SO-36

For details see page D2.





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
ØD		16.51		.650	
F,	2.9	5.5	.113	.220	1
J		30.48		1.200	
ØM	4.91	6.35	.193	.250	2
N	10.72	11.50	.422	.453	
N_1		2.26		.089	2
S	3.05		.120		3
ØT_1	3.18	4.44	.125	.175	
ØT_2	1.53		.060		

NOTES 1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) .544" min., (14.27mm) .562" max.

2. ØM refers to length N_1. 3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage

	Type BTX35-	500R	600R	700R	800R	
V_R	Continuous reverse voltage (see note 1)	500	600	700	800	Vd.c.
V_{RWM}	Crest working reverse voltage (see note 1)	500	600	700	800	V
V_B	Continuous blocking voltage (see note 2)	500	600	700	800	Vd.c.
V_{BWM}	Crest working blocking voltage (see note 2)	500	600	700	800	V

NOTES

1. These ratings apply for zero or negative bias on the gate with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must not exceed 9.0 deg C/W for a.c. operation and 4.5 deg C/W for d.c. operation.
2. These ratings apply when the rate of rise of forward voltage is less than 20V/μs.

Current

I_F	Continuous forward current	15	A
$I_{F(AV)}$	Mean forward current (see page C2)	12	A
I_{FRM}	Repetitive peak forward current	115	A
I_{FSM}	Maximum forward surge current (see page C4 and C5)	106	A
I^2t	I^2t for fusing (1.5ms to 10ms) (see page C5)	55	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	20	A

GATE TO CATHODE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward current	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power	0.5	W

Thermal

Operating temperature range		-55 to +125	^oC
Storage temperature range	T_{stg}	-55 to +125	^oC
Maximum junction temperature	T_j max.	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	2.0 degC/W
Θ_i	Contact thermal resistance for a torque of 17kg cm on the nut	0.2 degC/W
Θ_i	Contact thermal resistance with mica washer	4.0 degC/W

ELECTRICAL CHARACTERISTICS (T_j = 125 °C unless otherwise stated)

		500R	600R	700R	800R	
V_{BO}	Minimum forward breakover voltage (see note 3)	550	660	770	880	V
V_{RA}	Minimum reverse avalanche voltage	550	660	770	880	V
i_B	Maximum forward leakage current at V_{BWM}	6.0	5.0	4.5	4.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	6.0	5.0	4.5	4.0	mA
	Maximum non-repetitive reverse avalanche power (10μs)					
	$T_j = 25^{\circ}C$				18	kW
	$T_j = 125^{\circ}C$				7.5	kW
V_F	Maximum instantaneous forward voltage drop, at $I_F = 50A$ and $T_j = 25^{\circ}C$				3.0	V
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$				3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$				65	mA
V_{GNT}	Maximum continuous gate voltage which will not initiate turn-on				250	mV
I_H	Typical holding current				10	mA
I_{pu}	Typical pick-up current				20	mA
t_{on}	Typical turn-on time (see page C7)				2.0	μs
t_{off}	Typical turn-off time (see page C9)				15	μs

NOTES

3. This device will breakover at any voltage greater than that stated into the maximum rated current.

MECHANICAL DATA

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

ACCESSORIES

Accessory	Code No.	Notes
1/4 in UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

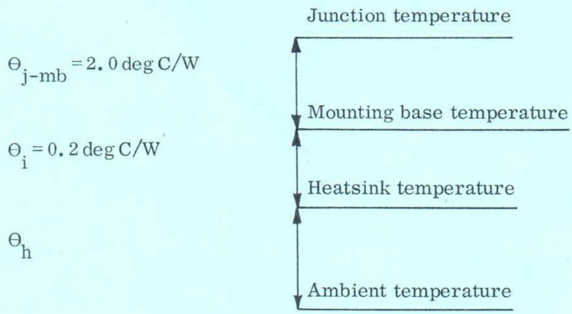
OPERATING NOTES

1. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

2. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Dissipation and heatsink considerations

   The various components of the rise of junction temperature above ambient are illustrated below: -



The method of using the curve on page C2 is as follows: -

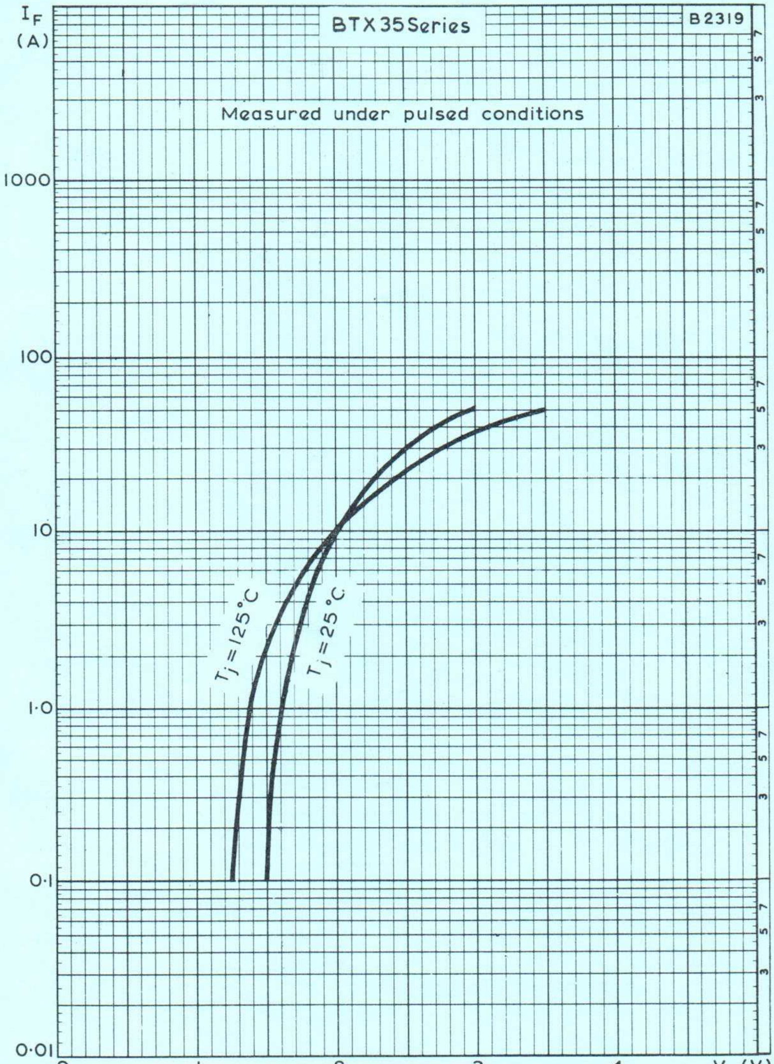
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D5. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

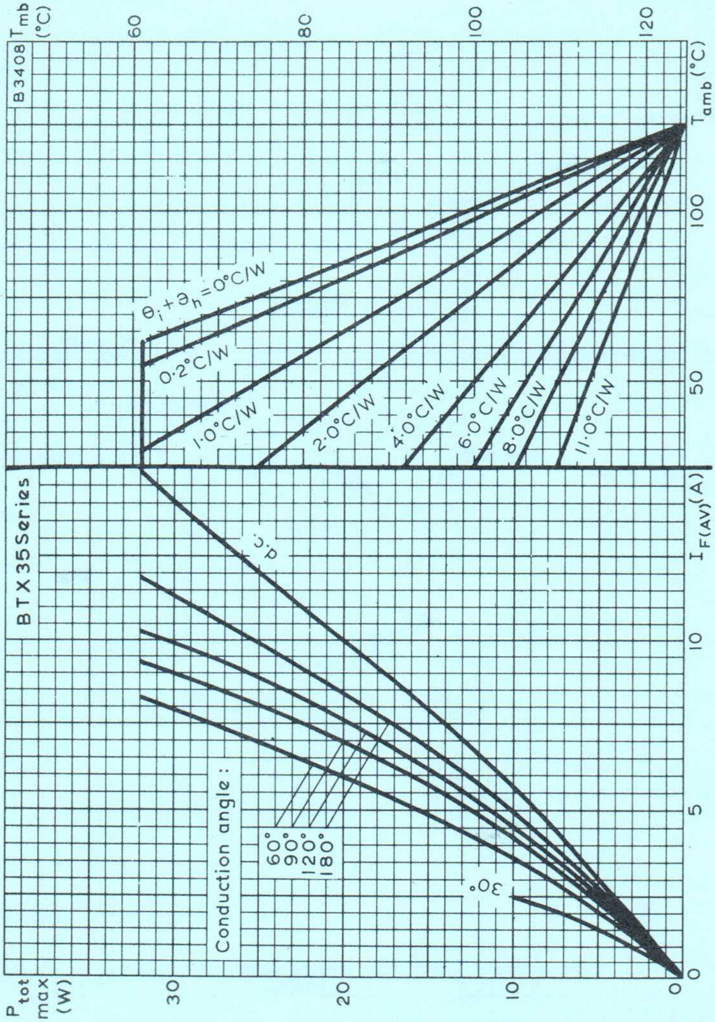
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by:-

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \mathrm{max.}} - \Theta_i$$

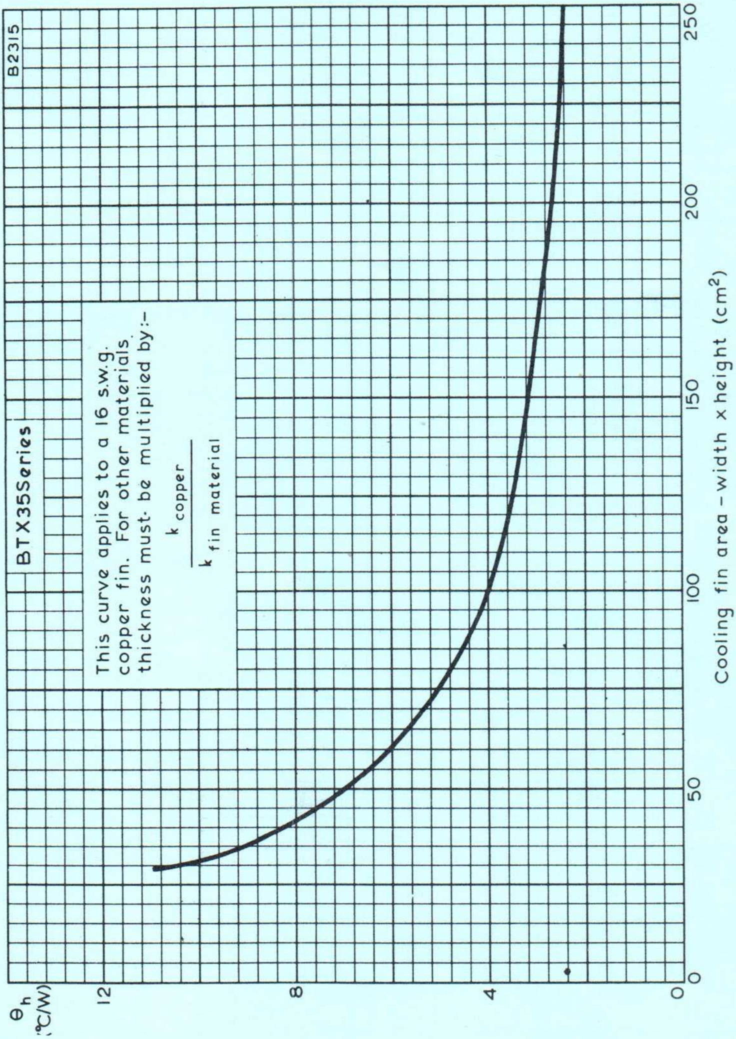
The size of the heatsink required may be found from the graph on page C3.



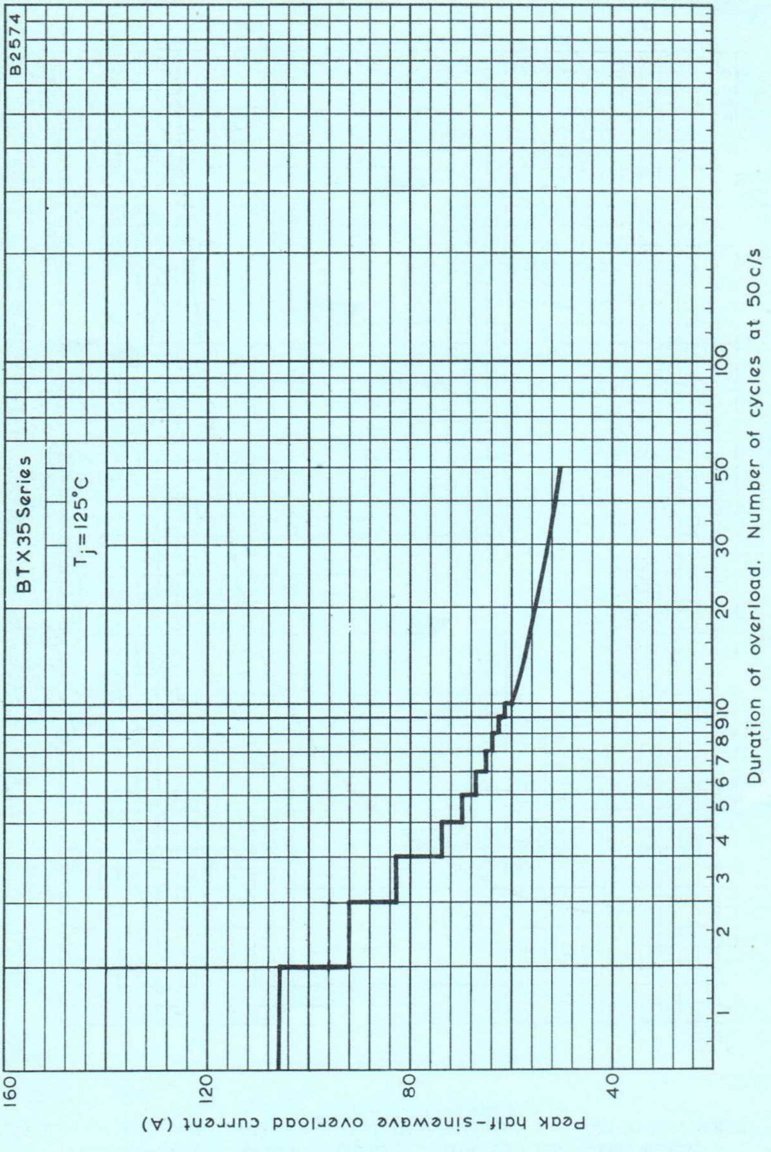
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



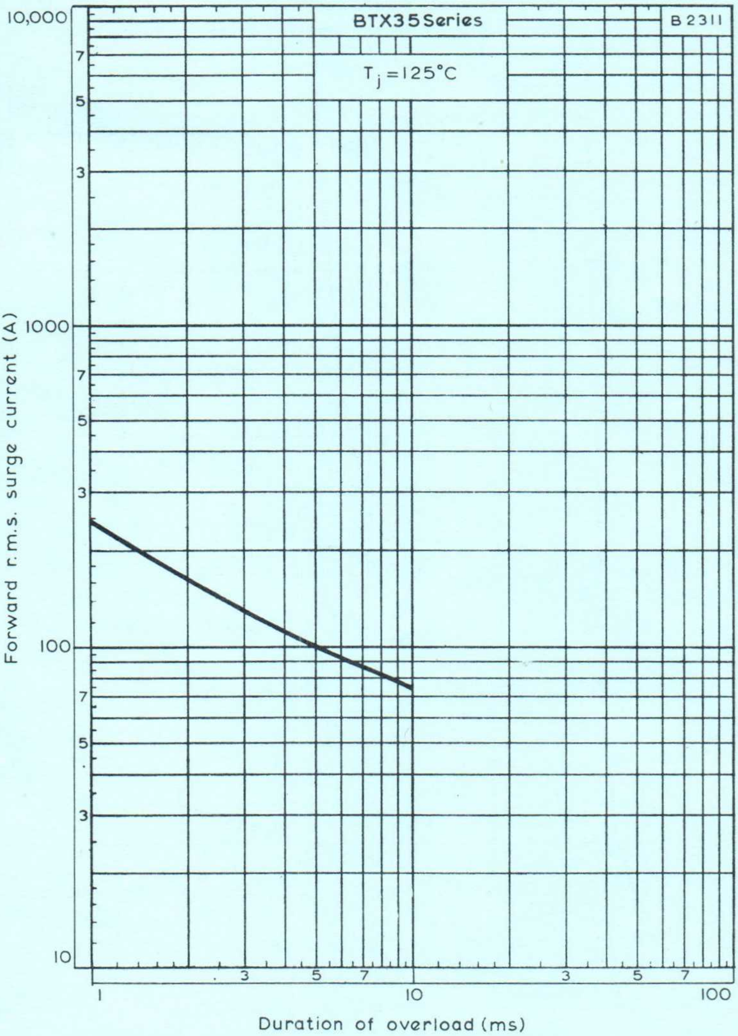
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



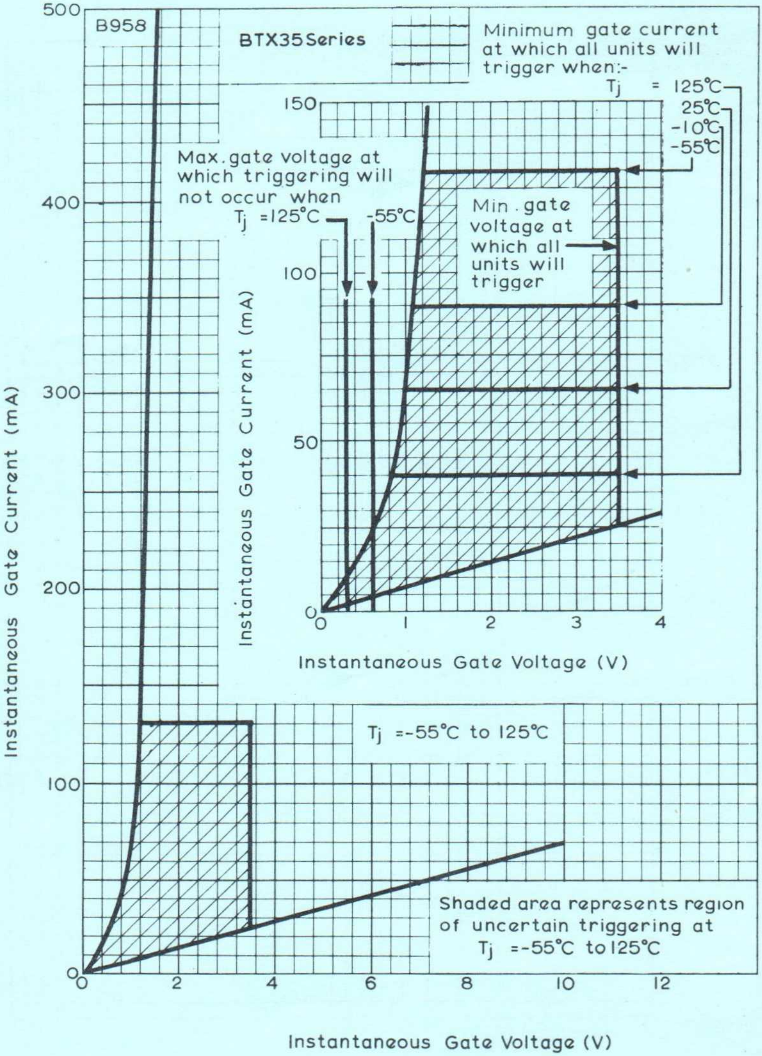
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



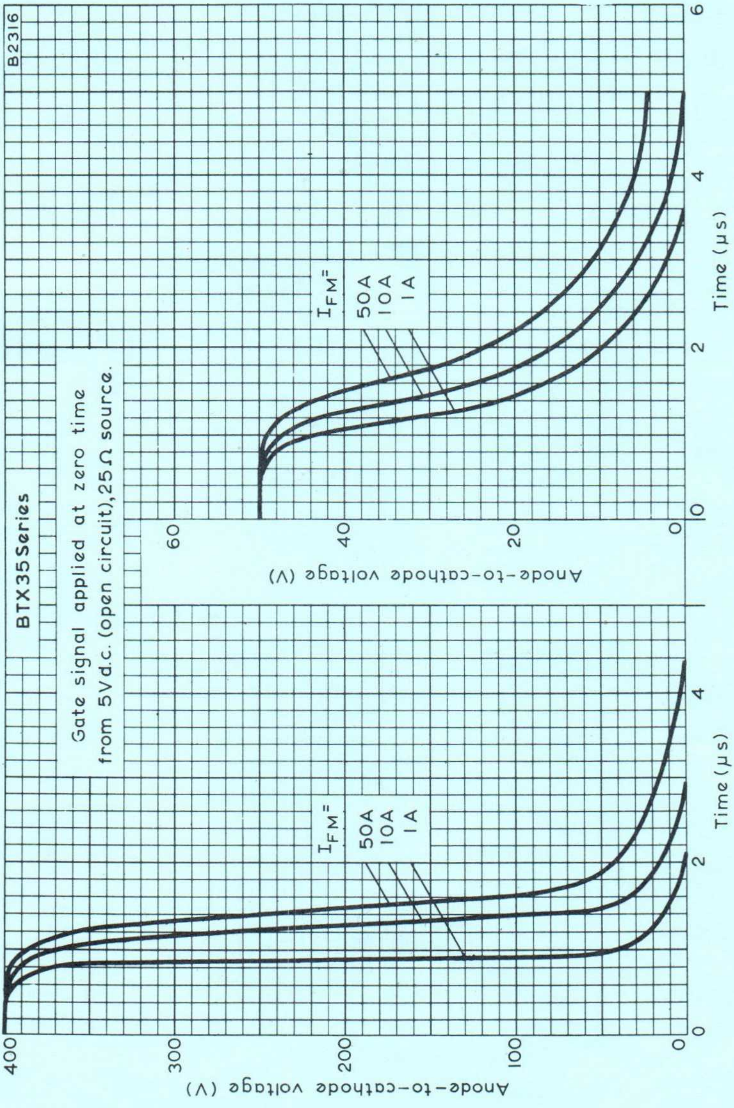
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST THE NUMBER OF CYCLES AT 50c/s



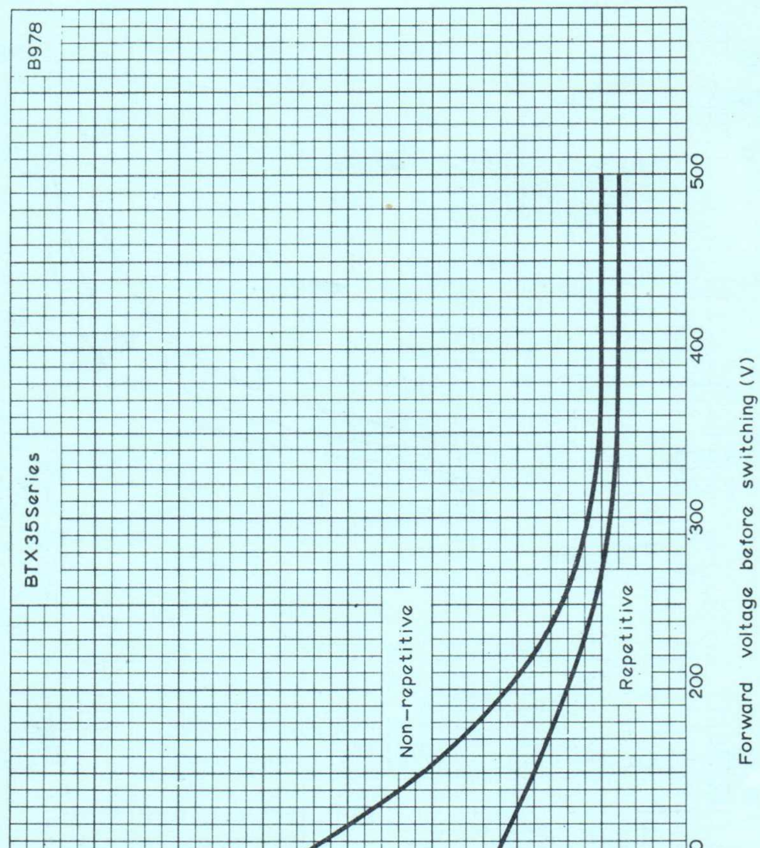
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50c/s



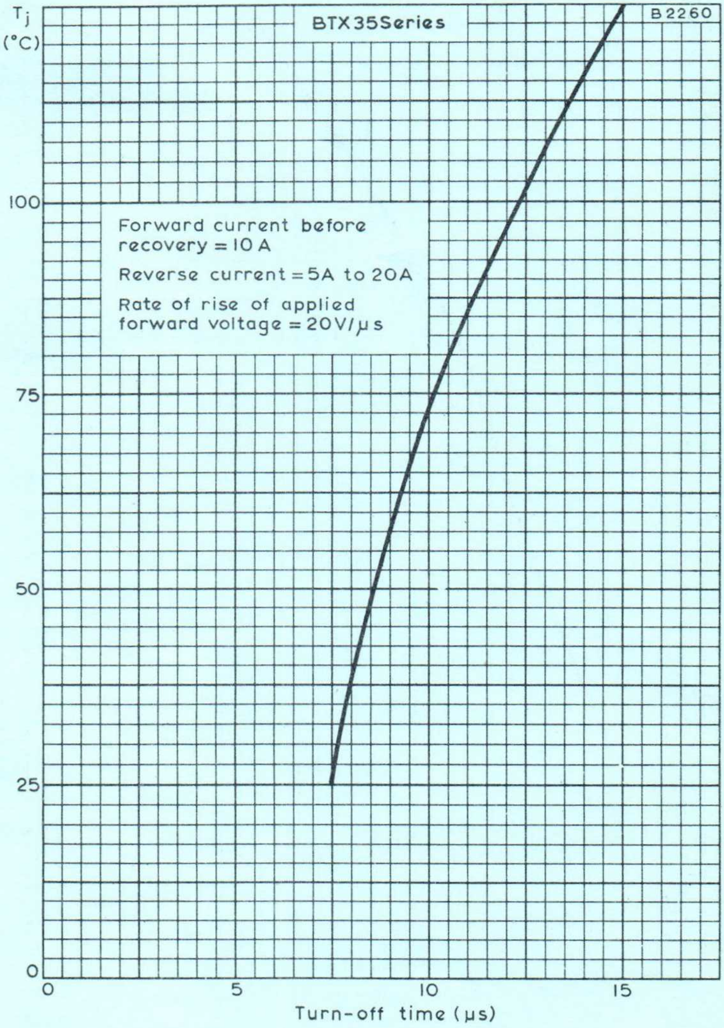
GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



TYPICAL TURN-ON CHARACTERISTIC

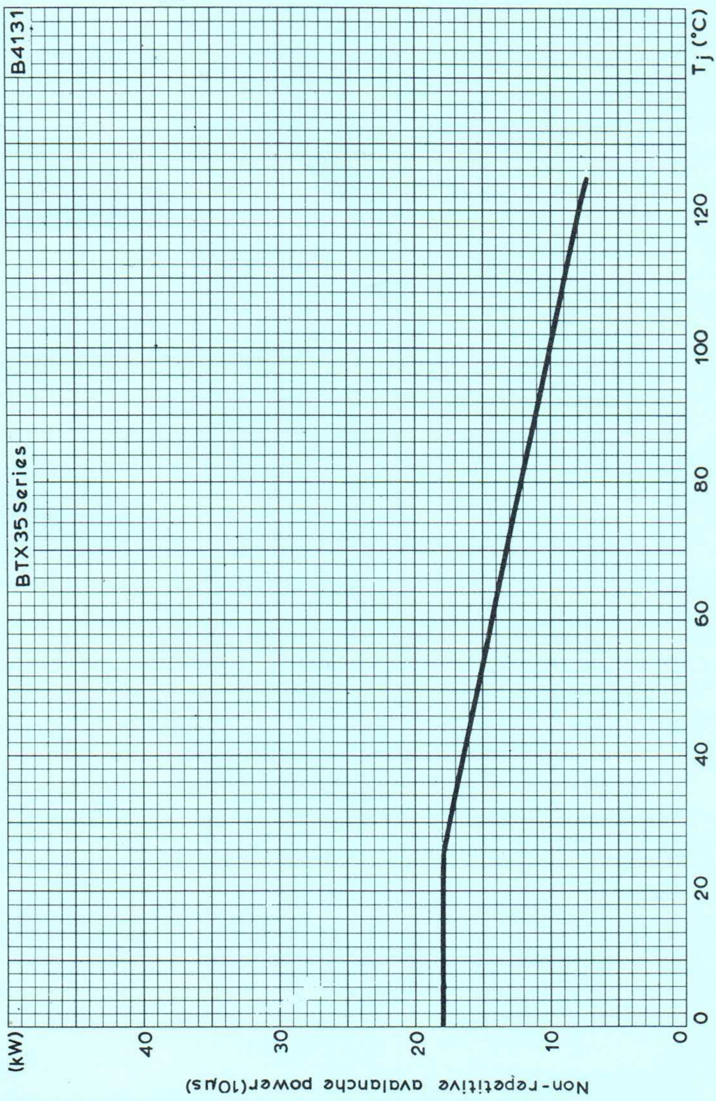


PEAK FORWARD CURRENT DURING TURN-ON PLOTTED AGAINST
FORWARD VOLTAGE BEFORE SWITCHING



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE

TYPICAL RATE OF RISE OF FORWARD VOLTAGE NOT TO TRIGGER THE THYRISTOR PLOTTED AGAINST JUNCTION TEMPERATURE



NON-REPETITIVE AVALANCHE POWER PLOTTED AGAINST JUNCTION TEMPERATURE

TENTATIVE DATA

The BTX36 series is a range of p-gate reverse blocking thyristors with controlled avalanche characteristics for use in power control circuits. This range of thyristors is capable of absorbing transient energy within the rectifier circuit without damage.

Unless otherwise shown data is applicable to all types in the series

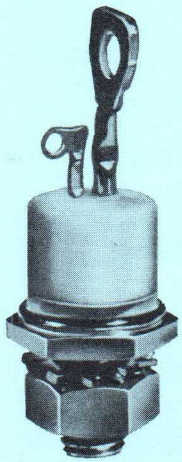
QUICK REFERENCE DATA

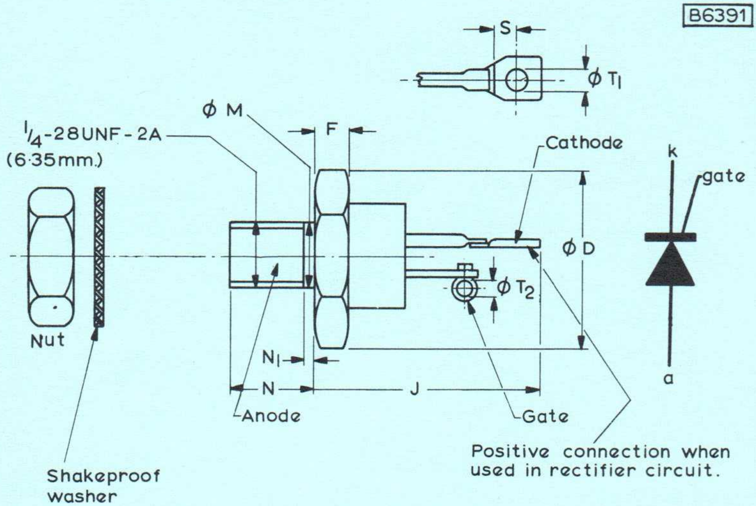
Type BTX36-	500R	600R	700R	800R	
V_{BO} min.	550	660	770	880	V
V_{RA} min.	550	660	770	880	V
$I_{F(AV)}$ max.				16	A
Reverse power surge (non-repetitive)					
10μs, $T_j = 25^{\circ}C$				18	kW
10μs, $T_j = 125^{\circ}C$				7.5	kW

OUTLINE AND DIMENSIONS

Conforms to J.E.D.E.C. TO-48
B.S. 3934 SO-36

For details see page D2.





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
ØD		16.51		.650	
F	2.9	5.5	.113	.220	1
J		30.48		1.200	
ØM	4.91	6.35	.193	.250	2
N	10.72	11.50	.422	.453	
N_1		2.26		.089	2
S	3.05		.120		3
ØT_1	3.18	4.44	.125	.175	
ØT_2	1.53		.060		

NOTES 1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) .544" min., (14.27mm) .562" max.

2. ØM refers to length N_1.

3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage

	BTX36 -	500R	600R	700R	800R	
V_R	Continuous reverse voltage (see note 1)	500	600	700	800	Vd.c.
V_{RWM}	Crest working reverse voltage (see note 1)	500	600	700	800	V
V_B	Continuous blocking voltage (see note 2)	500	600	700	800	Vd.c.
V_{BWM}	Crest working blocking voltage (see note 2)	500	600	700	800	V

NOTES

1. These ratings apply for zero or negative bias on the gate with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must not exceed 9.0 deg C/W for a.c. operation and 4.5 deg C/W for d.c operation.

2. These ratings apply when the rate of rise of forward voltage is less than 20V/μs.

Current

I_F	Continuous forward current	19	A
$I_{F(AV)}$	Mean forward current (see page C2)	16	A
I_{FRM}	Repetitive peak forward current	140	A
I_{FSM}	Maximum forward surge current (see page C4 and C5)	136	A
I^2t	I^2t for fusing (1.5ms to 10ms) (see page C5)	75	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	20	A

GATE TO CATHODE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward current	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power	0.5	W

Thermal

Operating temperature range		-55 to +125	^oC
Storage temperature range	T_{stg}	-55 to +125	^oC
Maximum junction temperature	T_j max.	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	2.0 deg C/W
Θ_i	Contact thermal resistance for a torque of 17kg cm on the nut	0.2 deg C/W
Θ_i	Contact thermal resistance with mica washer	4.0 deg C/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^{\circ}C$ unless otherwise stated)

		500R	600R	700R	800R	
V_{BO}	Minimum forward breakover voltage (see note 3)	550	660	770	880	V
V_{RA}	Minimum reverse avalanche voltage	550	660	770	880	V
i_B	Maximum forward leakage current at V_{BWM}	6.0	5.0	4.5	4.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	6.0	5.0	4.5	4.0	mA
	Maximum non-repetitive reverse avalanche power (10µs)					
	$T_j = 25^{\circ}C$				18	kW
	$T_j = 125^{\circ}C$				7.5	kW
V_F	Maximum instantaneous forward voltage drop, at $I_F = 50A$ and $T_j = 25^{\circ}C$				2.0	V
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$				3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$				40	mA
V_{GNT}	Maximum continuous gate voltage which will not initiate turn-on				250	mV
I_H	Typical holding current				10	mA
I_{pu}	Typical pick-up current				20	mA
t_{on}	Typical turn-on time (see page C7)				2.0	µs
t_{off}	Typical turn-off time (see page C9)				15	µs

NOTE

3. This device will breakover at any voltage greater than that stated into the maximum rated current.

MECHANICAL DATA

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

ACCESSORIES

Accessory	Code No.	Notes
1/4 in UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

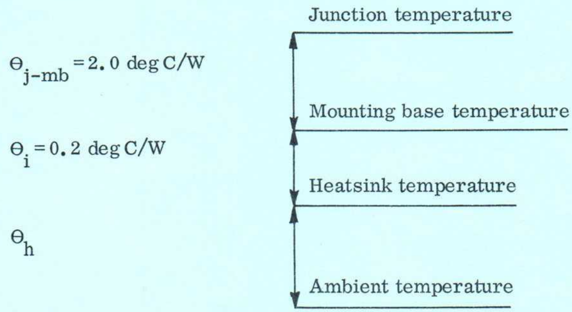
OPERATING NOTES

1. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

2. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Dissipation and heatsink considerations

   The various components of the rise of junction temperature above ambient are illustrated below:-



The method of using the curve on page C2 is as follows:-

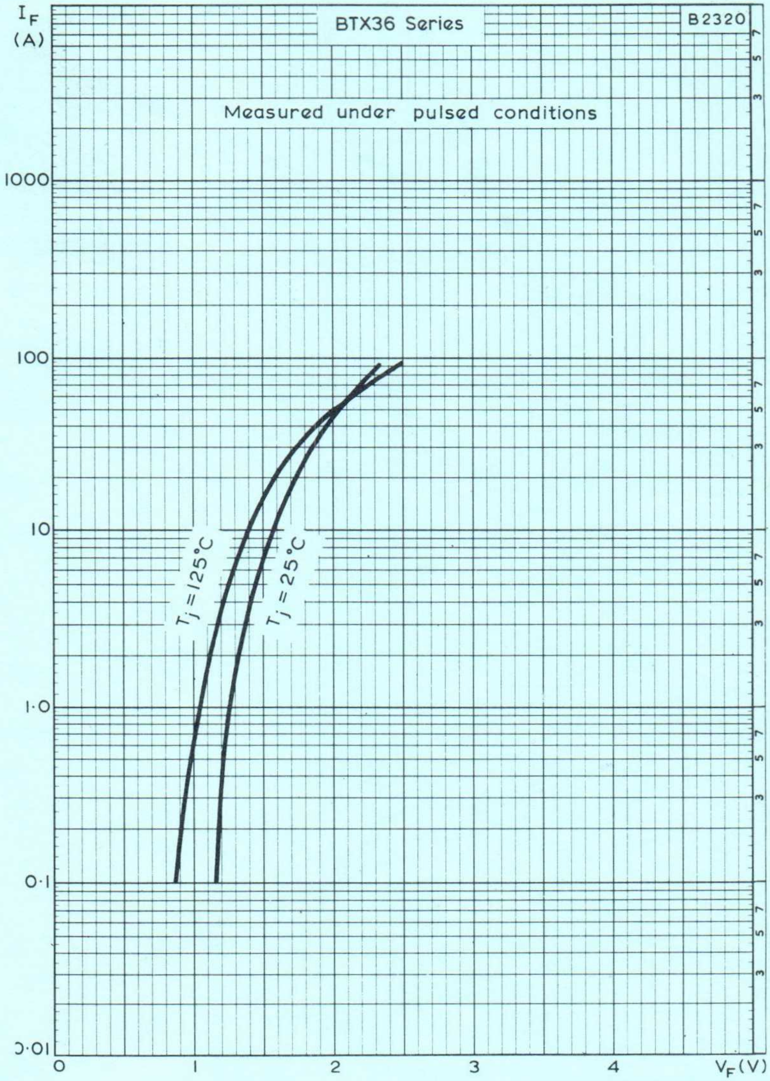
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D5. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

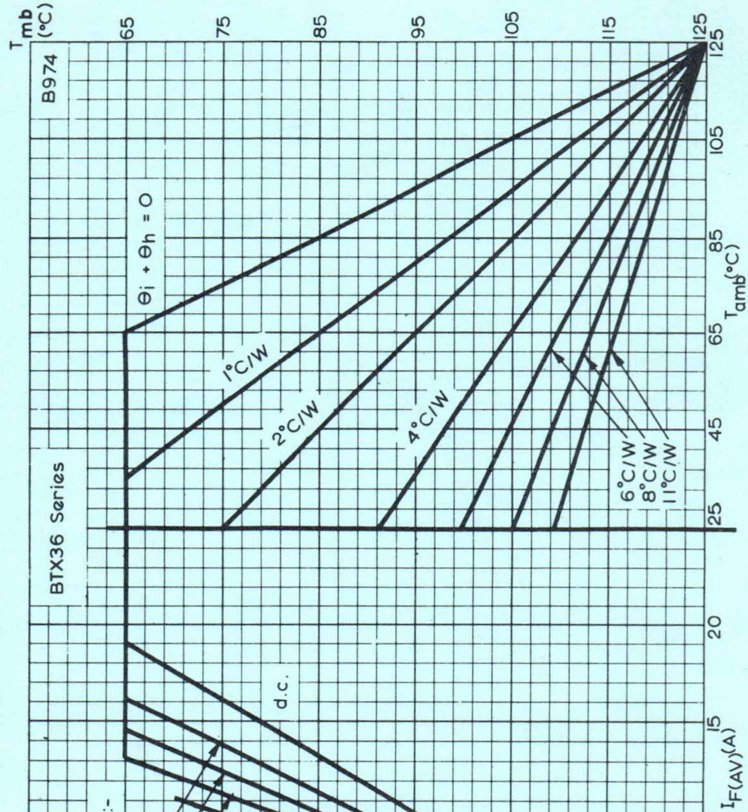
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by:-

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot} \text{ max.}} - \Theta_i$$

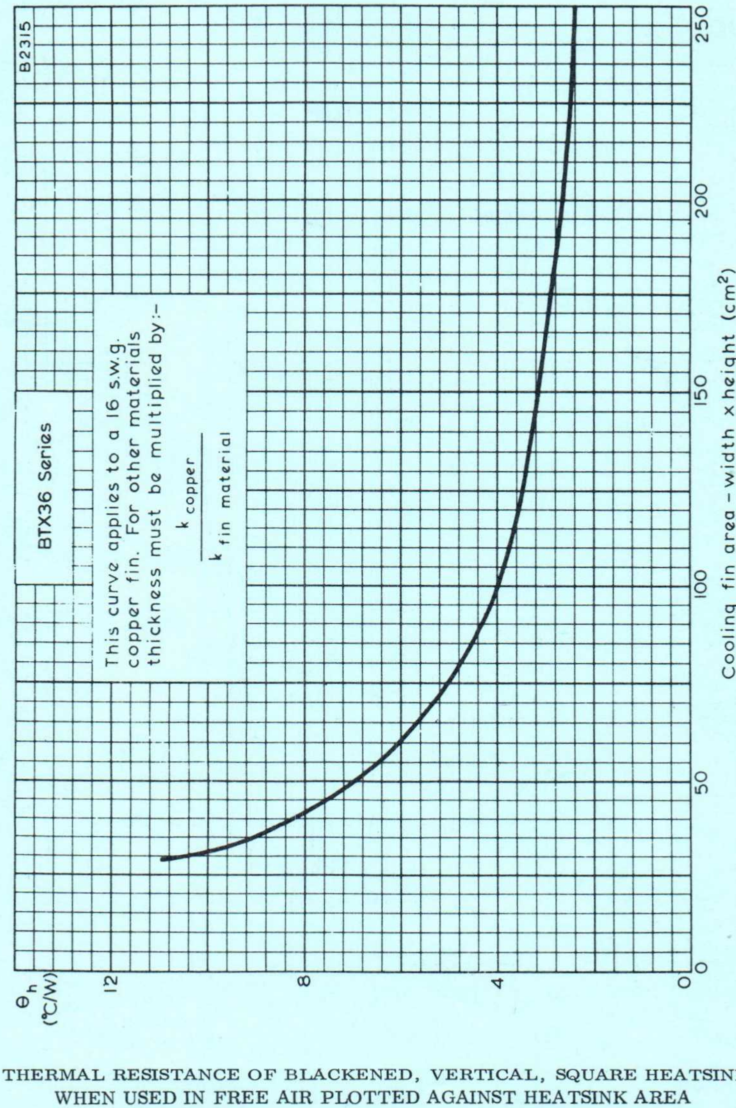
The size of the heatsink required may be found from the graph on page C3.



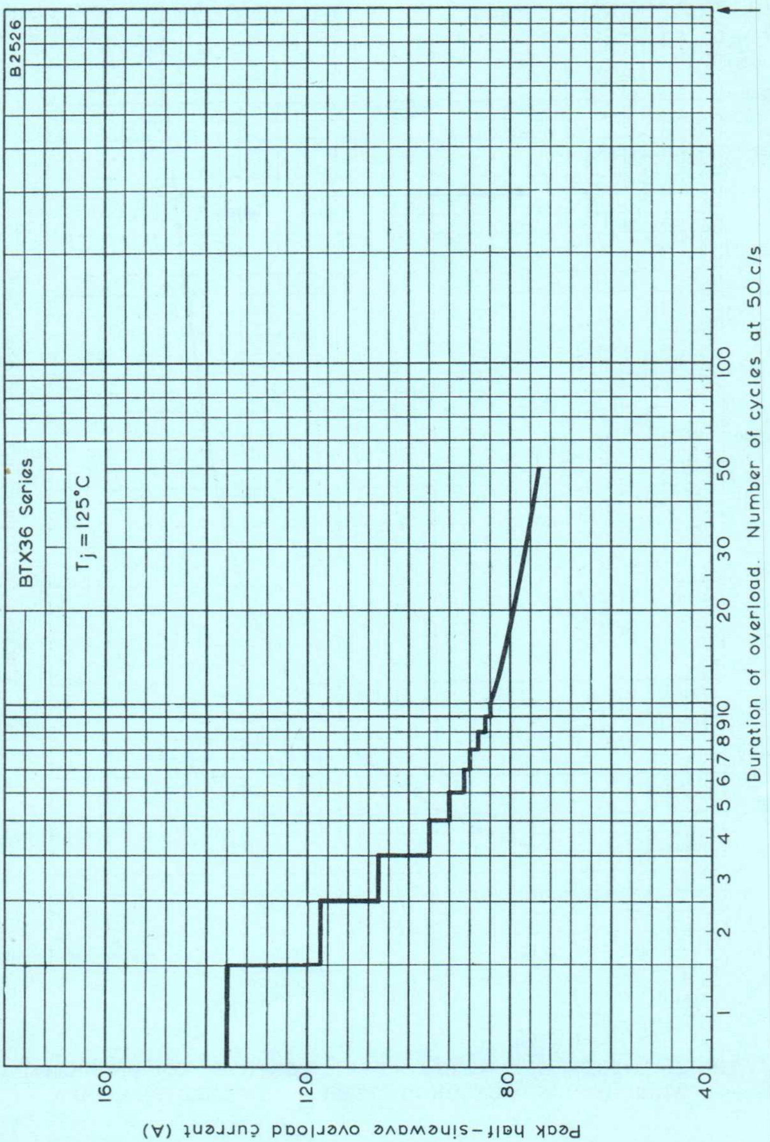
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



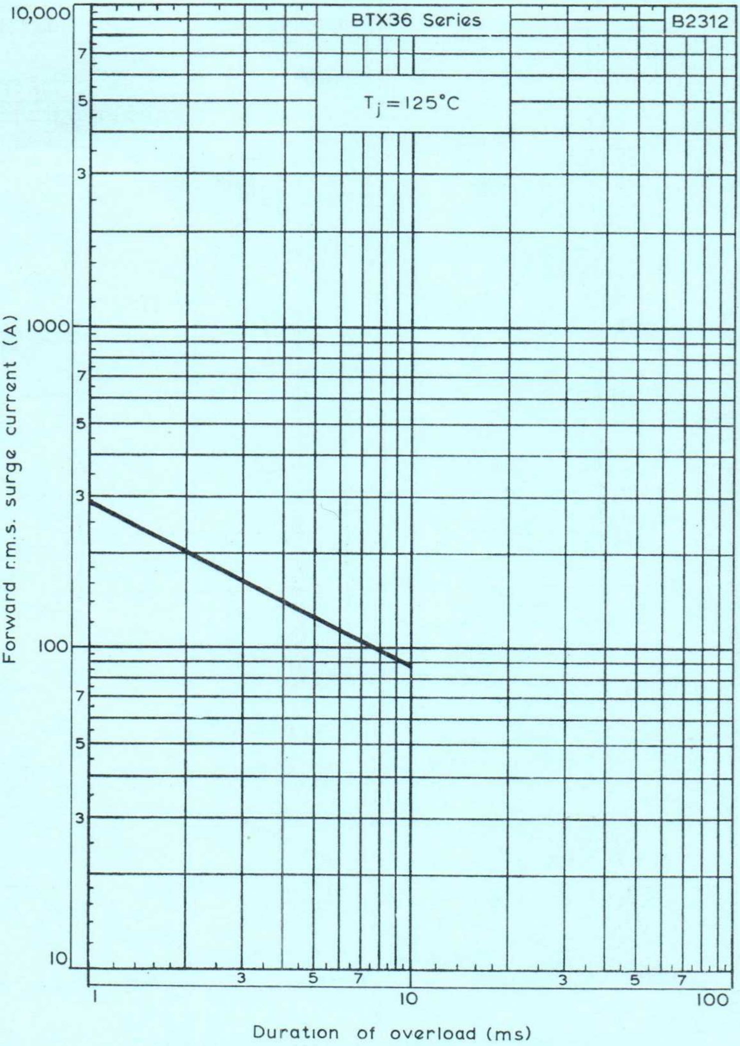
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



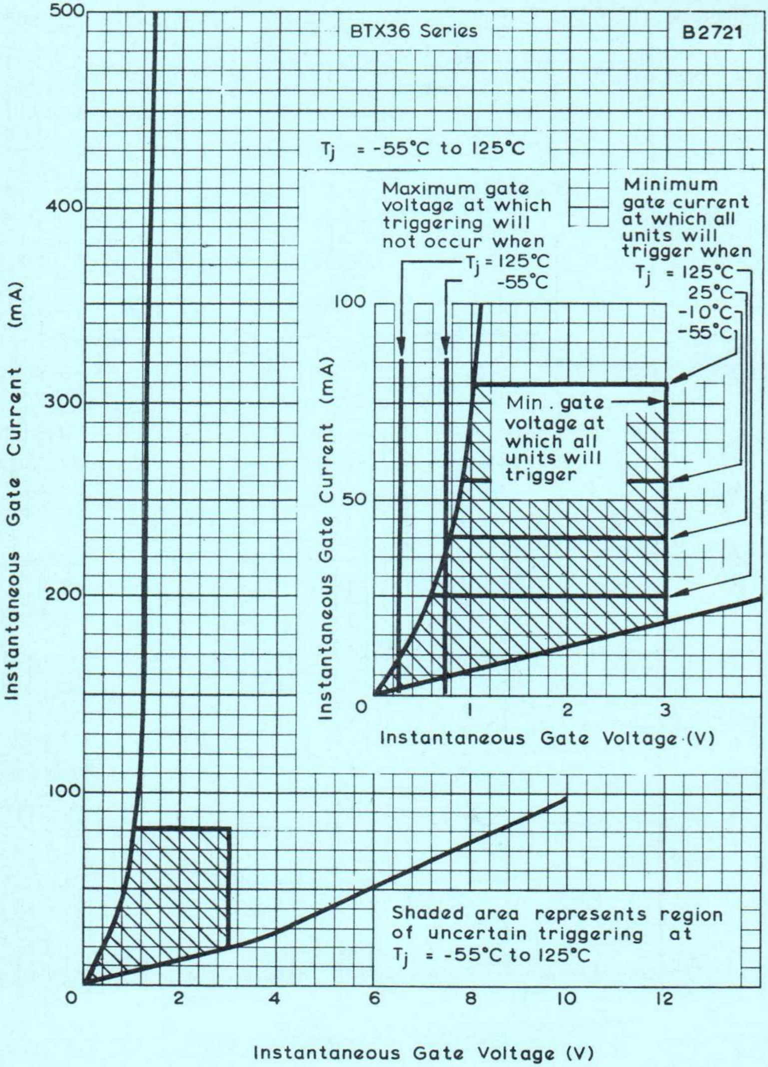
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



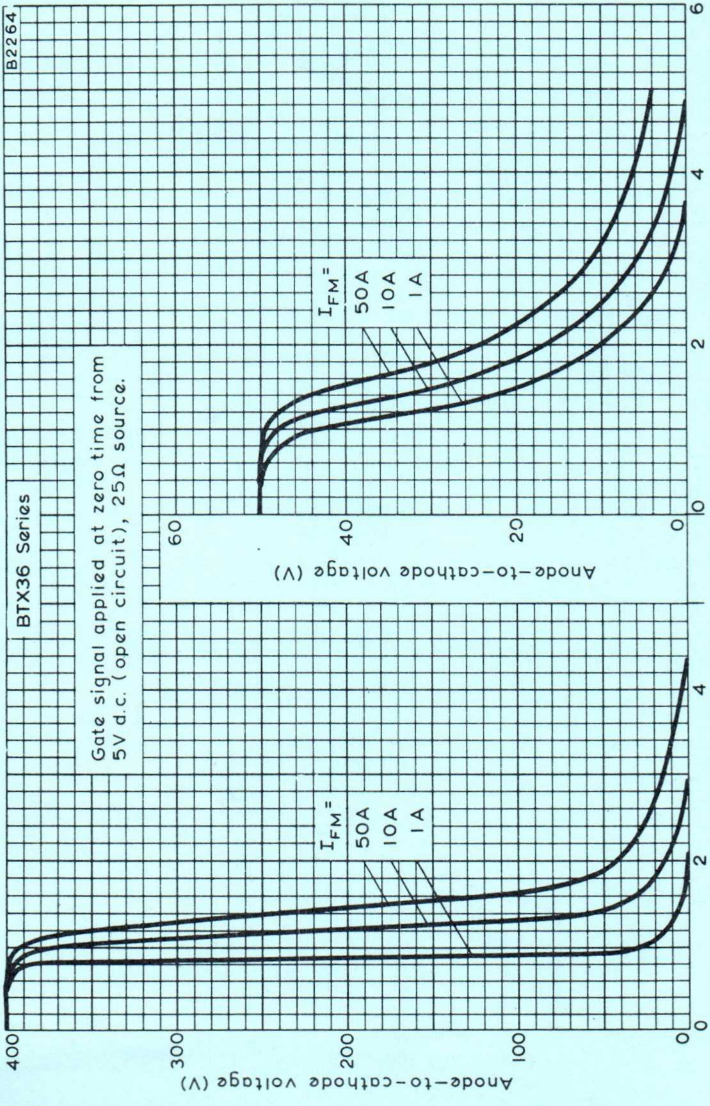
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST
THE NUMBER OF CYCLES AT 50c/s



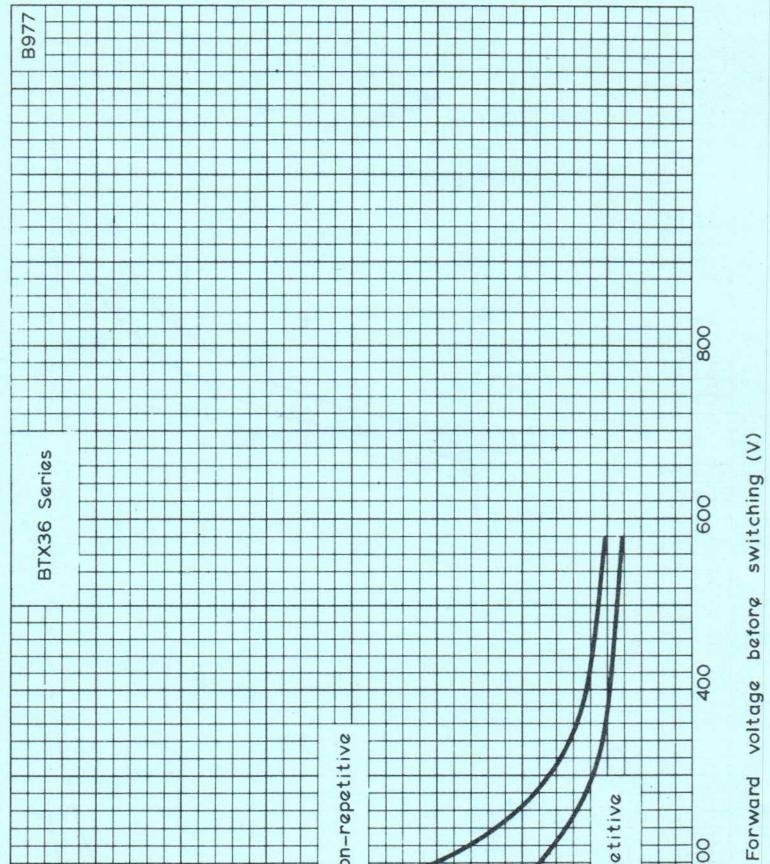
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50c/s



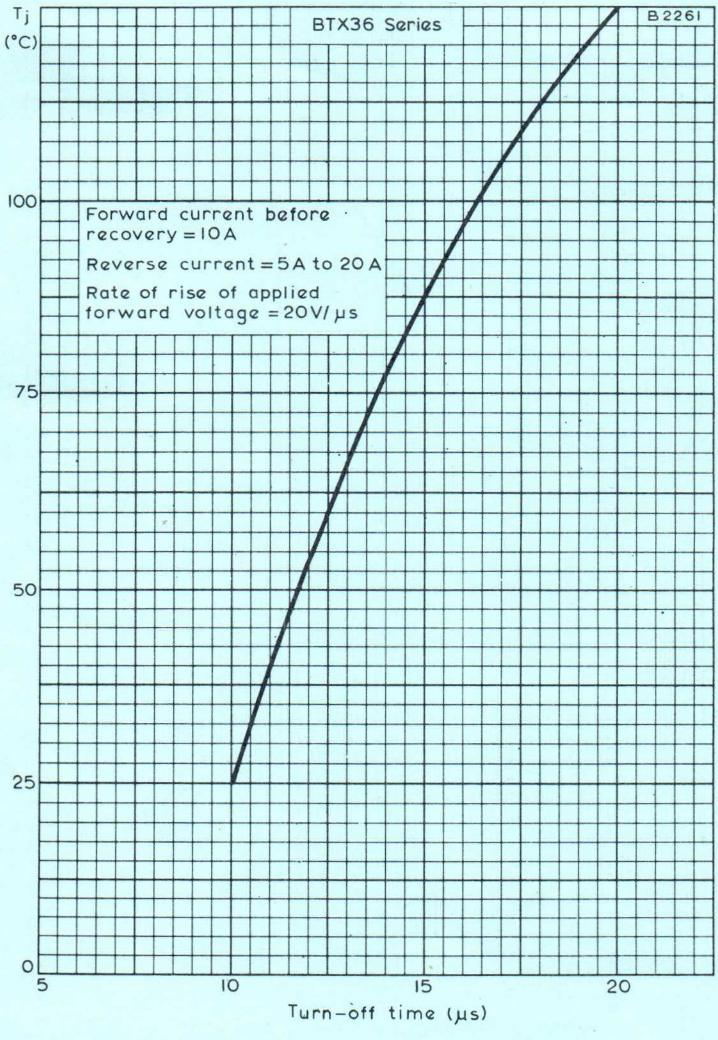
GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



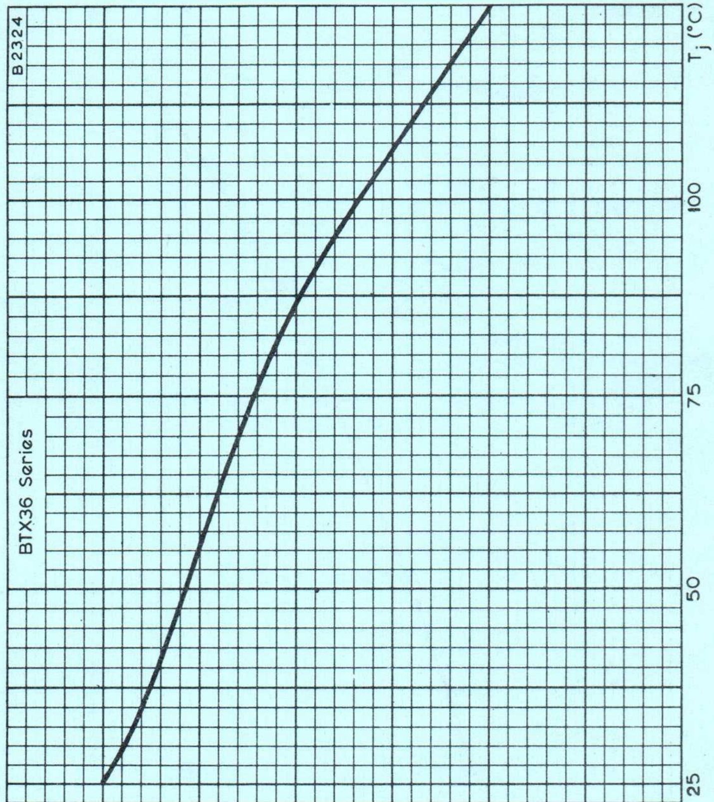
TYPICAL TURN-ON CHARACTERISTIC



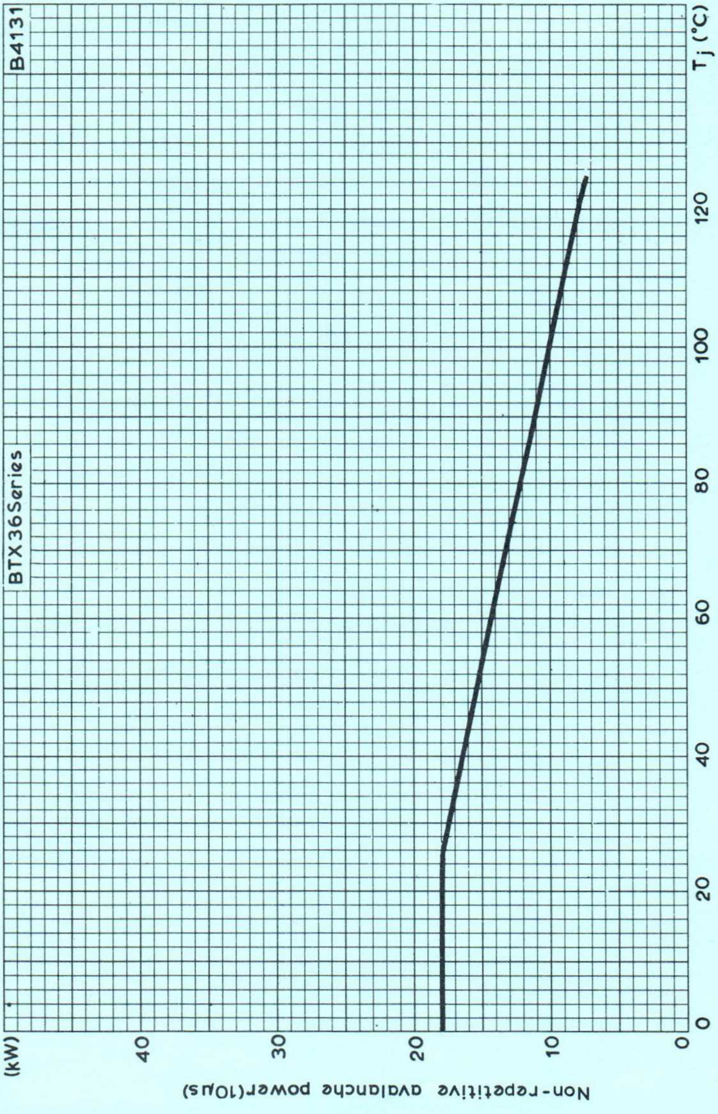
PEAK FORWARD CURRENT DURING TURN-ON PLOTTED AGAINST FORWARD VOLTAGE BEFORE SWITCHING



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE



TYPICAL RATE OF RISE OF FORWARD VOLTAGE NOT TO TRIGGER
THE THYRISTOR PLOTTED AGAINST JUNCTION TEMPERATURE



NON-REPETITIVE AVALANCHE POWER PLOTTED AGAINST JUNCTION TEMPERATURE

TENTATIVE DATA

The BTX37 series is a range of p-gate reverse blocking thyristors with controlled avalanche characteristics for use in power control circuits. This range of thyristors is capable of absorbing transient energy within the rectifier circuit without damage.

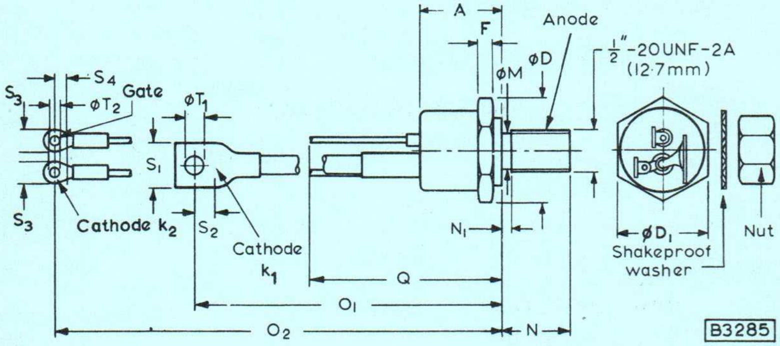
Unless otherwise shown data is applicable to all types in the series

QUICK REFERENCE DATA

Type BTX37 -	500R	600R	700R	800R	
V_{BO} min.	550	660	770	880	V
V_{RA} min.	550	660	770	880	V
$I_{F(AV)}$ max.				50	A
Reverse power surge (non-repetitive)					
10µs, $T_j = 25^{\circ}C$				40	kW
10µs, $T_j = 125^{\circ}C$				18	kW

OUTLINE AND DIMENSIONS

For details see page D2



The cathode lead k_2 is being introduced. Thyristors without this lead will conform to V.A.S.C.A. outline SO-30A. Those with k_2 will conform to SO-30C.

Dimensions in millimetres

	Min.	Max.	Notes		Min.	Max.	Notes
A		28.57		Q		63.5	1
ØD		31.24		S_1		16.51	
ØD_1	26.19	26.97	1	S_2	6.35		3
F	4.4	8.8		S_3		7.62	
ØM	10.55	12.70	2	S_4	3.81		3
N	18.5	21.0					
N_1		3.17	2	ØT_1	6.35	8.40	
O_1	140	203		ØT_2	2.80	3.93	
O_2	166	228					

NOTES
1. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter ØD_1. Q allows for the leads to be bent at right angles.
2. ØM refers to the unthreaded length N_1.
3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage

	Type BTX37	500R	600R	700R	800R	
V_R	Continuous reverse voltage (see note 1)	500	600	700	800	Vd.c.
V_{RWM}	Crest working reverse voltage (see note 1)	500	600	700	800	V
V_B	Continuous blocking voltage (see note 2)	500	600	700	800	Vd.c.
V_{BWM}	Crest working blocking voltage (see note 2)	500	600	700	800	V

NOTES

1. These ratings apply for zero or negative bias on the gate with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must not exceed 3.0 deg C/W for a.c. operation and 1.5 deg C/W for d.c. operation.

2. These ratings apply when the rate of rise of forward voltage is less than 10V/μs.

Current

I_F	Continuous forward current	75	A
$I_{F(AV)}$	Mean forward current (see page C2)	50	A
I_{FRM}	Repetitive peak forward current	700	A
I_{FSM}	Maximum forward surge current (see page C4 and C5)	680	A
I^2t	I^2t for fusing (1.5ms to 10ms) (see page C5)	2000	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	30	A

GATE TO CATHODE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward current	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power	0.5	W

Thermal

Operating temperature range		-55 to +125	^{o}C
Storage temperature range	T_{stg}	-55 to +125	^{o}C
Maximum junction temperature	T_j max.	125	^{o}C

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	0.6	deg C/W
Θ_i	Contact thermal resistance for a torque of 17kg cm on the nut	0.1	deg C/W

ELECTRICAL CHARACTERISTICS (T_j = 125°C unless otherwise stated)

		500R	600R	700R	800R	
V_{BO}	Minimum forward breakover voltage (see note 3)	550	660	770	880	V
V_{RA}	Minimum reverse avalanche voltage	550	660	770	880	V
i_B	Maximum forward leakage current at V_{BWM}	12	12	12	10	mA
i_R	Maximum reverse leakage current at V_{RWM}	12	12	12	10	mA
	Maximum non-repetitive reverse avalanche power (10μs)					
	T_j = 25°C				40	kW
	T_j = 125°C				18	kW
V_F	Maximum instantaneous forward voltage drop, at I_F = 500A and T_j = 25°C				3.3	V
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-off at T_j = 25°C				3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25°C				80	mA
V_{GNT}	Maximum continuous gate voltage which will not initiate turn-on				250	mV
I_H	Typical holding current				10	mA
I_{pu}	Typical pick-up current				20	mA
t_{on}	Typical turn-on time (see page C7)				3.0	μs
t_{off}	Typical turn-off time (see page C8)				20	μs

NOTE

3. This device will breakover at any voltage greater than that stated into the maximum rated current.

MECHANICAL DATA

Weight

Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

ACCESSORIES

Accessory	Code No.	Notes
$^{1}/2$ in UNF nut)		Supplied
Shakeproof washer)		with
Tag)		thyristor

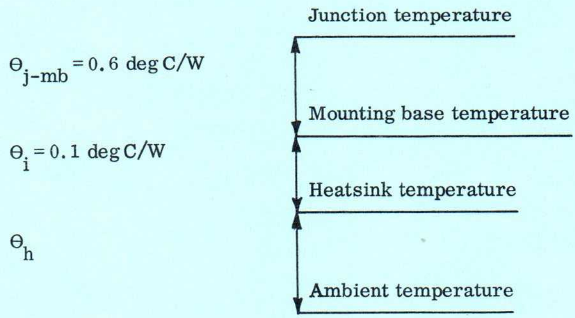
OPERATING NOTES

1. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

2. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Dissipation and heatsink considerations

   The various components of the rise of junction temperature above ambient are illustrated below:-



The method of using the curve on page C2 is as follows:-

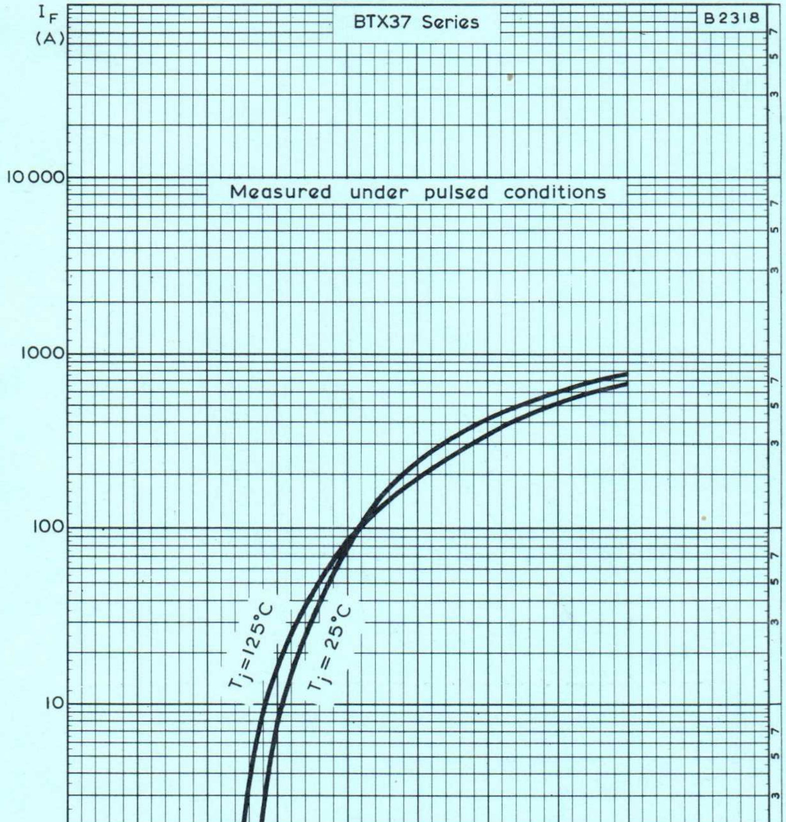
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D5. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

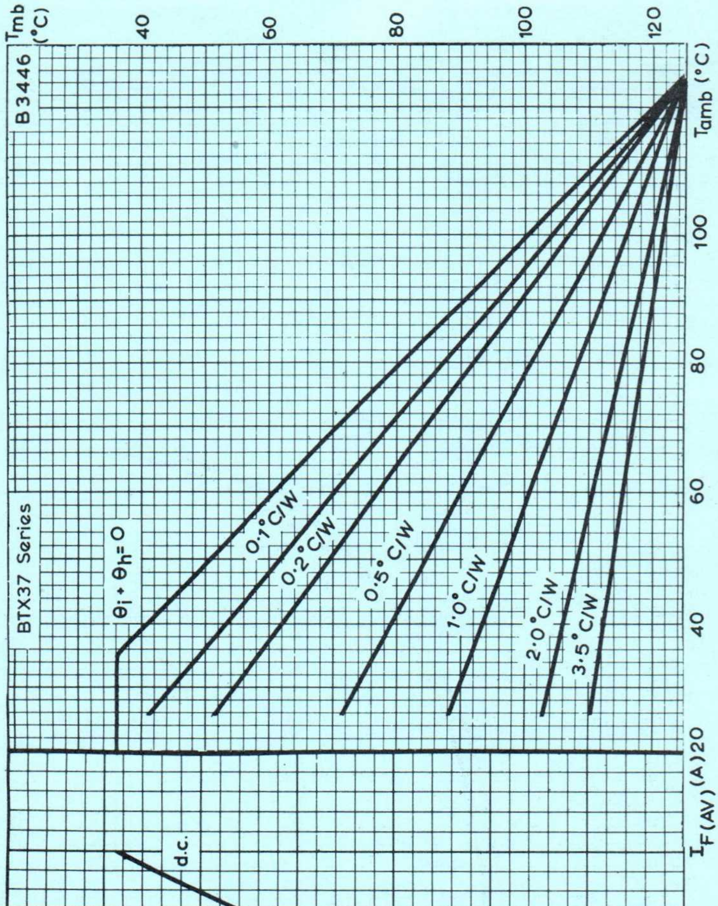
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by:-

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot\ max.}} - \theta_i$$

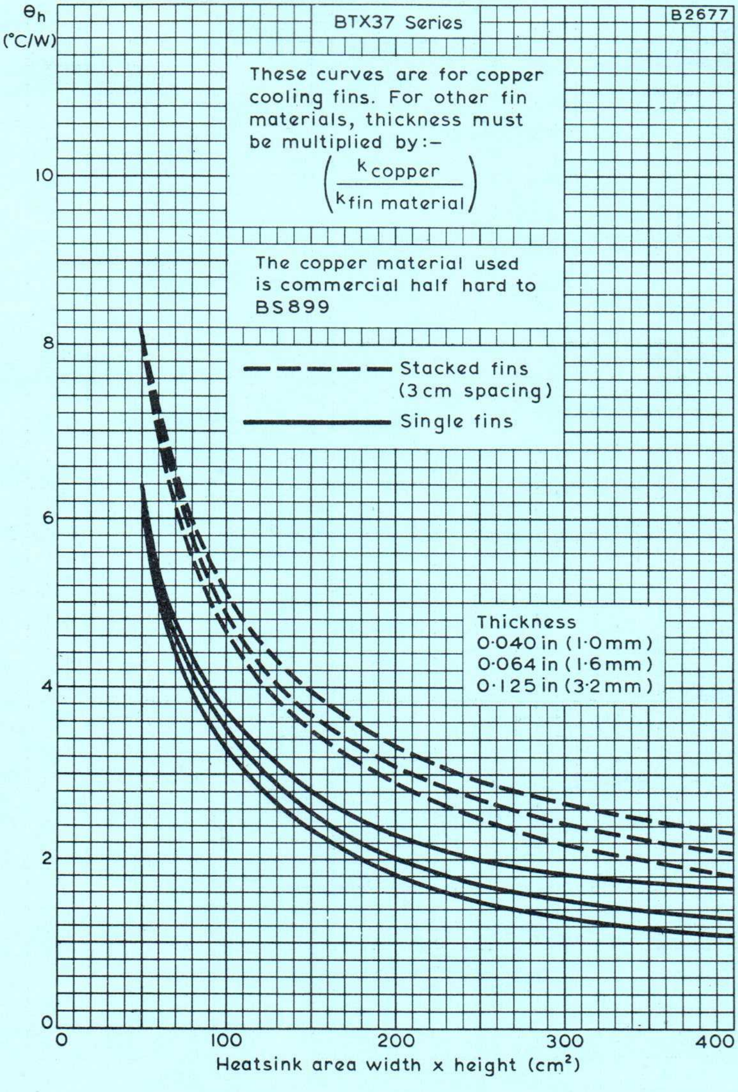
The size of the heatsink required may be found from the graph on page C3.



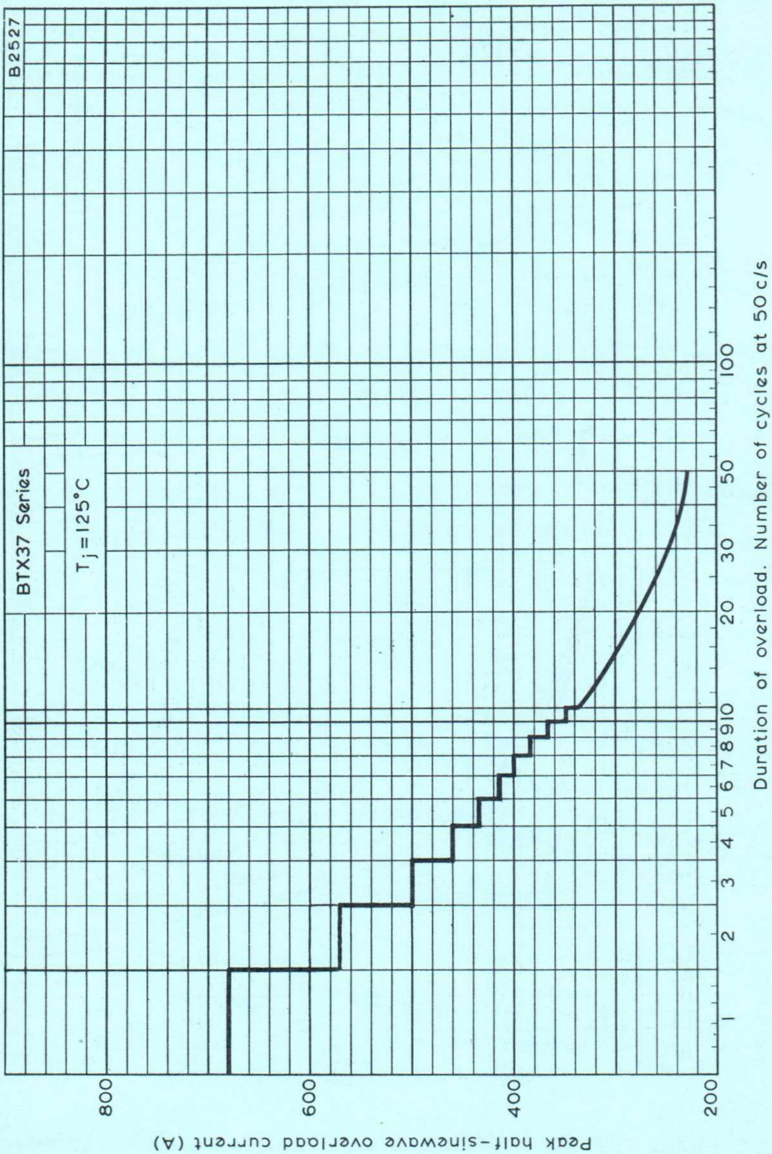
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



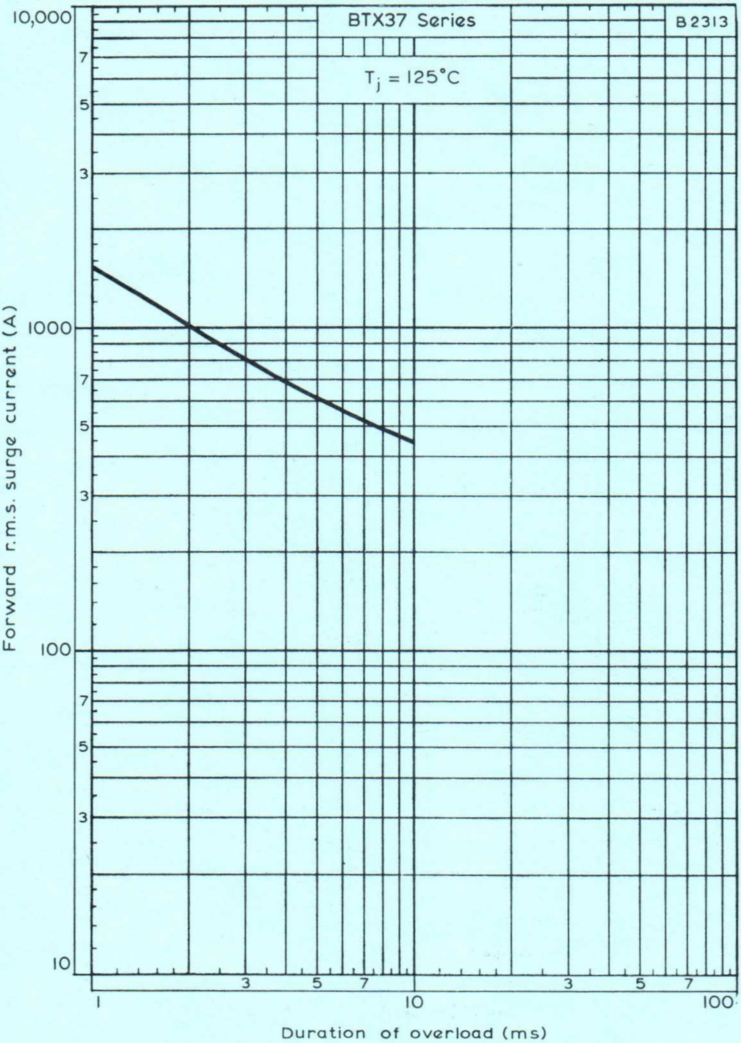
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



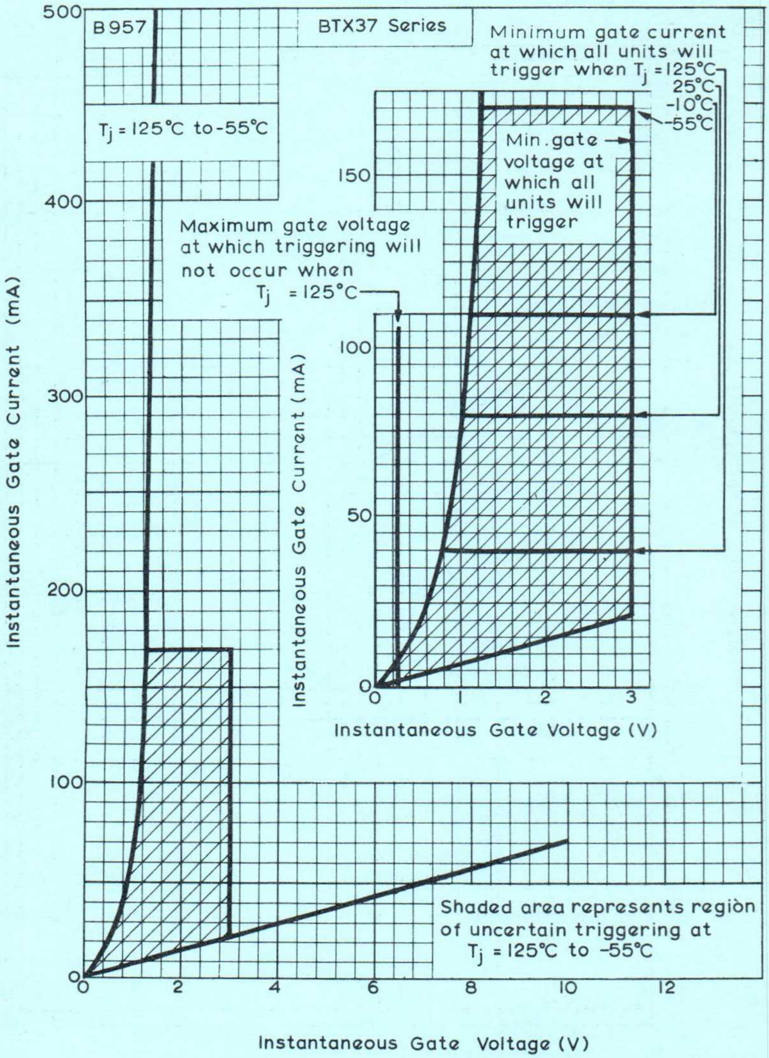
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



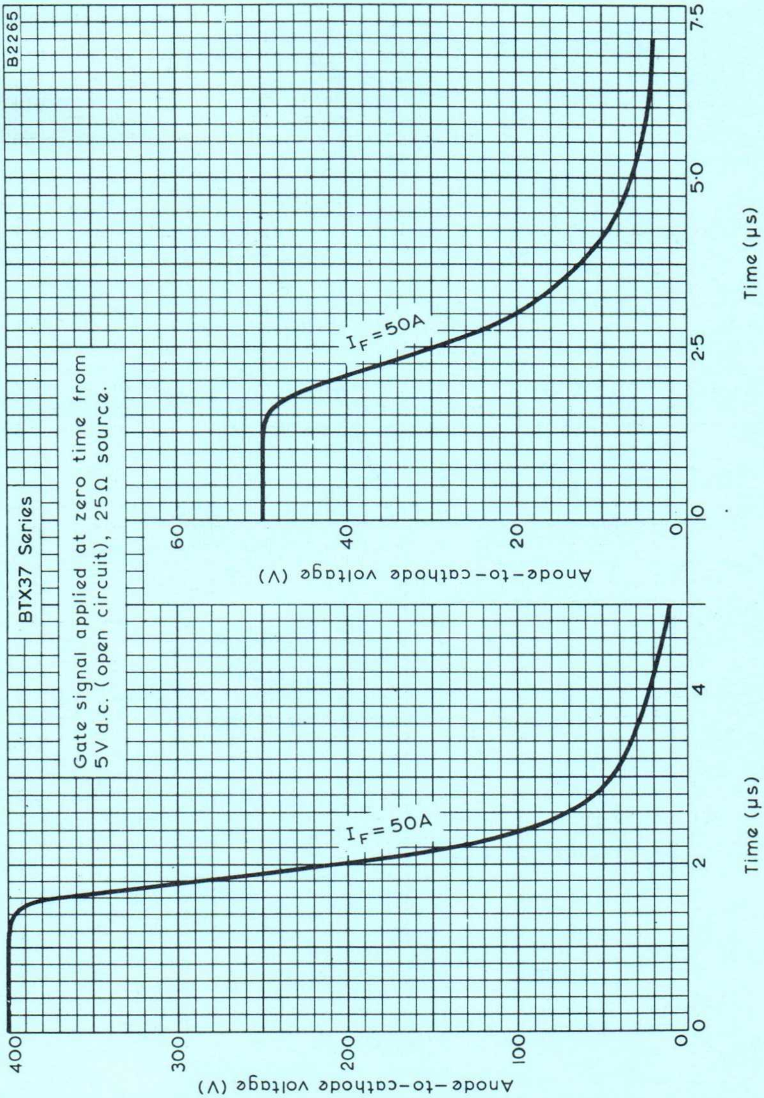
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST
THE NUMBER OF CYCLES AT 50c/s



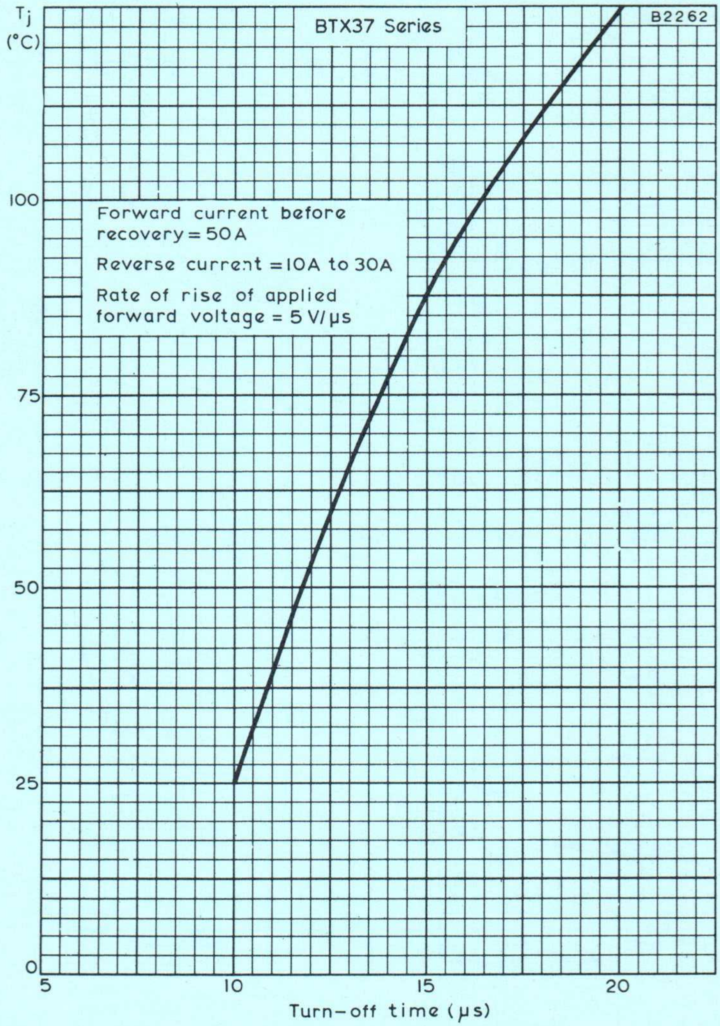
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50c/s



GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



TYPICAL TURN-ON CHARACTERISTIC



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE

NON-REPETITIVE AVALANCHE POWER PLOTTED AGAINST JUNCTION TEMPERATURE

TENTATIVE DATA

The BTX38 series is a range of p-gate reverse blocking thyristors with controlled avalanche characteristics for use in power control circuits. This range of thyristors is capable of absorbing transient energy within the rectifier circuit without damage.

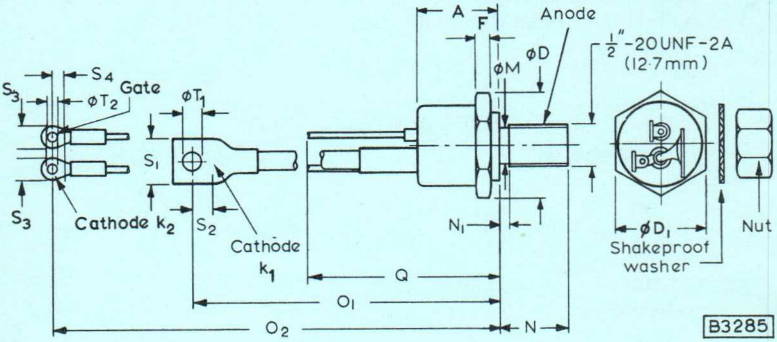
Unless otherwise shown data is applicable to all types in the series

QUICK REFERENCE DATA

Type BTX38	500R	600R	700R	800R	
V_{BO} min.	550	660	770	880	V
V_{RA} min.	550	660	770	880	V
$I_{F(AV)}$ max.				70	A
Reverse power surge (non-repetitive)					
10μs, $T_j = 25^{\circ}C$				40	kW
10μs, $T_j = 125^{\circ}C$				18	kW

OUTLINE AND DIMENSIONS

For details see page D2.



The cathode lead k_2 is being introduced. Thyristors without this lead will conform to V.A.S.C.A. outline SO-30A. Those with k_2 will conform to SO-30C.

Dimensions in millimetres

	Min.	Max.	Notes		Min.	Max.	Notes
A		28.57		Q		63.5	1
ØD		31.24		S_1		16.51	
ØD_1	26.19	26.97	1	S_2	6.35		3
F	4.4	8.8		S_3		7.62	
ØM	10.55	12.70	2	S_4	3.81		3
N	18.5	21.0					
N_1		3.17	2	ØT_1	6.35	8.40	
O_1	140	203		ØT_2	2.80	3.93	
O_2	166	228					

NOTES 1. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and the diameter ØD_1. Q allows for the leads to be bent at right angles.

2. ØM refers to the unthreaded length N_1.

3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage

	Type BTX38	500R	600R	700R	800R	
V_R	Continuous reverse voltage (see note 1)	500	600	700	800	Vd.c.
V_{RWM}	Crest working reverse voltage (see note 1)	500	600	700	800	V
V_B	Continuous blocking voltage (see note 2)	500	600	700	800	Vd.c.
V_{BWM}	Crest working blocking voltage (see note 2)	500	600	700	800	V

NOTES

1. These ratings apply for zero or negative bias on the gate with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must not exceed 3.0 deg C/W for a.c. operation and 1.5 deg C/W for d.c. operation.

2. These ratings apply when the rate of rise of forward voltage is less than 10V/μs.

Current

I_F	Continuous forward current	100	A
$I_{F(AV)}$	Mean forward current (see page C2)	70	A
I_{FRM}	Repetitive peak forward current	1000	A
I_{FSM}	Maximum forward surge current (see page C4 and C5)	900	A
I^2t	I^2T for fusing (1.5ms to 10ms) (see page C5)	4000	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	30	A

GATE TO CATHODE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward current	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power	0.5	W

Thermal

Operating temperature range		-55 to +125	^{o}C
Storage temperature range	T_{stg}	-55 to +125	^{o}C
Maximum junction temperature	T_j max.	125	^{o}C

THERMAL CHARACTERISTICS

$\Theta_{j\text{-}mb}$	Maximum thermal resistance from junction to mounting-base	0.4 deg C/W
Θ_i	Contact thermal resistance for a torque of 17kg cm on the nut	0.1 deg C/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

		500R	600R	700R	800R	
V_{BO}	Minimum forward breakover voltage (see note 3)	550	660	770	880	V
V_{RA}	Minimum reverse avalanche voltage	550	660	770	880	V
i_B	Maximum forward leakage current at V_{BWM}	12	12	12	10	mA
i_R	Maximum reverse leakage current at V_{RWM}	12	12	12	10	mA
	Maximum non-repetitive reverse avalanche power (10µs)					
	$T_j = 25^oC$				40	kW
	$T_j = 125^oC$				18	kW
V_F	Maximum instantaneous forward voltage drop at $I_F = 500A$ and $T_j = 25^oC$				2.5	V
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$				3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$				70	mA
V_{GNT}	Maximum continuous gate voltage which will not initiate turn-on				250	mV
I_H	Typical holding current				10	mA
I_{pu}	Typical pick-up current				20	mA
t_{on}	Typical turn-on time (see page C7)				3.0	µs
t_{off}	Typical turn-off time (see page C9)				20	µs

NOTE

3. This device will breakover at any voltage greater than that stated into the maximum rated current.

MECHANICAL DATA

Weight

Without accessories	80	g
	3.1	oz
With accessories	108	g
	3.8	oz

ACCESSORIES

Accessory	Code No.	Notes
1/2 in UNF nut)		Supplied
Shakeproof washer)		with
Tag)		thyristor

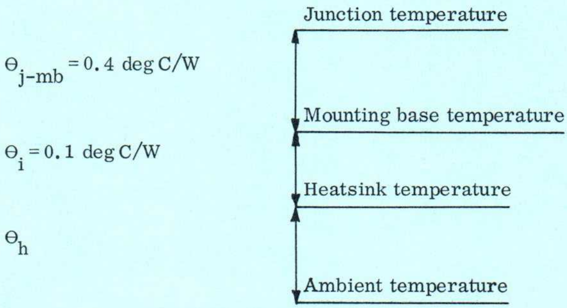
OPERATING NOTES

1. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

2. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

3. Dissipation and heatsink considerations

   The various components of the rise of junction temperature above ambient are illustrated below:-



   The method of using the curve on page C2 is as follows:-

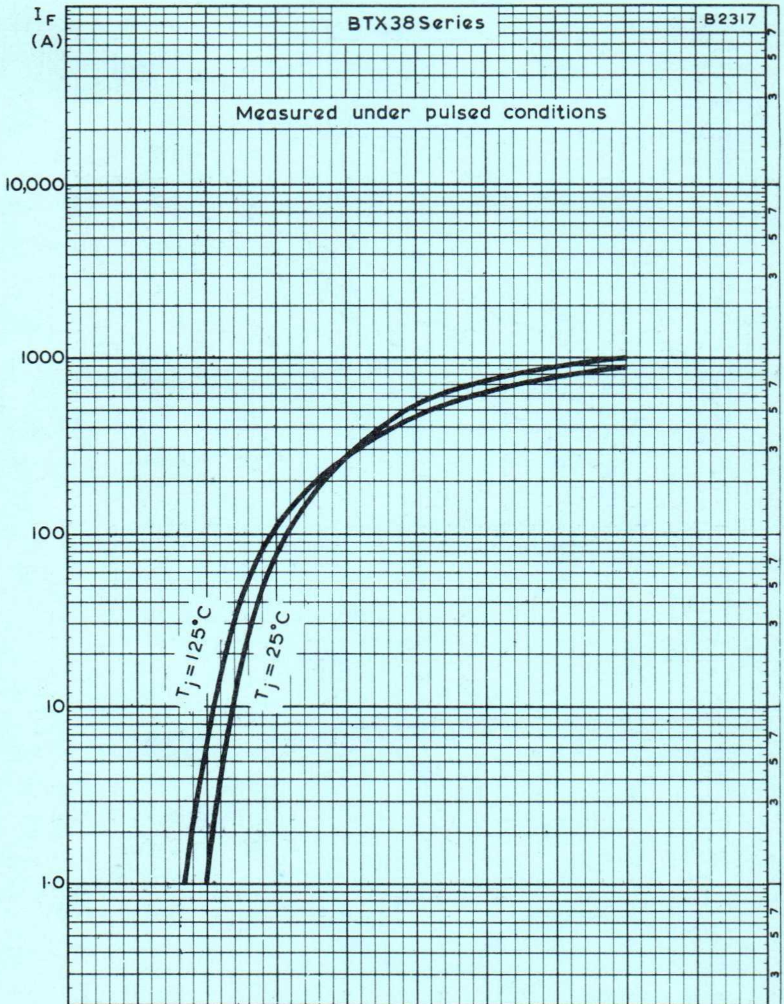
   Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

   θ_i is the contact thermal resistance for minimum torque, as given on page D5. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

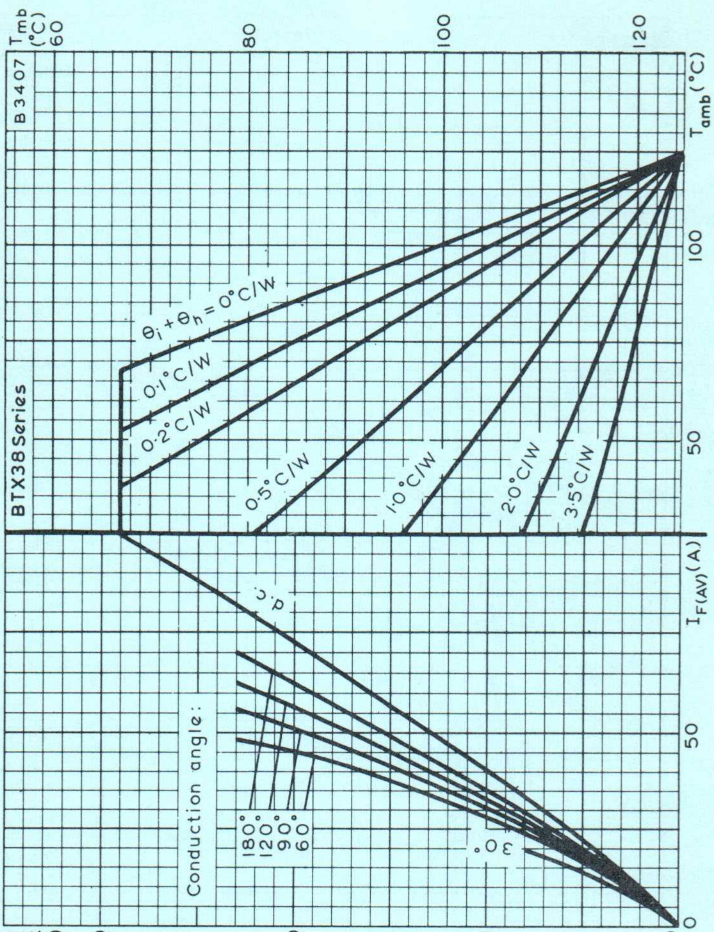
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by:-

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \Theta_i$$

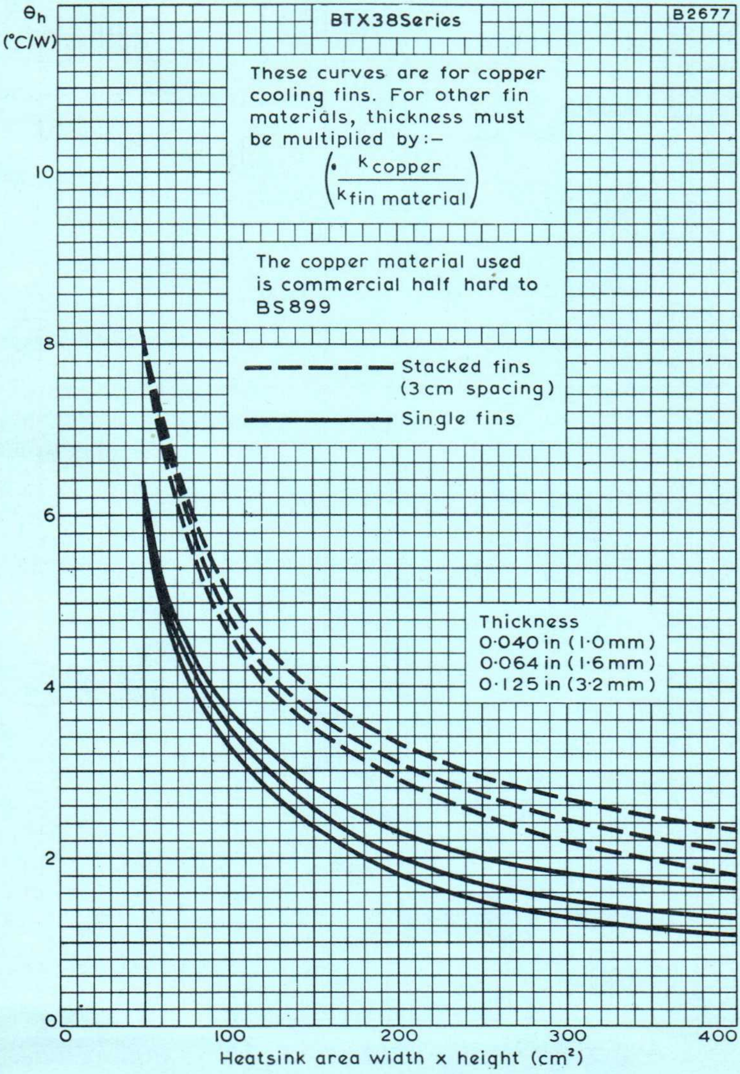
The size of the heatsink required may be found from the graph on page C3.



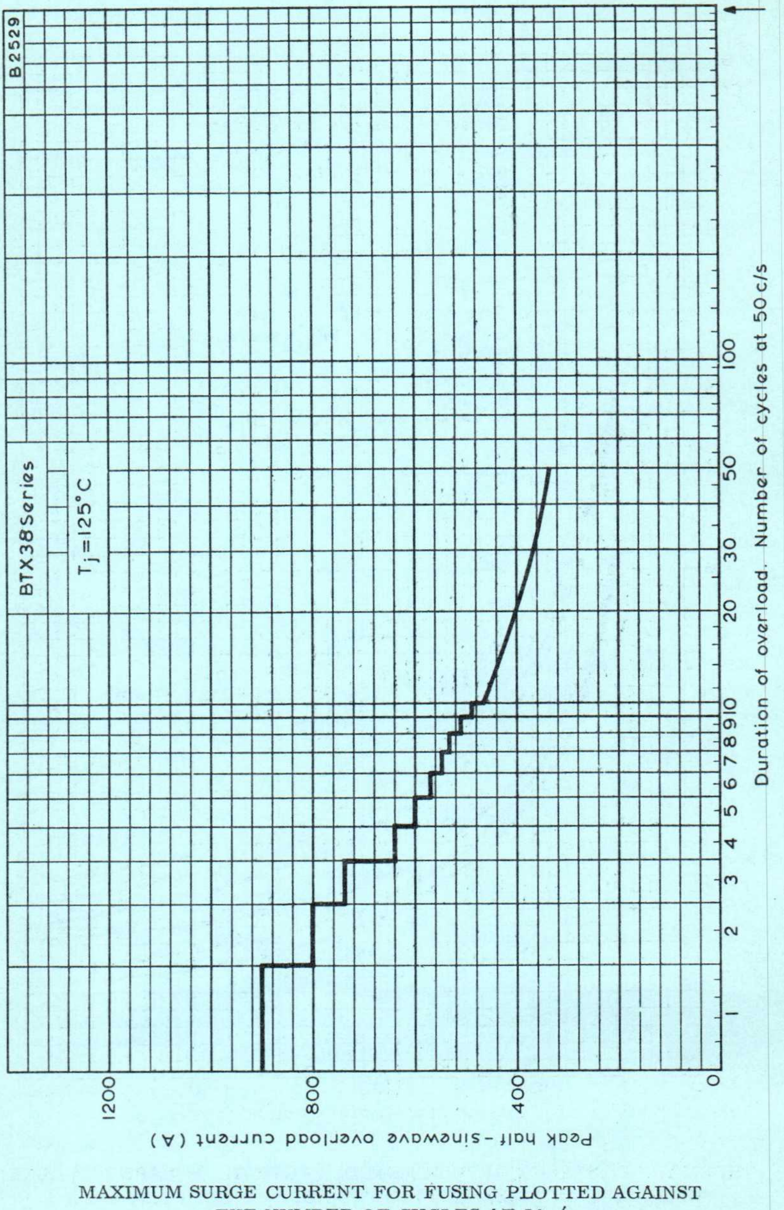
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



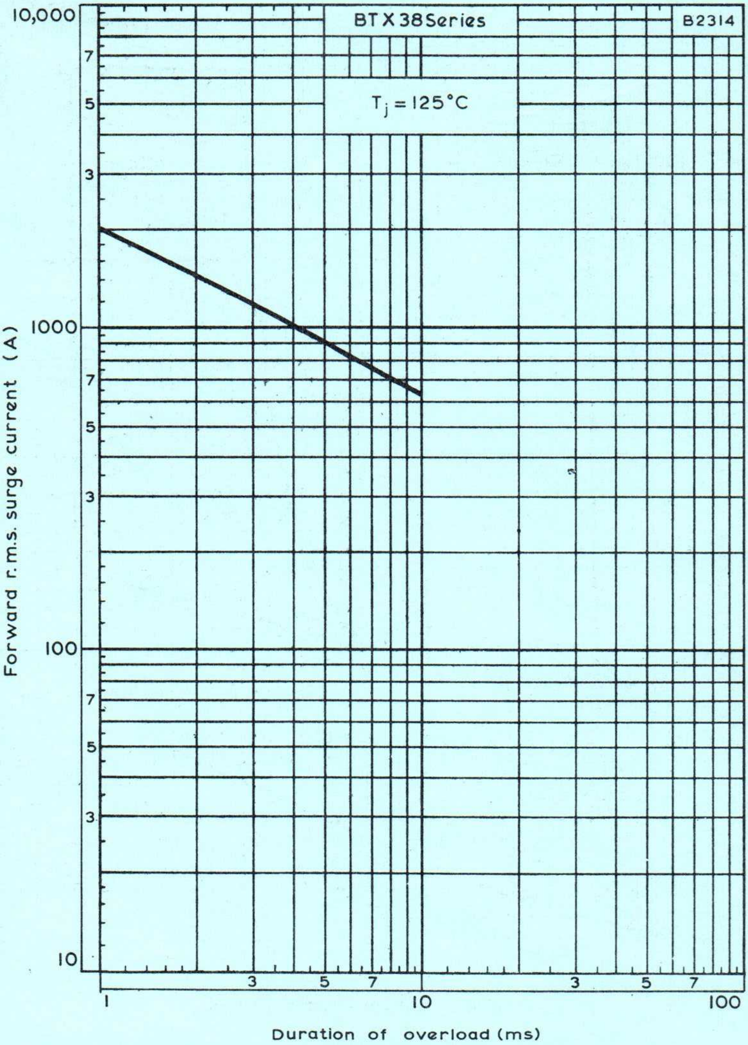
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



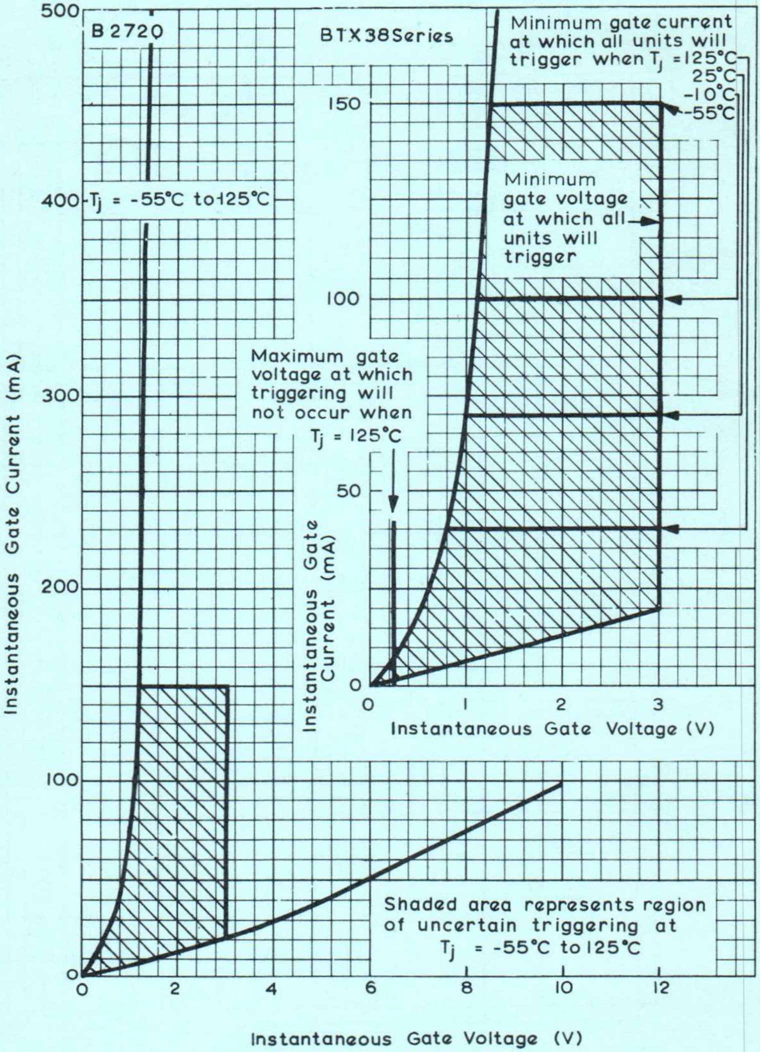
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



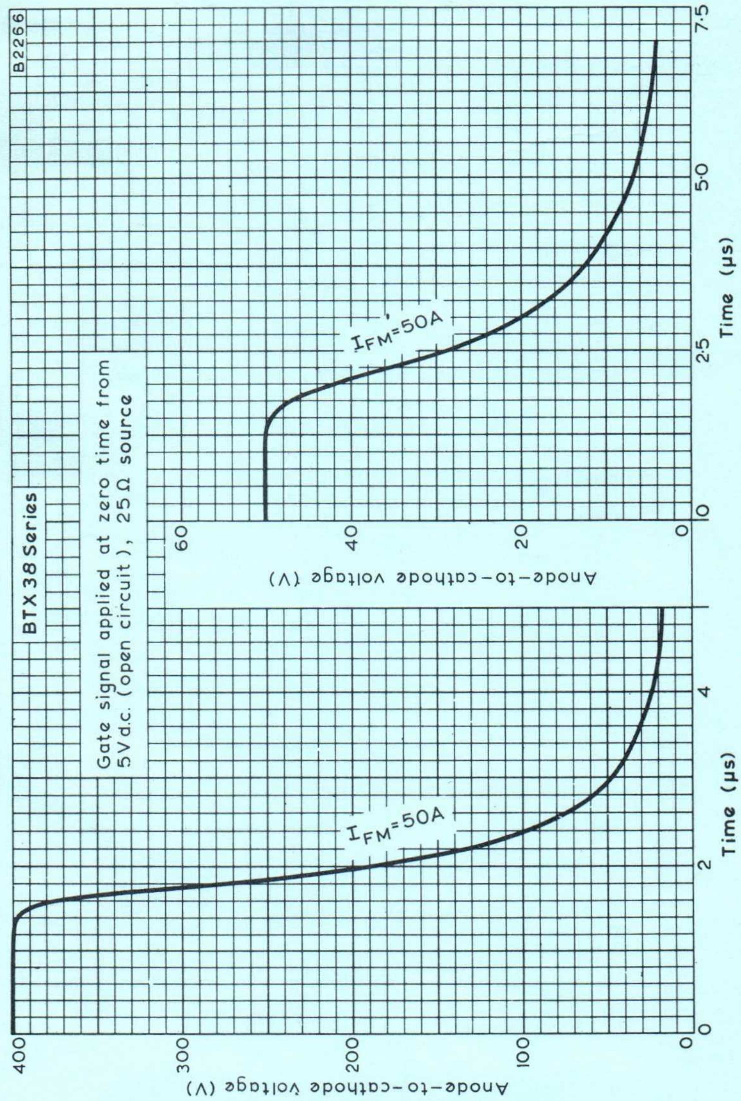
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST THE NUMBER OF CYCLES AT 50c/s



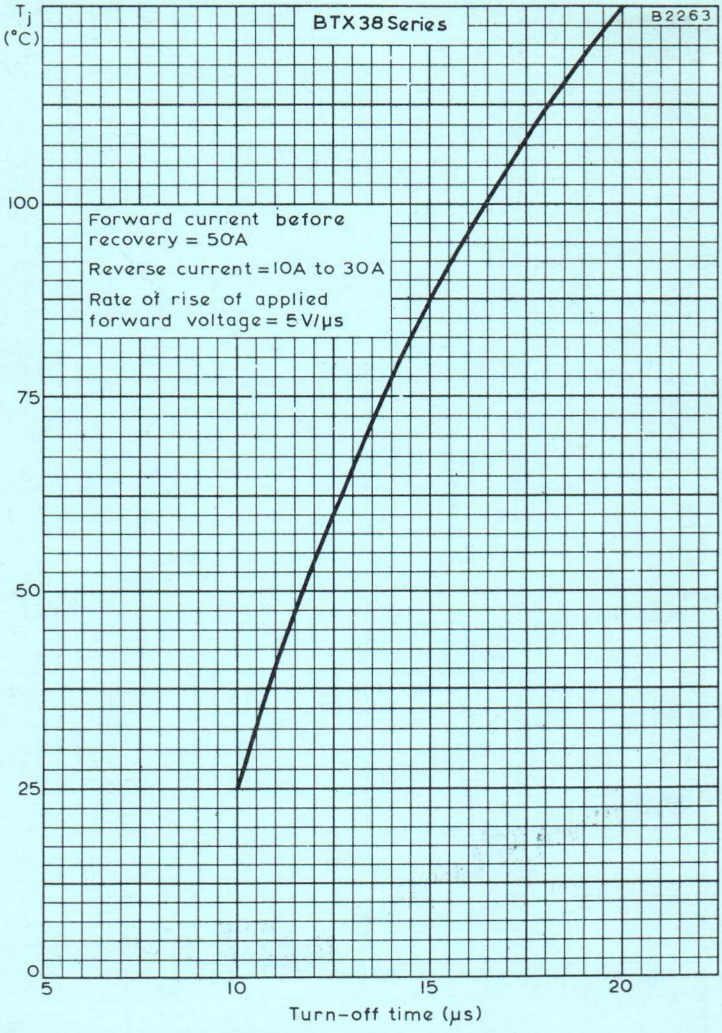
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50c/s



GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



TYPICAL TURN-ON CHARACTERISTIC



TYPICAL TURN-OFF TIME, PLOTTED AGAINST
JUNCTION TEMPERATURE

NON-REPETITIVE AVALANCHE POWER PLOTTED AGAINST JUNCTION TEMPERATURE

TENTATIVE DATA

The BTX47 is a range of p-gate reverse blocking thyristors for use in power control circuits, direct on 440V supplies. They have controlled avalanche characteristics and are therefore capable of absorbing reverse transients. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

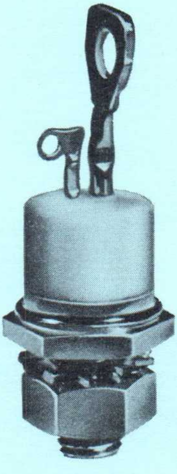
BTX47 -	1000R	1200R	1400R	
V_{BO} min.	900	1100	1300	V
$V_{(BR)}$ aval. min.	1000	1200	1400	V
V_{DWM}	800	800	800	V
V_{RWM}	800	800	800	V
$I_{F(AV)}$ ($T_{stud} = 85^{\circ}C$)		11.5		A
$I_{F(RMS)}$		25		A

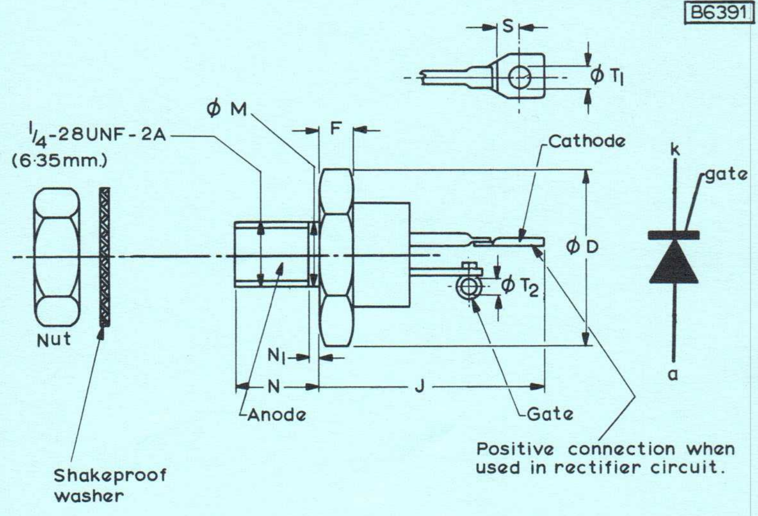
Unless otherwise shown, data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page D2





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
ØD		16.51		0.650	
F	2.9	5.5	0.113	0.220	1
J		30.48		1.200	
ØM	4.91	6.35	0.193	0.250	2
N	10.72	11.50	0.422	0.453	
N_1		2.26		0.089	2
S	3.05		0.120		3
ØT_1	3.18	4.44	0.125	0.175	
ØT_2	1.53		0.060		

NOTES 1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) 0.544" min., (14.27mm) 0.562" max.

2. ØM refers to lengths N_1.

3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)		1000R	1200R	1400R	
V_R	Continuous reverse voltage	800	800	800	V
V_{RWM}	Crest working reverse voltage	800	800	800	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	1000	1200	1400	V
V_{RWM}	Non-repetitive peak reverse voltage (< 10ms)	1000	1200	1400	V
V_D	Continuous off-state voltage	800	800	800	V
V_{DWM}	Crest working off-state voltage	800	800	800	V
V_{DRM}	Repetitive off-state voltage (1% duty cycle 50Hz)	900	1100	1300	V

Power

P_R	Maximum non-repetitive reverse avalanche power (10μs)		
	$T_j = 25^oC$	18	kW
	$T_j = 125^oC$	7.5	kW

Note 1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 6degC/W for a.c. operation, and 3.0degC/W for d.c. operation.

Current

I_F	Continuous forward current	25	A
$I_{F(AV)}$	Mean forward current (see page C2)	16	A
I_{FRM}	Repetitive peak forward current	160	A
I_{FSM}	Maximum forward surge current peak of half-sine at maximum operating conditions (see page C4)	155	A
I^2t	I^2t for fusing (< 10ms) (see pages C4 and C5)	125	A^2s
$\frac{di}{dt}$	Rate of rise of forward current (see page C8)	50	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward gate current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature	-55	^oC
T_{stg} max.	Storage temperature	125	^oC
T_j max.	Junction temperature	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	1.0	degC/W
Θ_i	Maximum thermal resistance for a torque of 17kg cm. on the nut	0.2	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance (1ms)	0.05	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

		1000R	1200R	1400R	
V_{BO}	Minimum forward break-over voltage (see Note 2)	900	1100	1300	V
V_F	Maximum instantaneous forward voltage at $I_F = 50A$, $T_j = 25^oC$			4.0	V
i_D	Maximum forward leakage current at V_{DWM}	5.0	5.0	5.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	5.0	5.0	5.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$ (see page C6)			3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn on at $T_j = 25^oC$ (see page C6)			65	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)			250	mV
I_H	Typical holding current			10	mA
I_P	Typical pick-up current			20	mA
t_{off}	Typical turn-off time $I_F = 10A$, $I_R = 10A$ (see page C7)			50	μs
t_{on}	Typical turn-on time (see page C7)			5.0	μs

Note 2. The device may breakover into the maximum repetitive peak forward current at the maximum rate of rise of forward current.

MECHANICAL DATA

Mechanical torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Tag Insulating bush Mica washer	56264A	Supplied on request.

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

	R-C in primary of transformer		R-C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

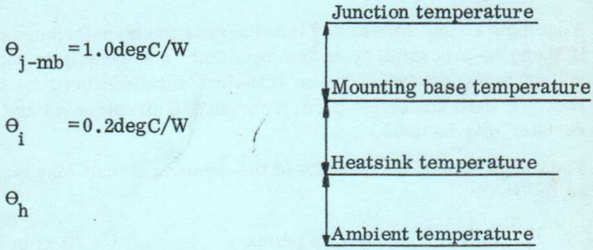
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations.

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page C2 is as follows.

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot\,max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

b) The applied voltage must not exceed the nominal peak rating of the fuse.

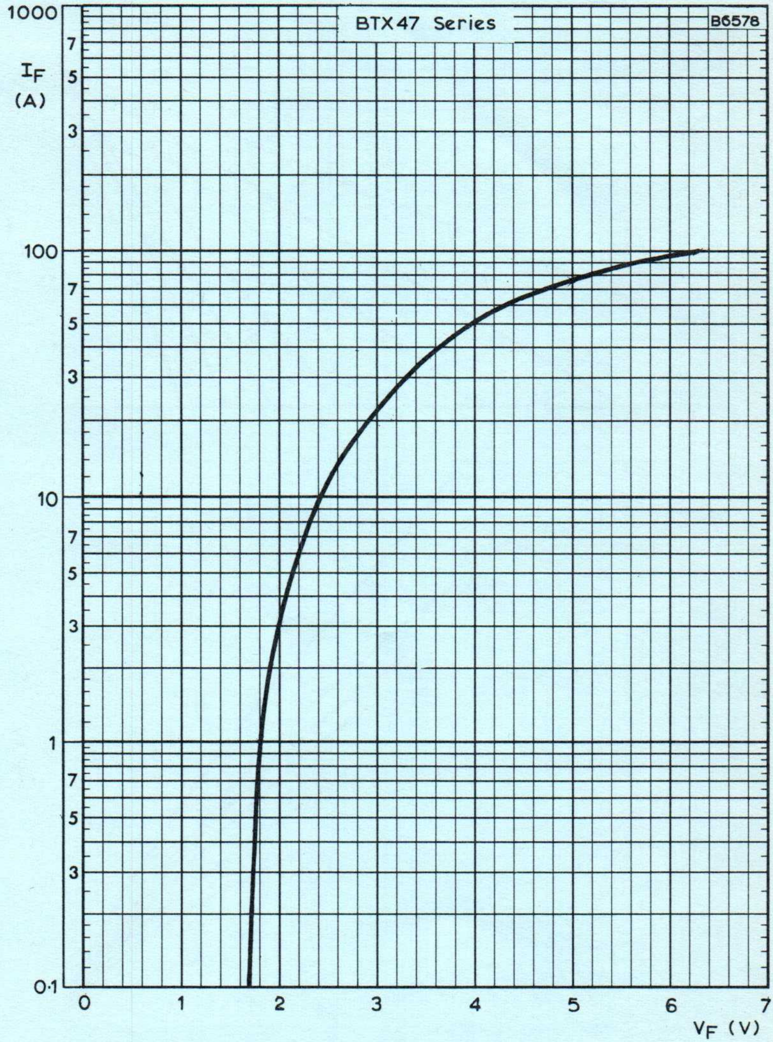
c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

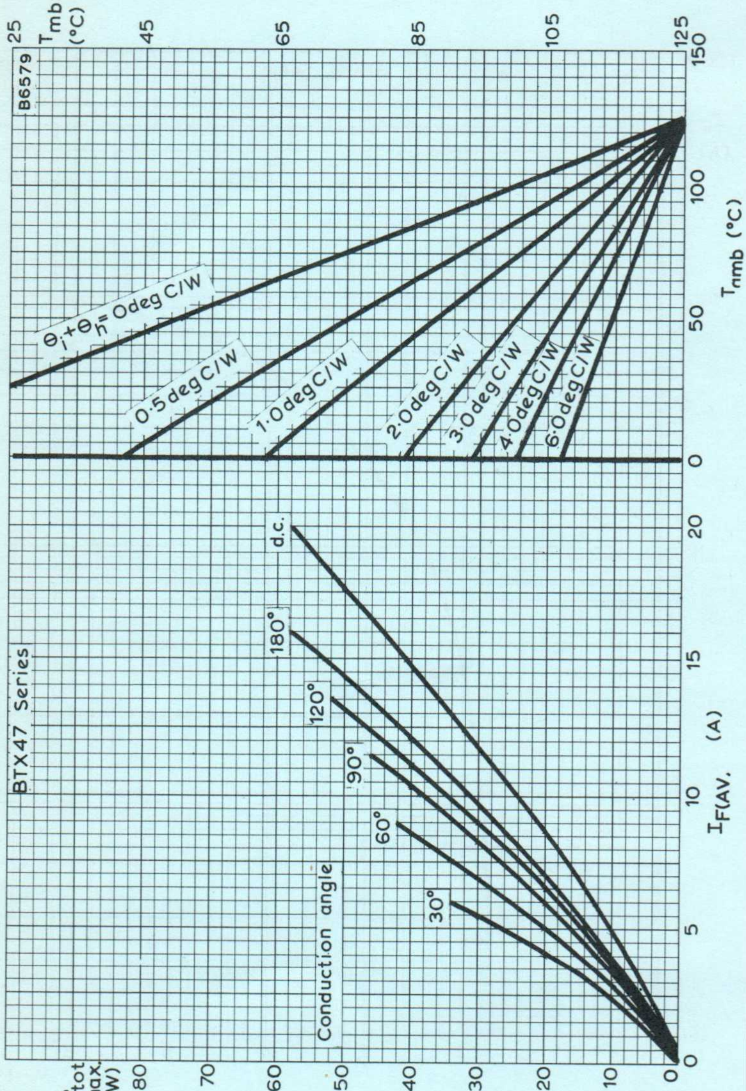
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

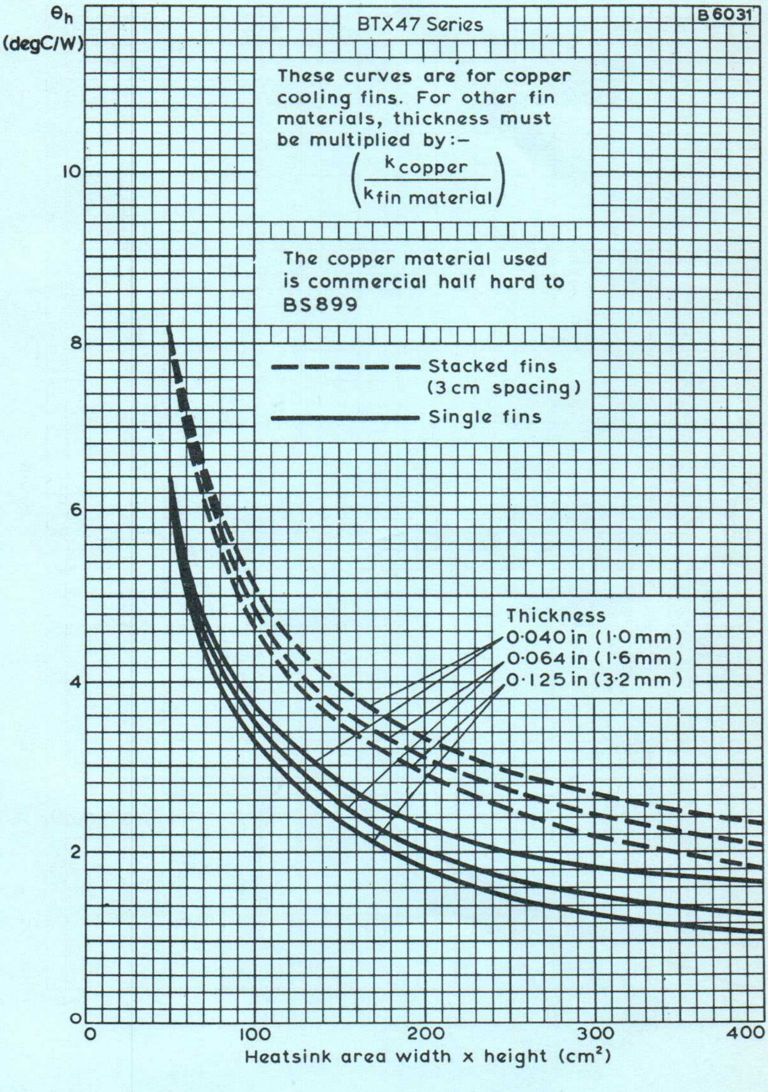
When starting conditions are likely to exceed the current limits given on page C2, the curves on pages C9 and C10 may be used. Page C9 refers to the output of a single-phase bridge and page C10 to a three-phase bridge.



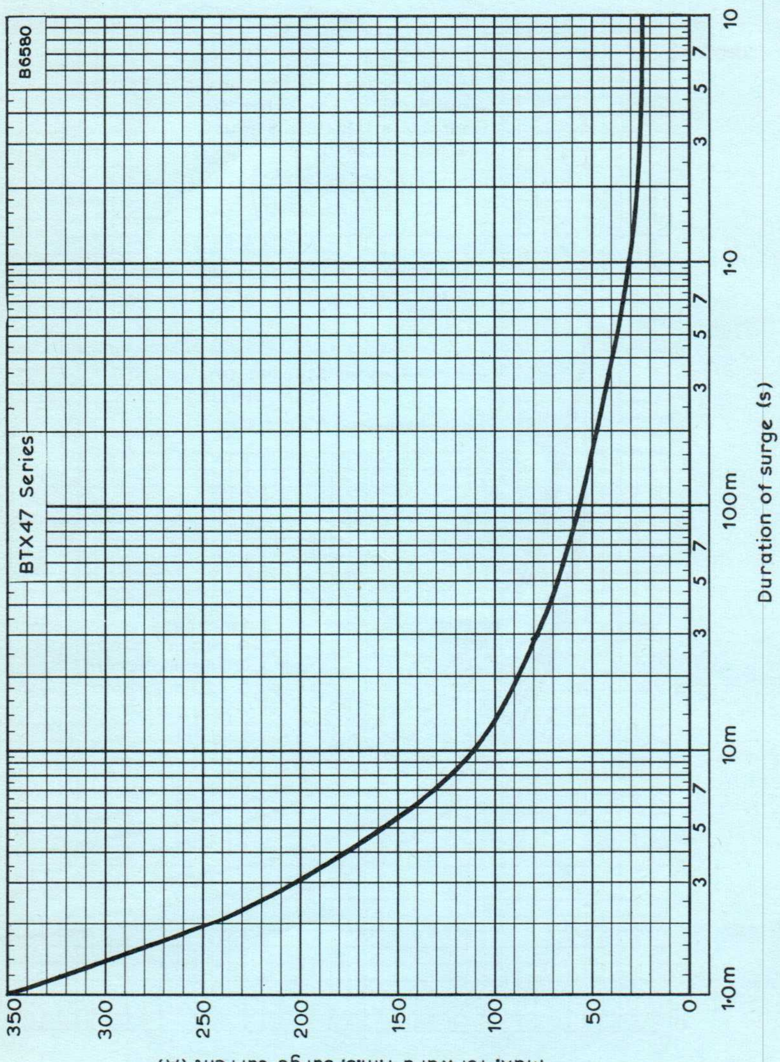
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



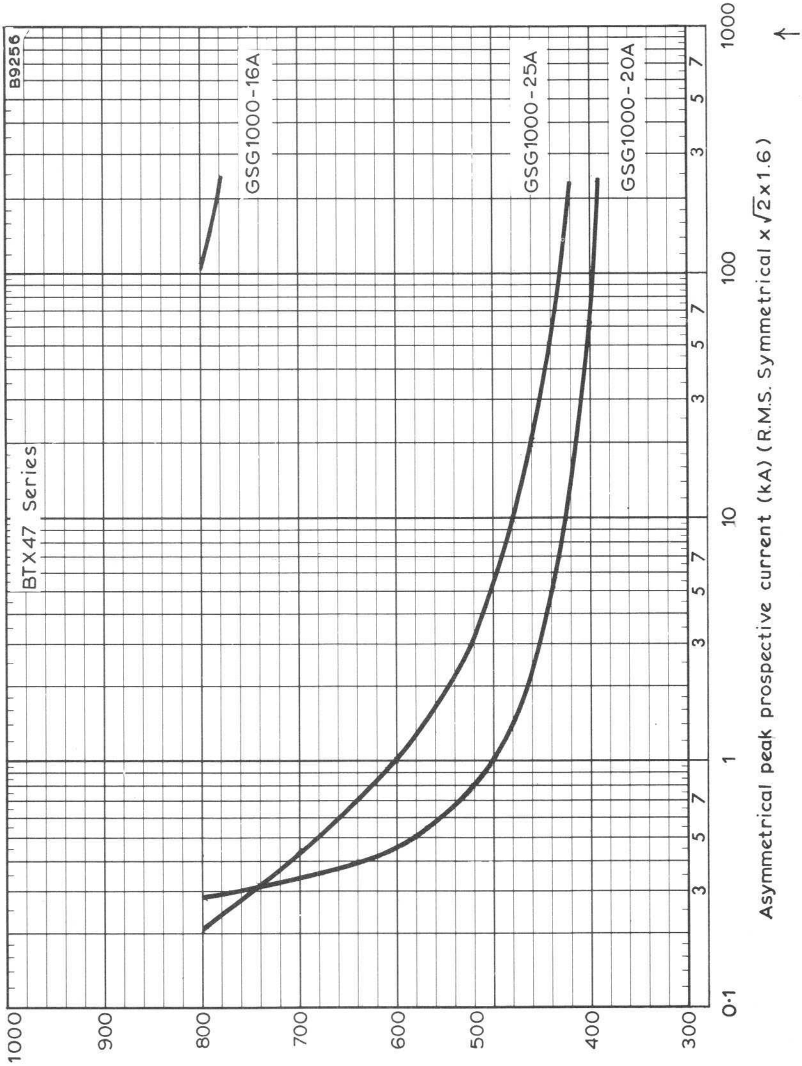
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



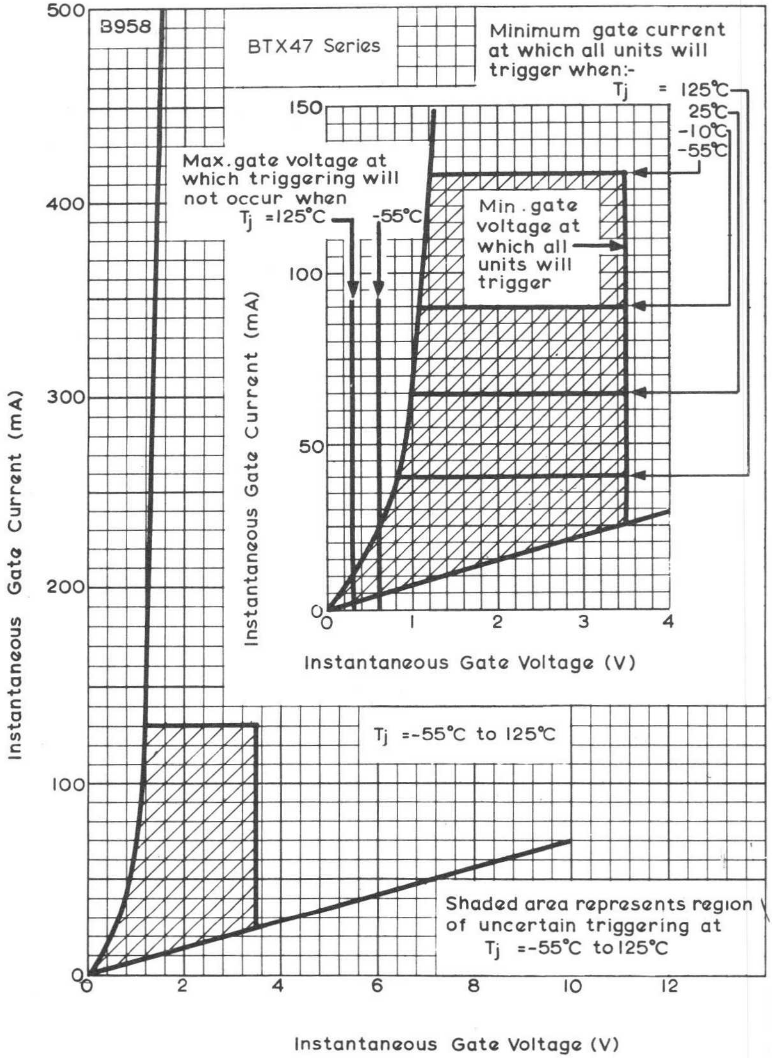
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



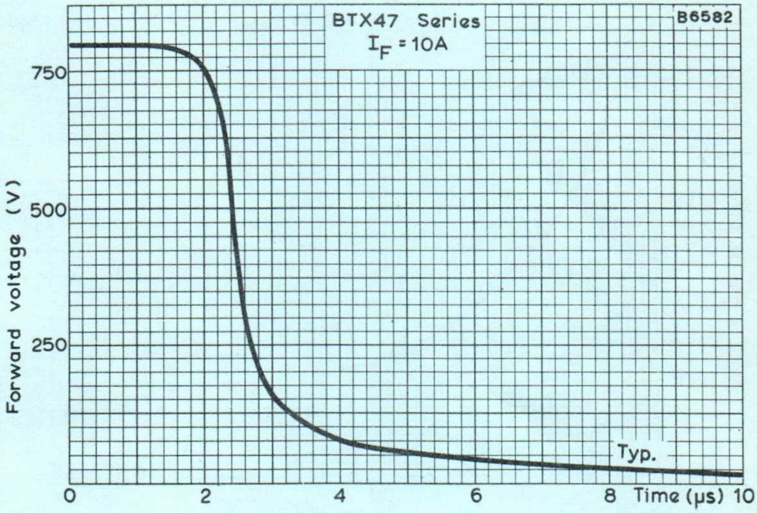
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)

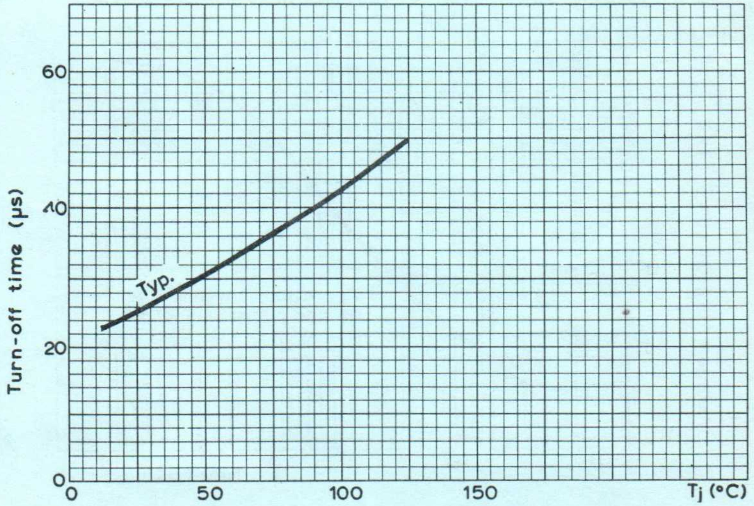


CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT

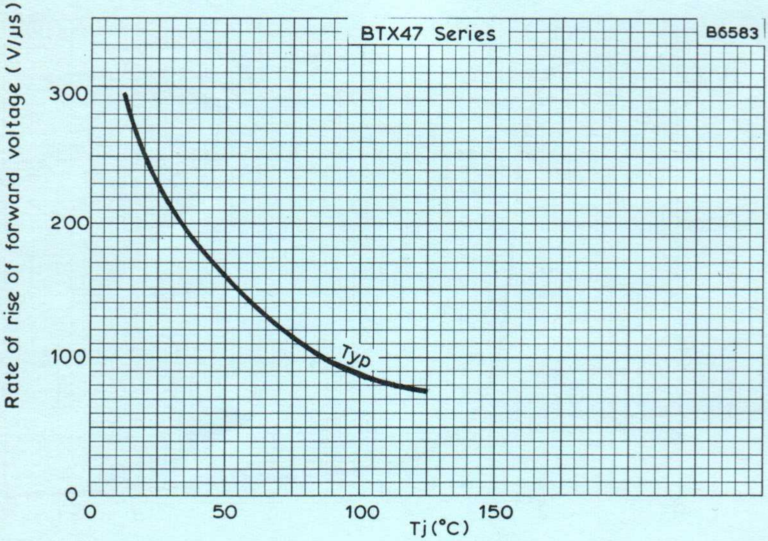


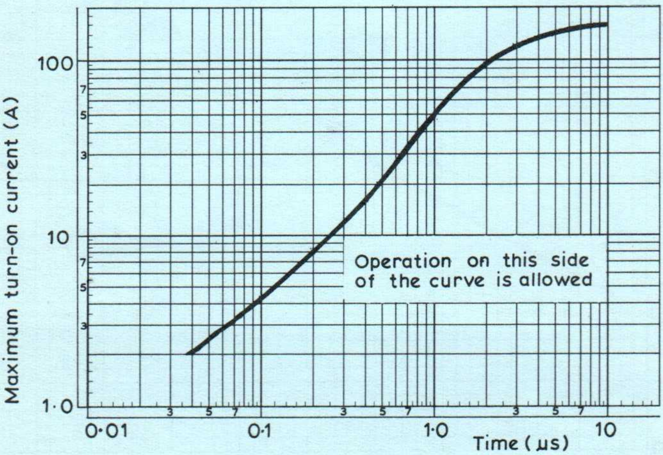
THYRISTOR GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN





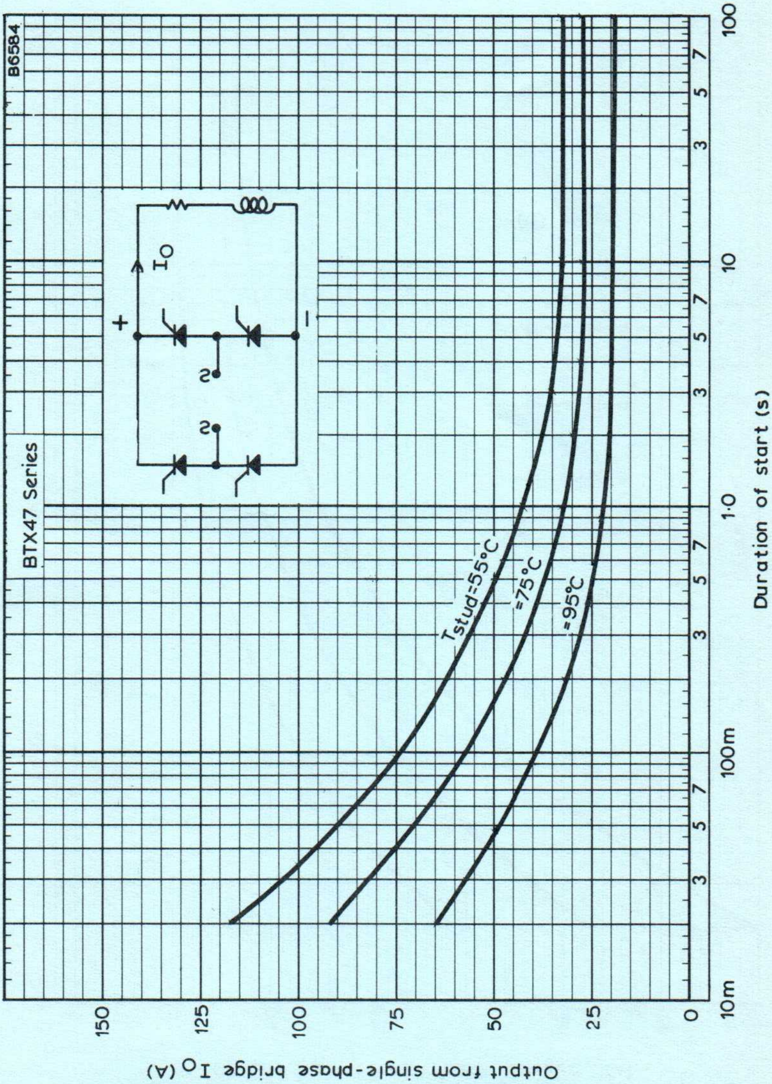
TYPICAL TURN-ON CHARACTERISTIC
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE



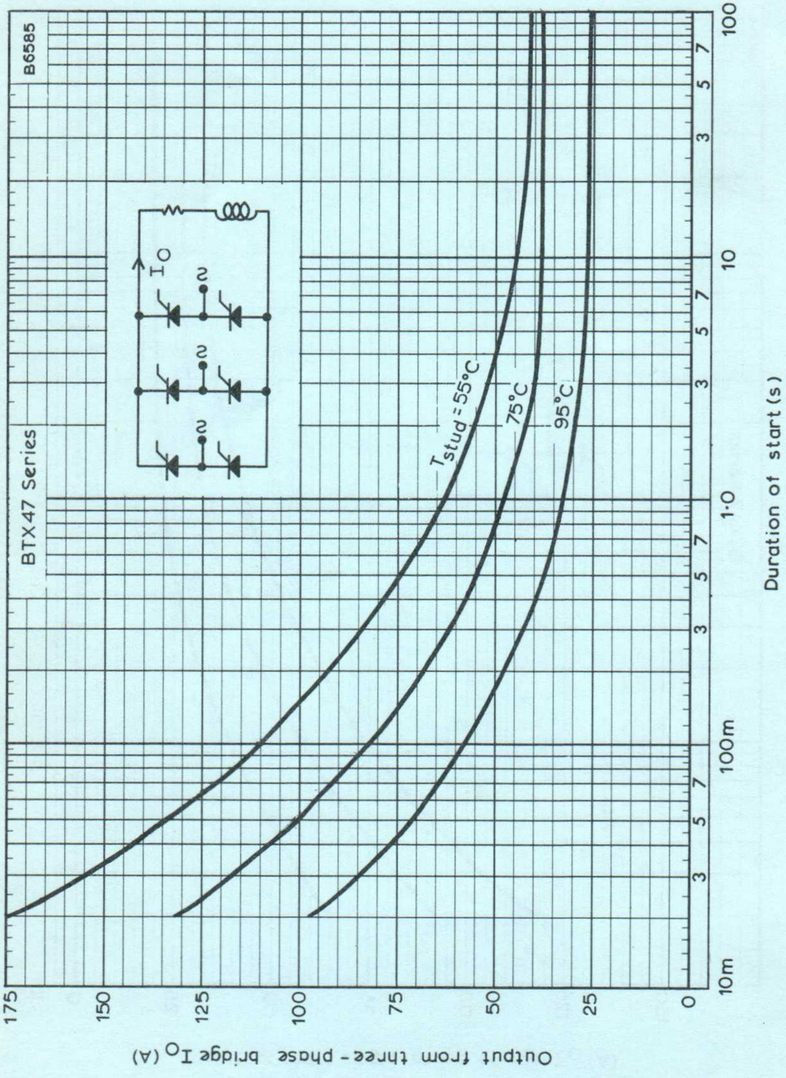


VARIATION OF RATE OF RISE OF FORWARD VOLTAGE WITH JUNCTION TEMPERATURE

MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A THREE-PHASE BRIDGE

TENTATIVE DATA

The BTX48 is a range of p-gate reverse blocking thyristors for use in power control circuits, direct on 440V supplies. They have controlled avalanche characteristics and are therefore capable of absorbing reverse transients. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

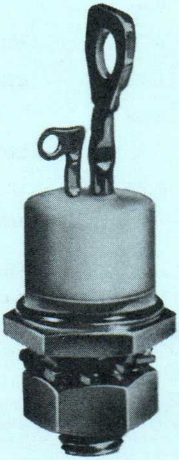
BTX48 -	1000R	1200R	1400R	
V_{BO} min.	900	1100	1300	V
$V_{(BR)}$ aval. min.	1000	1200	1400	V
V_{DWM}	800	800	800	V
V_{RWM}	800	800	800	V
$I_{F(AV)}$ ($T_{stud} = 85^{o}C$)		16		A
$I_{F\ (RMS)}$		25		A

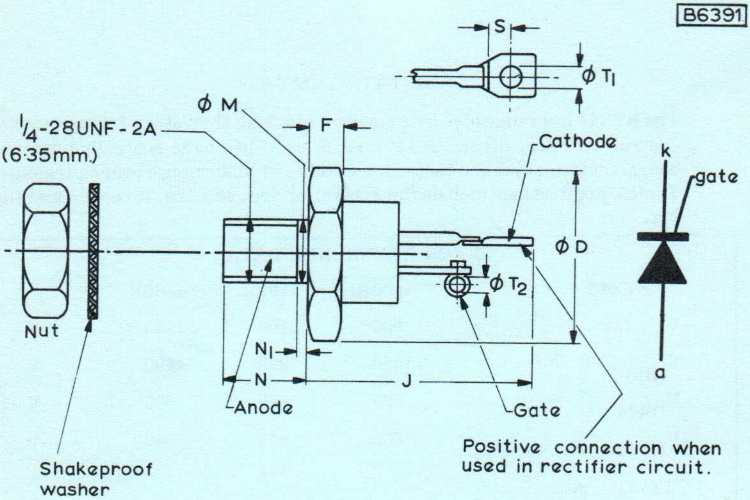
Unless otherwise shown, data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page D2.





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
ØD		16.51		.650	
F	2.9	5.5	.113	.220	1
J		30.48		1.200	
ØM	4.91	6.35	.193	.250	2
N	10.72	11.50	.422	.453	
N_1	2.26	2.26		.089	2
S	3.05		.120		3
ØT_1	3.18	4.44	.125	.175	
ØT_2	1.53		.060		

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) .544" min., (14.27mm) .562" max.
2. ØM refers to lengths N_1.
3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (See note 1)	BTX48 -	1000R	1200R	1400R	
V_R	Continuous reverse voltage	800	800	800	V
V_{RWM}	Crest working reverse voltage	800	800	800	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	1000	1200	1400	V
V_{RSM}	Non-repetitive peak reverse voltage (< 10ms)	1000	1200	1400	V
V_D	Continuous off-state voltage	800	800	800	V
V_{DWM}	Crest working off-state voltage	800	800	800	V
V_{DRM}	Repetitive off-state voltage (1% duty cycle at 50Hz)	900	1100	1300	V

Power

P_R	Maximum non-repetitive reverse avalanche power (10μs)		
	$T_j = 25^oC$	18	kW
	$T_j = 125^oC$	7.5	kW

Note 1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 6degC/W for a.c. operation, and 3degC/W for d.c. operation.

Current

I_F	Continuous forward current	25	A
$I_{F(AV)}$	Mean forward current (see page C2)	16	A
I_{FRM}	Repetitive peak forward current	200	A
I_{FSM}	Maximum forward surge current peak of half-sine at maximum operating conditions (see page C4)	200	A
I^2t	I^2t for fusing (< 10ms) (see pages C4 and C5)	200	A^2s
$\frac{di}{dt}$	Rate of rise of forward current (see page C8)	50	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance for junction to mounting-base	1.0	degC/W
Θ_i	Maximum thermal resistance for a torque of 17kg.cm. on the nut	0.2	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance (1ms)	0.05	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

	BTX48 -	1000R	1200R	1400R	
V_{BO}	Minimum forward breakover voltage (see Note 2)	900	1100	1300	V
V_F	Maximum instantaneous forward voltage at $I_F = 50A$, $T_j = 25^oC$			2.7	V
i_D	Maximum forward leakage current at V_{DWM}	5.0	5.0	5.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	5.0	5.0	5.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$ (see page C6)			3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$			65	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)			250	mV
I_H	Typical holding current			10	mA
I_P	Typical pick-up current			20	mA
t_{off}	Typical turn-off time $I_F = 10A$, $I_R = 10A$ (see Page C7)			50	µs
t_{on}	Typical turn-on time (see Page C7)			5.0	µs

Note 2. The device may breakover into the maximum repetitive peak forward current at the maximum rate of rise of forward current.

MECHANICAL DATA

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Tag Insulating bush Mica washer	56264A	Supplied on request.

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

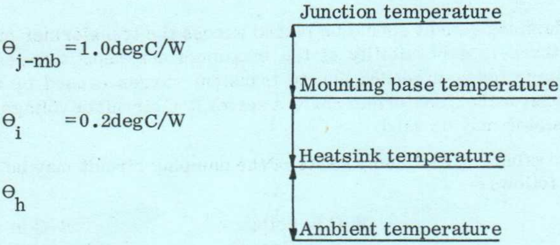
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page C2 is as follows.

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot\ max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

b) The applied voltage must not exceed the nominal peak rating of the fuse.

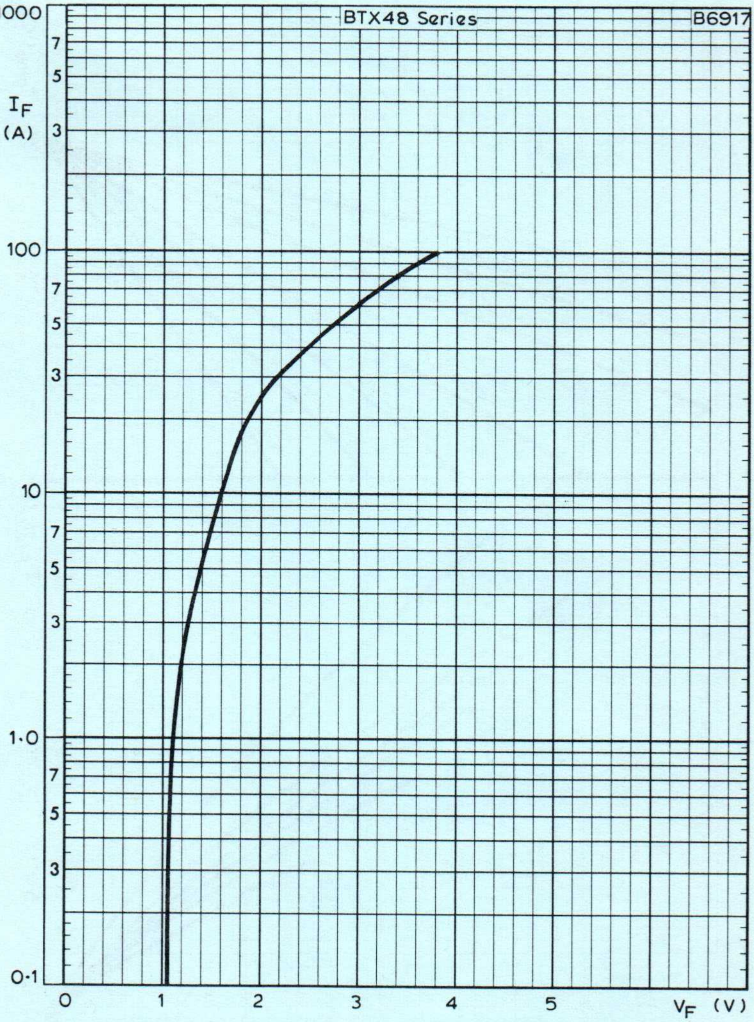
c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

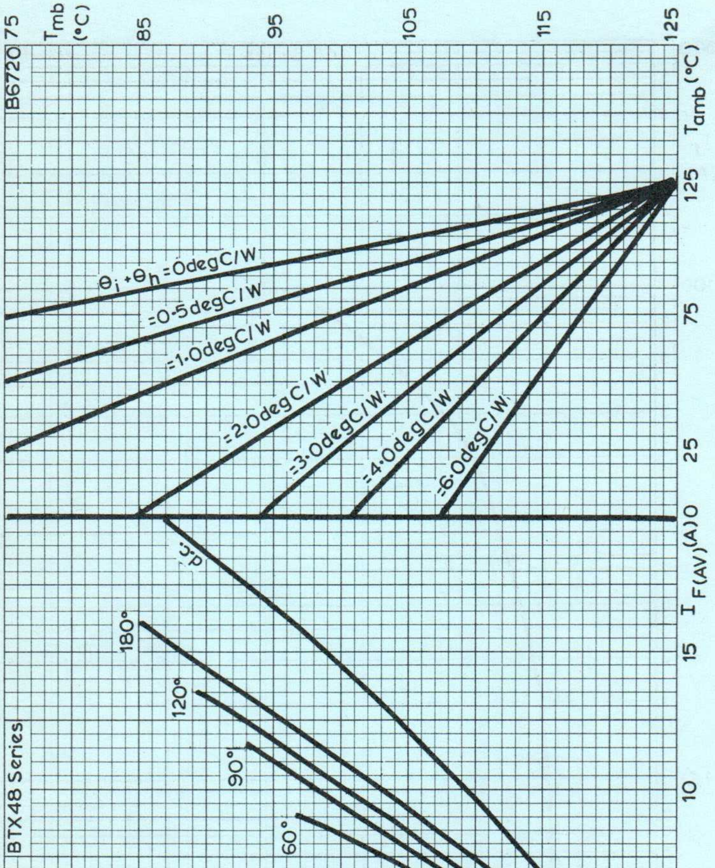
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

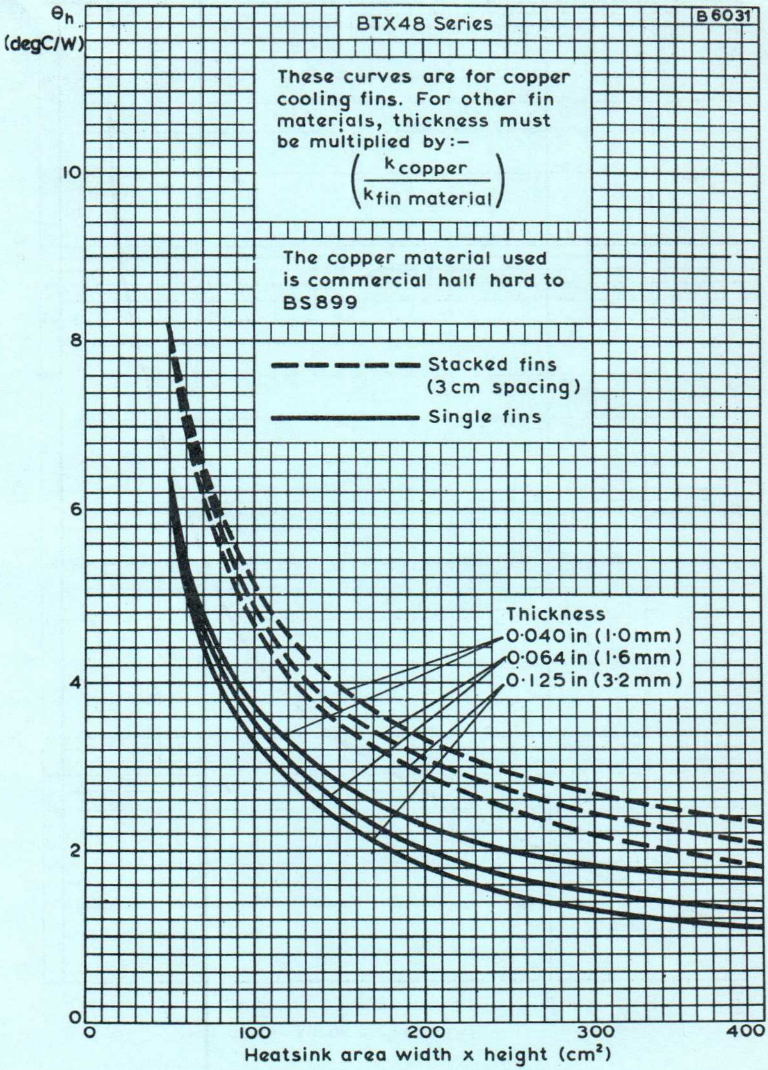
Where starting conditions are likely to exceed the current limits given on page C2, the curves on pages C9 and C10 may be used. Page C9 refers to the output of a single-phase bridge and page C10 to a three-phase bridge.



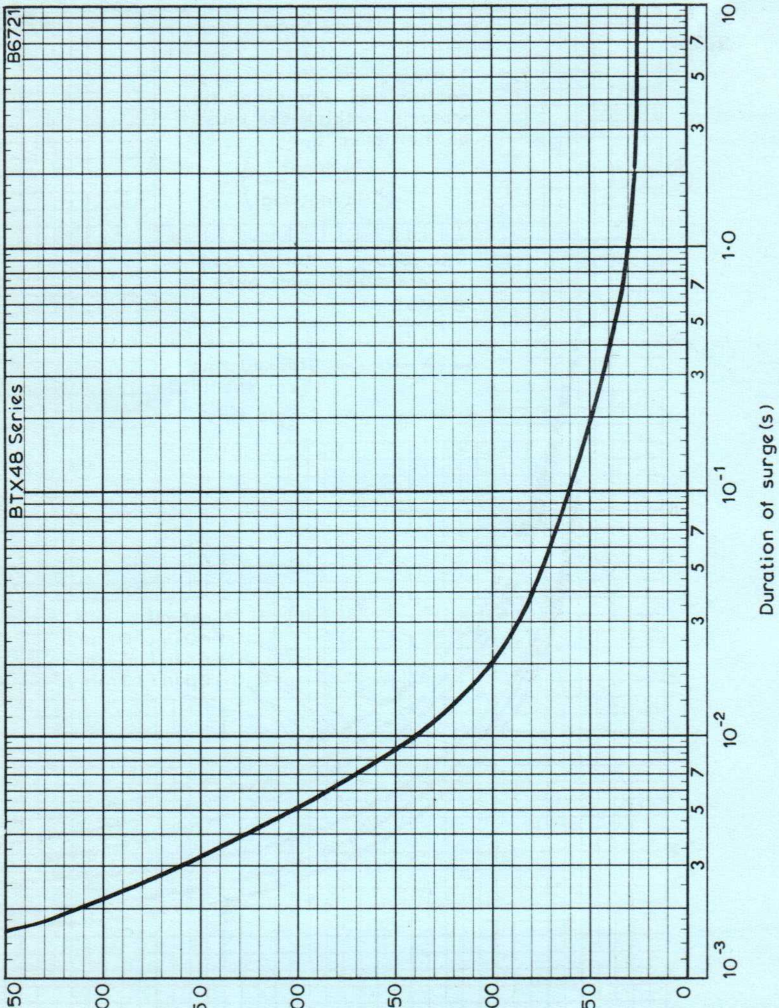
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



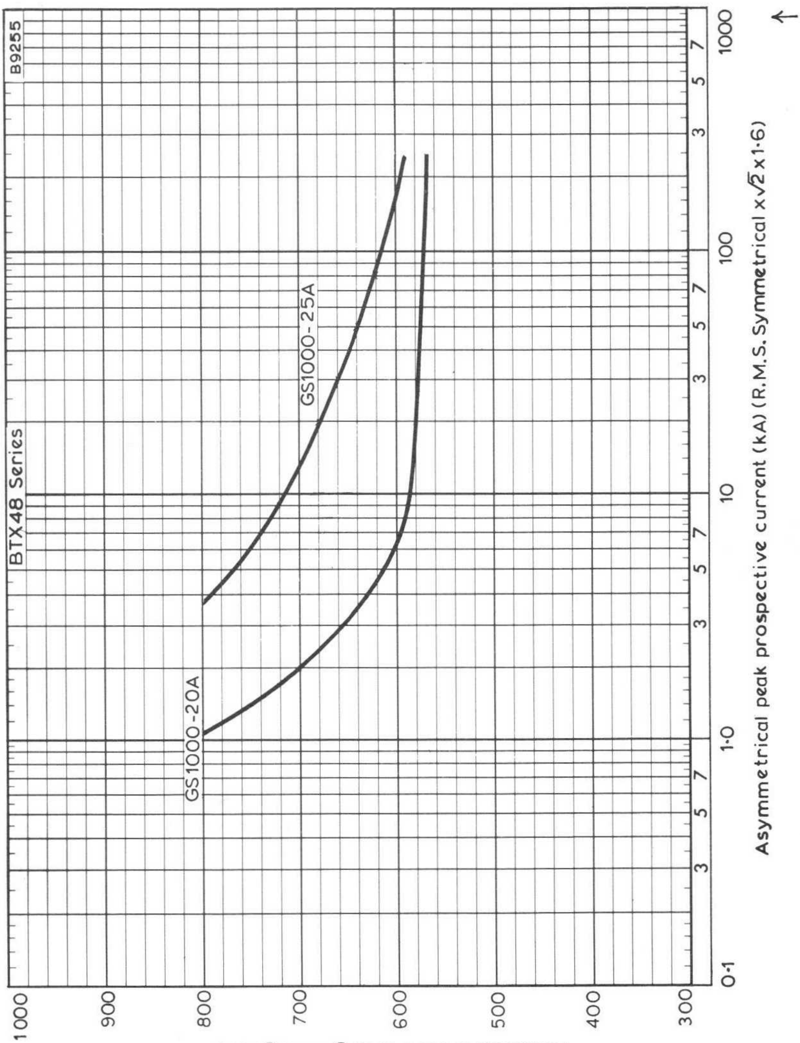
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURE FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



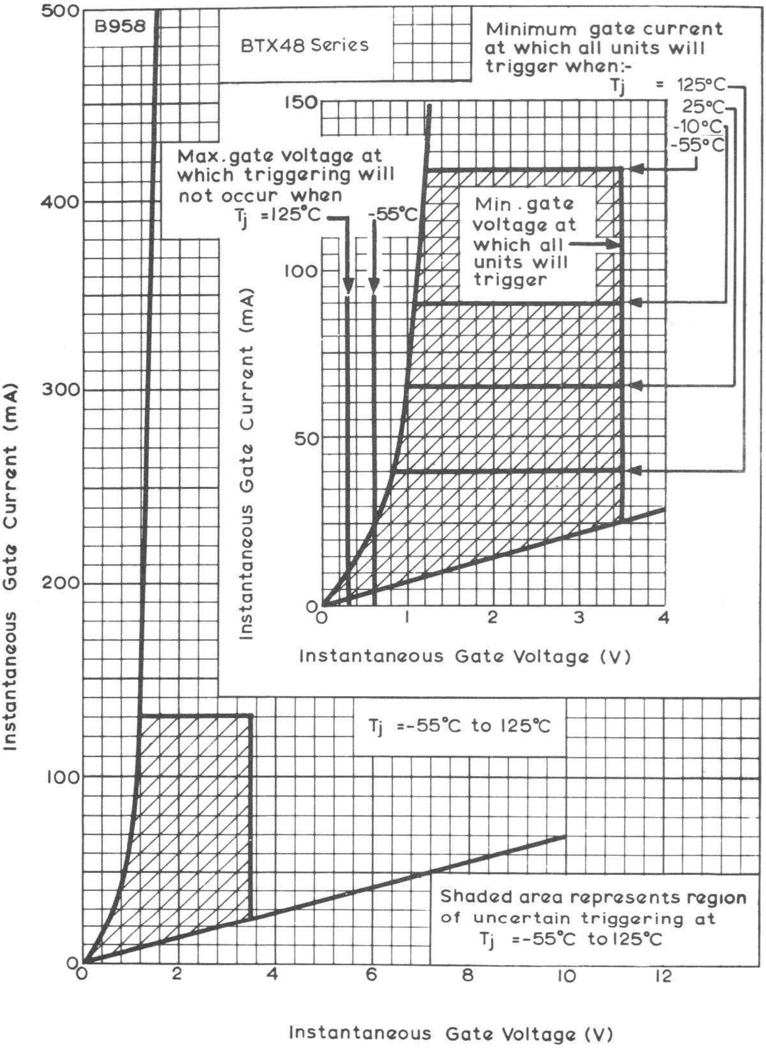
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



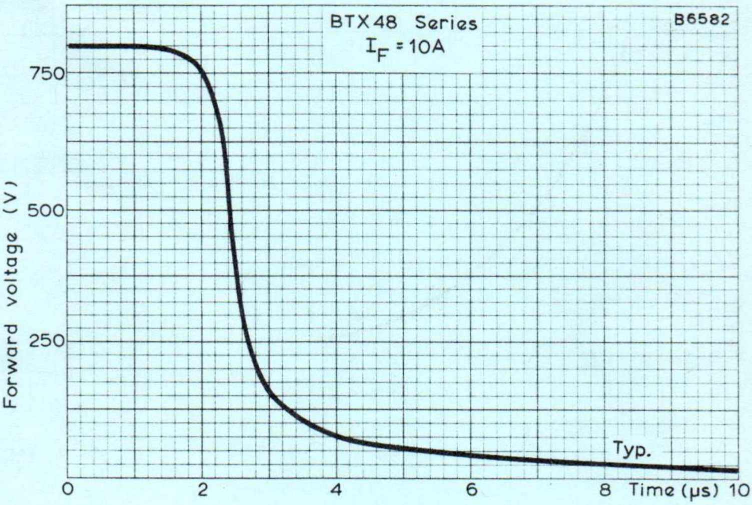
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC)

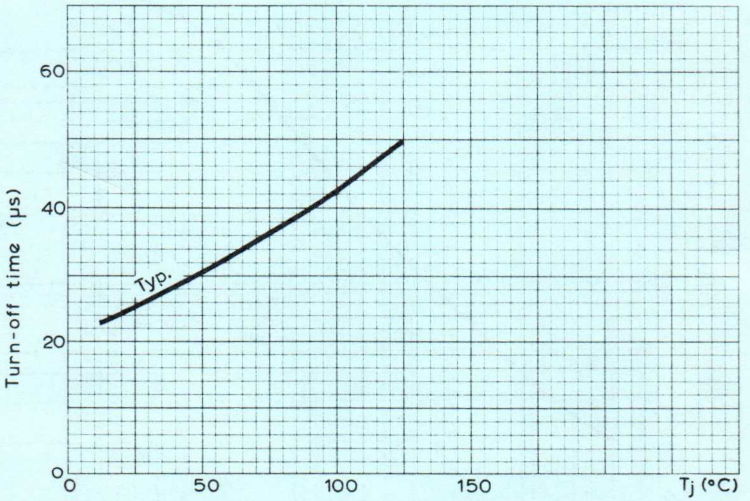


CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT

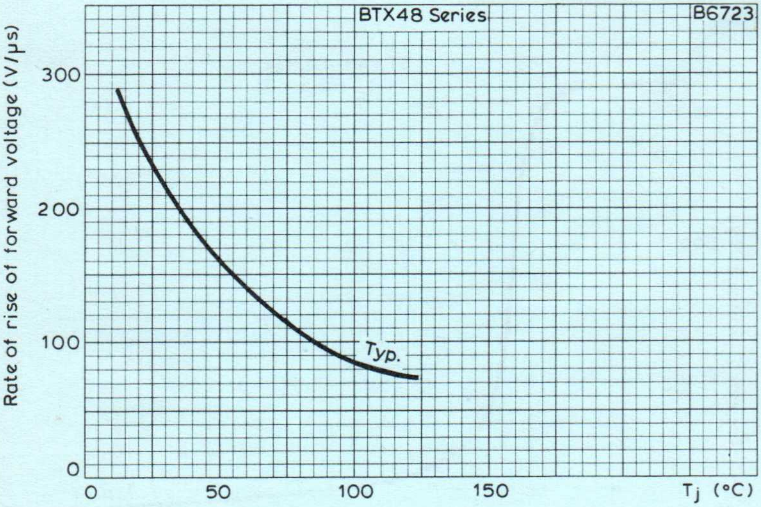


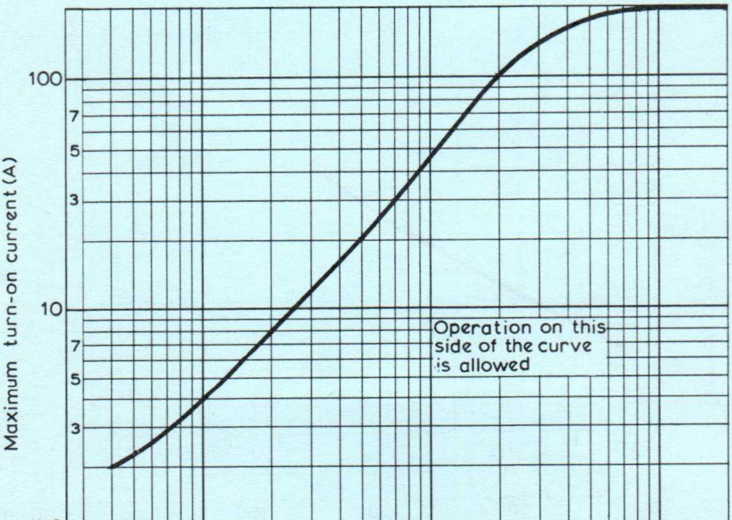
THYRISTOR GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



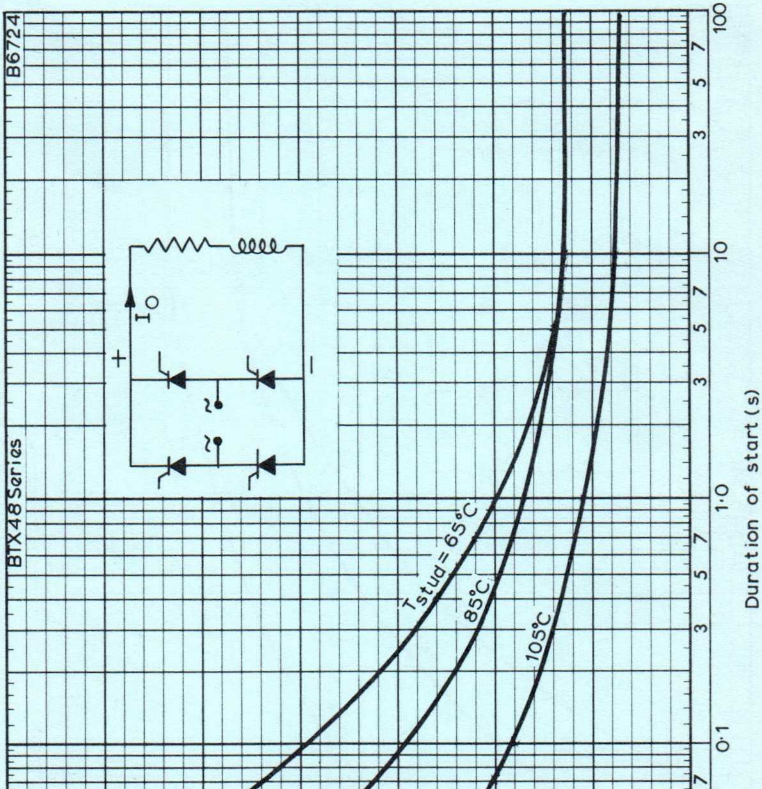


TYPICAL TURN-ON CHARACTERISTIC
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE

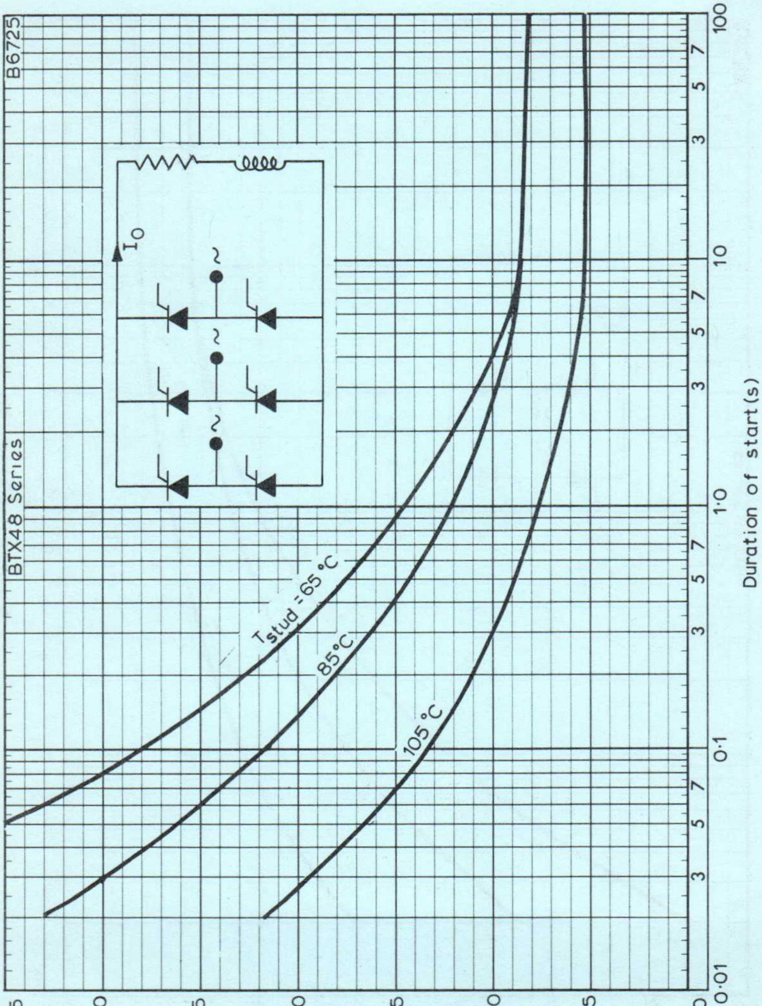




VARIATION OF RATE OF RISE OF FORWARD VOLTAGE
WITH JUNCTION TEMPERATURE
MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES
PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A THREE-PHASE BRIDGE

THYRISTORS

BTX49 Series

TENTATIVE DATA

The BTX49 is a range of p-gate reverse blocking thyristors for use in power control circuits, direct on 440V supplies. They have controlled avalanche characteristics and are therefore capable of absorbing reverse transients. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

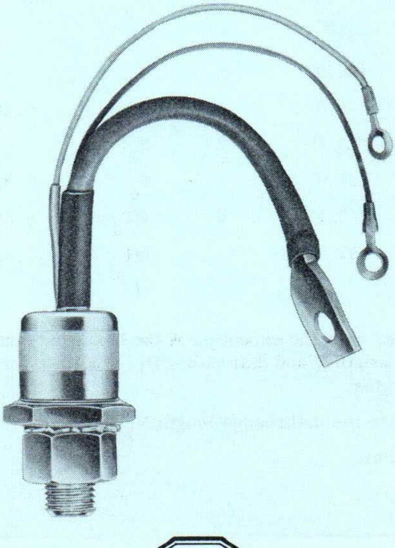
BTX49 -	1000R	1200R	1400R	
V_{BO} min.	900	1100	1300	V
$V_{(BR)}$ aval. min.	1000	1200	1400	V
V_{DWM}	800	800	800	V
V_{RWM}	800	800	800	V
$I_{F(AV)}$ ($T_{stud} = 85^{o}C$)		60		A
$I_{F(RMS)}$		110		A

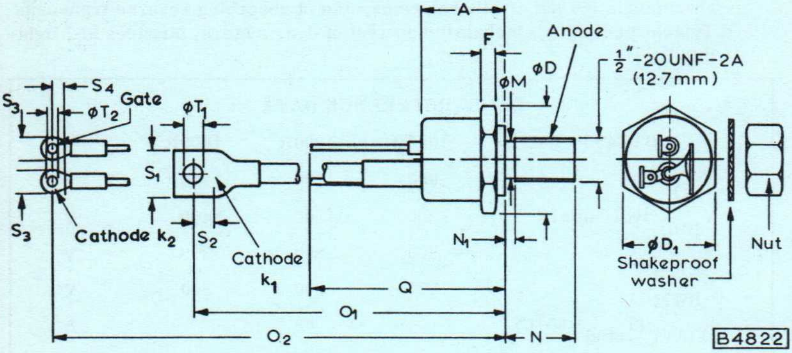
Unless otherwise shown, data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-30C

For details see page D2





Dimensions in millimetres

	Min.	Max.	Notes		Min.	Max.	Notes
A	-	28.57		O_2	166	228	
ØD		31.24		Q		63.5	1
$ØD_1$	26.19	26.97	1	S_1		16.51	
F	4.4	8.8		S_2	6.35		3
ØM	10.55	12.7	2	S_3		7.62	
N	18.5	21.0		S_4	3.81		3
N_1		3.17	2	$ØT_1$	6.35	8.40	
O_1	140	203		$ØT_2$	2.80	3.93	

NOTES

1. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter $ØD_1$. Q allows for the leads to be bent at right angles.
2. ØM refers to the unthreaded length N_1.
3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)		1000R	1200R	1400R	
V_R	Continuous reverse voltage	800	800	800	V
V_{RWM}	Crest working reverse voltage	800	800	800	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	1000	1200	1400	V
V_{RWM}	Non-repetitive peak reverse voltage (< 10ms)	1000	1200	1400	V
V_D	Continuous off-state voltage	800	800	800	V
V_{DWM}	Crest working off-state voltage	800	800	800	V
V_{DRM}	Repetitive off-state voltage (1% duty cycle 50Hz)	900	1100	1300	V

Power

P_R	Maximum non-repetitive reverse avalanche power (10μs)		
	$T_j = 25^oC$	40	kW
	$T_j = 125^oC$	18	kW

Note 1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 3.0degC/W for a.c. operation, and 1.5degC/W for d.c. operation.

Current

I_F	Continuous forward current	110	A
$I_{F(AV)}$	Mean forward current (see page C2)	70	A
I_{FRM}	Repetitive peak forward current	1000	A
I_{FSM}	Maximum forward surge current peak of half-sine at maximum operating conditions (see page C4)	1050	A
I^2t	I^2t for fusing (< 10ms) (see pages C4 and C5)	5600	A^2s
$\frac{di}{dt}$	Rate of rise of forward current (see page C8)	50	A/μs
I_{RRM}	Repetitive peak reverse current	30	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature	-55	^oC
T_{stg} max.	Storage temperature	125	^oC
T_j max.	Junction temperature	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	0.3	degC/W
Θ_i	Maximum thermal resistance for a torque of 17kg.cm. on the nut	0.1	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance (1ms)	0.015	degC/W

ELECTRICAL CHARACTERISTICS (T_j = 125°C unless otherwise stated)

	BTX49 -	1000R	1200R	1400R	
V_{BO}	Minimum forward breakover voltage (see note 2)	900	1100	1300	V
V_F	Maximum instantaneous forward voltage at I_F = 500A, T_j = 25°C			3.5	V
i_D	Maximum forward leakage current at V_{DWM}	10	10	10	mA
i_R	Maximum reverse leakage current at V_{RWM}	10	10	10	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at T_j = 25°C (see page C6)			3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25°C (see page C6)			80	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)			250	mV
I_H	Typical holding current			10	mA
I_P	Typical pick-up current			20	mA
t_{off}	Typical turn-off time I_F = 50A, I_R = 30A (see page C7)			50	µs
t_{on}	Typical turn-on time (see page C7)			5.0	µs

Note 2. The device may breakover into the maximum repetitive peak forward current at the maximum rate of rise of forward current.

MECHANICAL DATA

Maximum torque on hexagon or nut	175	kg cm
	13	lb ft
Minimum torque on hexagon or nut for good thermal contact	90	kg cm
	6.5	lb ft
Recommended diameter of hole in heatsink	13	mm
	0.51	in
Weight		
Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

Accessories

Accessory	Note
1/2" UNF nut Shakeproof washer	Supplied with thyristor

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the dampint circuit may be calculated as follows:-

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R × C (μs)	R-C in secondary of transformer C (μF)	R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

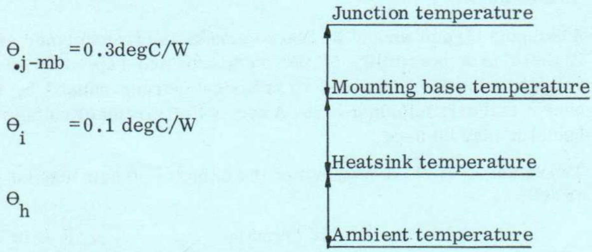
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page C2 is as follows.

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot\ max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

b) The applied voltage must not exceed the nominal peak rating of the fuse.

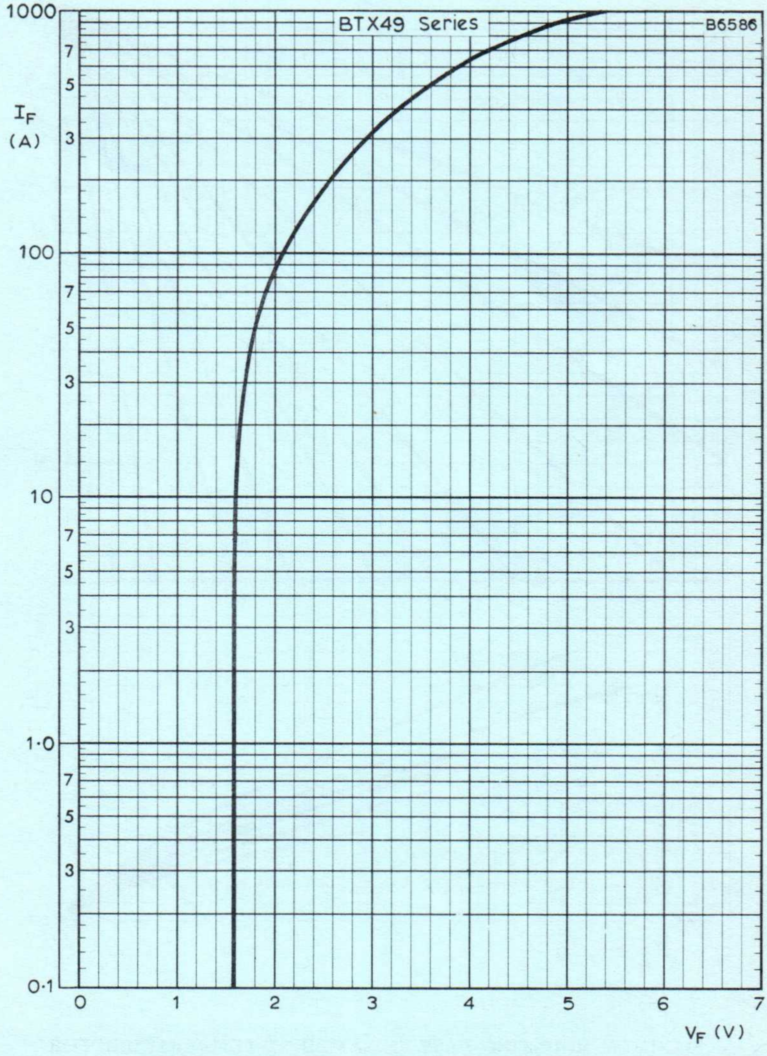
c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

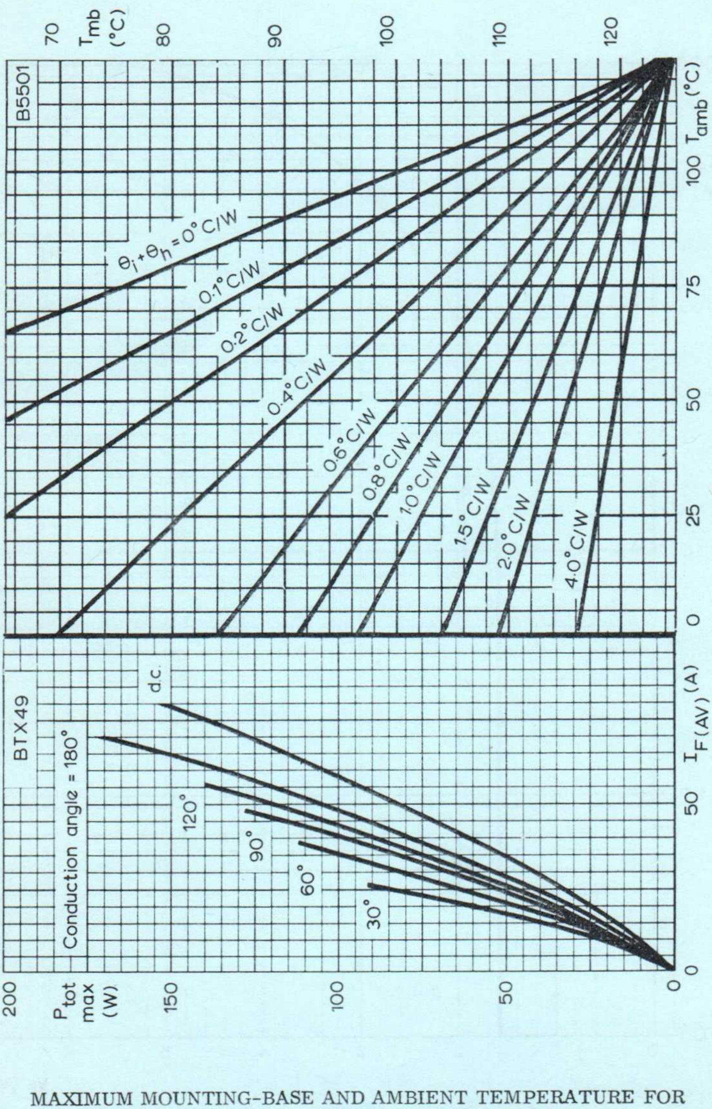
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

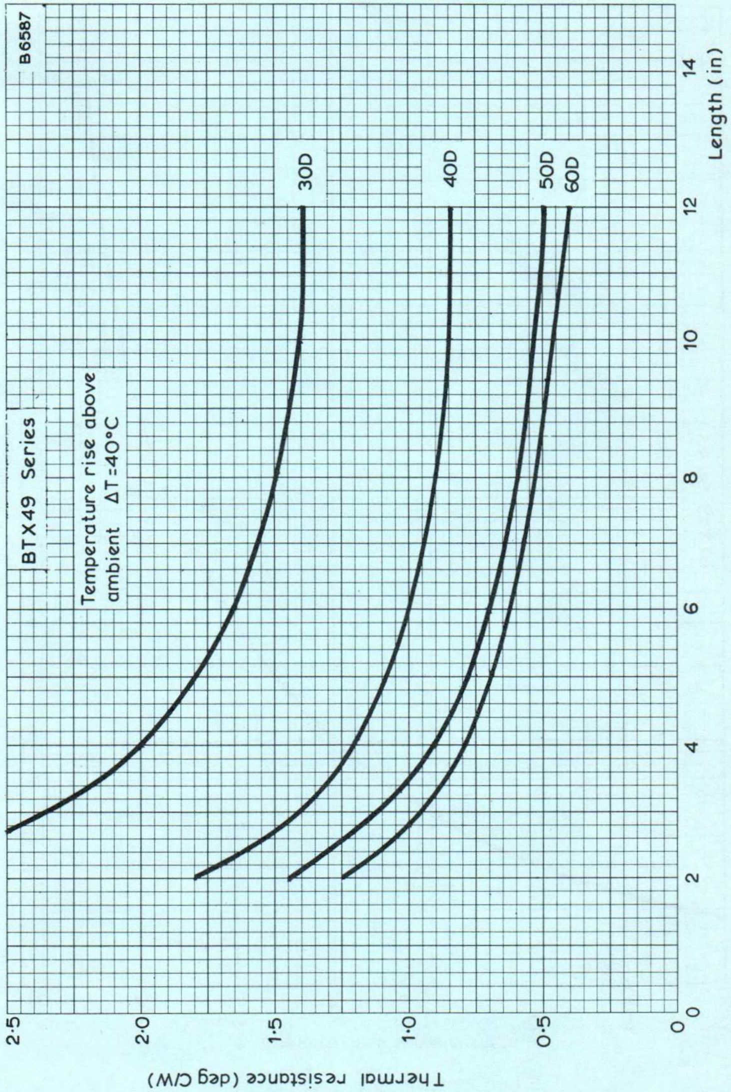
When starting conditions are likely to exceed the current limits given on page C2, the curves on pages C9 and C10 may be used. Page C9 refers to the output of a single-phase bridge and page C10 to a three-phase bridge.



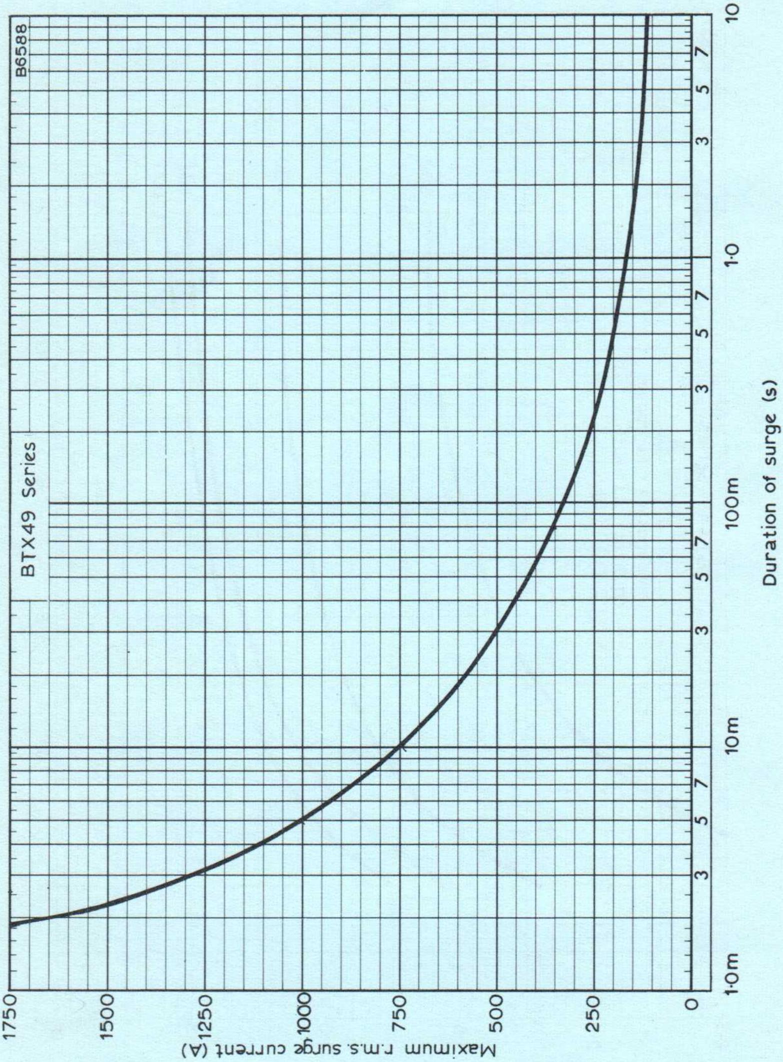
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



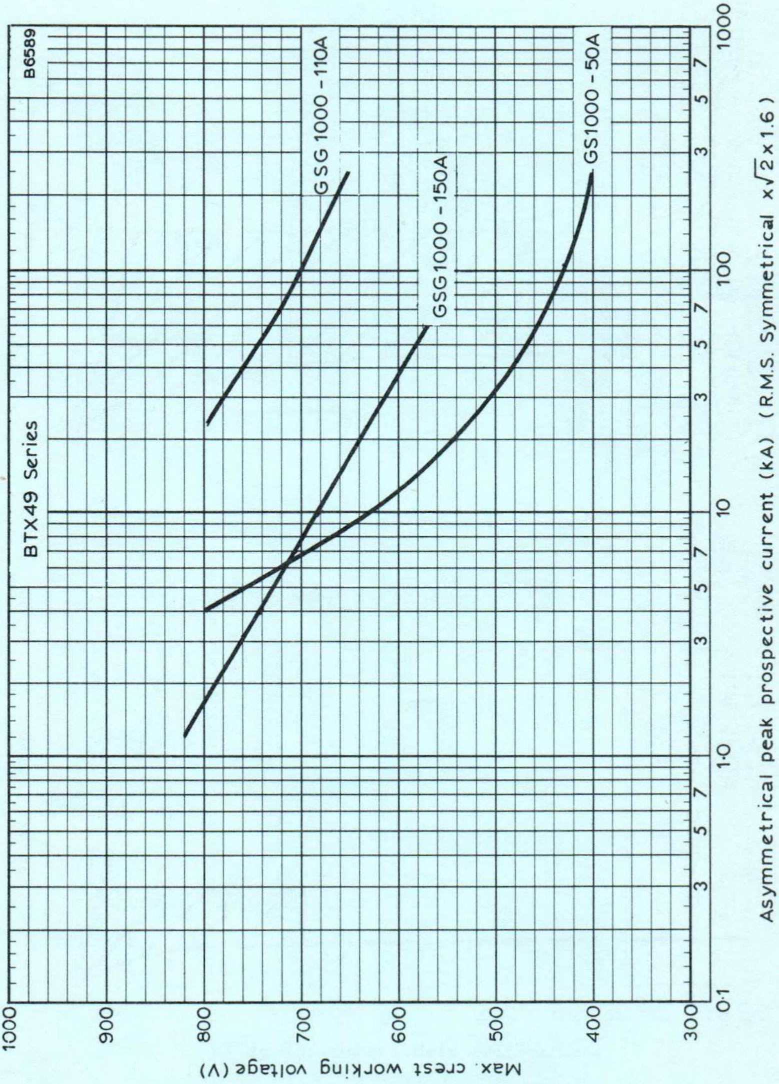
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURE FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



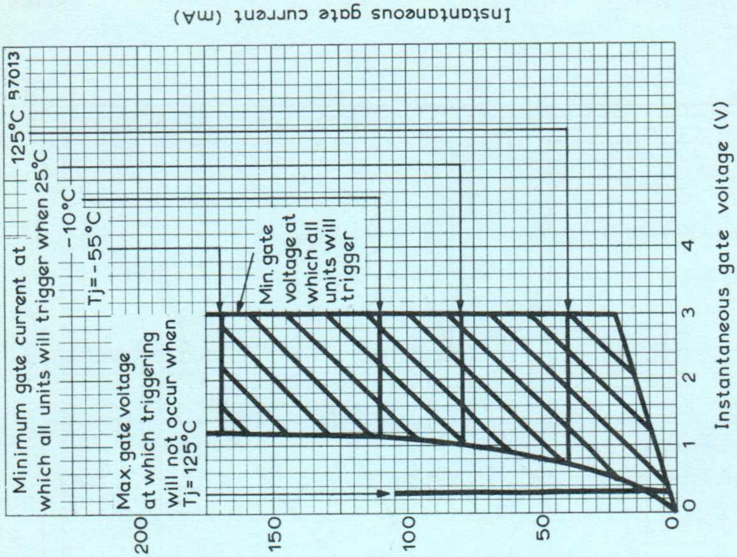
THERMAL RESISTANCE OF BLACKENED EXTRUSION PLOTTED AGAINST EXTRUSION LENGTH IN FREE AIR

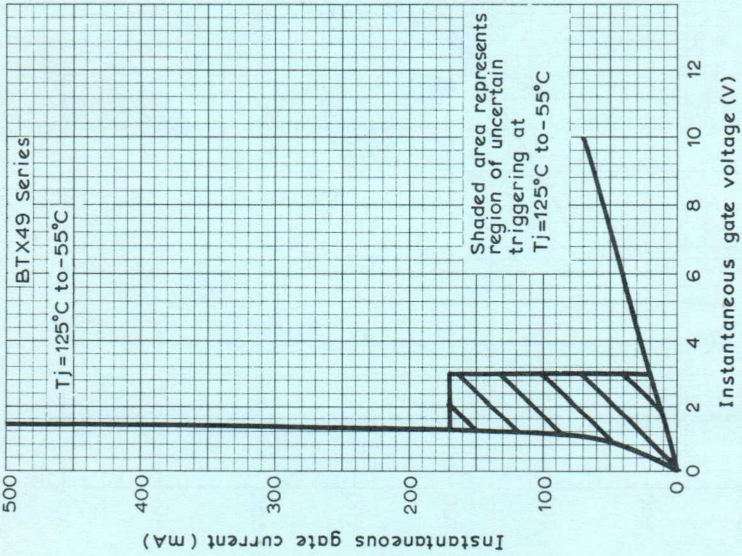


MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)

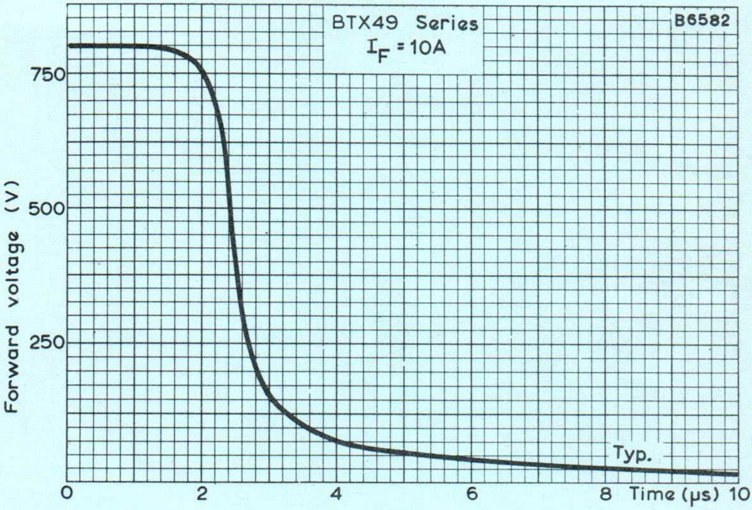


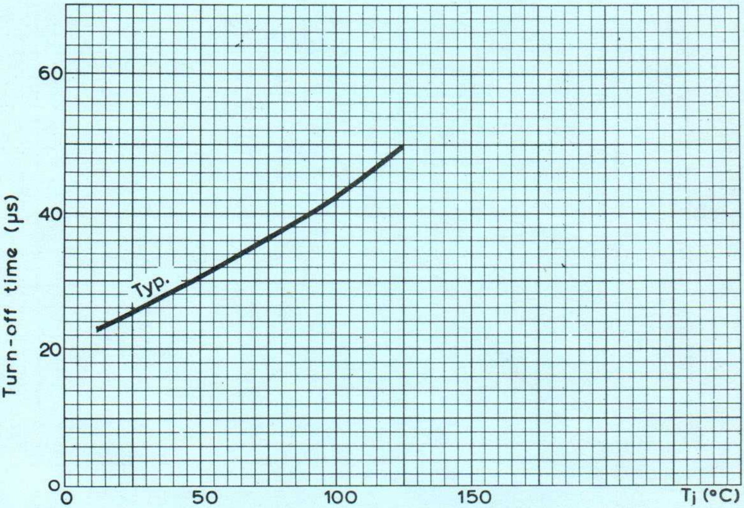
CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT



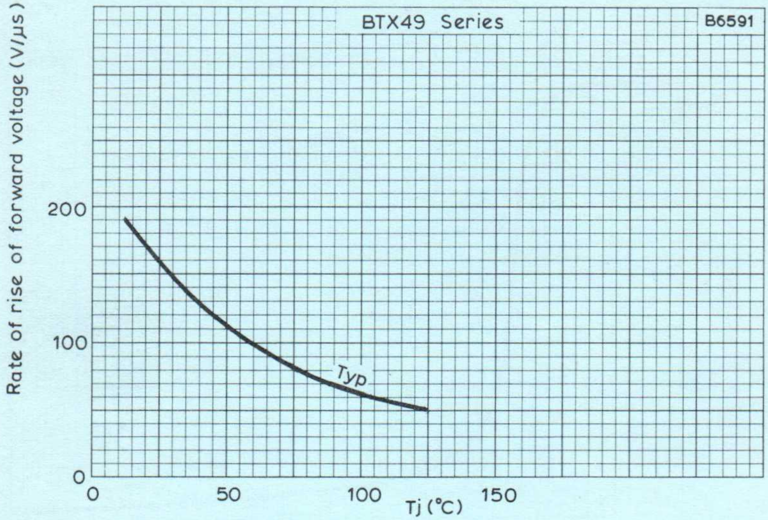


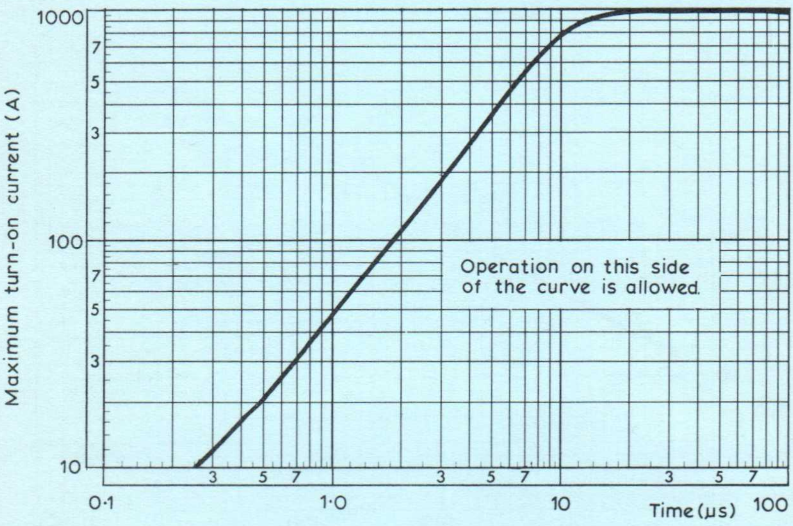
THYRISTOR GATE CHARACTERISTIC
THE TOP GRAPH IS AN ENLARGEMENT OF THE PORTION
OF THE GRAPH NEAR THE ORIGIN





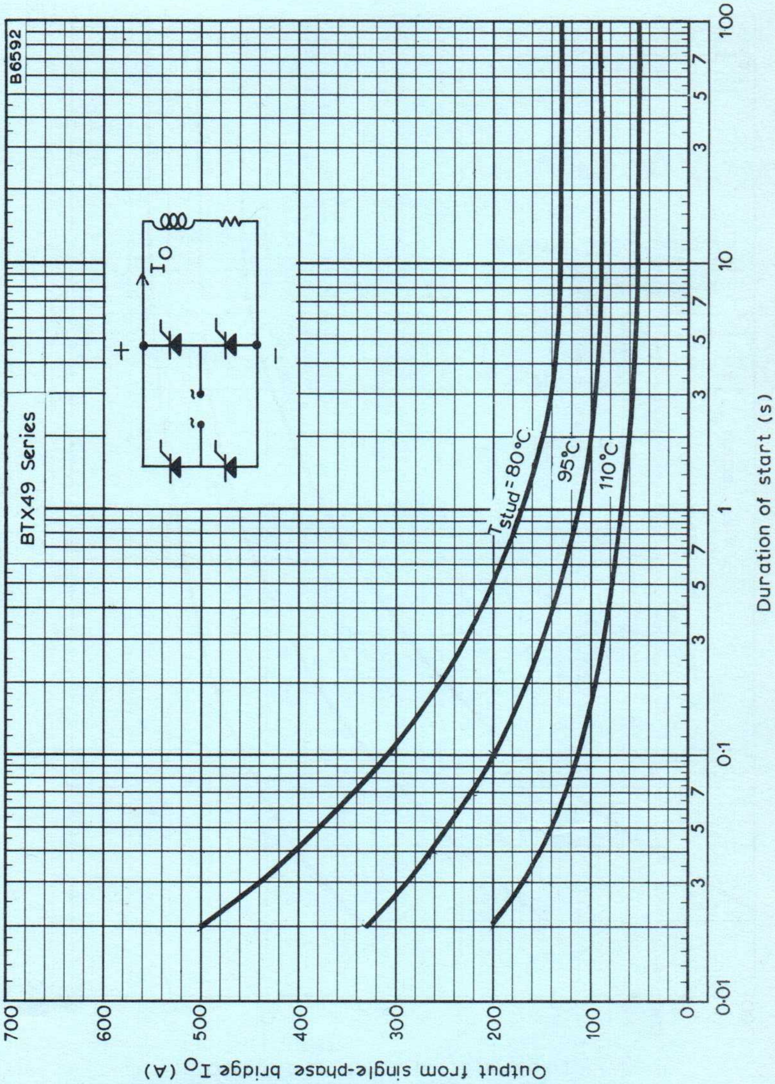
TYPICAL TURN-ON CHARACTERISTIC
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE



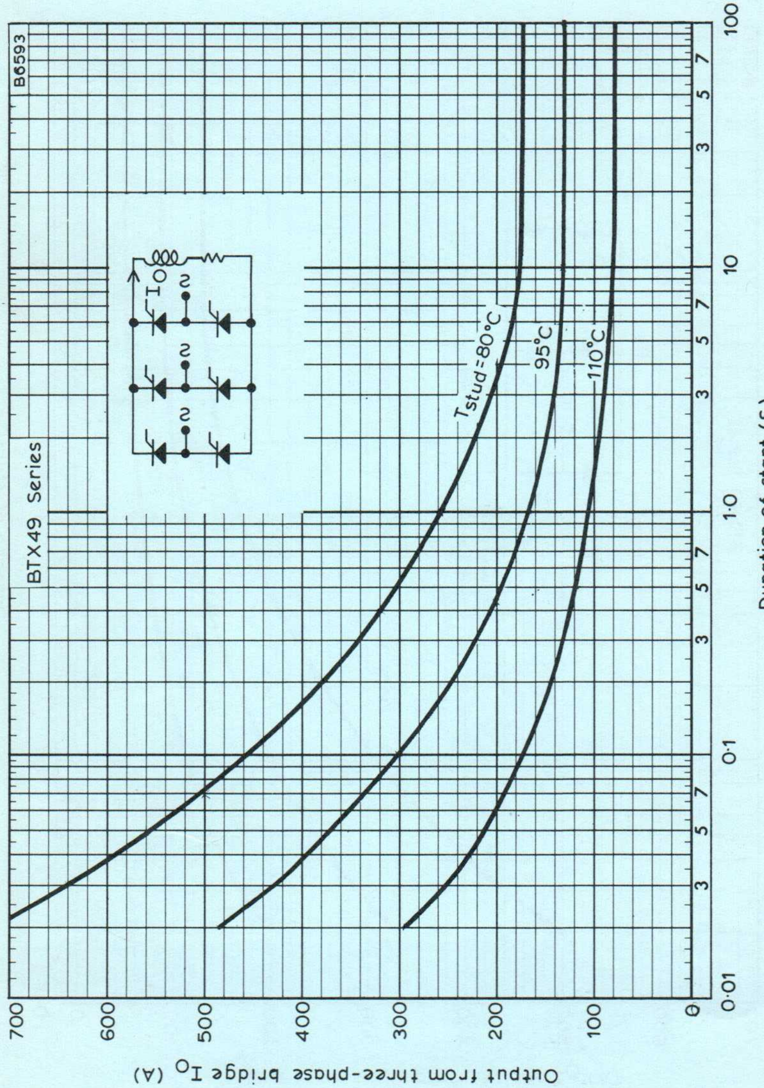


VARIATION OF RATE OF RISE OF FORWARD VOLTAGE WITH JUNCTION TEMPERATURE

MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A THREE-PHASE BRIDGE

TENTATIVE DATA

The BTX50 is a range of p-gate reverse blocking thyristors for use in power control circuits, direct on 440V supplies. They have controlled avalanche characteristics and are therefore capable of absorbing reverse transients. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

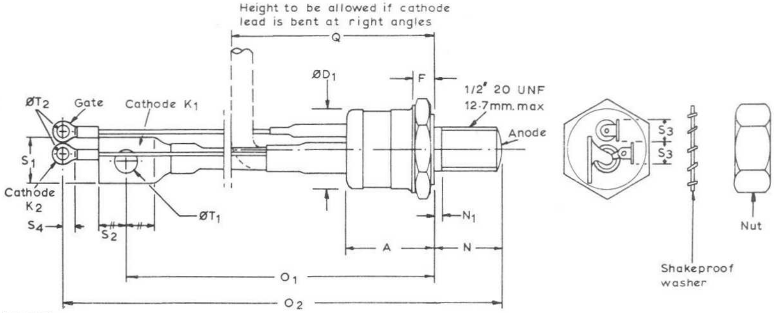
BTX50-	1000R	1200R	1400R	
V_{BO} min.	900	1100	1300	V
$V_{(BR)}$ aval. min.	1000	1200	1400	V
V_{DWM}	800	800	800	V
V_{RWM}	800	800	800	V
$I_{F(AV)}$ $T_{stud} = 85^{\circ}C$		70		A
$I_{F(RMS)}$		110		A

Unless otherwise shown, data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-30C

For details see page D2.



B7482

All dimensions in mm

Ref.	Min.	Max.	Notes	Ref.	Min.	Max.	Notes
A	-	28.6		Q	-	63.5	2
$ØD_1$	-	25.4		S_1	-	16.5	
F	-	8.9	1	S_2	9.6	-	3
N	20.24	21.0		S_3	-	7.6	
N_1	-	2.5		S_4	3.8	-	3
O_1	148	158		$ØT_1$	8.1	8.3	
O_2	174	190		$ØT_2$	4.05	4.2	

NOTES

1. This zone includes a standard hexagon 27mm (1.062in) nominally across flats.
2. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter $ØD_1$. Q allows for the leads to be bent at right angles.
3. Minimum flat.

THYRISTORS

BTX50
Series

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)	BTX50-	1000R	1200R	1400R	
V_R	Continuous reverse voltage	800	800	800	V
V_{RWM}	Crest working reverse voltage	800	800	800	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	1000	1200	1400	V
V_{RWM}	Non-repetitive peak reverse voltage (< 10ms)	1000	1200	1400	V
V_D	Continuous off-state voltage	800	800	800	V
V_{DWM}	Crest working off-state voltage	800	800	800	V
V_{DRM}	Repetitive off-state voltage (1% duty cycle at 50Hz)	900	1100	1300	V
V_{DSM}	Non-repetitive off-state voltage (< 10ms)	900	1100	1300	V
Power					
P_R	Maximum non-repetitive reverse avalanche power (10μs)				
	$T_j = 25^oC$		40		kW
	$T_j = 125^oC$		18		kW

Note 1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 3.0degC/W for a.c. operation, and 1.5degC/W for d.c. operation.

RATINGS (cont'd)

Current

I_F	Continuous forward current	110	A
$I_{F(AV)}$	Mean forward current (see page 11)	70	A
I_{FRM}	Repetitive peak forward current	1000	A
I_{FSM}	Maximum forward surge current peak of half-sine at maximum operating conditions (see page 13)	1500	A
I^2t	I^2t for fusing (< 10ms) (see pages 13 and 14)	10 000	A^2s
$\frac{di}{dt}$	Rate of rise of forward current (see page 17)	50	A/μs
I_{RRM}	Repetitive peak reverse current	30	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature	-55	^oC
T_{stg} max.	Storage temperature	125	^oC
T_j max.	Junction temperature	125	^oC

THERMAL CHARACTERISTICS

$R_{th(j-mb)}$	Maximum thermal resistance from junction to mounting base	0.3	degC/W
$R_{th(i)}$	Maximum thermal resistance for a torque of 17kg cm on the nut	0.1	degC/W
$R_{th(t)}$	Transient thermal resistance from junction to mounting base (1ms)	0.015	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

	BTX50-	1000R	1200R	1400R	
V_{BO}	Minimum forward breakover voltage (see note 2)	900	1100	1300	V
V_F	Maximum instantaneous forward voltage at $I_F = 500A$, $T_j = 25^oC$			2.5	V
i_D	Maximum forward leakage current at V_{DWM}	10	10	10	mA
i_R	Maximum reverse leakage current at V_{RWM}	10	10	10	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$ (see page 15)			3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$ (see page 15)			80	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page 15)			250	mV
I_H	Typical holding current			10	mA
I_P	Typical pick-up current			20	mA
t_{off}	Typical turn-off time $I_F = 50A$, $I_R = 30A$ (see page 16)			50	μs
t_{on}	Typical turn-on time (see page 16)			5.0	μs

Note 2. The device may breakover into the maximum repetitive peak forward current at the maximum rate of rise of forward current.

MECHANICAL DATA

Maximum torque on hexagon or nut	175	kg cm
	13	lb ft
Minimum torque on hexagon or nut for good thermal contact	90	kg cm
	6.5	lb ft
Recommended diameter of hole in heatsink	13	mm
	0.51	in
Weight		
Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

Accessories

Accessory	Note
1/2" UNF nut	Supplied with thyristor
Shakeproof washer	Supplied with thyristor

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

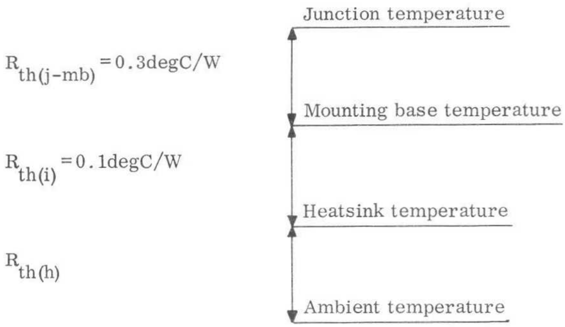
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page 11 is as follows.

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $R_{th(i)} + R_{th(h)}$ is reached. Finally trace downwards to determine the maximum ambient temperature.

$R_{th(i)}$ is the contact thermal resistance for minimum torque, as given on page 4. $R_{th(h)}$ is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of $R_{th(h)}$ for blackened vertical heatsinks see the curve on page 12.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page 11. Thus, knowing the maximum ambient temperature the maximum value of $R_{th(h)}$ is given by

$$R_{th(h)} = \frac{T_{mb} - T_{amb}}{P_{tot}\ max.} - R_{th(i)}$$

The size of the heatsink required may be found from the graph on page 12.

OPERATING NOTES (cont'd)

5. FUSING

The curve given on page 13 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

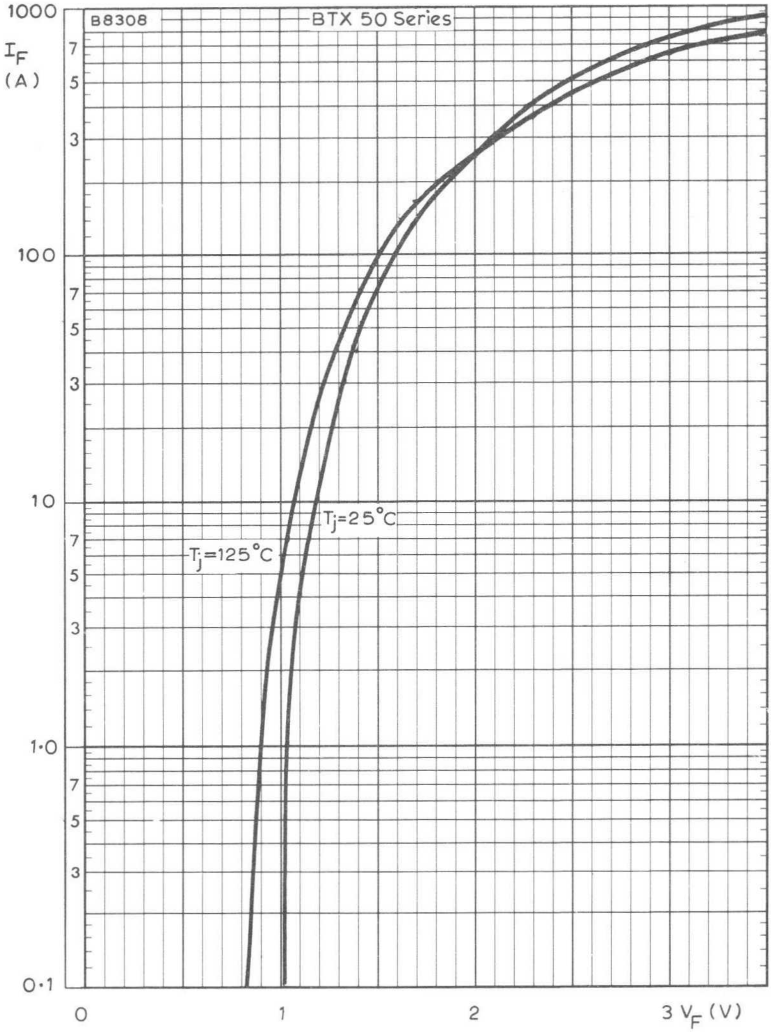
(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

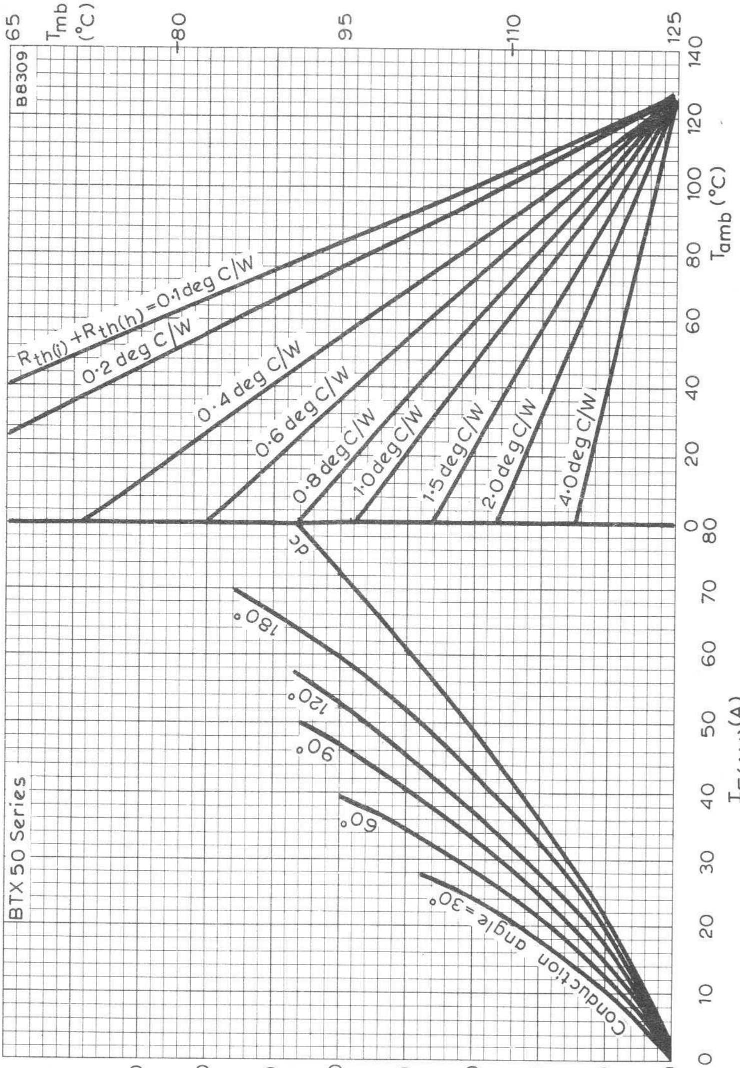
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

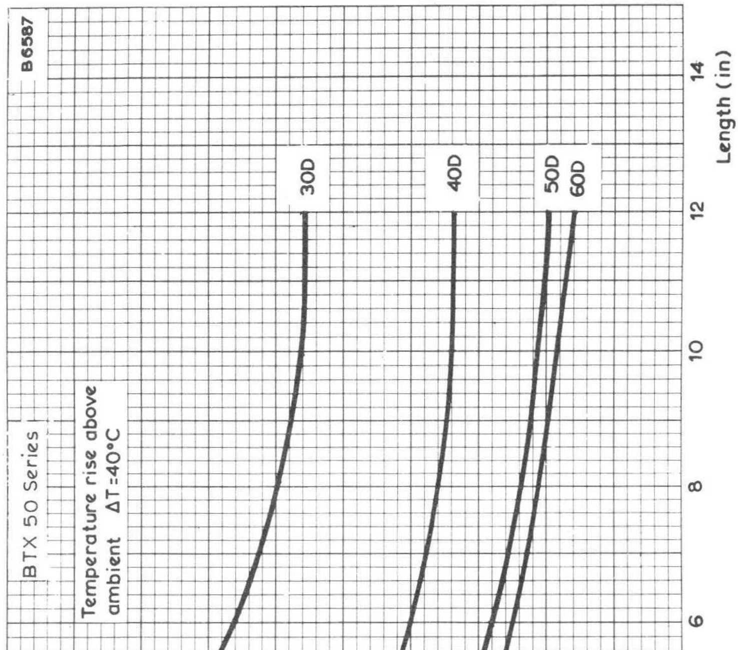
The curve shown on page 14 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.



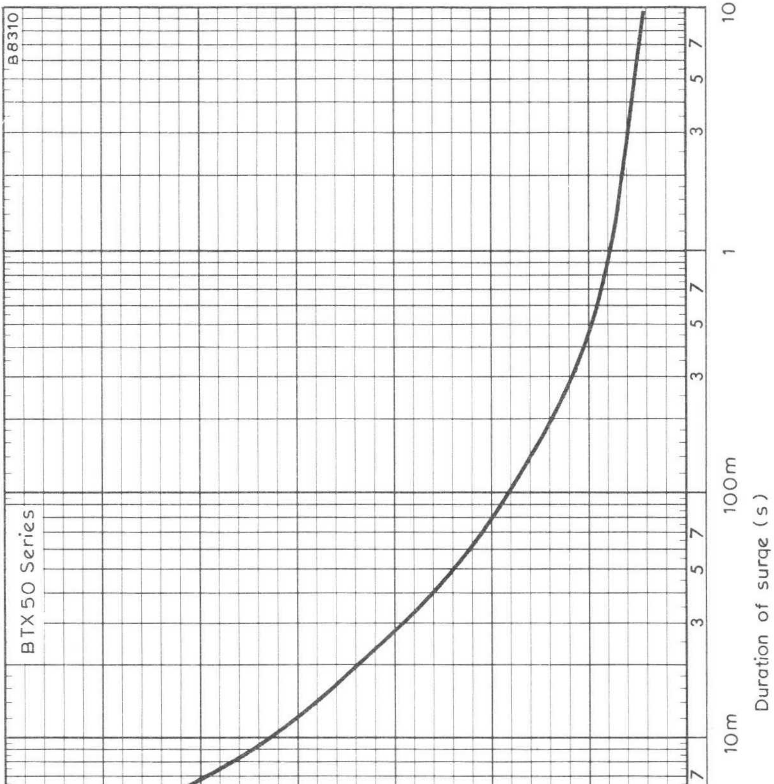
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



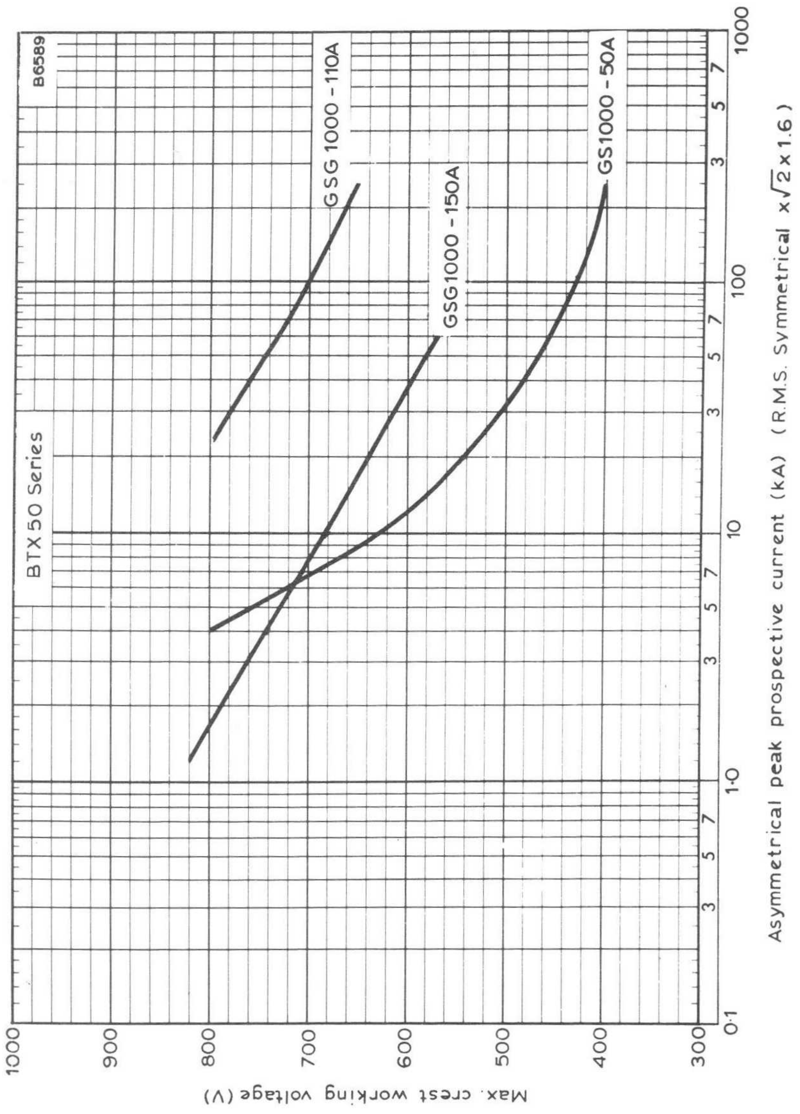
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



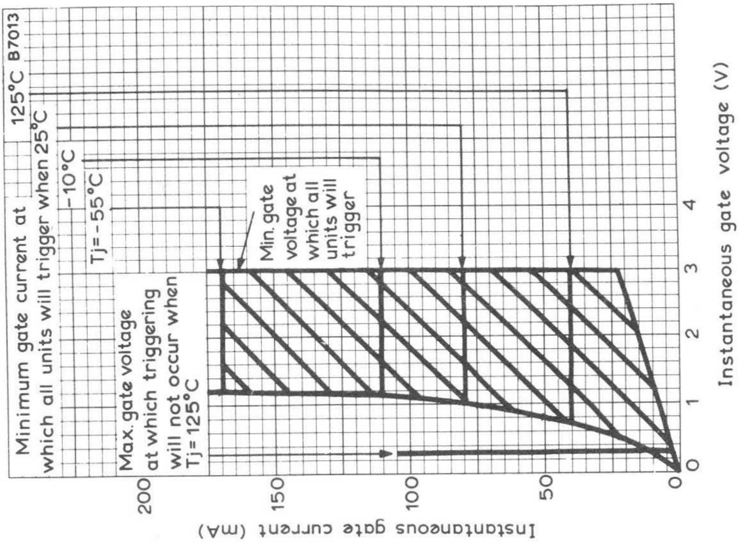
THERMAL RESISTANCE OF BLACKENED EXTRUSION PLOTTED AGAINST EXTRUSION LENGTH IN FREE AIR

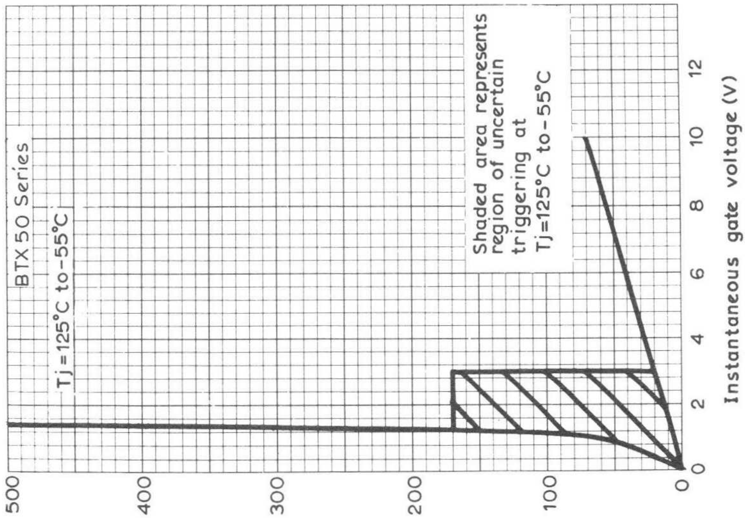


MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)

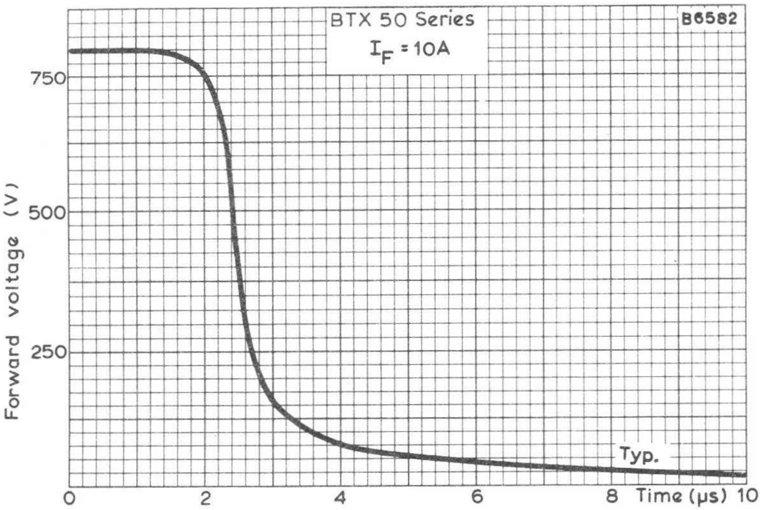


CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT

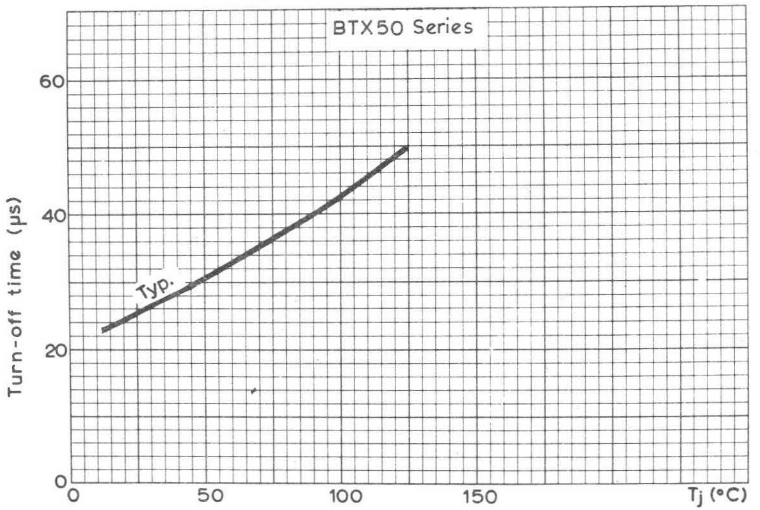




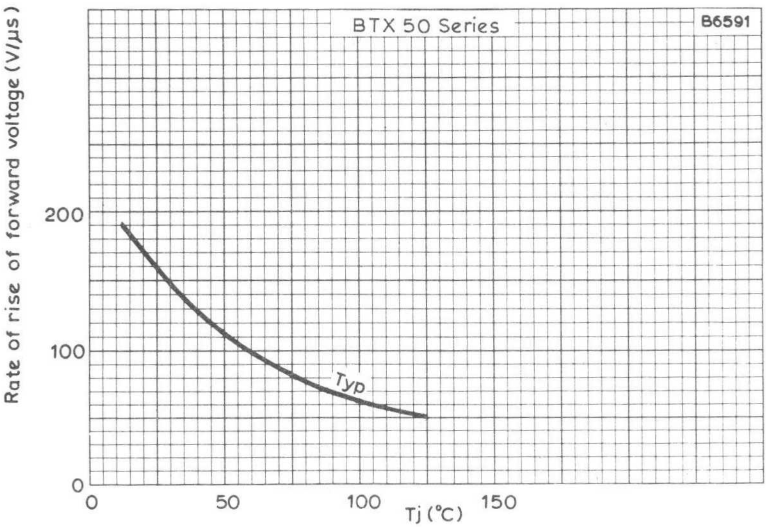
THYRISTOR GATE CHARACTERISTIC
THE TOP GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



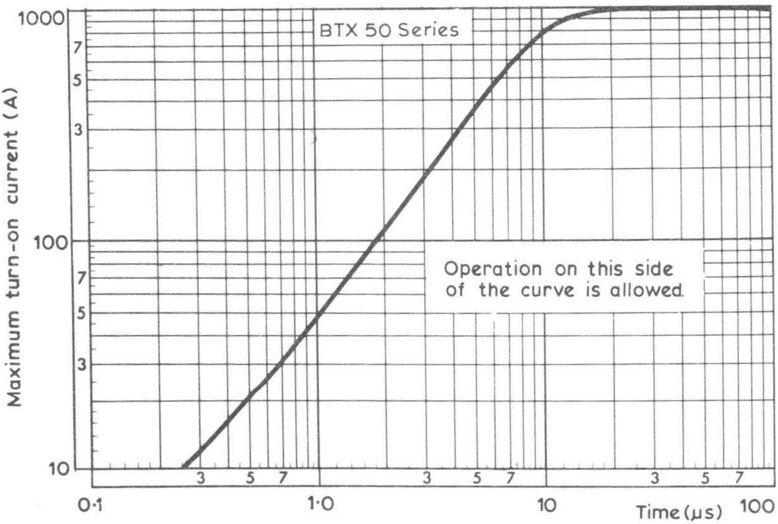
TYPICAL TURN-ON CHARACTERISTIC



VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE



VARIATION OF RATE OF RISE OF FORWARD VOLTAGE WITH JUNCTION TEMPERATURE



MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME

THYRISTORS

FOR PARALLEL OPERATION

TENTATIVE DATA

This series of thyristors is for use in parallel operation where the current requirement is more than the maximum for a single device. In all other respects it is identical with the BTY99 series.
For general information regarding individual devices reference should be made to the corresponding device in the BTY99 series.

QUICK REFERENCE DATA

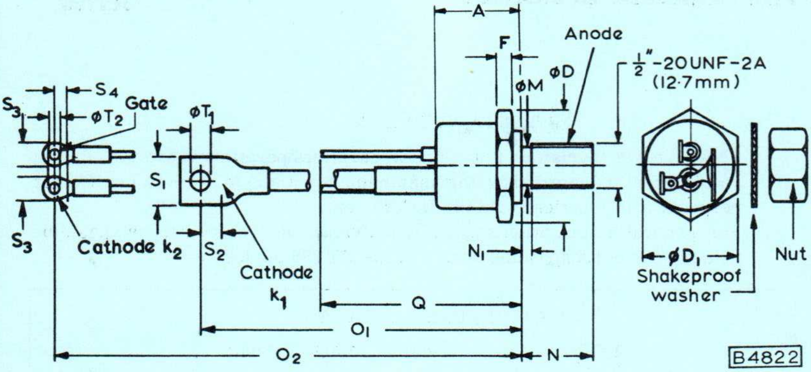
BTX51-	500R	600R	700R	800R	
V_{BO} min.	500	600	700	800	V
V_{RRM} max.	500	600	700	800	V
$I_{F(AV)}$ max.				70	A
θ_{j-mb} max.				0.4	deg C/W
V_F min. at 500A				2.0	V
V_F max. at 500A				2.1	V
T_j max.				125	^oC

Unless otherwise stated data is applicable to all types in the series.

OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-30A or SO-30C

For details see page D2.



Thyristors without the cathode lead k_2 conform to V.A.S.C.A. outline SO-30A. Those with k_2 conform to SO-30C.

Dimensions in millimetres

	Min.	Max.	Notes		Min.	Max.	Notes
A	-	28.57		O_2	166	228	
ØD		31.24		Q		63.5	1
ØD_1	26.19	26.97	1	S_1		16.51	
F	4.4	8.8		S_2	6.35		3
ØM	10.55	12.7	2	S_3		7.62	
N	18.5	21.0		S_4	3.81		3
N_1		3.17	2	ØT_1	6.35	8.40	
O_1	140	203		ØT_2	2.80	3.93	

NOTES

1. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter ØD_1. Q allows for the leads to be bent at right angles.
2. ØM refers to the unthreaded length N_1
3. Minimum flat.

PARALLEL OPERATION DESIGN DATA

When the required total average current I_T is greater than the maximum average current $I_{F(AV)}$ for one device, choose the required number "n" of parallel devices such that $n.I_{F(AV)}$ is equal to or greater than I_T.

In most cases, particularly where n is small, $n.I_{F(AV)}$ will be appreciably greater than I_T, but in the final design this will be offset to some extent by the use of smaller heatsinks.

Having determined the number of devices "n" required in parallel for any particular application, the average current per device will be given by I_T/n. This will be true for all practical purposes of the design by virtue of the selection procedure for these devices.

The graph on page C1 will then give the power dissipation P in each device for this current and the circuit configuration. The thermal circuit is represented in Fig. 1.

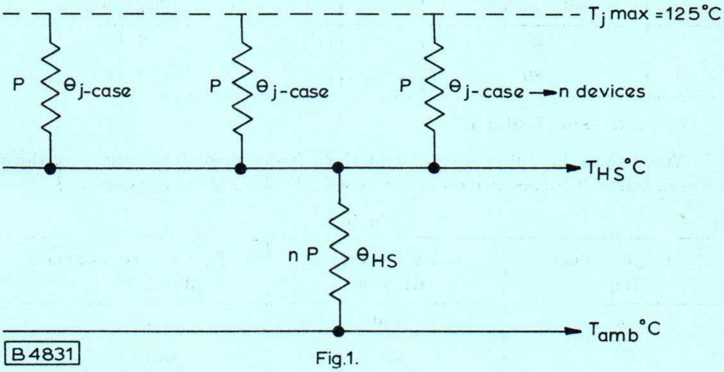


Fig.1.

For this series of devices the maximum junction temperature is $125^{o}C$, the maximum thermal resistance junction to case ($\Theta_{j\text{-case}}$) is 0.4degC/W and the maximum contact resistance (Θ_i) when screwed into a copper or aluminium heatsink using silicone grease and the recommended minimum torque is 0.1degC/W. Thus the maximum permissible heatsink temperature T_{HS} is given by:

$$P\,(\Theta_{j\text{-case}} + \Theta_i) = (125 - T_{HS})\ ^{o}C$$

$$\text{or } T_{HS} = (125 - 0.5P)\ ^{o}C$$

The total power to be dissipated to ambient is nP. If the ambient temperature is T_{amb} then the calculated value of Θ_{HS} is:

$$\frac{\text{temperature rise above ambient}}{\text{total power}} = \frac{T_{HS} - T_{amb}}{nP}$$

These calculations assume that reasonable good thermal sharing is used which means mounting the devices in as compact a group as mechanically possible on the chosen heatsinks.

FUSING

For n devices in parallel each of I^2t rating "A", the total I^2t for group fusing is given by n^2A. (The I^2t rating for a single BTX51 is $4000A^2$ per second where A is in amps).

HEATSINK THERMAL RESISTANCE VALUES

Table 1 gives the results of the calculations for the case of 2 and 3 devices in parallel with the maximum value of total current obtainable in three phase operation, with ambient temperature 35°C.

Table 1

n	Total mean current per leg (A)	Heatsink Temp. (°C)	Θ_{HS}, T_{amb} = 35°C (degC/W)
2	120	71.5	0.17
3	180	71.5	0.12

60D Extrusion heatsink

The values in Table 1 can be obtained from convenient lengths of the 60D extrusion if forced air cooling is used. Table 2 gives the detail

Table 2

Length of 60D (in)	Air velocity (ft/min)	Thermal resistance (degC/W)
8	400	0.17
8	600	0.12

The 60D extrusion is so designed that individual pieces can be bolted together along their lengths for electrical and thermal connection. A tongue and groove in the mating flanges facilitates this operation. Thus, using the figures obtained, it is possible to join any number of devices in parallel. Table 3 illustrates the method for up to 7 devices in parallel.

Table 3

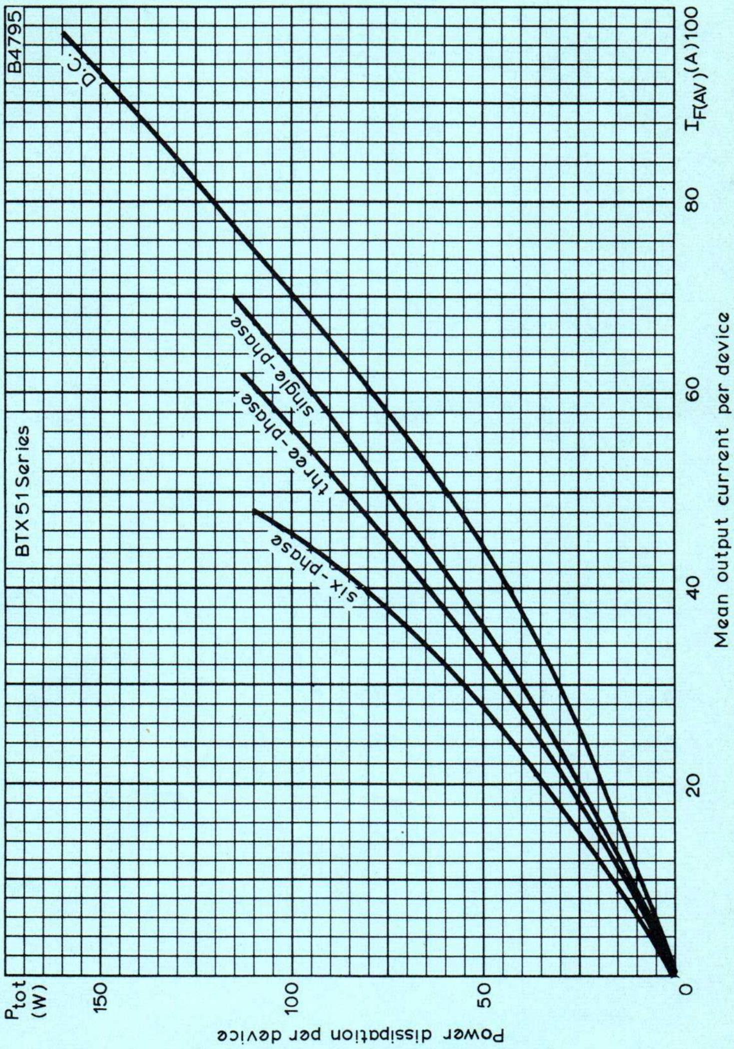
Based on three-phase bridge operation

No. of parallel devices per leg	Total mean current per leg (A)	60D Heatsink arrangement $T_{amb} = 35^{o}C$	Air velocity (ft./min.)
2	120	One 8" length (2 devices)	400
3	180	One 8" length (3 devices)	600
4	240	Two 8" lengths (2 devices on each)	400
5	300	Two 8" lengths (2 on one, 3 on other)	600*
6	360	Two 8" lengths (3 on each)	600
7 etc.	420	Three 8" lengths (2, 2 and 3 devices)	600*

*These arrangements have to be blown at 600ft/min. It is possible in these cases to recalculate a smaller heatsink than 8" which will give a thermal resistance of 0.17degC/W when blown at 600ft/min. for the length with two devices.

Example

In the particular cases of 5 and 7 devices in parallel, and with reference to the lengths of 60D heatsink extrusions with 2 devices only, when blown at 600ft/min. the length of extrusion may be reduced to six inches.



POWER DISSIPATION PER DEVICE PLOTTED AGAINST MEAN OUTPUT CURRENT PER DEVICE

TENTATIVE DATA

The BTX64 is a range of p-gate reverse blocking thyristors for use in power control circuits where a low turn-off is required. Typical applications include all kinds of inverters, for a.c. motor speed control, emergency power supplies and pulse generators up to 20kHz.

QUICK REFERENCE DATA

BTX64-		100R	200R	300R	400R	500R	600R	
V_{BO}	min.	100	200	300	400	500	600	V
V_{RRM}	max.	100	200	300	400	500	600	V
$I_{T(AV)}$ ($T_{stud} = 85^{o}C$)	max.						10	A
$I_{T(RMS)}$	max.						25	A
t_q							10	μs

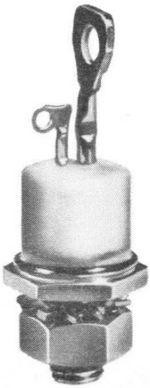
Unless otherwise shown data is applicable to all types in the series

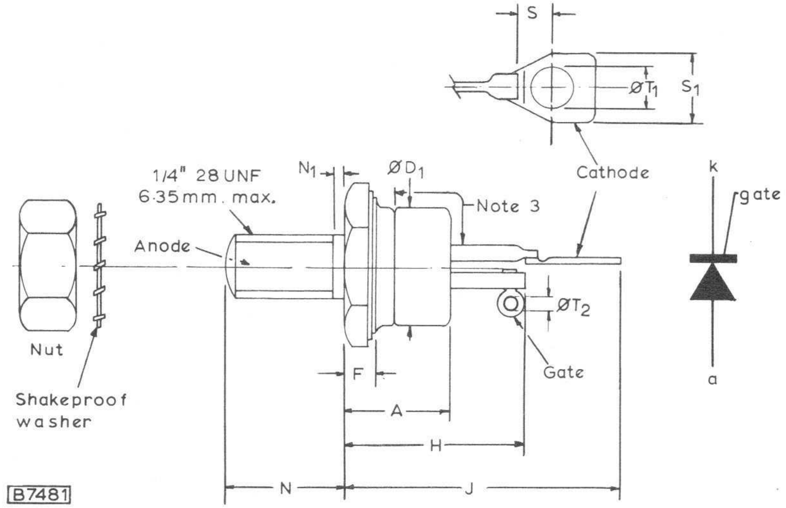
OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

J.E.D.E.C. TO-48

For details see page D2





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.552").
2. Minimum flat
3. Minimum creepage path 6mm (0.236")

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 20kHz. Simultaneous applications of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX64-	100R	200R	300R	400R	500R	600R	
V_R	Continuous reverse voltage	100	200	300	400	500	600	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	600	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	500	600	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	600	600	V
V_D	Continuous off-state voltage	100	200	300	400	500	600	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	600	V
V_{DRM}	Repetitive off-state voltage	100	200	300	400	500	600	V
V_{DSM}	Non-repetitive off-state voltage	600	600	600	600	600	600	V
$\frac{dV}{dt}$	Rate of rise of voltage not to trigger the device (see note 2)	10	20	30	40	50	60	V/μs

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 9degC/W for a.c. operation, and 4.5degC/W for d.c. operation.
2. These ratings apply with a 100Ω resistor connected between gate and cathode.

Current

I_T	Continuous on-state current	25	A
$I_{T(AV)}$	Mean on-state current (see page C2)	16	A
I_{TRM}	Repetitive peak on-state current	140	A
I_{TSM}	Maximum on-state surge current peak of half-sine at maximum operating conditions (see page C4)	140	A
I^2t	I^2t for fusing (< 10ms)	100	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current	100	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	20	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to mounting base	1.6	degC/W
θ_i	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
θ_t	Transient thermal resistance from junction to mounting base	See page C5	

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

		BTX64- 100R	200R	300R	400R	500R	600R	
V_{BO}	Minimum forward breakover voltage (see note 2)	100	200	300	400	500	600	V
V_T	Maximum instantaneous forward voltage at $I_T = 50A$, $T_j = 25^oC$						3.0	V
i_D	Maximum forward leakage current at V_{DWM}	13	12	10	8.0	6.0	5.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	13	12	10	8.0	6.0	5.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$						3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$						65	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on						250	mV
I_H	Typical holding current						10	mA
I_L	Typical latching current						20	mA
t_q	Maximum turn-off time $I_T = 10A$, $I_R = 10A$ at rated $\frac{dV}{dt}$ (see page C6)						10	µs
t_{gt}	Typical turn-on time (see page C7)						0.4	µs

NOTE

2. The device may breakover into the maximum repetitive peak forward current at the maximum rate of rise of forward current.

MECHANICAL DATA

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core.

   A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows: -

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R x C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R x C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

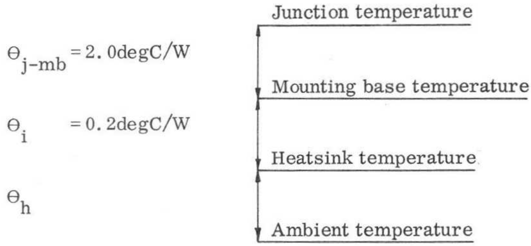
   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heat sink considerations.

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page C2 is as follows:

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i+\Theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ max.} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

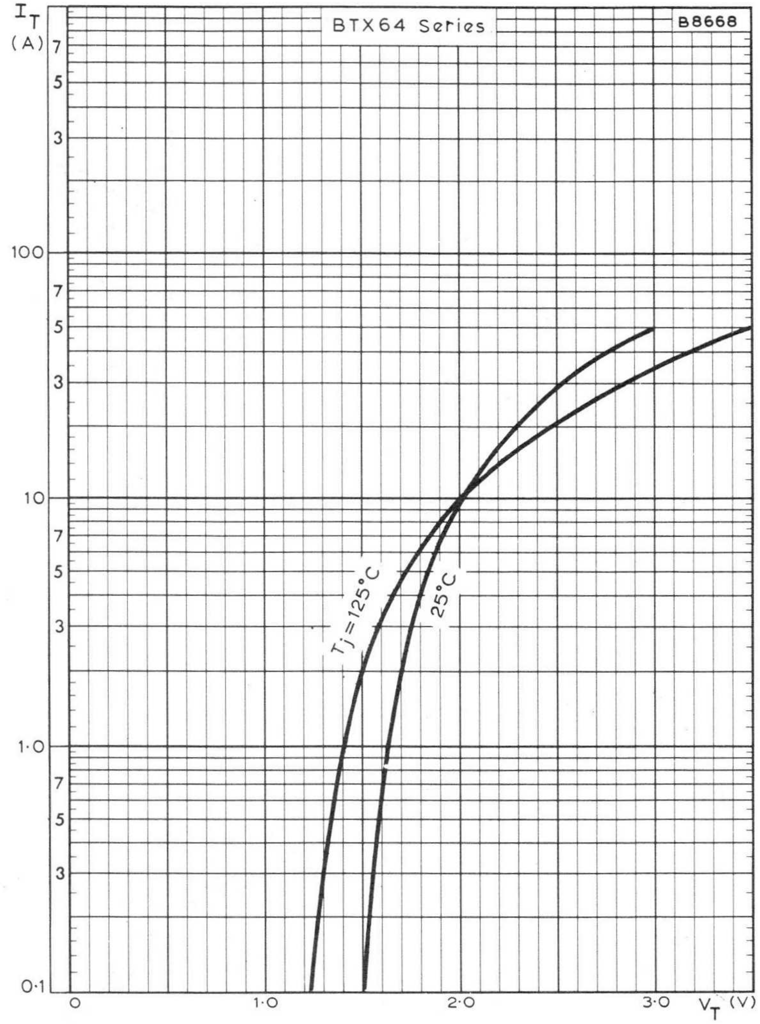
a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

b) The applied voltage must not exceed the nominal peak rating of the fuse.

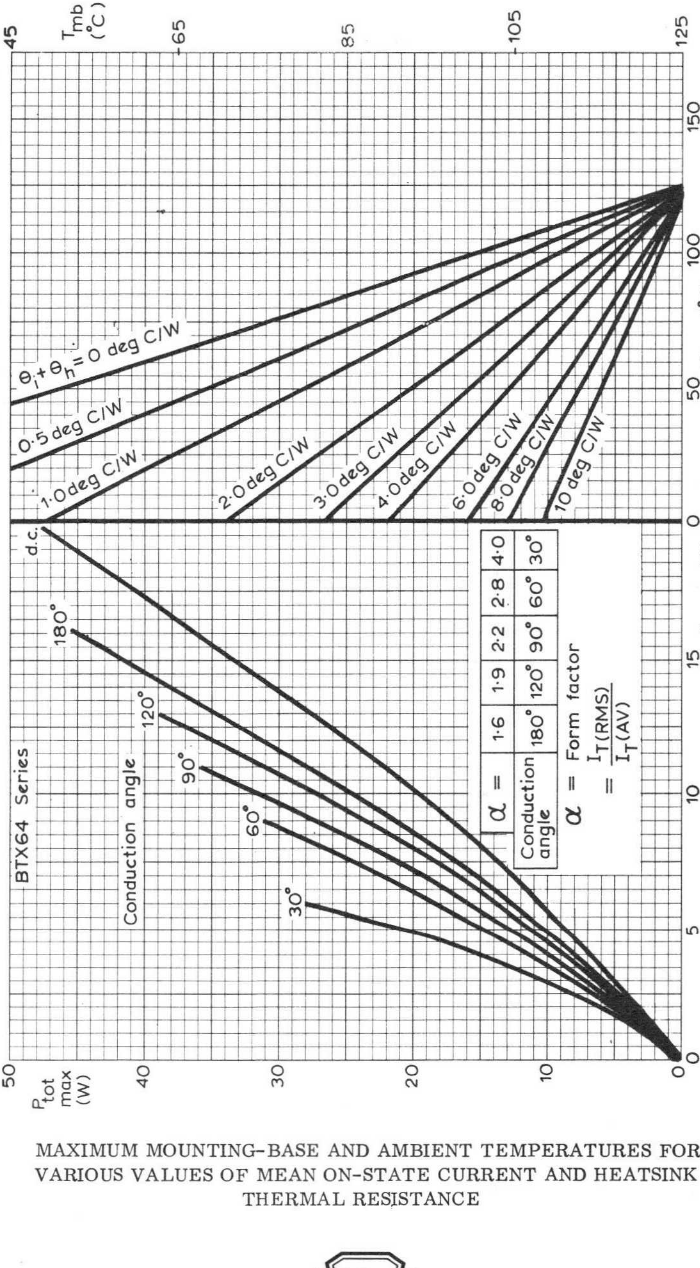
c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

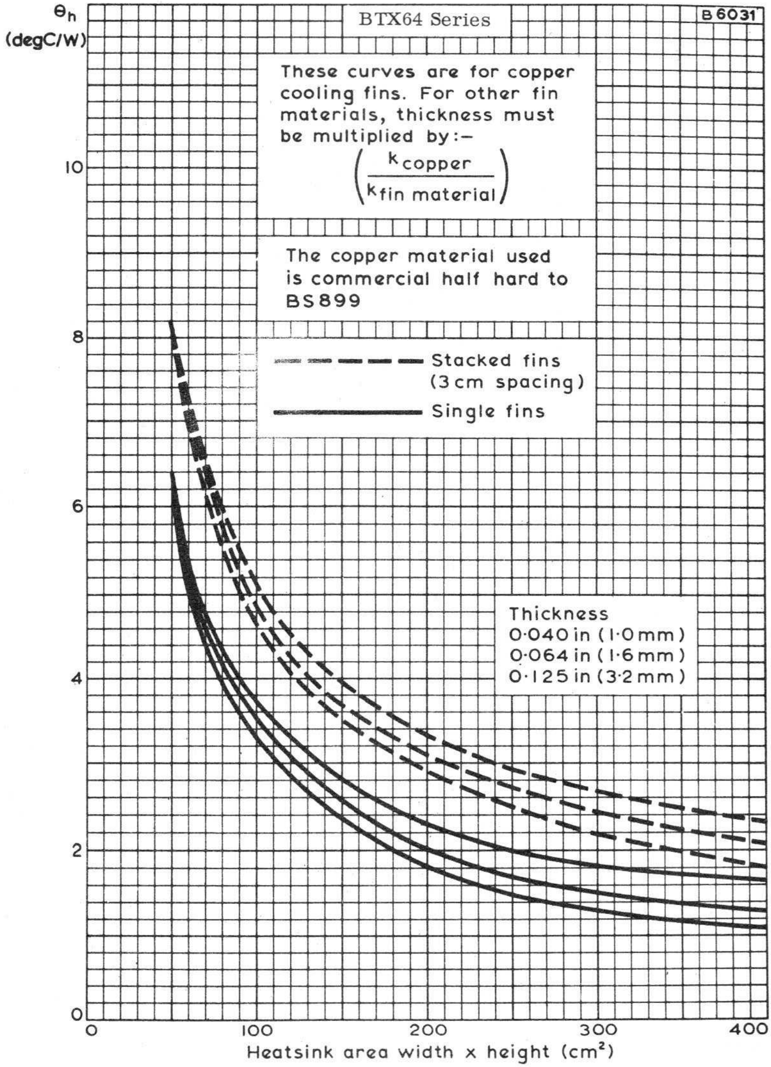
The curve shown on page C9 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.



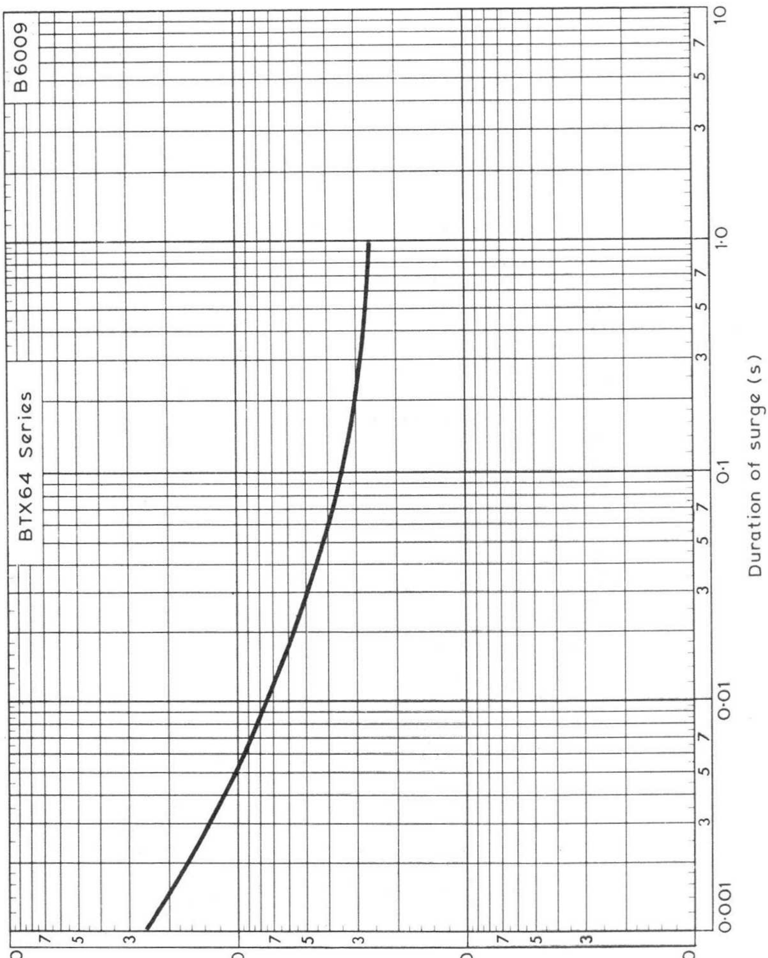
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



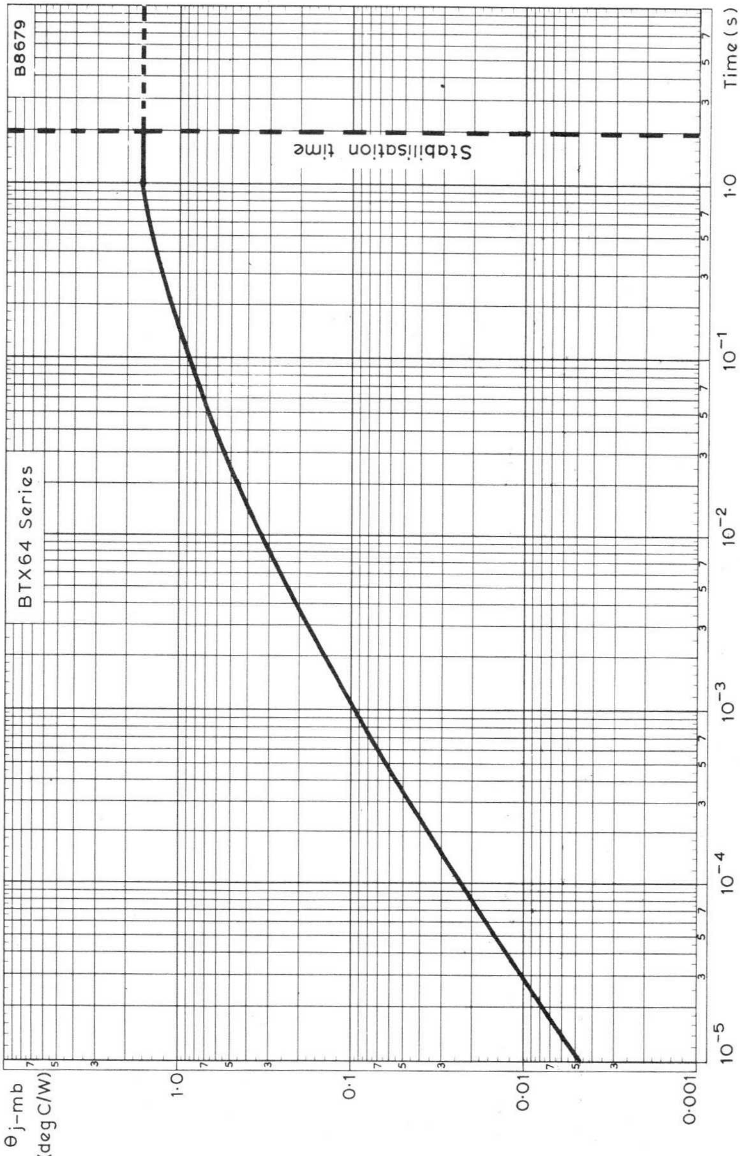
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



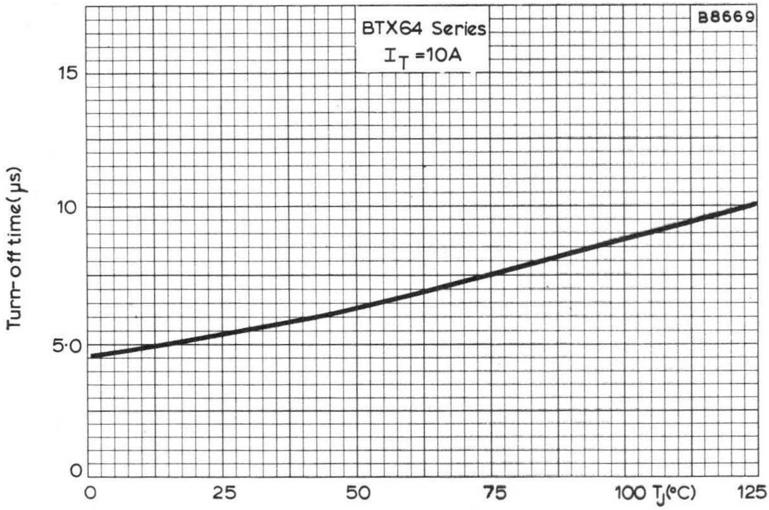
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA

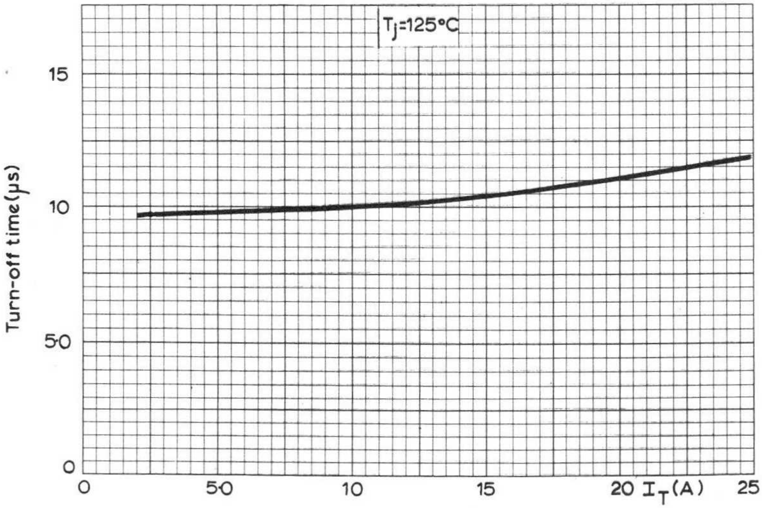


MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES CIRCUIT BREAKERS ETC.)

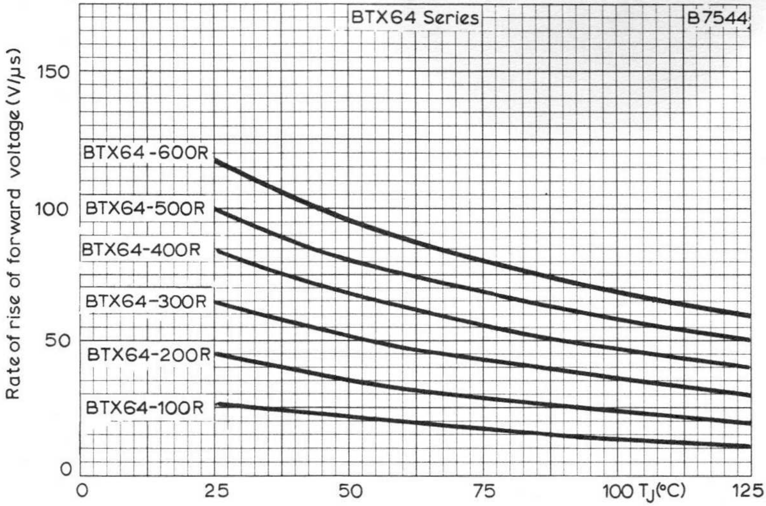


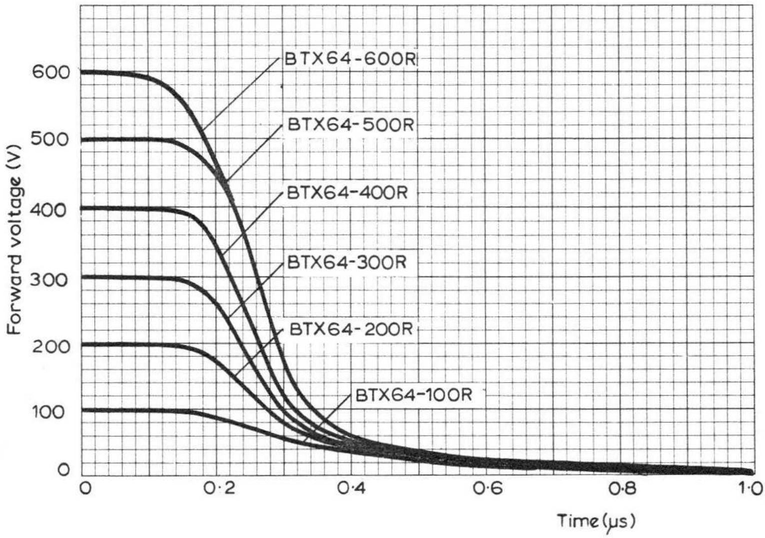
TRANSIENT THERMAL RESISTANCE PLOTTED AGAINST TIME





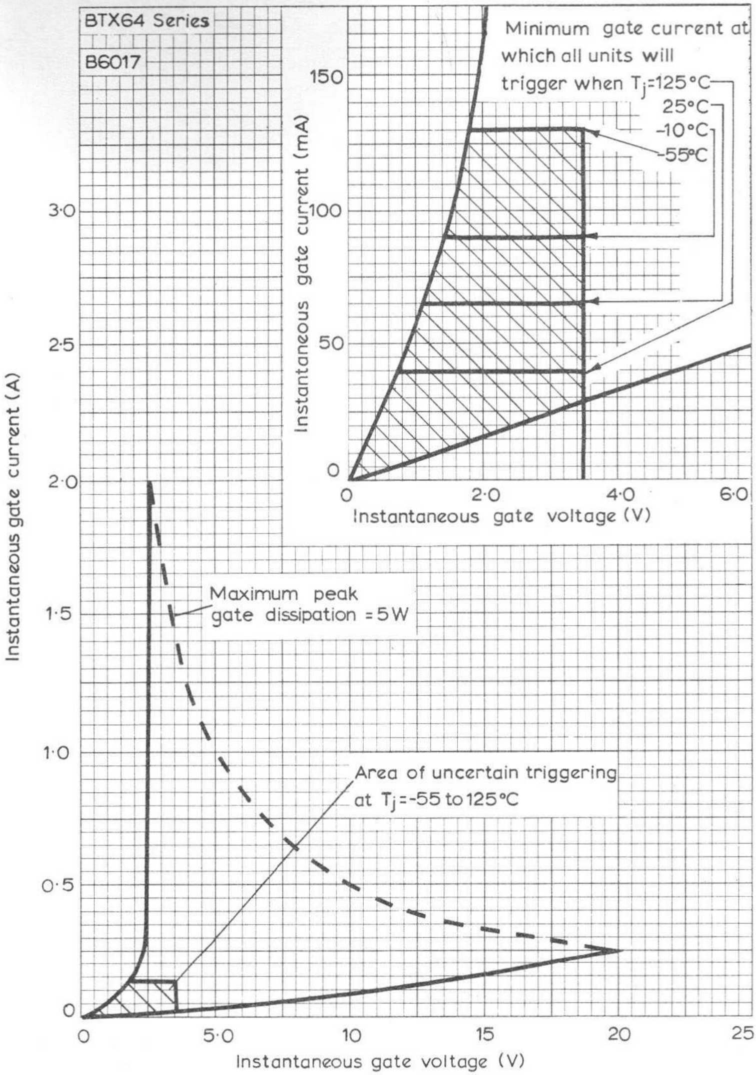
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE AND ON-STATE CURRENT



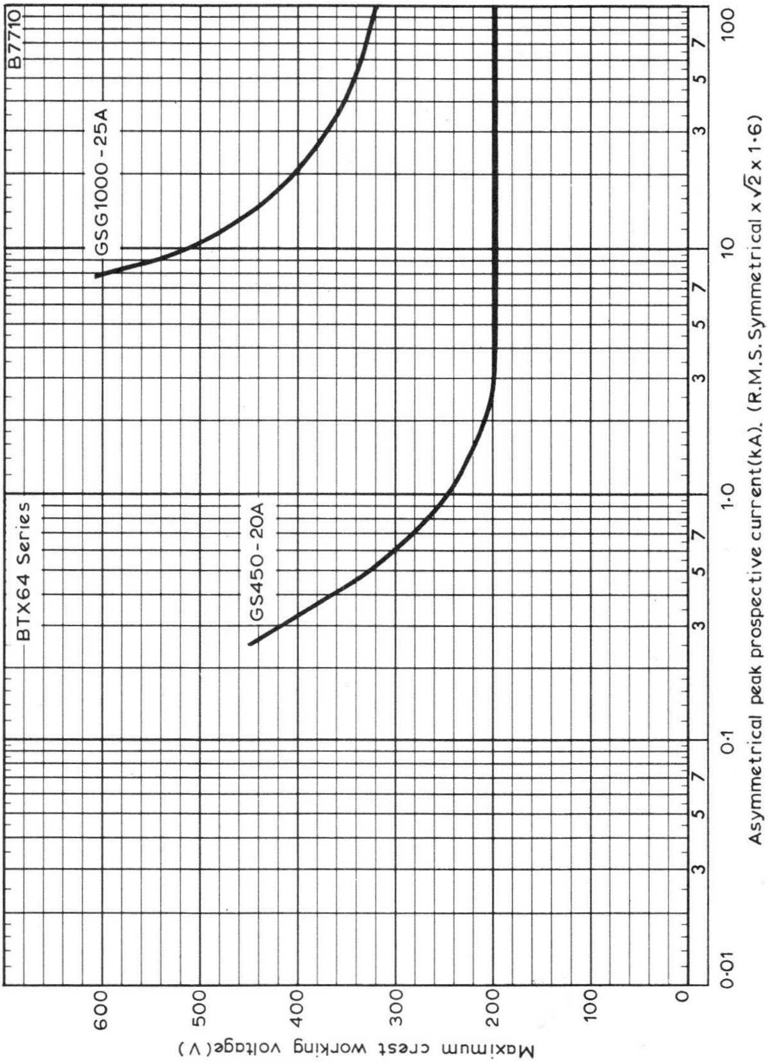


VARIATION OF RATE OF RISE OF FORWARD VOLTAGE WITH JUNCTION TEMPERATURE

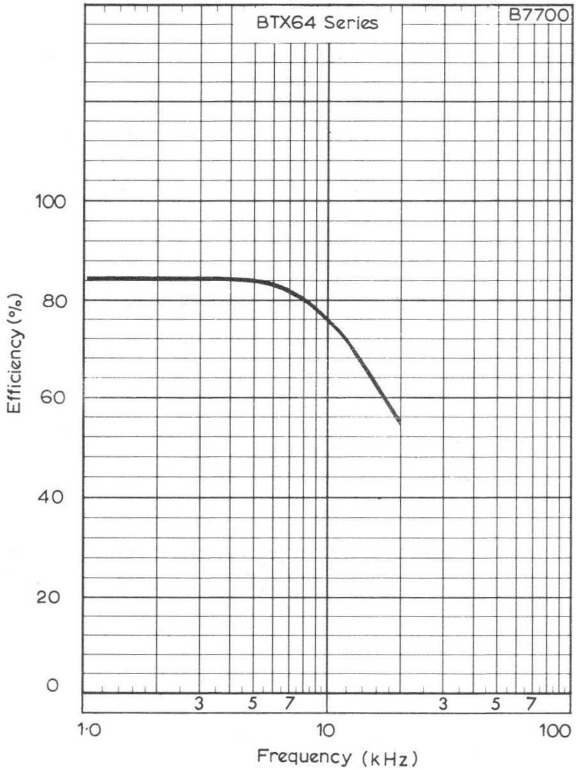
TYPICAL TURN-ON CHARACTERISTIC



THYRISTOR GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT



TYPICAL EFFICIENCY/FREQUENCY CHARACTERISTIC OF AN INVERTER WITH A BASIC EFFICIENCY OF 85%

THYRISTORS

BTX65
Series

TENTATIVE DATA

The BTX65 is a range of p-gate reverse blocking thyristors for use in power control circuits where a low turn-off is required. Typical applications include all kinds of invertors, for a.c. motor speed control, emergency power supplies, and pulse generators up to 20kHz.

QUICK REFERENCE DATA

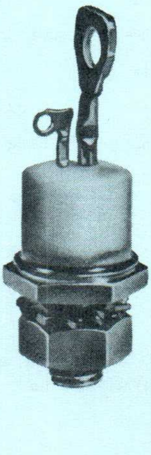
BTX65-	100R	200R	300R	400R	500R	
V_{BO} min.	100	200	300	400	500	V
V_{RRM} max.	100	200	300	400	500	V
$I_{T(AV)}$ max. (T_{stud} = 85 °C)					12	A
$I_{T(RMS)}$					25	A
t_q					10	µs

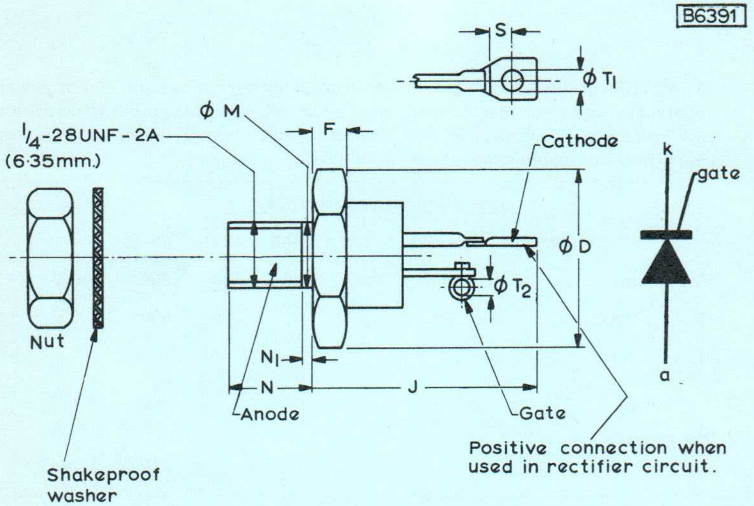
Unless otherwise shown data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page D2





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
ØD	-	16.51	-	0.650	
F	2.9	5.5	0.113	0.220	1
J	-	30.48	-	1.200	
ØM	4.91	6.35	0.193	0.250	2
N	10.72	11.50	0.422	0.453	
N_1	-	2.26	-	0.089	2
S	3.05	-	0.120	-	3
ØT_1	3.18	4.44	0.125	0.175	
ØT_2	1.53	-	0.060	-	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) 0.544" min., (14.27mm) 0.562" max.
2. ØM refers to length N_1
3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 20kHz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX65-	100R	200R	300R	400R	500R	
V_R	Continuous reverse voltage	100	200	300	400	500	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	500	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	600	V
V_D	Continuous off-state voltage	100	200	300	400	500	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	V
V_{DRM}	Repetitive off-state voltage	100	200	300	400	500	V
V_{DSM}	Non-repetitive off-state voltage	100	200	300	400	500	V
$\frac{dV}{dt}$	Rate of rise of voltage not to trigger the device	10	20	30	40	50	V/μs

NOTE

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 9degC/W for a.c. operation, and 4.5degC/W for d.c. operation.

Current

I_T	Continuous on-state current	25	A
$I_{T(AV)}$	Mean on-state current (see page C2)	16	A
I_{TRM}	Repetitive peak on-state current	140	A
I_{TSM}	Maximum on-state surge current peak of half-sine at maximum operating conditions (see page C4)	140	A
I^2t	I^2t for fusing (< 10ms)	100	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current	100	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	20	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	°C
T_{stg} max.	Storage temperature max.	125	°C
T_j max.	Junction temperature max.	125	°C

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting base	2.0	degC/W
Θ_i	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance	See page C5	

ELECTRICAL CHARACTERISTICS ($T_j = 125^{\circ}C$ unless otherwise stated)

	BTX65-	100R	200R	300R	400R	500R	
V_{BO}	Minimum forward break-over voltage (see note 2)	100	200	300	400	500	V
V_T	Maximum instantaneous on-state voltage at $I_T = 50A$, $T_j = 25^{\circ}C$					2.0	V
i_D	Maximum off-state current at V_{DWM}	13	12	10	8.0	6.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	13	12	10	8.0	6.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$					3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$					65	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on					250	mV
I_H	Typical holding current					10	mA
I_L	Typical latching current					20	mA
t_q	Maximum turn-off time $I_T = 10A$, $I_R = 10A$ at rated $\frac{dV}{dt}$ (see page C6)					10	μs
t_{gt}	Typical turn-on time (see page C7)					0.4	μs

NOTE

2. The device may breakover into the maximum repetitive peak on-state current at the maximum rate of rise of on-state current.

MECHANICAL DATA

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in

Weight

Without accessories	10	g
	0.35	oz
With accessories		
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core.

   A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:

	R-C in primary of transformer		R-C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200\,\frac{I_{mag}}{V_1}$	150	$225\,\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\,\frac{I_{mag}}{V_1}$	225	$400\,\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\,\frac{I_{mag}}{V_1}$	300	$900\,\frac{I_{mag}T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)

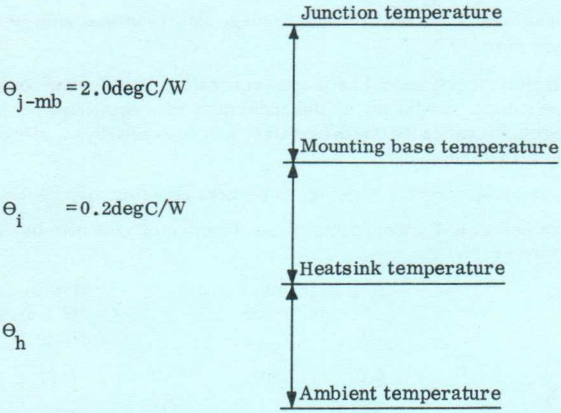
   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heat sink considerations.

   The various components of the rise of junction temperature above ambient are illustrated below.



   The method of using the curve on page C2 is as follows:

   Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

   Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

   Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \Theta_i$$

   The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:-

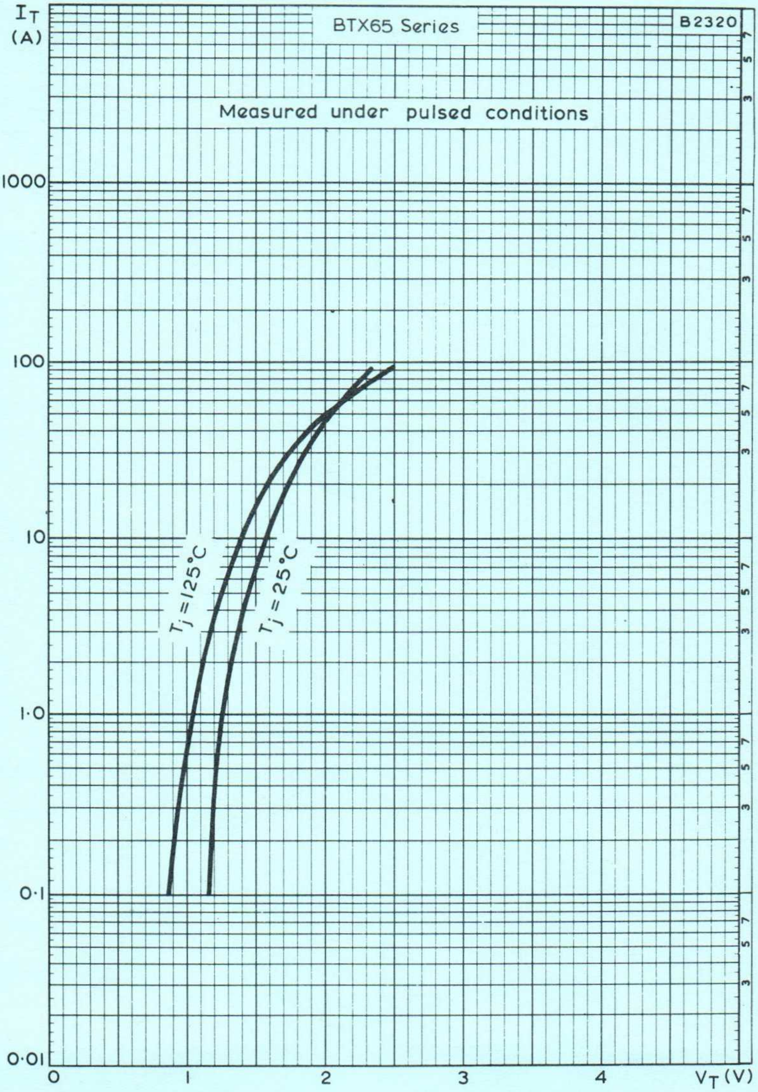
(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

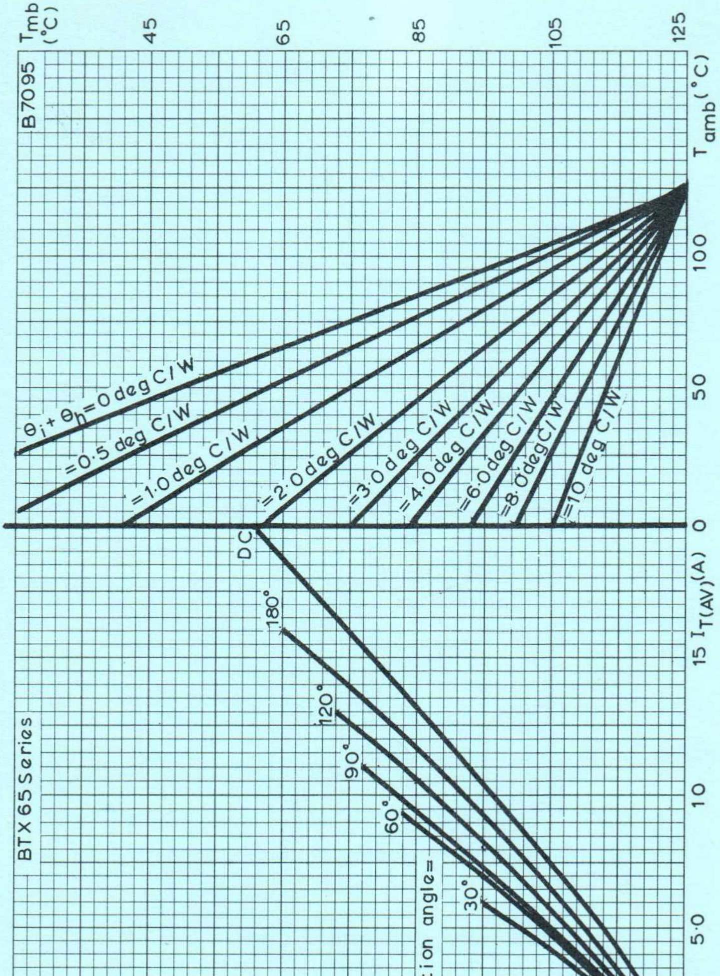
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

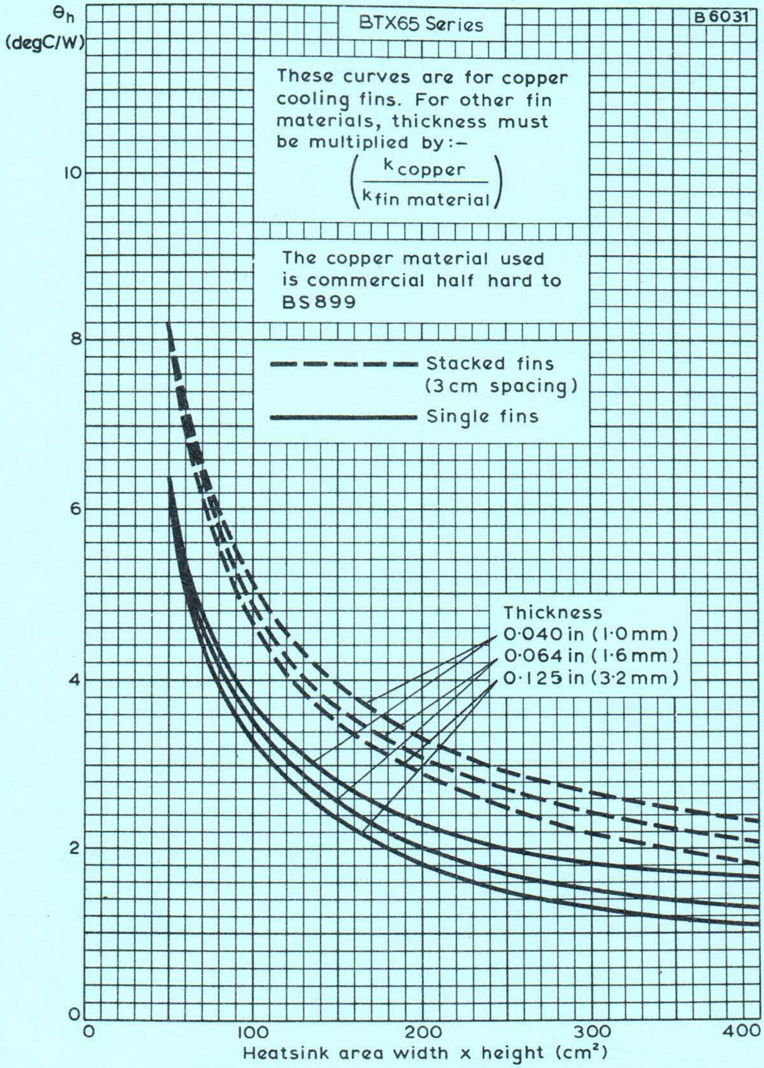
The curve shown on page C9 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.



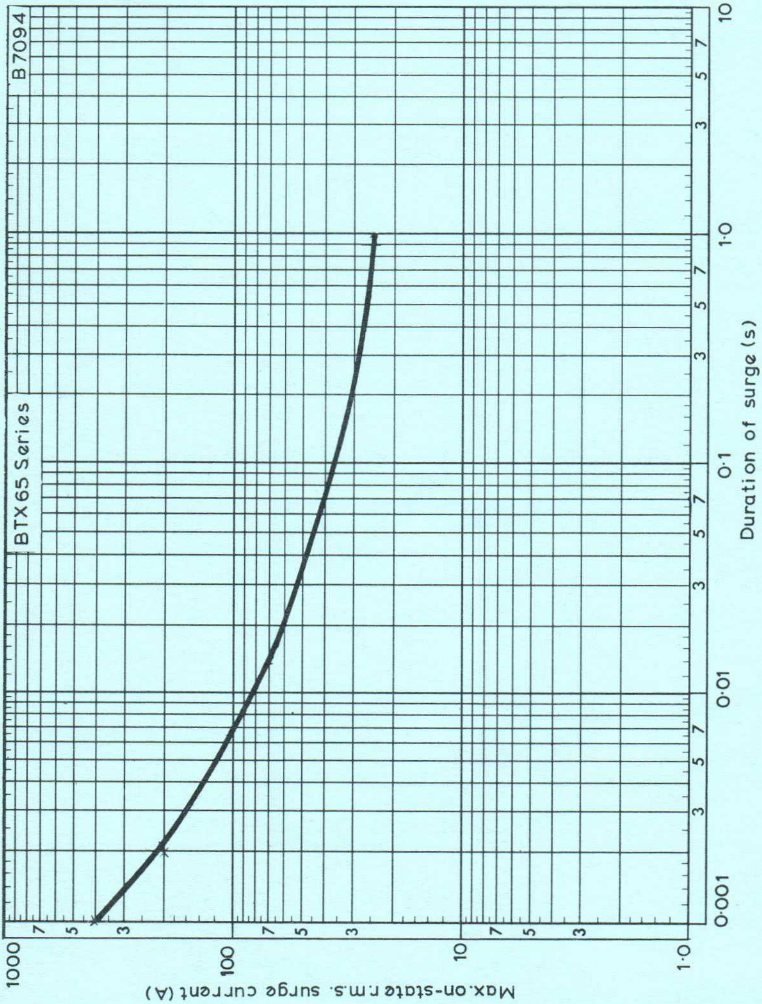
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



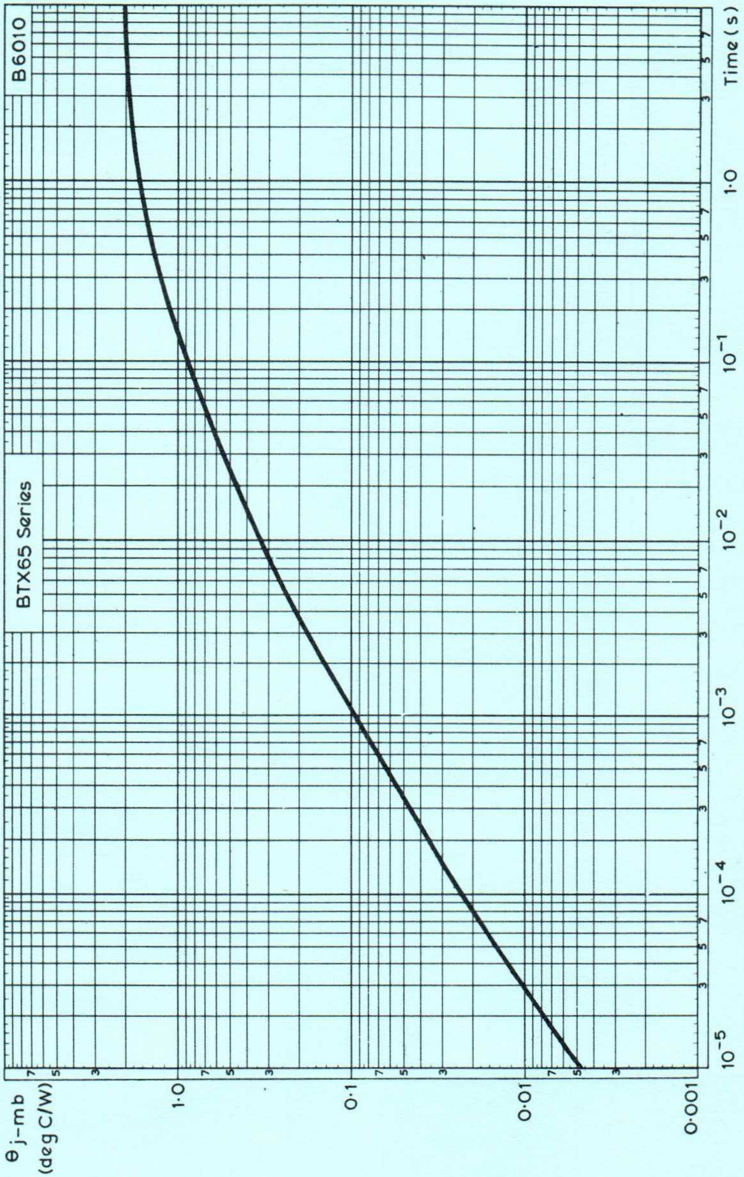
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



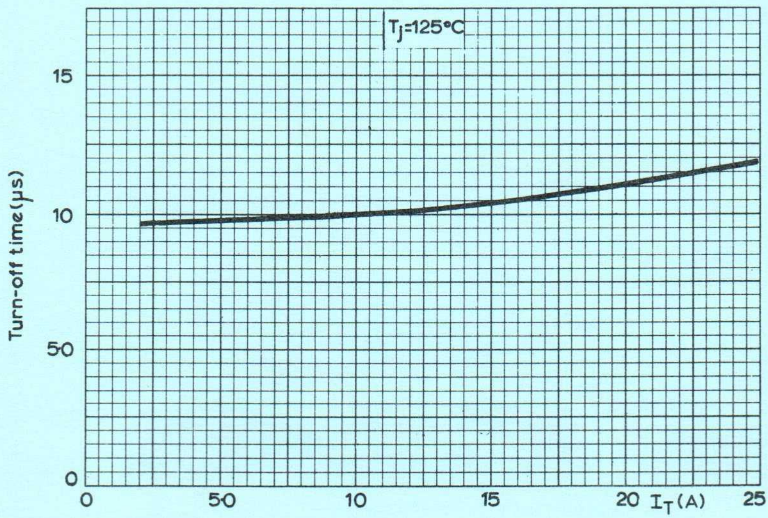
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



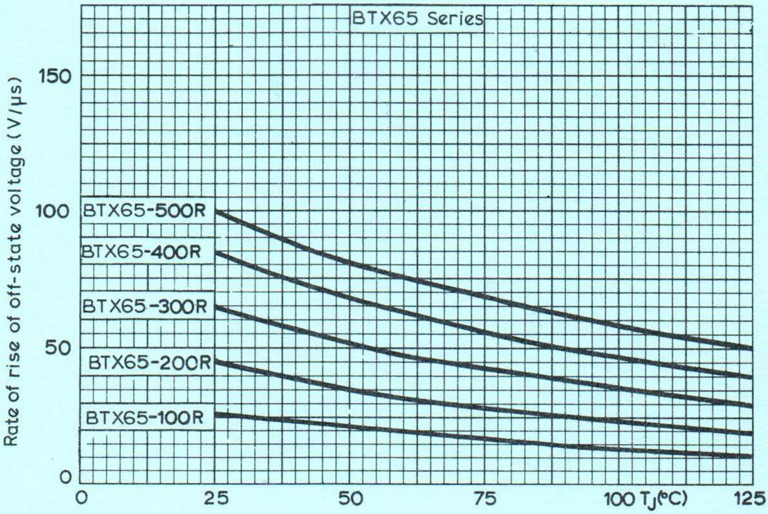
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES CIRCUIT BREAKERS ETC.)

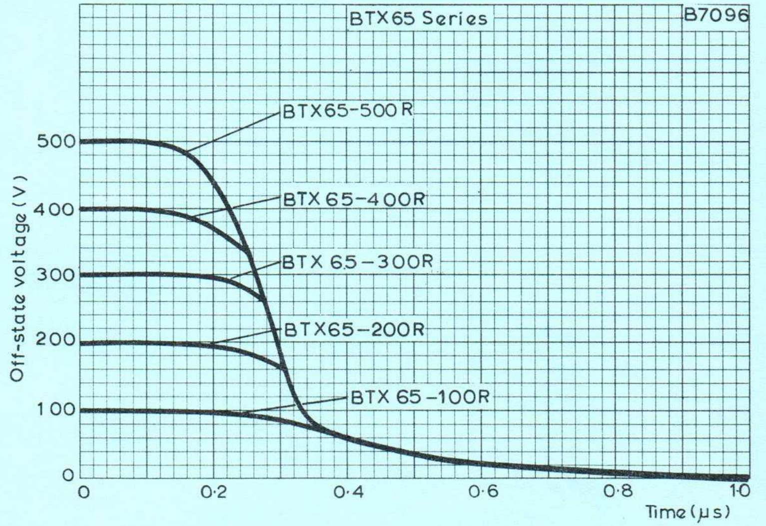


TRANSIENT THERMAL RESISTANCE PLOTTED AGAINST TIME



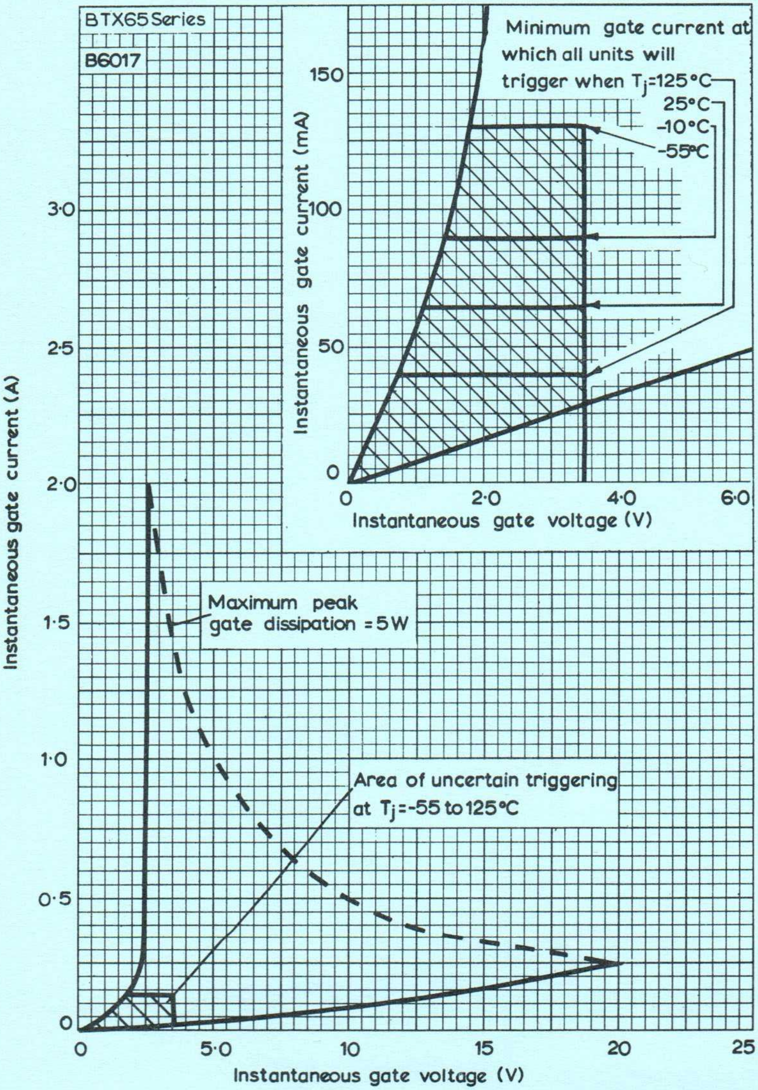
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE AND ON-STATE CURRENT



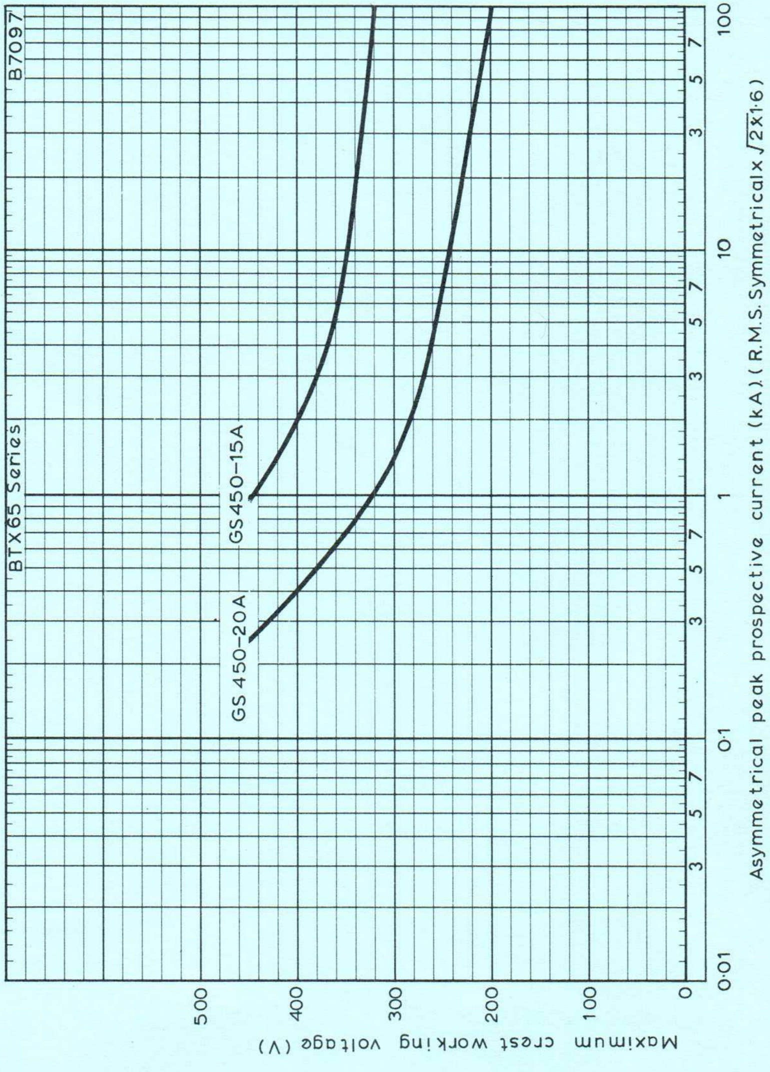


VARIATION OF RATE OF RISE OF FORWARD VOLTAGE WITH JUNCTION TEMPERATURE

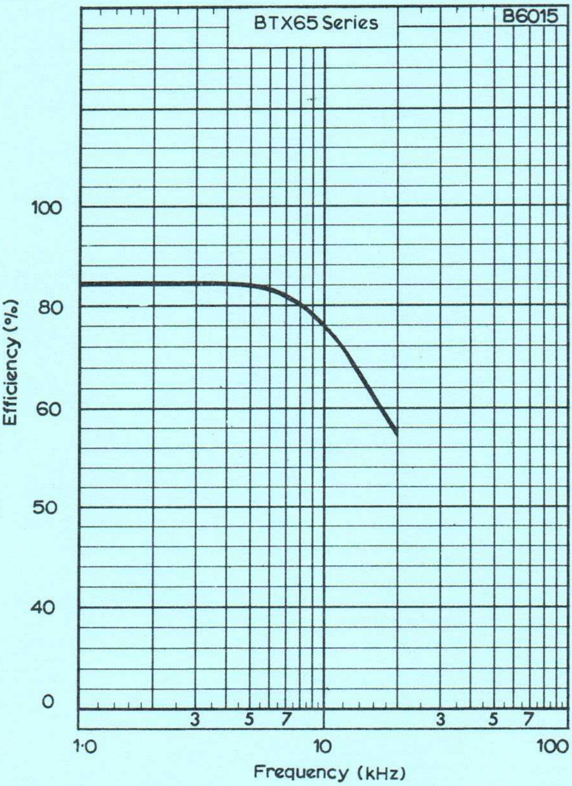
TYPICAL TURN-ON CHARACTERISTIC



THYRISTOR GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT



TYPICAL EFFICIENCY/FREQUENCY CHARACTERISTIC OF AN INVERTER WITH A BASIC EFFICIENCY OF 85%

TENTATIVE DATA

The BTX66 is a range of p-gate reverse blocking thyristors for use in power control circuits where a low turn-off is required. Typical applications include all kinds of inverters, for a.c. motor speed control, emergency power supplies, and pulse generators up to 13kc/s.

QUICK REFERENCE DATA

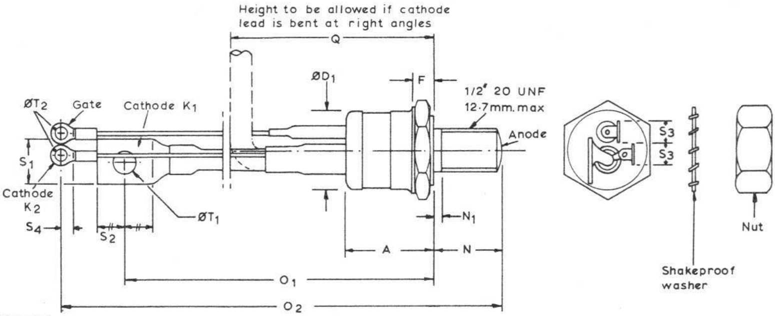
	BTX66-	100R	200R	300R	400R	500R	600R	
V_{BO} min.		100	200	300	400	500	600	V
V_{RRM} max.		100	200	300	400	500	600	V
$I_{F(AV)}$ max. ($T_{stud}=85^{o}C$)							32	A
$I_{F(RMS)}$ max.							110	A
t_{off}							15	μs

Unless otherwise shown data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-30C

For details see page D2



B7482

Dimensions in millimetres

Ref	Min.	Max.	Notes	Ref	Min.	Max.	Notes
A	-	28.57		Q	-	63.5	2
$ØD_1$	-	24.13		S_1	-	16.5	
F	-	8.89	1	S_2	9.6	-	3
N	20.24	21.0		S_3	-	7.6	
N_1	-	3.0		S_4	3.81	-	3
O_1	148	158		$ØT_1$	8.1	8.3	
O_2	174	190		$ØT_2$	4.05	4.2	

NOTES

1. This zone includes a standard hexagon 27mm (1.062ins) nominally across flats.
2. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter $ØD_1$. Q allows for the leads to be bent at right angles.
3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 13kc/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX66-	100R	200R	300R	400R	500R	600R	
V_R	Continuous reverse voltage	100	200	300	400	500	600	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	600	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	500	600	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	600	600	V
V_D	Continuous off-state voltage	100	200	300	400	500	600	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	600	V
V_{DRM}	Repetitive off-state voltage	100	200	300	400	500	600	V
V_{DSM}	Non-repetitive off-state voltage	600	600	600	600	600	600	V
$\frac{dV}{dt}$	Rate of rise of voltage not to trigger the device (see note 2)	7.0	13	20	27	33	40	V/μs ←

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 3degC/W for a.c. operation, and 1.5degC/W for d.c. operation.

2. These ratings apply with a 100Ω resistor connected between gate and cathode.

Current

I_F	Continuous forward current	110	A
$I_{F(AV)}$	Mean forward current (see page C2)	70	A
I_{FRM}	Repetitive peak forward current	700	A
I_{FSM}	Maximum forward surge current peak of half-sine at maximum operating conditions (see page C4)	680	A
I^2t	I^2t for fusing (< 10ms)	2000	A^2s
$\frac{di}{dt}$	Rate of rise of forward current	100	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	20	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	1.0	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	0.6	degC/W
Θ_i	Maximum thermal resistance for a torque of 90kg cm on the nut	0.1	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance	See page C5	

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

	BTX66-	100R	200R	300R	400R	500R	600R	
V_{BO}	Minimum forward breakover voltage (see note 2)	100	200	300	400	500	600	V
V_F	Maximum instantaneous forward voltage at $I_F = 500A$, $T_j = 25^oC$						3.3	V
i_D	Maximum forward leakage current at V_{DWM}	13	12	10	8.0	12	12	mA
i_R	Maximum reverse leakage current at V_{RWM}	13	12	10	8.0	12	12	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$						3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$						80	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on						250	mV
I_H	Typical holding current						10	mA
I_L	Typical latching current						20	mA
t_{off}	Maximum turn-off time $I_F = 50A$, $I_R = 20A$ at rated $\frac{dV}{dt}$ (see page C6)						15	μs
t_{on}	Typical turn-on time (see page C7)						0.5	μs

NOTE

2. The device may breakover into the maximum repetitive peak forward current at the maximum rate of rise of forward current.

MECHANICAL DATA

Maximum torque on hexagon or nut	175	kg cm
	13	lb ft
Minimum torque on hexagon or nut for good thermal contact	90	kg cm
	6.5	lb ft
Recommended diameter of hole in heatsink	13	mm
	0.51	in

Weight

Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

Accessories

Accessory	Note
1/2" UNF nut Shakeproof washer	Supplied with thyristor

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core.
   A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R x C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R x C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)

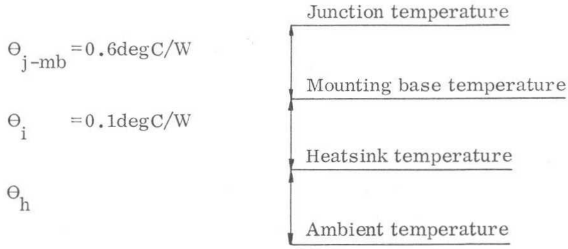
   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heat sink considerations.

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page C2 is as follows:

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:-

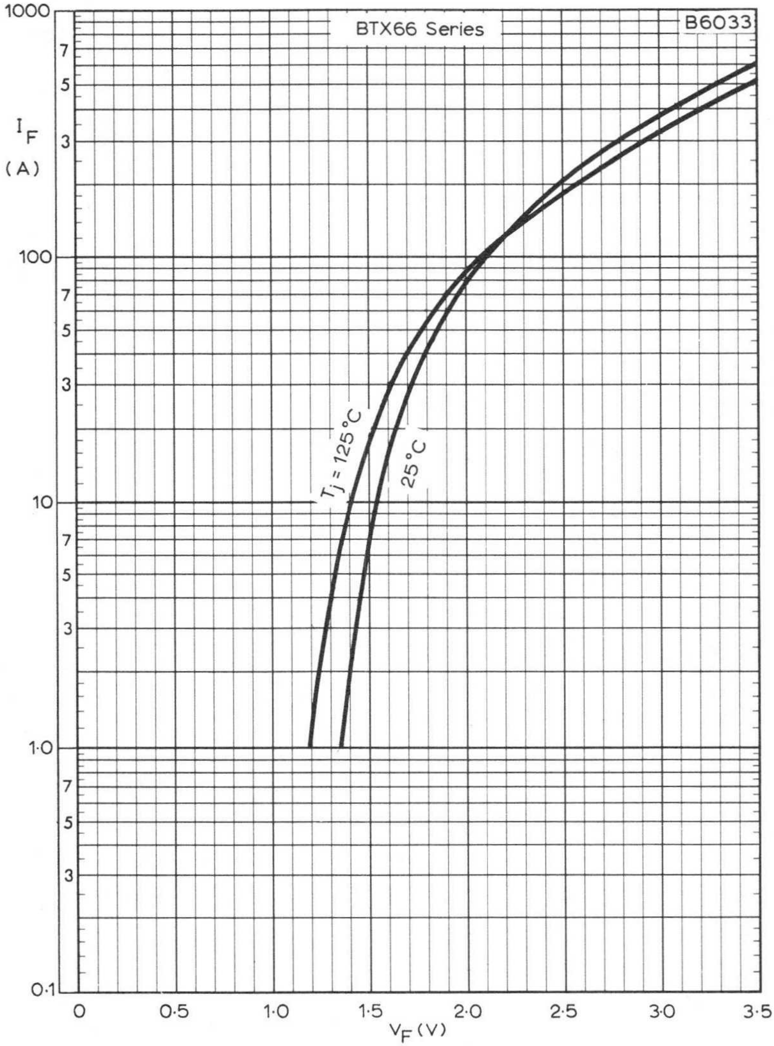
(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

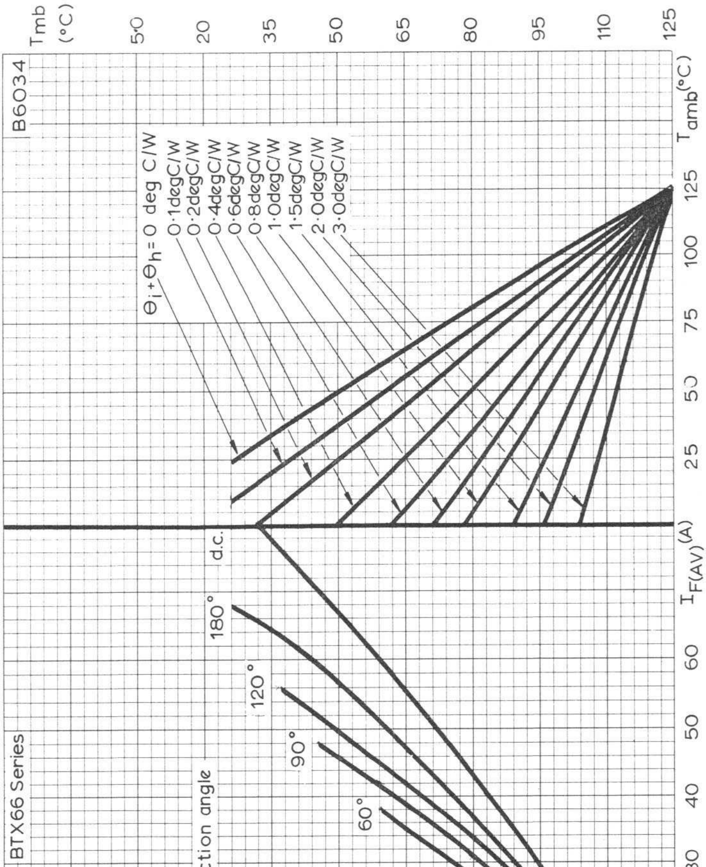
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

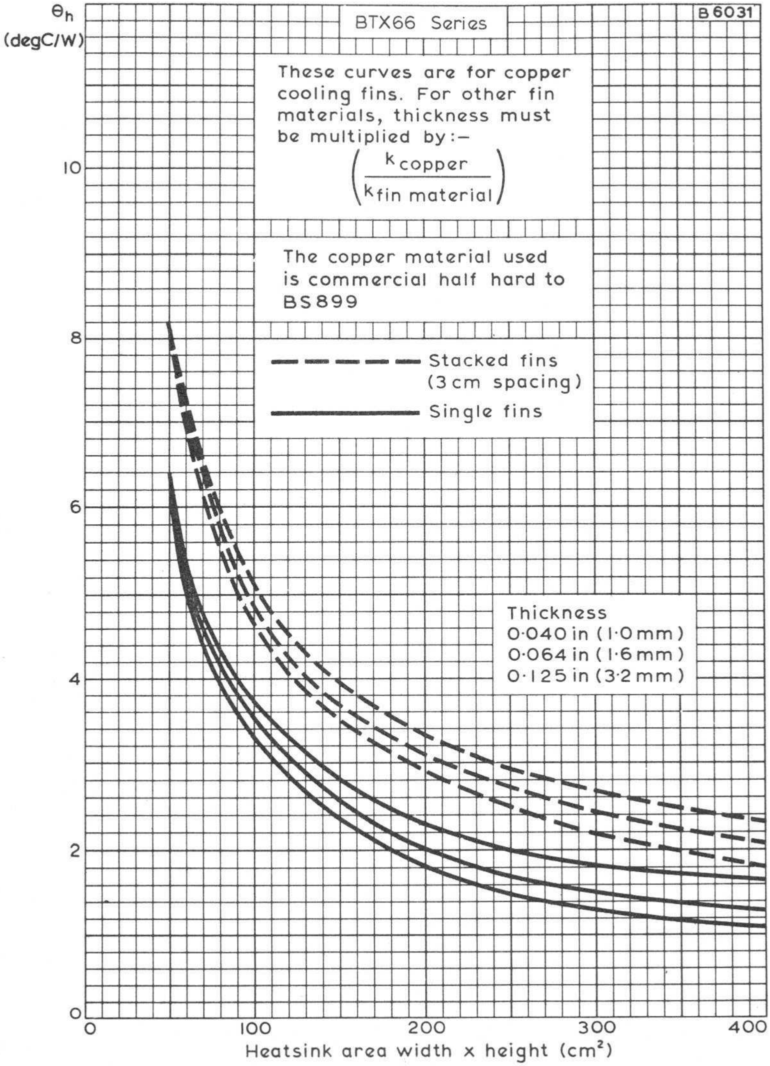
The curve shown on page C9 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.



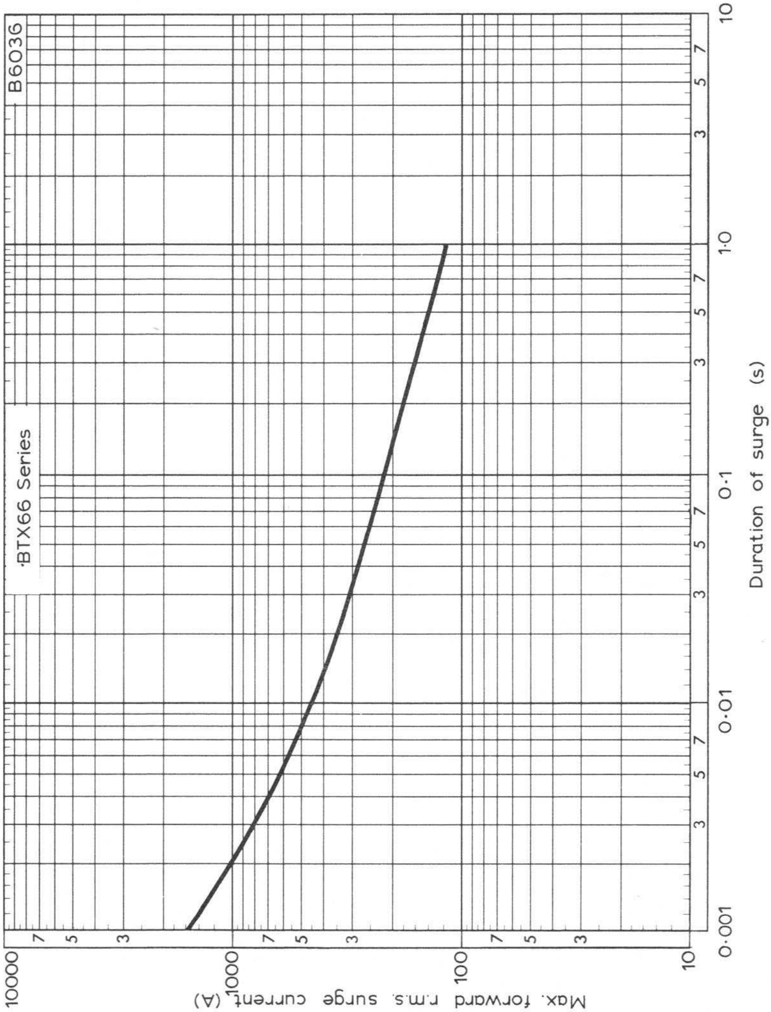
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



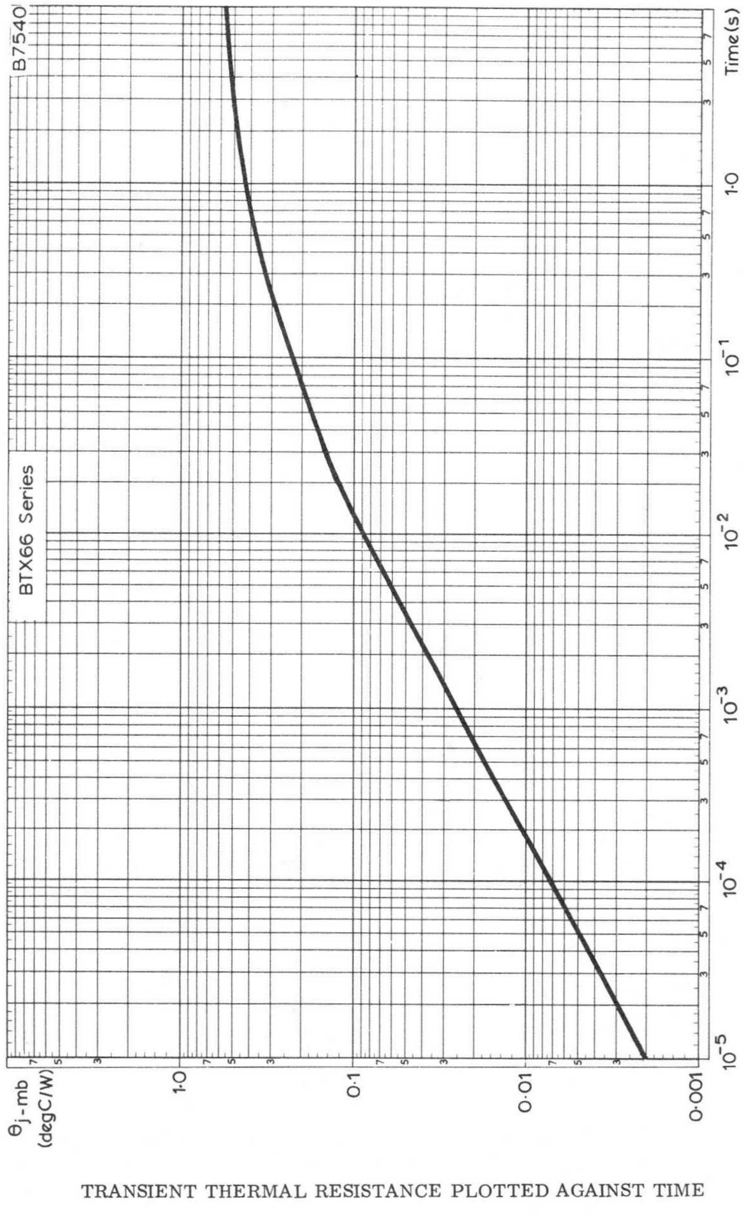
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



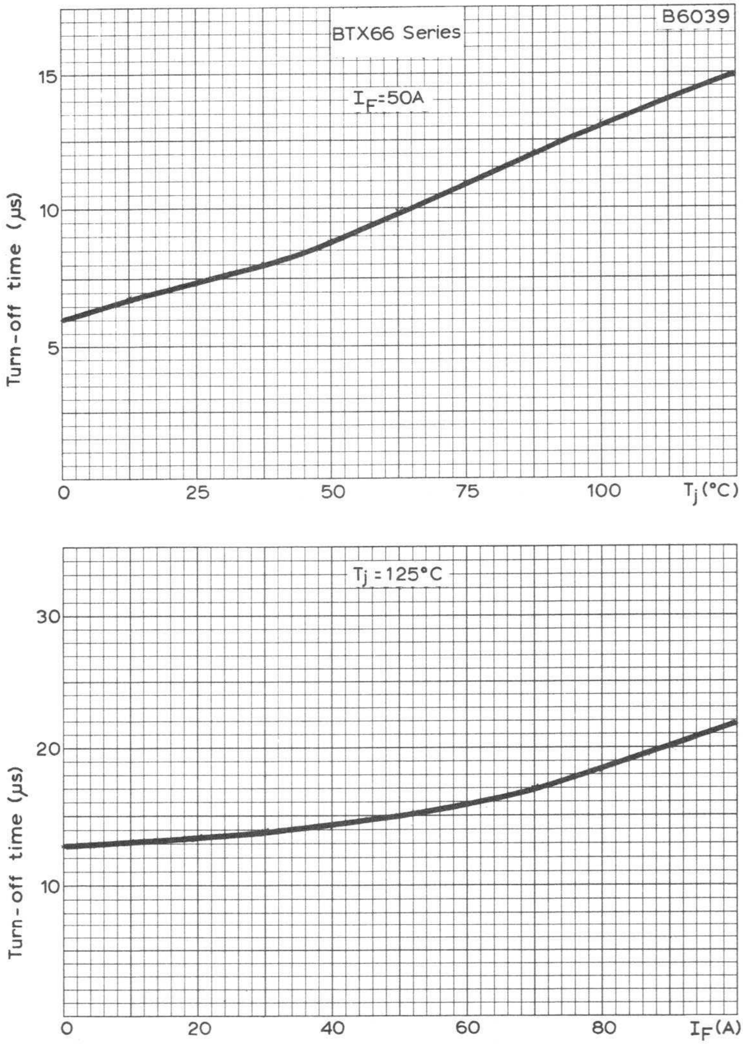
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



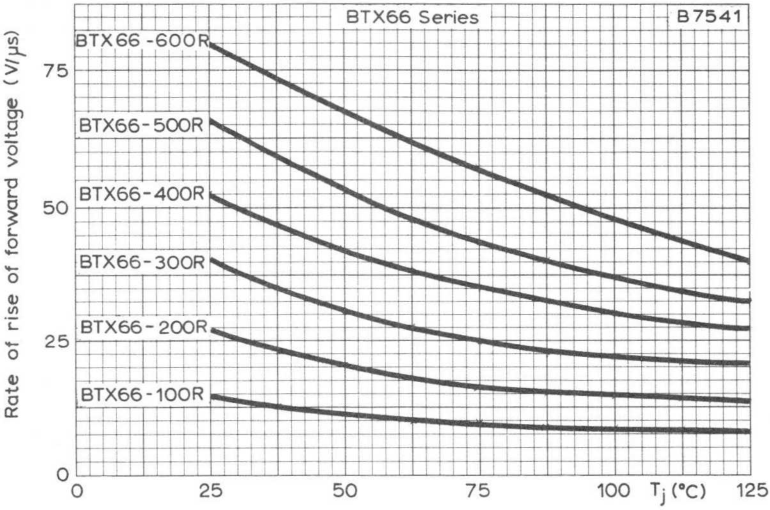
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES CIRCUIT BREAKERS ETC.)

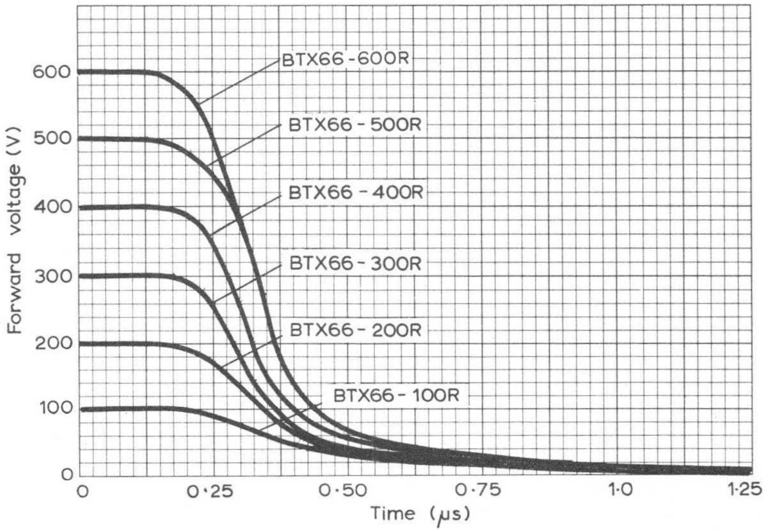


TRANSIENT THERMAL RESISTANCE PLOTTED AGAINST TIME



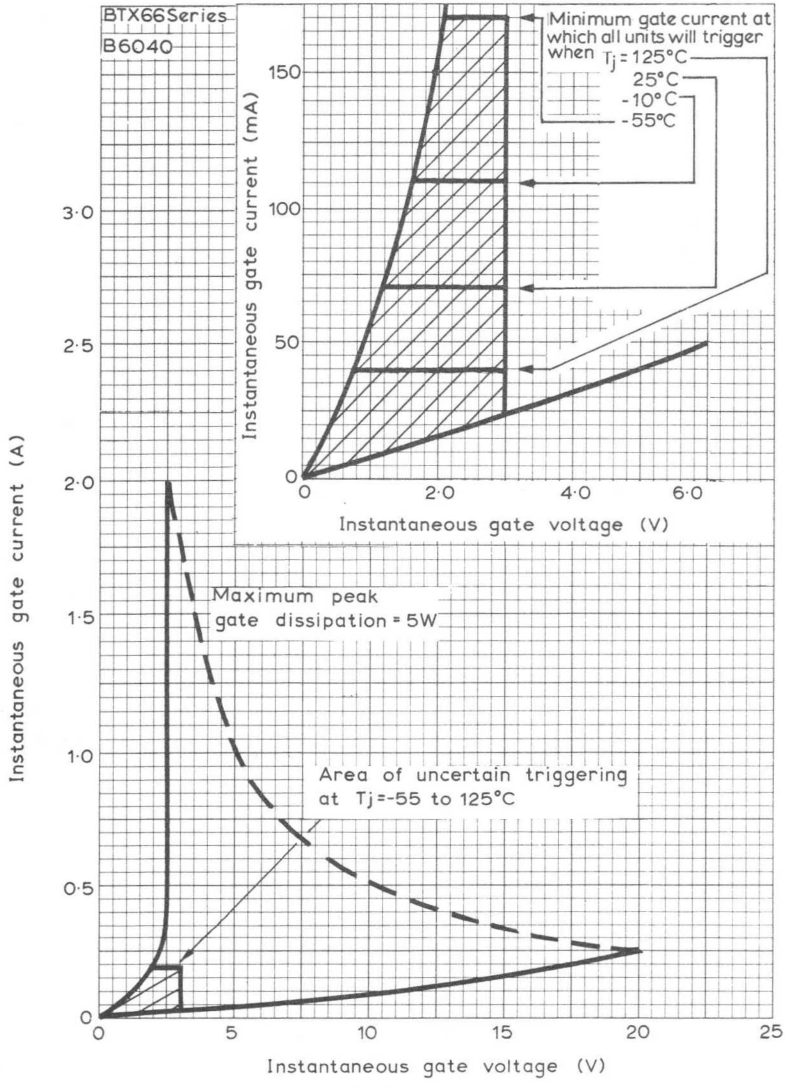
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE AND FORWARD CURRENT



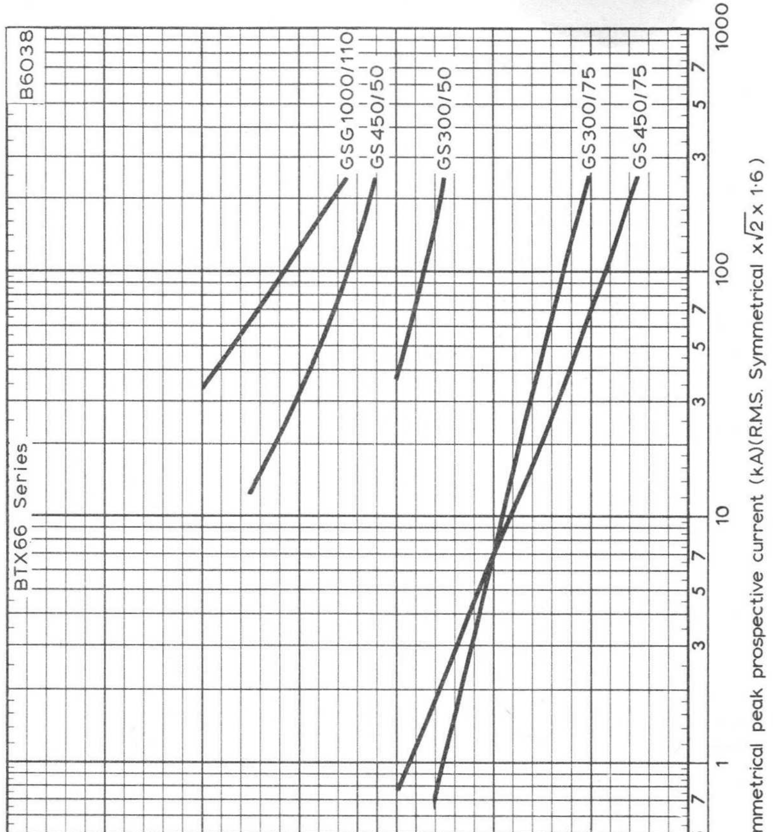


VARIATION OF RATE OF RISE OF FORWARD VOLTAGE WITH JUNCTION TEMPERATURE

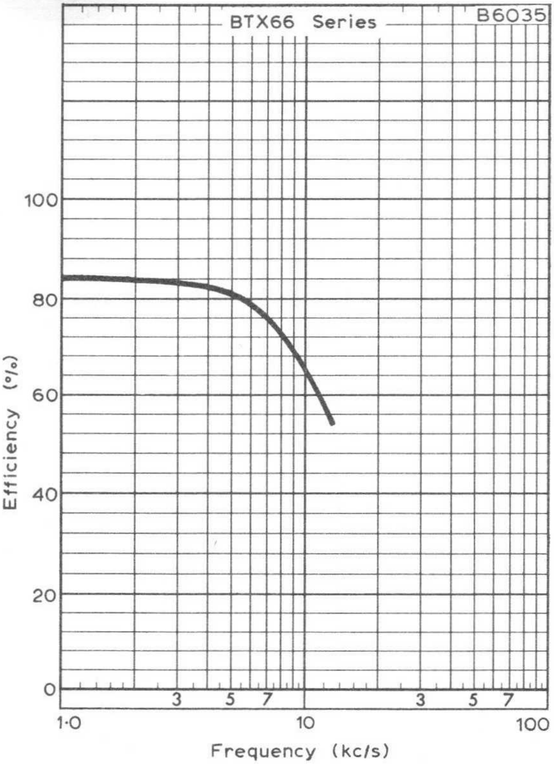
TYPICAL TURN-ON CHARACTERISTIC



THYRISTOR GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT



TYPICAL EFFICIENCY/FREQUENCY CHARACTERISTIC OF AN INVERTOR WITH A BASIC EFFICIENCY OF 85%

THYRISTORS

BTX67 Series

TENTATIVE DATA

The BTX67 is a range of p-gate reverse blocking thyristors for use in power control circuits where a low turn-off is required. Typical applications include all kinds of inverters, for a.c. motor speed control, emergency power supplies, and pulse generators up to 13kHz.

QUICK REFERENCE DATA

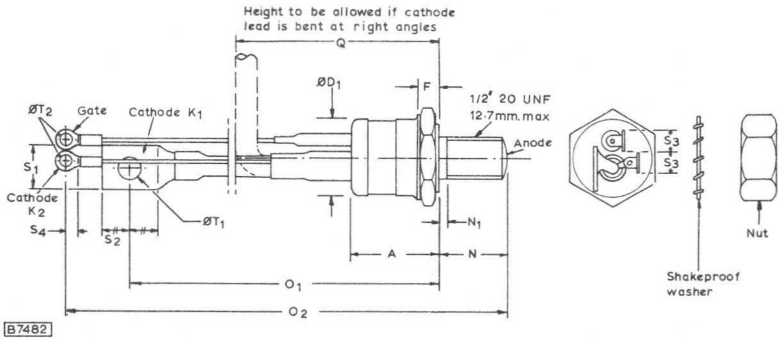
BTX67-	100R	200R	300R	400R	500R	600R	
V_{BO} min.	100	200	300	400	500	600	V
V_{RRM} max.	100	200	300	400	500	600	V
$I_{T(AV)}$ max. ($T_{stud} = 85^{o}C$)						62	A
$I_{T(RMS)}$ max.						110	A
t_q						15	μs

Unless otherwise shown data is applicable to both types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-30C

For details see page D2



Dimensions in millimetres

Ref.	Min.	Max.	Notes	Ref.	Min.	Max.	Notes
A	-	28.57		Q	-	63.5	2
$ØD_1$	-	24.15		S_1	-	16.5	
F	-	8.89	1	S_2	9.6	-	3
N	20.24	21.0		S_3	-	7.6	
N_1	-	3.0		S_4	3.81	-	3
O_1	148	158		$ØT_1$	8.1	8.3	
O_2	174	190		$ØT_2$	4.05	4.2	

NOTES

1. This zone includes a standard hexagon 27mm (1.062ins) nominally across flats
2. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter $ØD_1$. Q allows for the leads to be bent at right angles.
3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 13kHz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX67-	100R	200R	300R	400R	500R	600R	
V_R	Continuous reverse voltage	100	200	300	400	500	600	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	600	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	500	600	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	600	600	V
V_D	Continuous off-state voltage	100	200	300	400	500	600	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	600	V
V_{DRM}	Repetitive off-state voltage	100	200	300	400	500	600	V
V_{DSM}	Non-repetitive off-state voltage	600	600	600	600	600	600	V
$\frac{dV}{dt}$	Rate of rise of voltage not to trigger the device (see note 2)	7.0	13	20	27	33	40	V/μs ←

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 3degC/W for a.c. operation, and 1.5degC/W for d.c. operation.

2. These ratings apply with a 100Ω resistor connected between gate and cathode.

Current

I_T	Continuous on-state current	110	A
$I_{T(AV)}$	Mean on-state current (see page C2)	70	A
I_{TRM}	Repetitive peak on-state current	1000	A
I_{TSM}	Maximum on-state surge current peak of half-sine at maximum operating conditions (see page C4)	900	A
I^2t	I^2t for fusing (< 10ms)	4000	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current	100	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	20	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	1.0	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting-base	0.4	degC/W
Θ_i	Maximum thermal resistance for a torque of 90kg cm on the nut	0.1	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance	See page C5	

ELECTRICAL CHARACTERISTICS (T_j = 125 °C unless otherwise stated)

	BTX67-	100R	200R	300R	400R	500R	600R	
V_{BO}	Minimum forward breakover voltage (see note 2)	100	200	300	400	500	600	V
V_T	Maximum instantaneous on-state voltage at I_T = 500A, T_j = 25 °C						2.5	V
i_D	Maximum off-state current at V_{DWM}	13	12	10	8.0	12	12	mA
i_R	Maximum reverse leakage current at V_{RWM}	13	12	10	8.0	12	12	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at T_j = 25 °C						3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25 °C						80	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on						250	mV
I_H	Typical holding current						10	mA
I_L	Typical latching current						20	mA
t_q	Maximum turn-off time I_T = 50A, I_R = 20A at rated $\frac{dV}{dt}$ (see page C6)						15	µs
t_{gt}	Typical turn-on time (see page C7)						0.5	µs

NOTE

2. The device may breakover into the maximum repetitive peak on-state current at the maximum rate of rise of on-state current.

MECHANICAL DATA

Maximum torque on hexagon or nut	175	kg cm
	13	lb ft
Minimum torque on hexagon or nut for good thermal contact	90	kg cm
	6.5	lb ft
Recommended diameter of hole in heatsink	13	mm
	0.51	in
Weight		
Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

Accessories

1/2" UNF nut	Supplied with thyristor
Shakeproof washer	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core.
   A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)

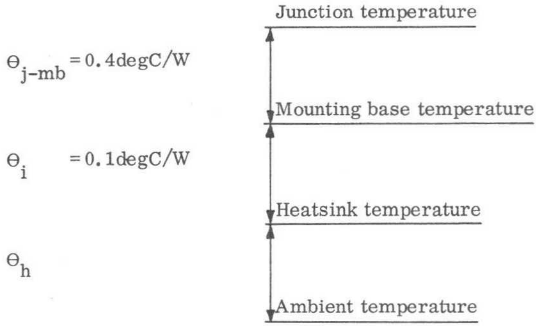
   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations.

The various components of the rise of junction temperature above ambient ar are illustrated below.



The method of using the curve on page C2 is as follows:

Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:-

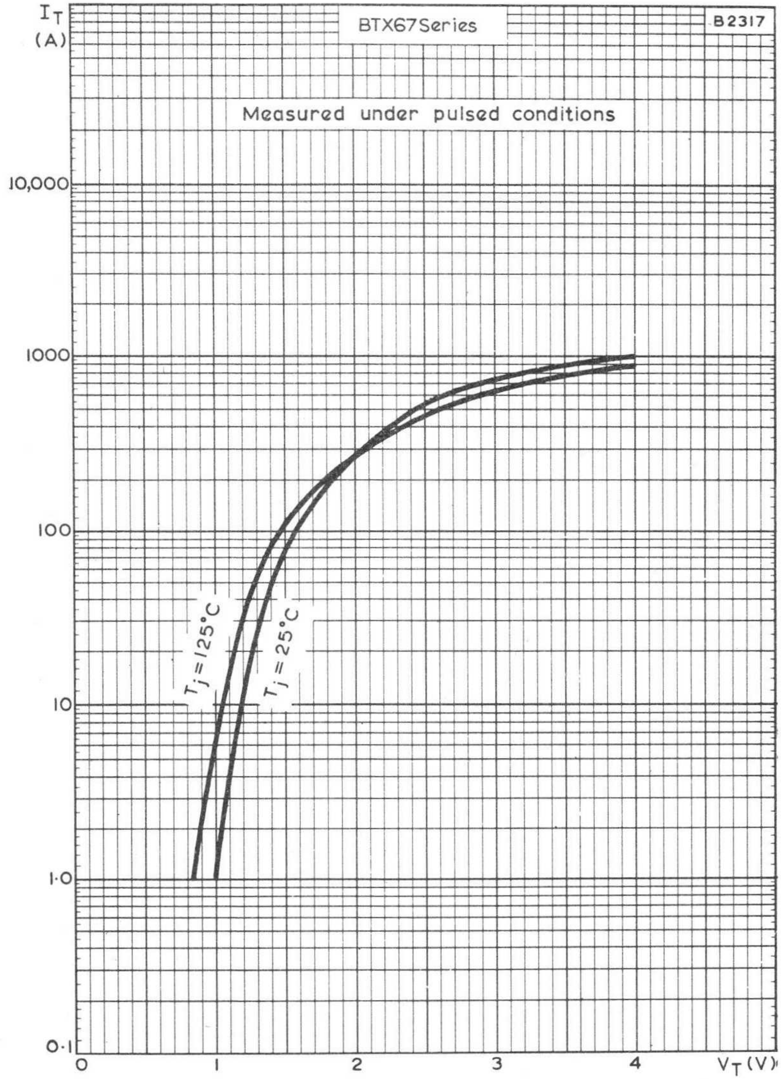
(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

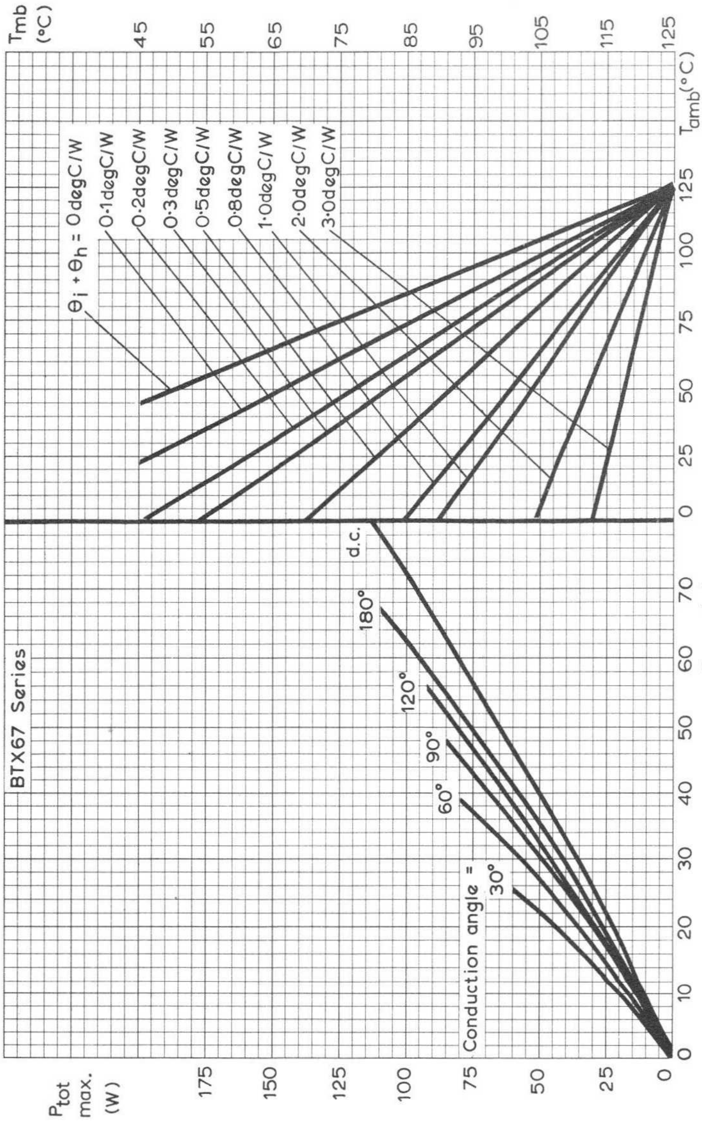
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

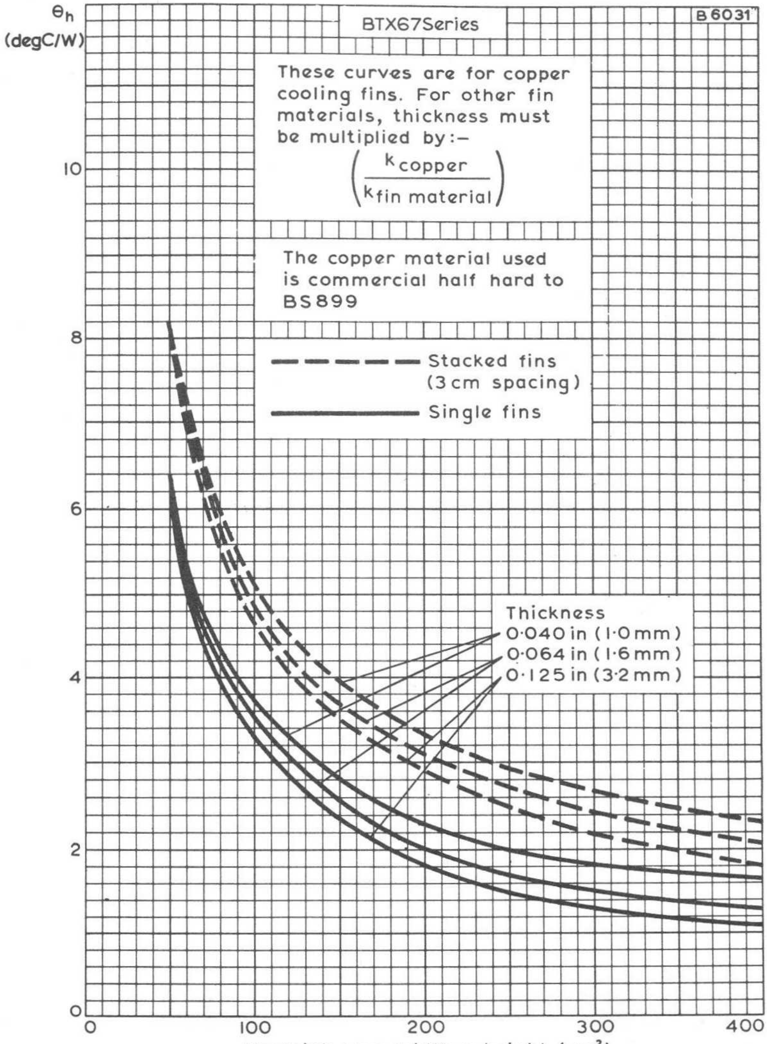
The curve shown on page C9 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.



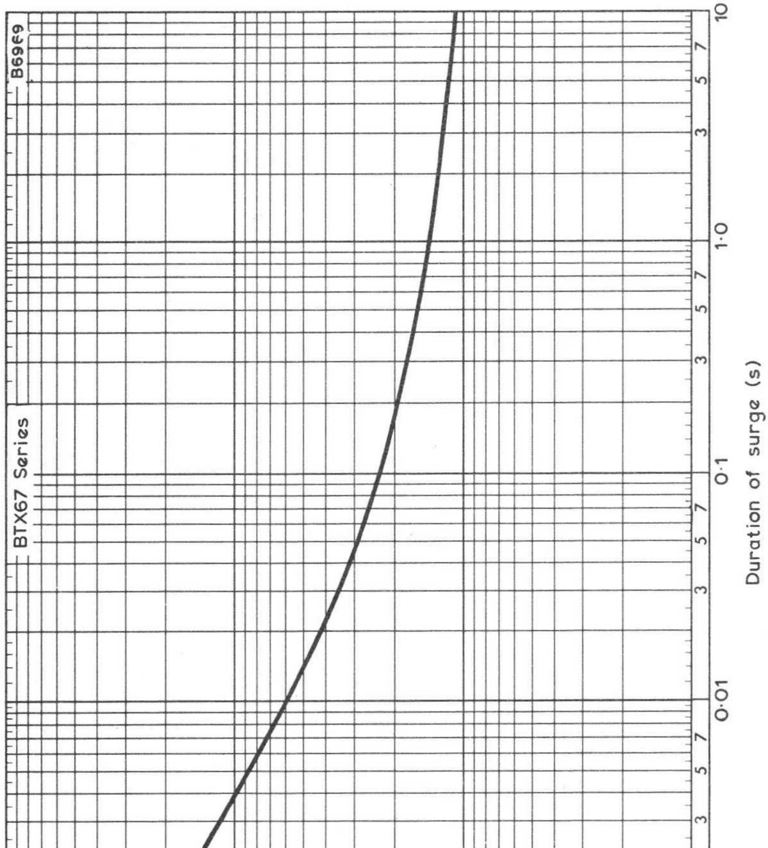
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



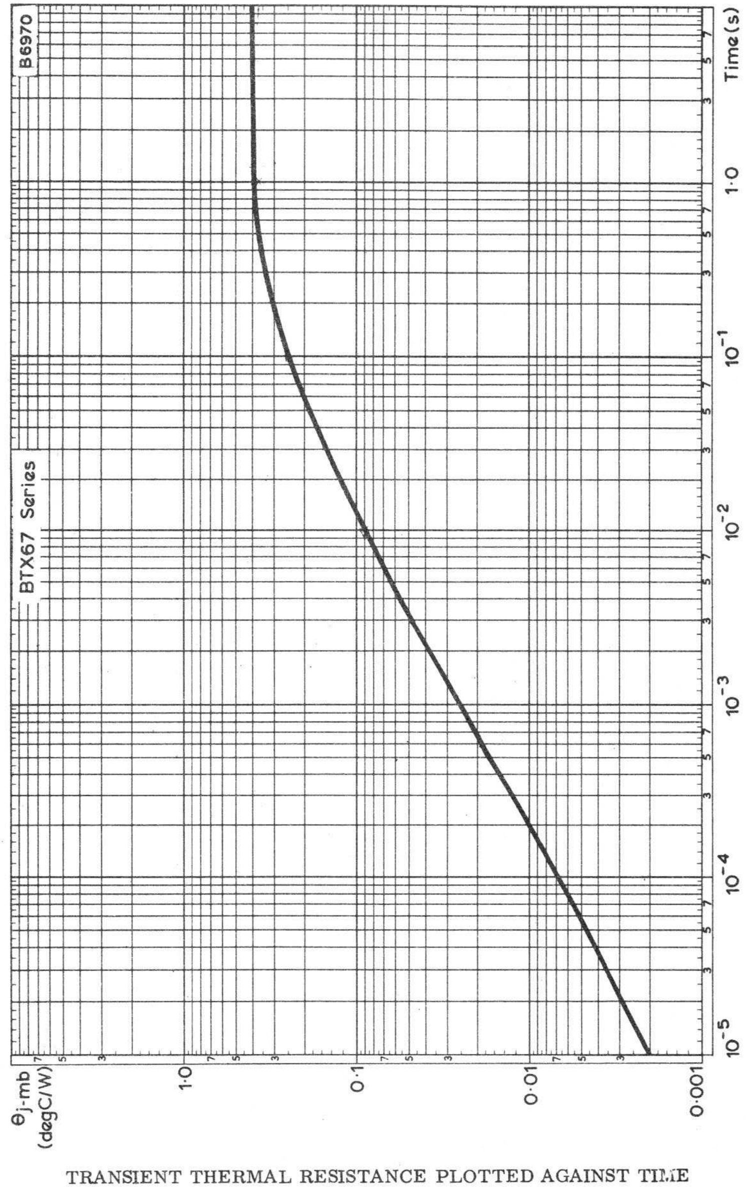
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



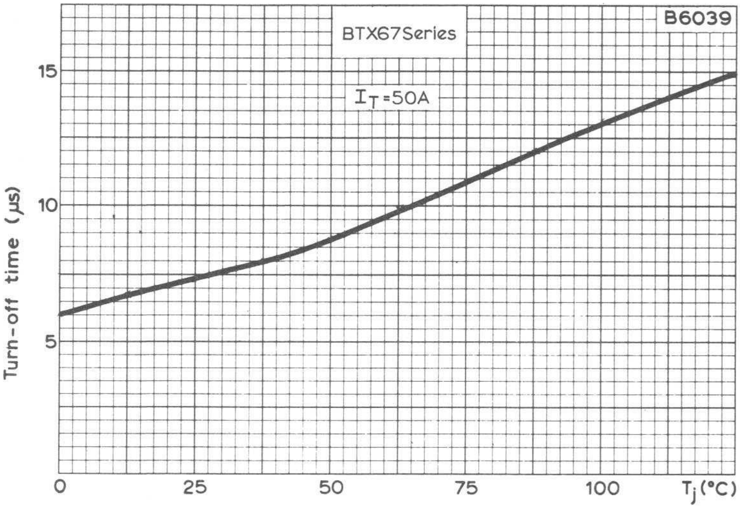
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA

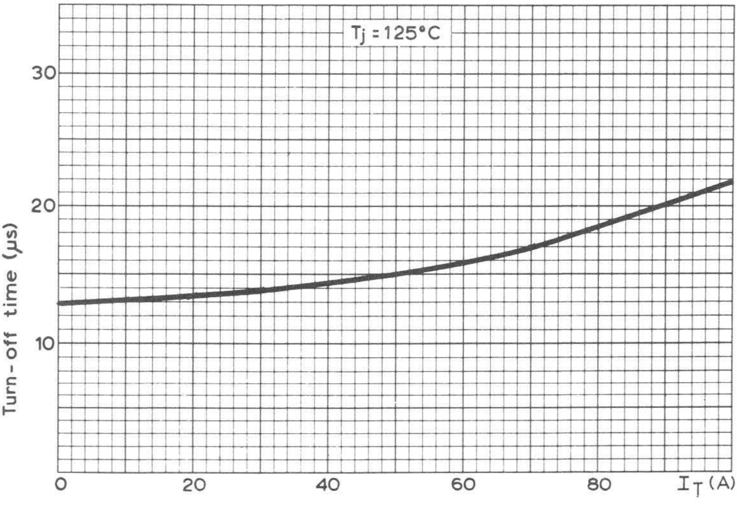


MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)

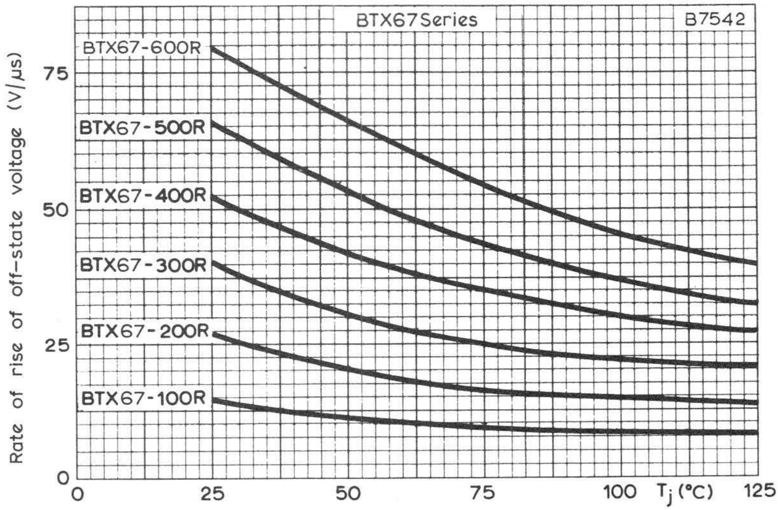


TRANSIENT THERMAL RESISTANCE PLOTTED AGAINST TIME

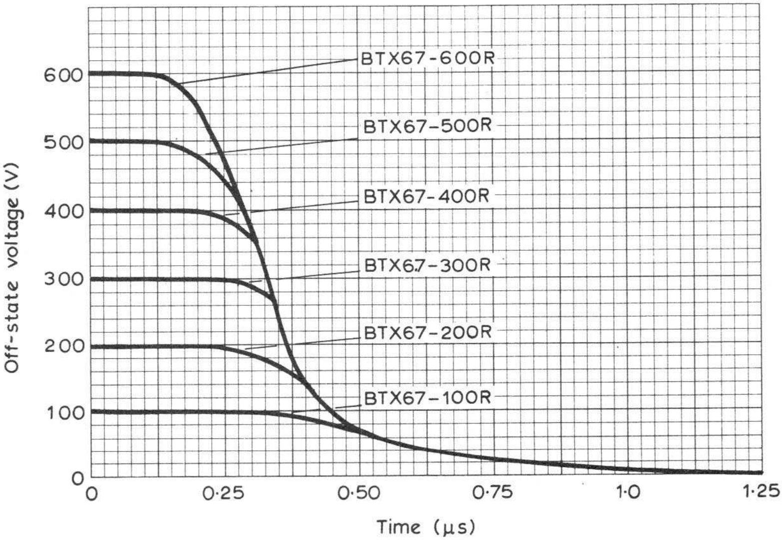




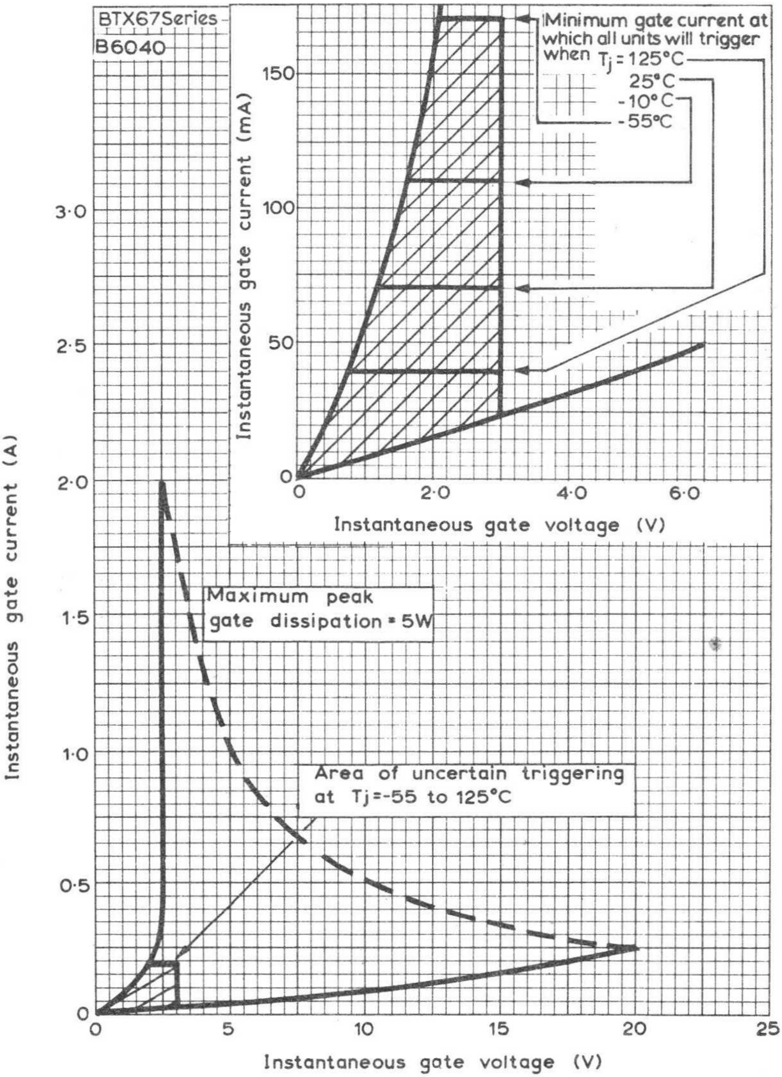
VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE
AND ON-STATE CURRENT



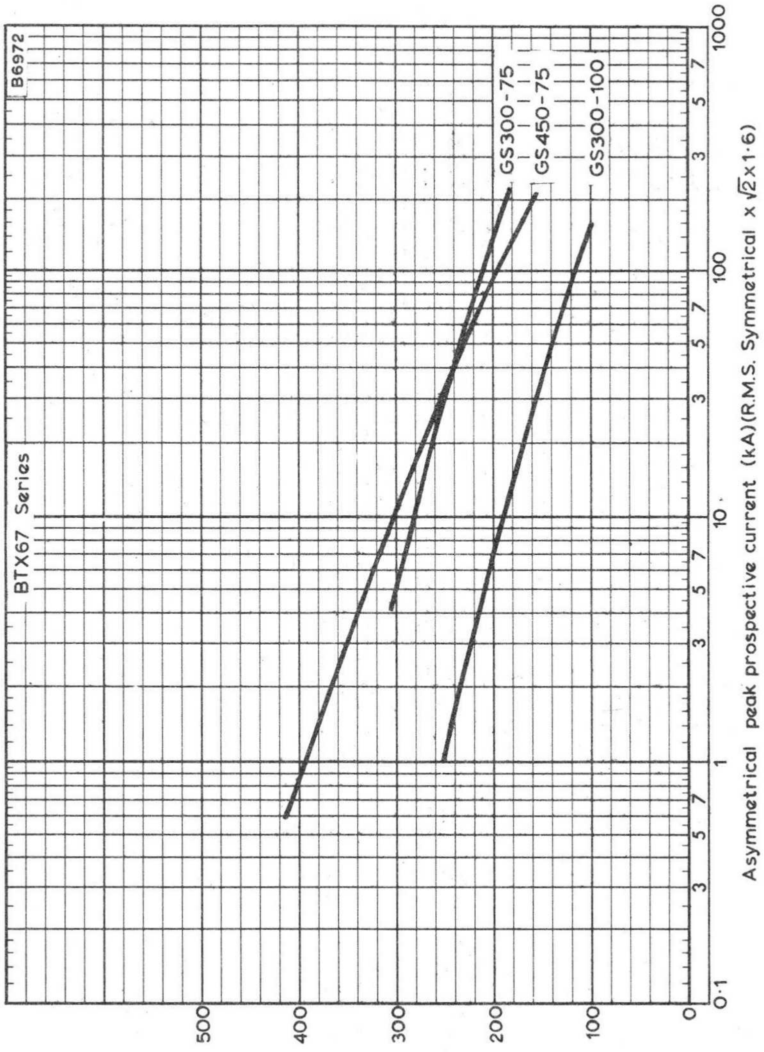
VARIATION OF RATE OF RISE OF OFF-STATE VOLTAGE WITH JUNCTION TEMPERATURE



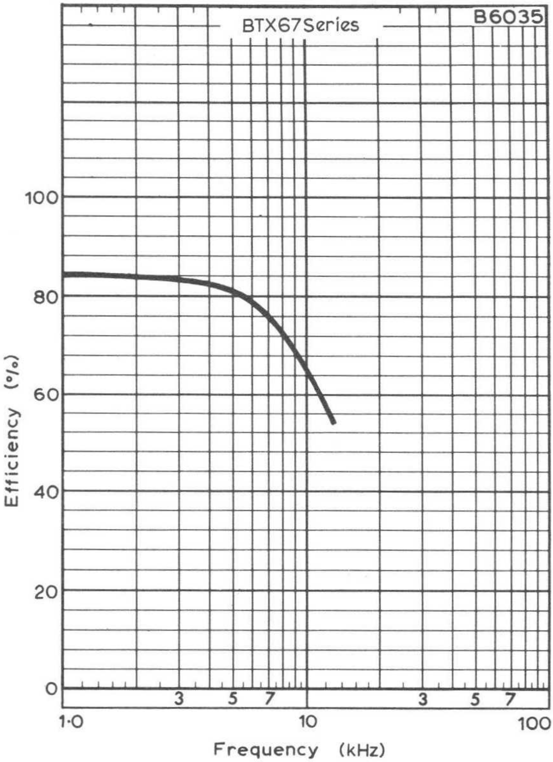
TYPICAL TURN-ON CHARACTERISTIC



THYRISTOR GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT



TYPICAL EFFICIENCY/FREQUENCY CHARACTERISTIC OF AN INVERTER WITH A BASIC EFFICIENCY OF 85%

TENTATIVE DATA

The BTX68 is a range of p-gate reverse blocking avalanche thyristors for use in power control circuits. Typical applications include the control of d.c. motors, furnaces and lighting. This range of thyristors is capable of absorbing transient energy within the rectifier circuit without damage.

QUICK REFERENCE DATA

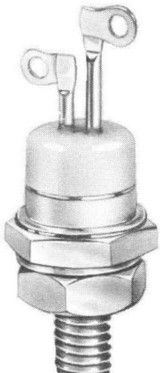
BTX68 -	500R	600R	700R	800R	1000R	
V_{BO} min.	550	660	770	880	1000	V
V_{RA} min.	550	660	770	880	1000	V
$I_{T(AV)}$ max.						
$T_{mb} = 85^{o}C$					6.4	A
$I_{T(RMS)}$					10	A
Θ_{j-mb} max.					3.0	degC/W
T_j max.					125	^{o}C
Reverse power surge (non repetitive)						
$10\mu s$, $T_j = 25^{o}C$					12	kW
$10\mu s$, $T_j = 125^{o}C$					4.0	kW

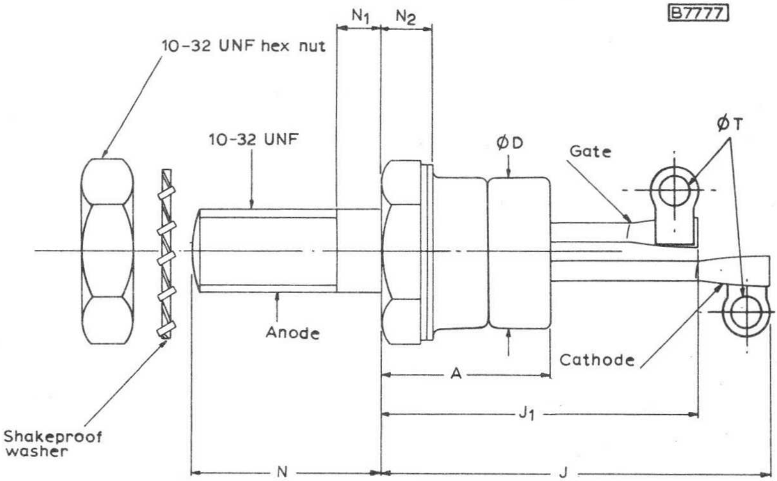
Unless otherwise shown data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-35A

For details see page D2





Inch dimensions derived from millimetre signals

	Millimetres			Inches			Note
Ref.	Min.	Nom.	Max.	Min.	Nom.	Max.	
A	-	-	10.28	-	-	0.405	
ØD	-	-	9.3	-	-	0.367	
J	-	-	21.72	-	-	0.856	
J_1	-	-	18.5	-	-	0.728	
N	10.72	11.1	11.5	0.423	0.437	0.453	
N_1	-	-	1.98	-	-	0.078	
N_2	-	-	3.5	-	-	0.138	1
ØT	1.6	-	1.9	0.063	-	0.075	

NOTES

1. This zone includes a $7/_{16}$in hexagon, across flats dimension 0.423in (10.75mm) minimum, 0.438in (11.12mm) maximum.
2. Devices with slight variations in lug pattern, still conforming to B.S.3934 SO-35A, may be supplied.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous applications of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX68 -	500R	600R	700R	800R	1000R	
V_R	Continuous reverse voltage	500	600	700	800	1000	V
V_{RWM}	Crest working reverse voltage	500	600	700	800	1000	V
V_D	Continuous off-state voltage	500	600	700	800	1000	V
V_{DWM}	Crest working off-state voltage	500	600	700	800	1000	V

NOTE

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 12degC/W for a.c. operation and 6.0degC/W for d.c. operation.

Current

I_T	Continuous on-state current	10	A
$I_{T(AV)}$	Mean on-state current (see page C2)	6.4	A
$I_{T(RMS)}$	R.M.S. on-state current	10	A
I_{TRM}	Repetitive peak on-state current	60	A
I_{TSM}	Non-repetitive on-state fault current, peak of half-sinewave at maximum operating conditions	80	A
I^2t	I^2t for fusing (< 10ms) (See pages C4 and C5)	32	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current (see lower curve Page C8)	20	A/μs
I_{RRM}	Repetitive peak reverse current	5.0	A

Power

	Reverse power surge (non-repetitive)		
	10μs, $T_j = 25^oC$	12	kW
	10μs, $T_j = 125^oC$	4.0	kW

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive, w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
P_G	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	125	^oC
T_j min.	Junction temperature min.	-55	^oC
T_j max.	Junction temperature max.	125	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting base	3.0	degC/W
Θ_i	Maximum thermal resistance for a torque of 9.0kg cm on the nut	0.5	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance (1.0ms)	0.16	degC/W

ELECTRICAL CHARACTERISTICS (T_j = 125°C unless otherwise stated)

	BTX68-	500R	600R	700R	800R	1000R	
V_{BO}	Minimum forward breakover voltage	550	660	770	880	1000	V
V_{RA}	Minimum reverse avalanche voltage	550	660	770	880	1000	V
V_T	Maximum instantaneous on-state voltage at I_T = 20A, T_j = 25°C					2.3	V
i_D	Maximum off-state leakage current at V_{DWM}					2.5	mA
i_R	Maximum reverse leakage current at V_{RWM}					2.5	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at T_j = 25°C (see page C6)					3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25°C (see page C6)					30	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)					250	mV
I_H	Typical holding current					10	mA
I_L	Typical latching current					20	mA
t_{gt}	Typical turn-on time Forward voltage before trigger = 50V, I_T = 10A (see page C7)					3.0	μs
t_q	Typical turn-off time I_T = 10A, I_R = 5.0A (see page C7)					20	μs

MECHANICAL DATA

Maximum torque on hexagon or nut	17	kg cm
	1.3	lb ft
Minimum torque on hexagon or nut for good thermal contact	9.0	kg cm
	0.6	lb ft
Recommended diameter of hole in heatsink	5.2	mm
	0.205	in
Weight		
Without accessories	5.3	g
	0.18	oz
With accessories	7.0	g
	0.25	oz

Accessories

Accessory	Code No.	Note
10-32 UNF Nut Shakeproof washer	56294	Supplied with thyristor
PTFE bush 2 Mica washers 2 BA washer Terminal	56295	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core.
   A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

	R-C in primary of transformer		R-C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

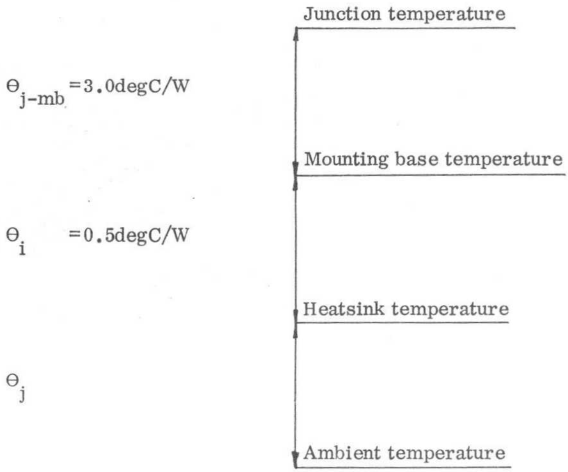
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations.

The various components of the rise of junction temperature above ambient are illustrated below.



The method of using the curve on page C2 is as follows:

Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ max.} - \theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:-

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

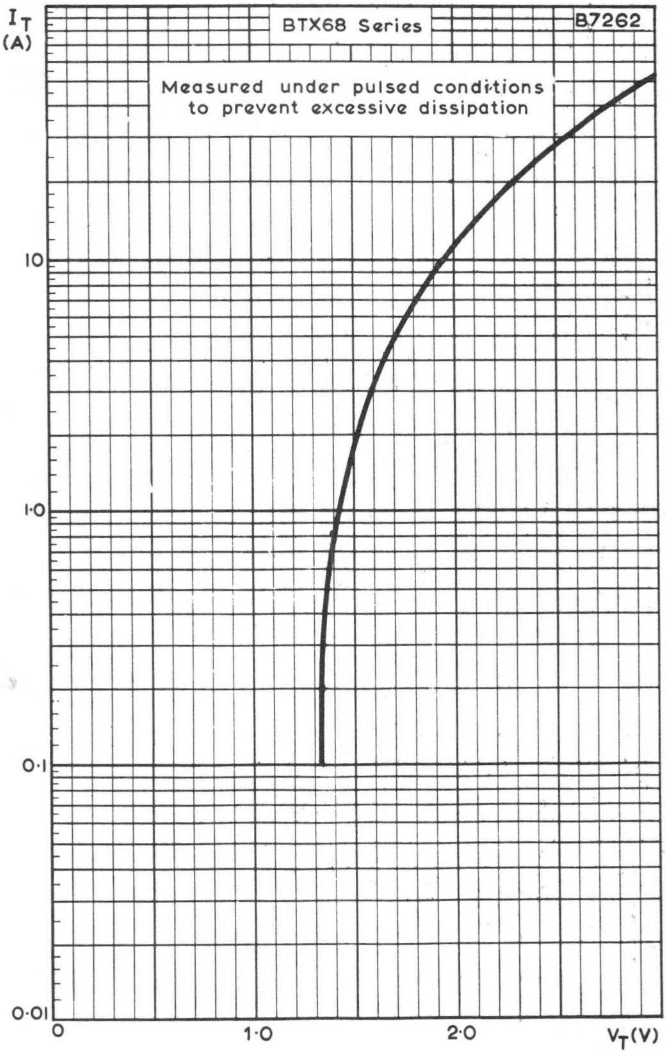
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

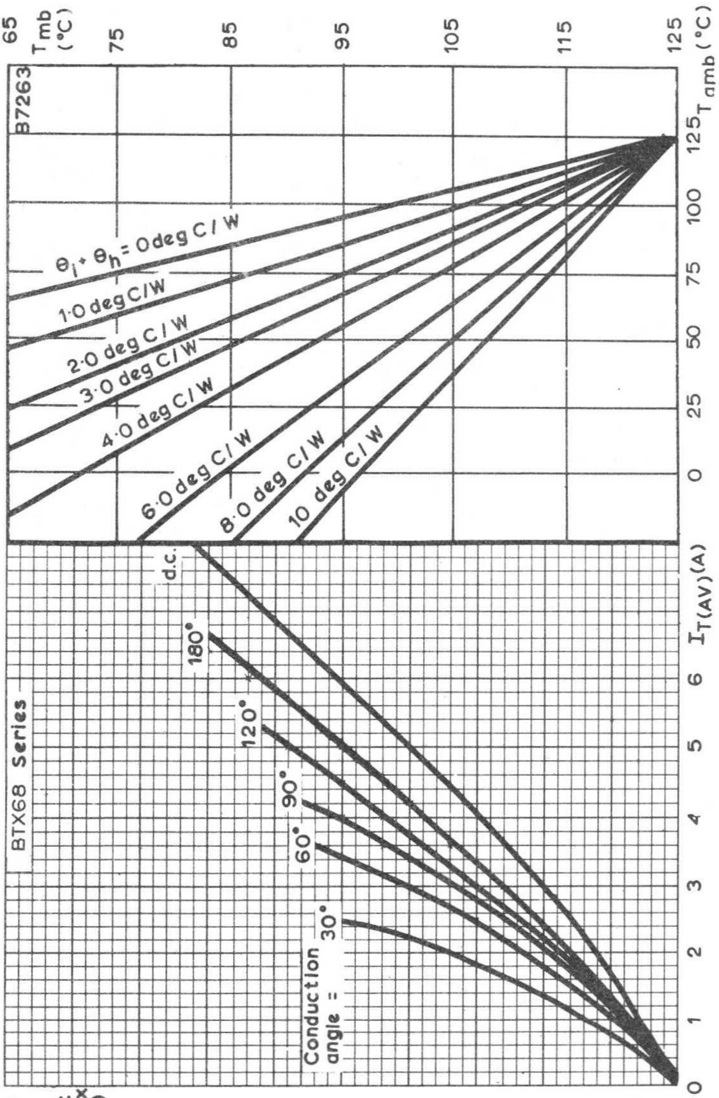
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

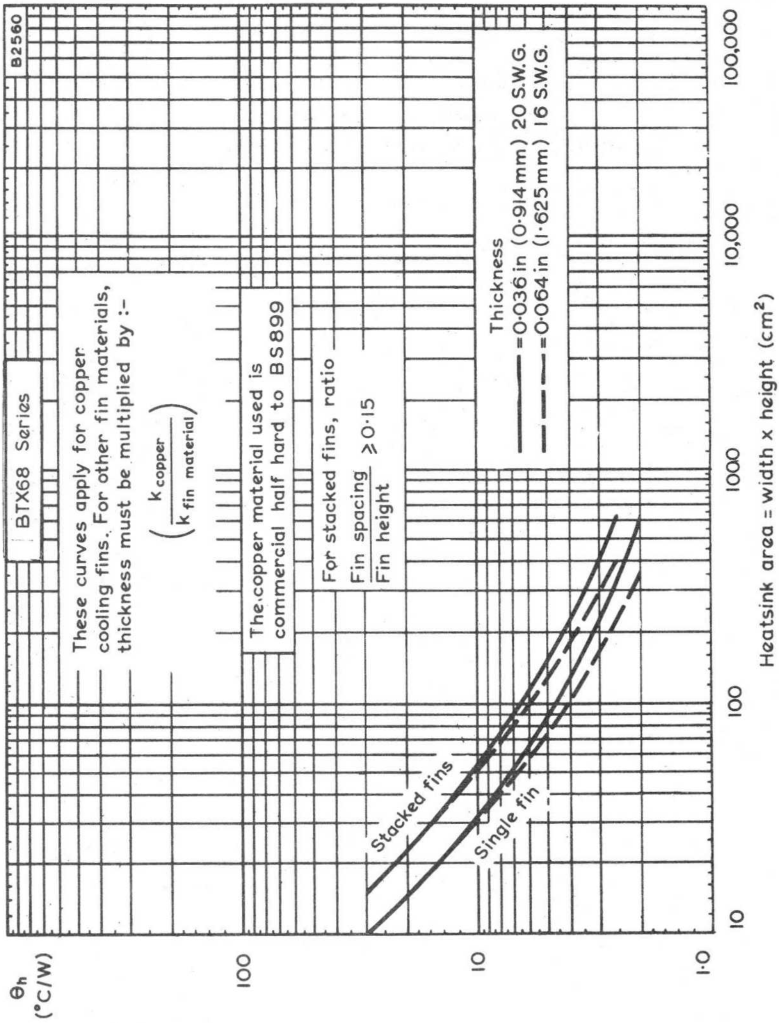
Where starting conditions are likely to exceed the current limits given on page C2 the upper curve on page C8 may be used. Upper curve on page C8 refers to the output of a single phase bridge.



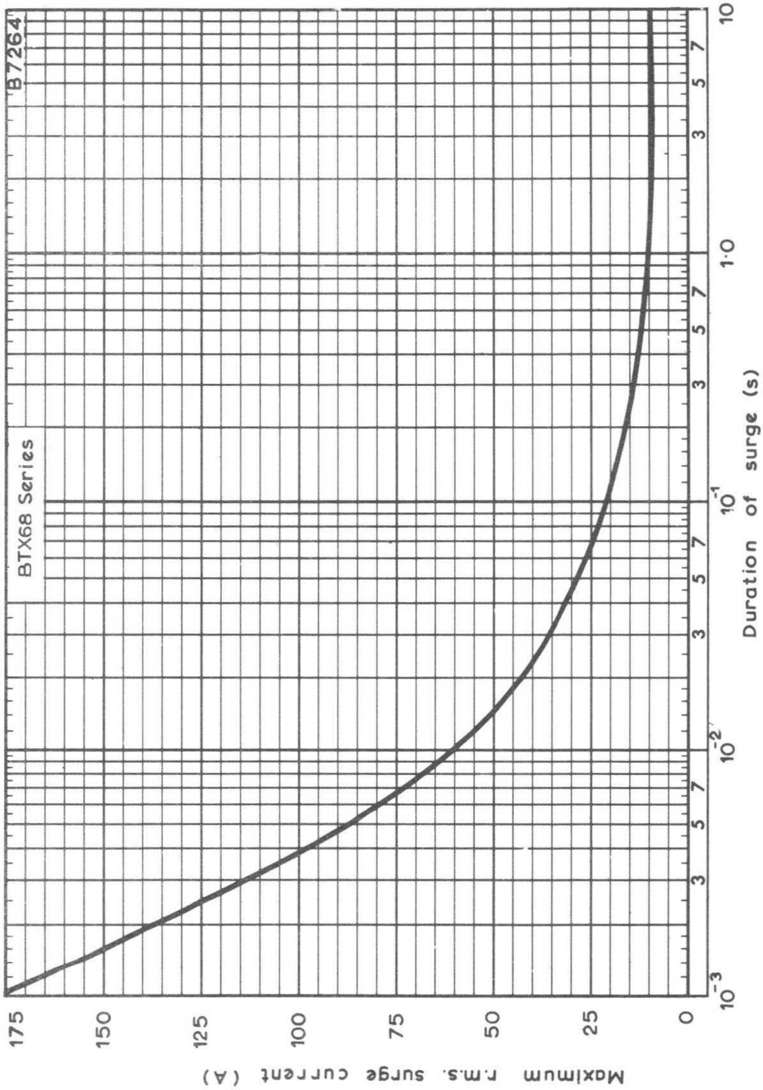
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



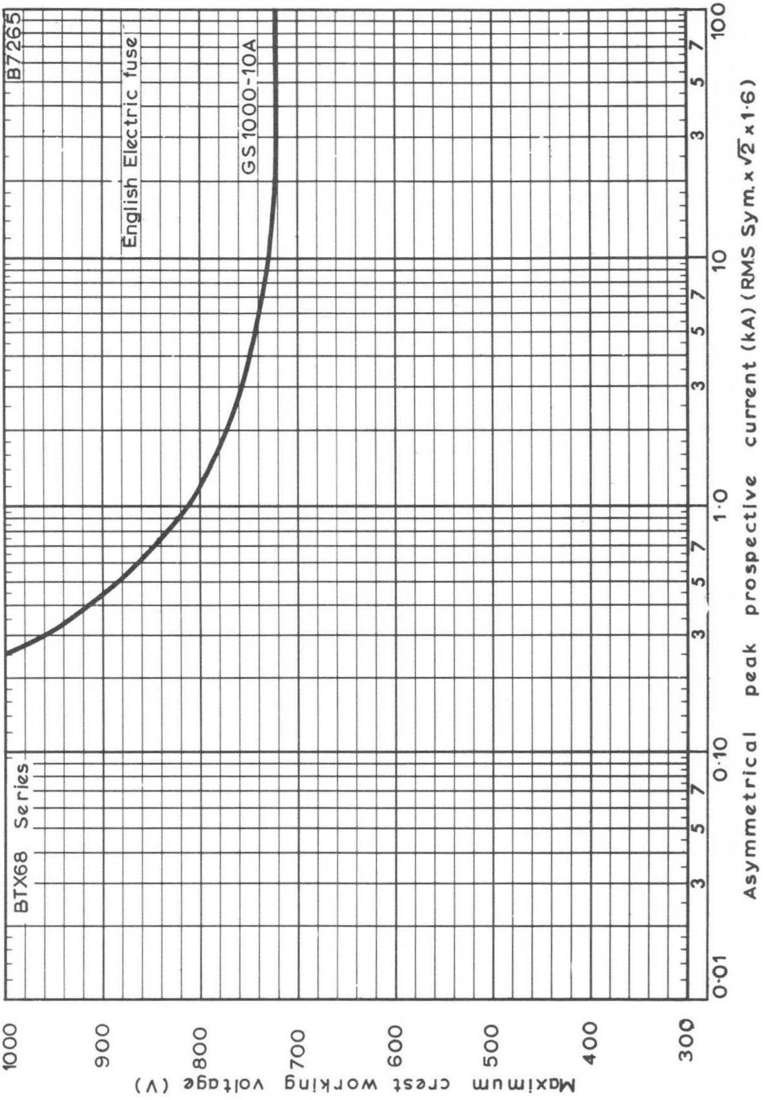
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



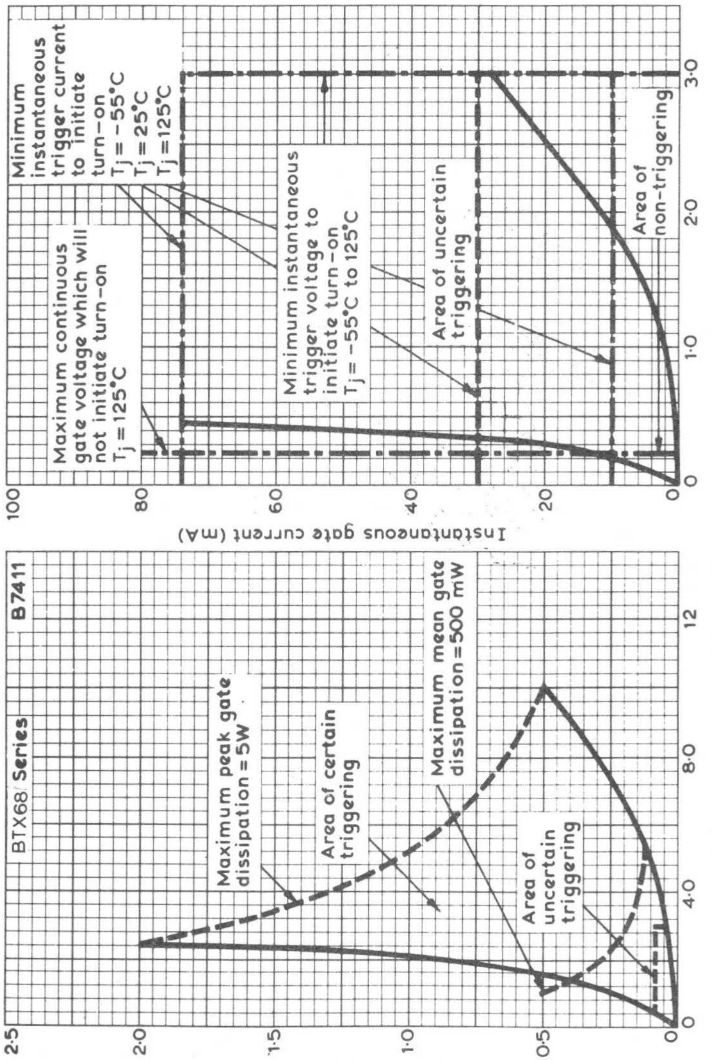
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



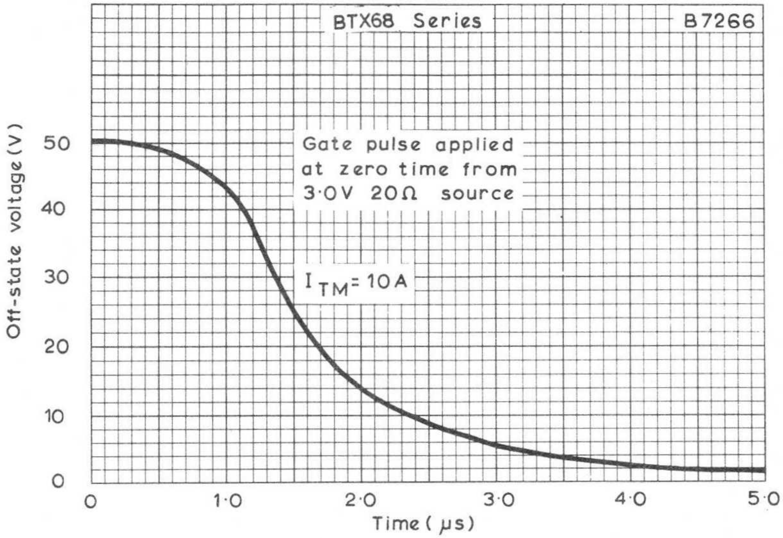
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE
DURATION FOR SELECTING PROTECTIVE DEVICES
FUSES, CIRCUIT BREAKERS ETC.



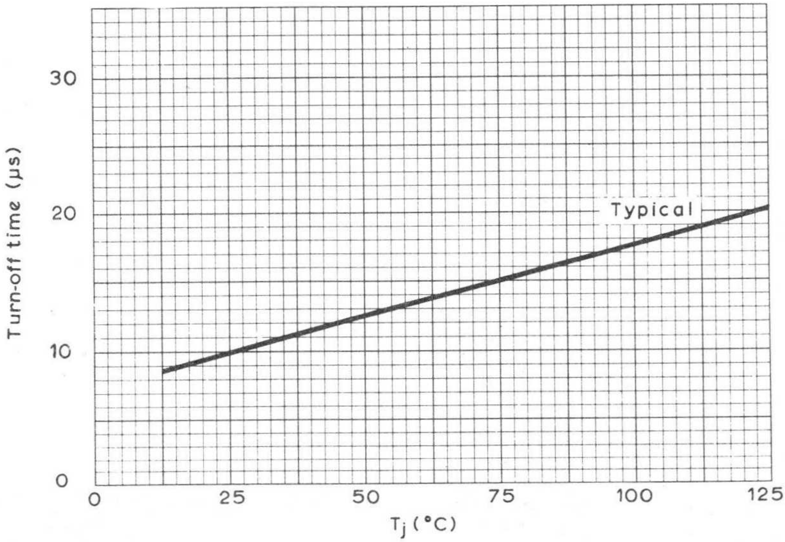
CREST WORKING VOLTAGE PLOTTED AGAINST
PROSPECTIVE CURRENT



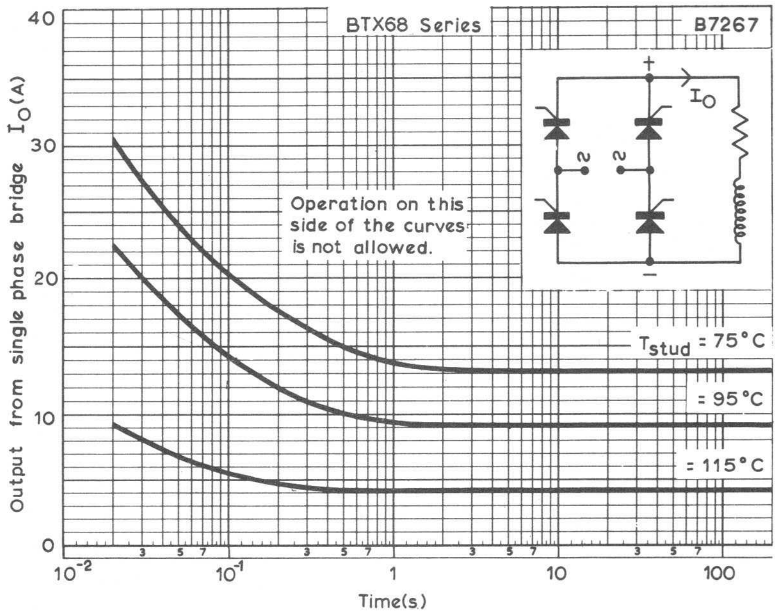
THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION
OF THE GRAPH NEAR THE ORIGIN



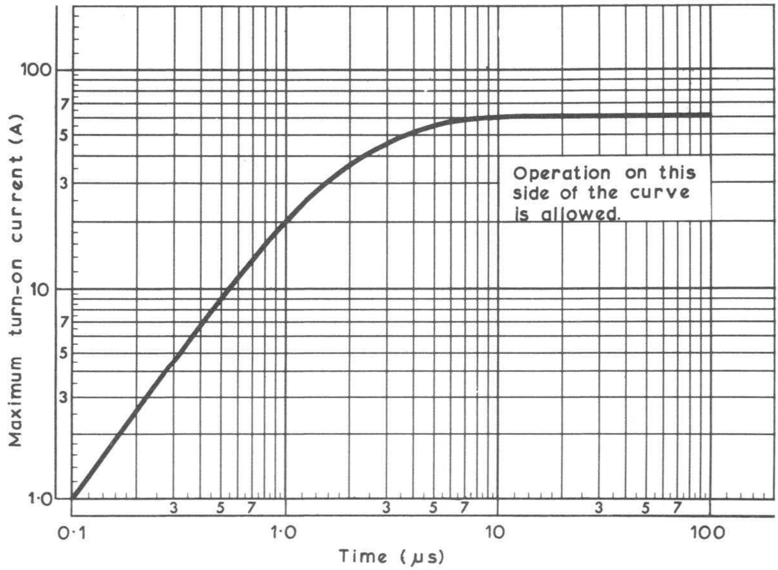
TYPICAL TURN-ON CHARACTERISTIC



TYPICAL VARIATION OF TURN-OFF TIME WITH
JUNCTION TEMPERATURE



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME

THYRISTORS

BTX75
Series

TENTATIVE DATA

The BTX75 is a range of p-gate reverse blocking thyristors for use in power control circuits. They have a maximum junction temperature of 150°C and are therefore suitable for operation in high ambient temperatures. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

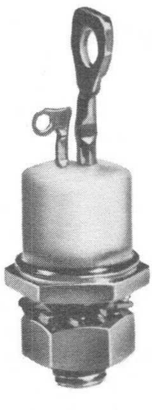
	BTX75-	100R	200R	300R	400R	
V_{BO} min.		100	200	300	400	V
V_{RRM} max.		100	200	300	400	V
$I_{T(AV)}$ max. (T_{stud} = 110°C)					8.5	A
$I_{T(RMS)}$ max.					25	A
T_j max.					150	°C

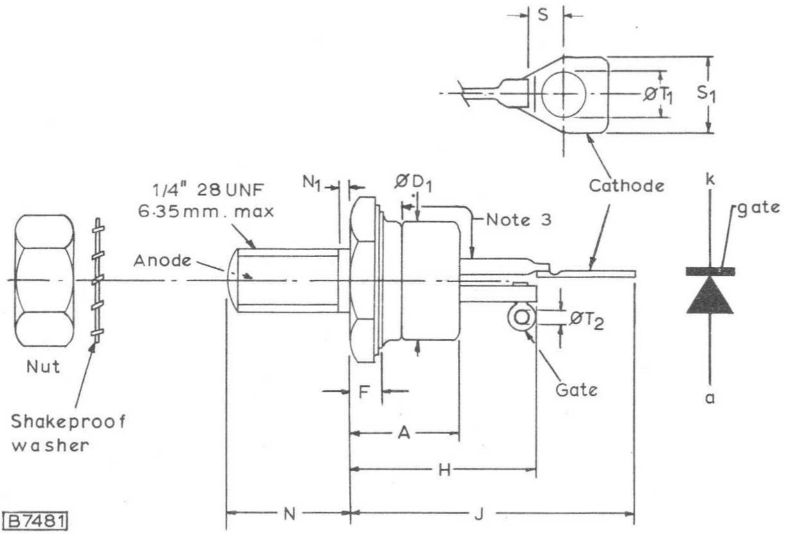
Unless otherwise shown data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page D2





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.522").
2. Minimum flat.
3. Minimum creepage path 6mm (0.236").

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX75-	100R	200R	300R	400R	
V_R	Continuous reverse voltage	100	200	300	400	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	V
V_D	Continuous off-state voltage (see note 2)	100	200	300	400	V
V_{DWM}	Crest working off-state voltage (see note 2)	100	200	300	400	V
V_{DRM}	Repetitive peak off-state voltage (see note 2)	100	200	300	400	V
V_{DSM}	Non-repetitive peak off-state voltage	500	500	500	500	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 9degC/W for a.c. operation and 4.5degC/W for d.c. operation.
2. This voltage may be exceeded up to the maximum non-repetitive peak forward voltage V_{DSM}, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

Current

I_T	Continuous on-state current	25	A
$I_{T(AV)}$	Mean on-state current (see page C2)	16	A
$I_{T(RMS)}$	R.M.S. on-state current	25	A
I_{TRM}	Repetitive peak on-state current	140	A
I_{TSM}	Non-repetitive on-state current, peak of half sinewave at maximum operating conditions	140	A
I^2t	I^2t for fusing	100	A^2s
$\frac{di}{dt}$	Rate of rise of forward current (see lower curve page C8)	20	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
P_G	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	150	^oC
T_j min.	Junction temperature min.	-55	^oC
T_j max.	Junction temperature max.	150	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting base	2.0	degC/W
Θ_i	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance (1.0ms)	0.095	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 150^{\circ}C$ unless otherwise stated)

	BTX75-	100R	200R	300R	400R	
V_{BO}	Minimum forward break-over voltage	100	200	300	400	V
V_T	Maximum instantaneous on-state voltage at $I_T = 50A$, $T_j = 25^{\circ}C$				3.0	V
i_D	Maximum off-state current at V_{DWM}	13	12	10	8.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	13	12	10	8.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$ (see page C6)				3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$ (see page C6)				65	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)				250	mV
I_H	Typical holding current				10	mA
I_L	Typical latching current				20	mA
t_{gt}	Typical turn-on time (see page C7)				3.0	μs
t_q	Typical turn-off time $I_T = 10A$, $I_R = 5.0A$ (see page C7)				25	μs

MECHANICAL DATA

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in
Weight		
Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below.

Junction temperature

Θ_{j-mb} =2.0degC/W

Mounting base temperature

Θ_i =0.2degC/W

Heatsink temperature

Θ_j

Ambient temperature

The method of using the curve on page C2 is as follows.

Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:-

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

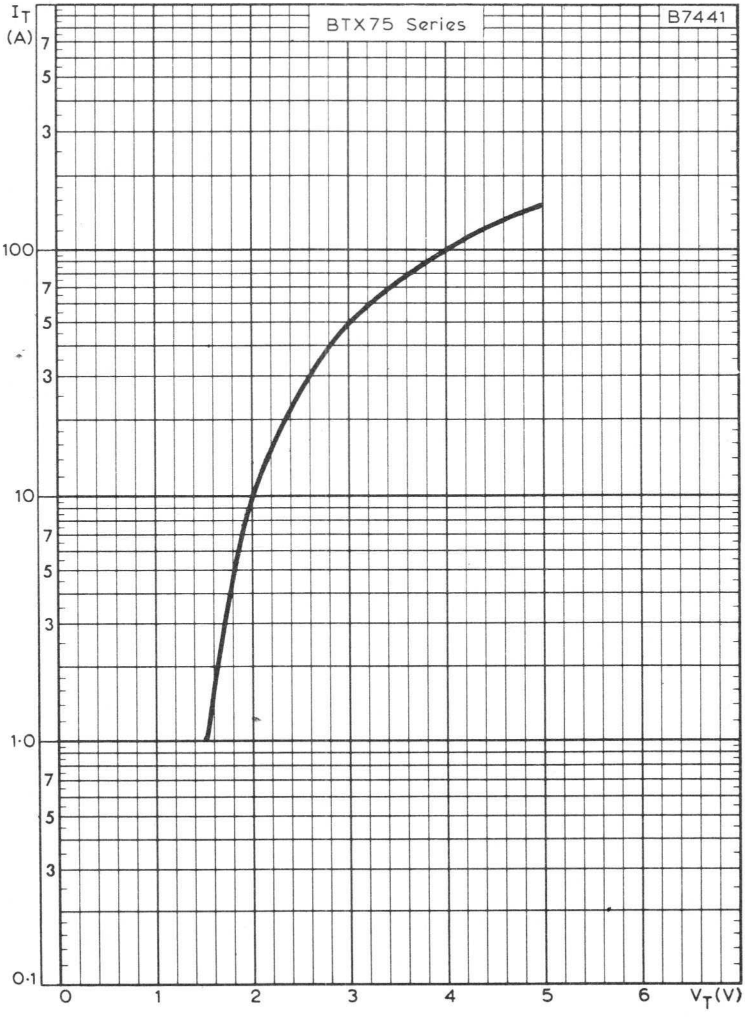
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

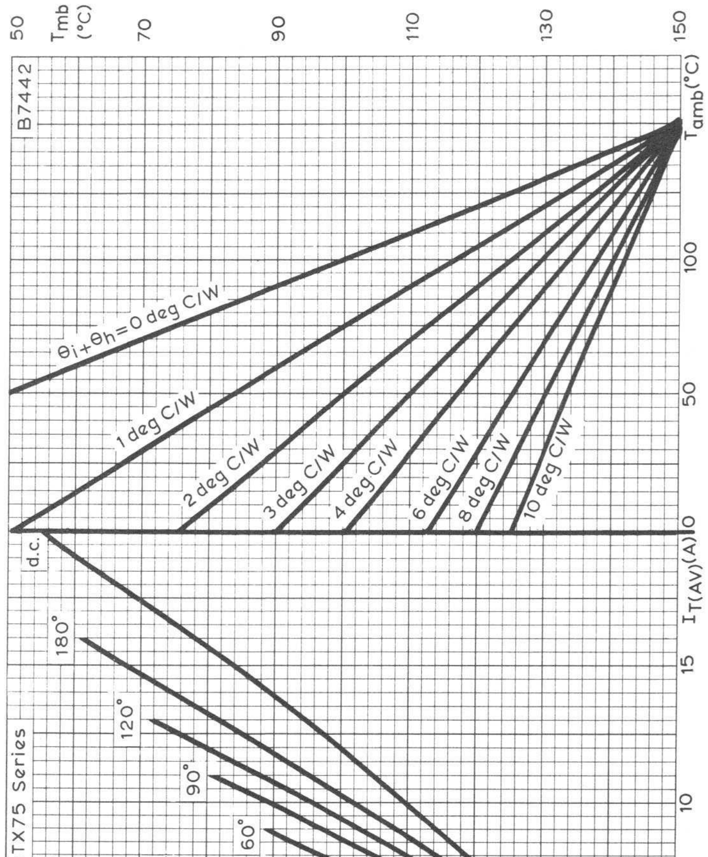
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

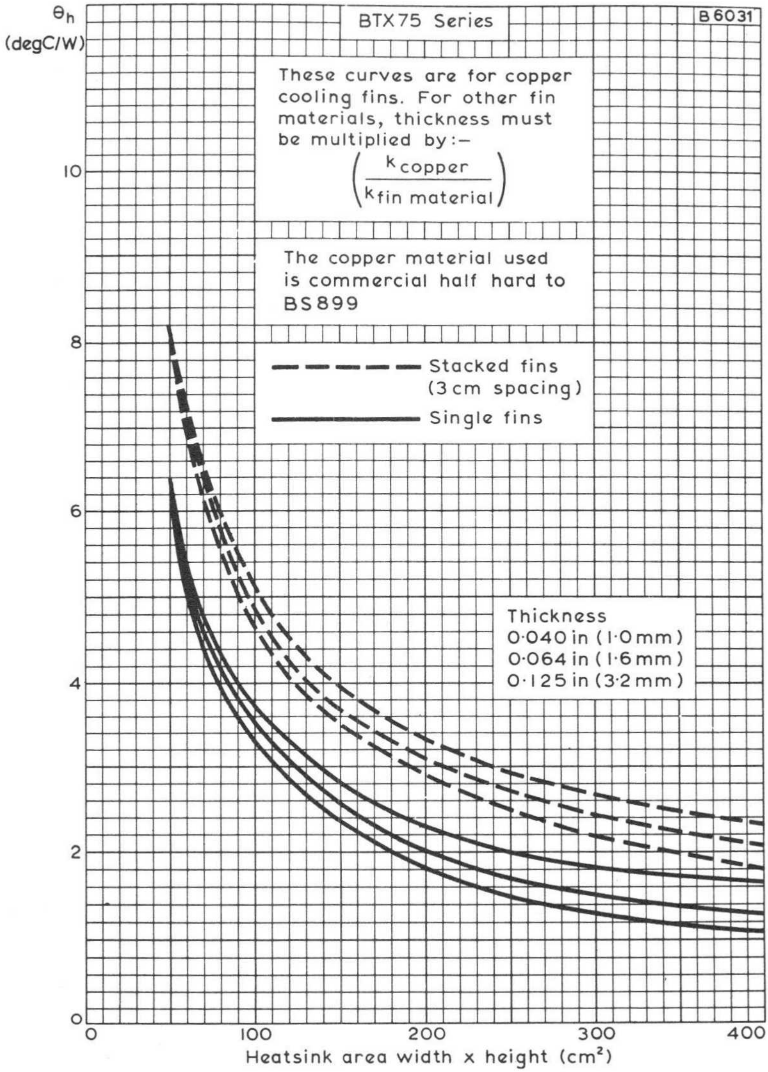
Where starting conditions are likely to exceed the current limits given on page C2 the curves on page C8 may be used. The upper curve refers to the output of a single phase bridge and the lower curve to a three phase bridge.



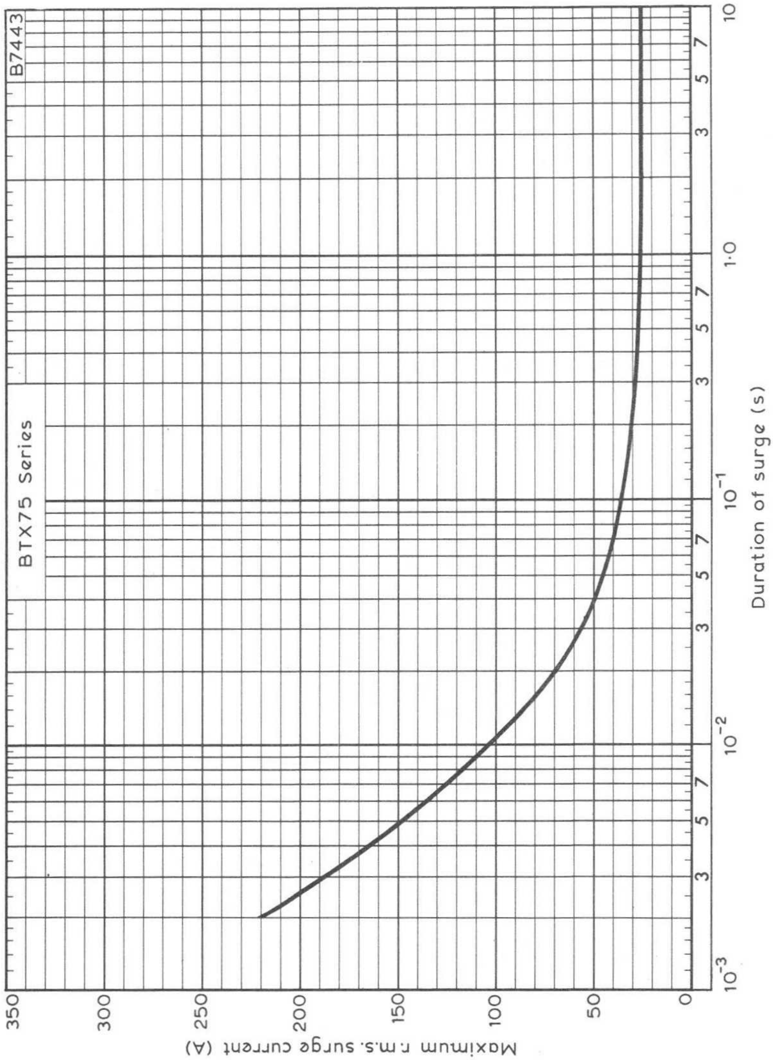
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



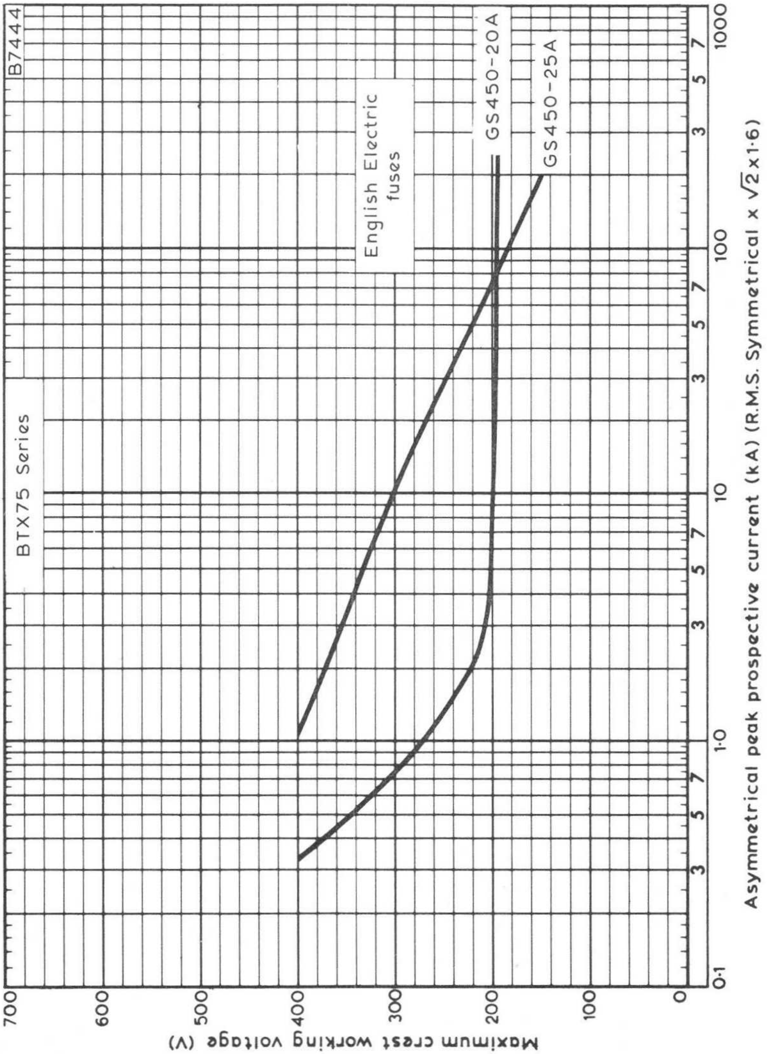
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



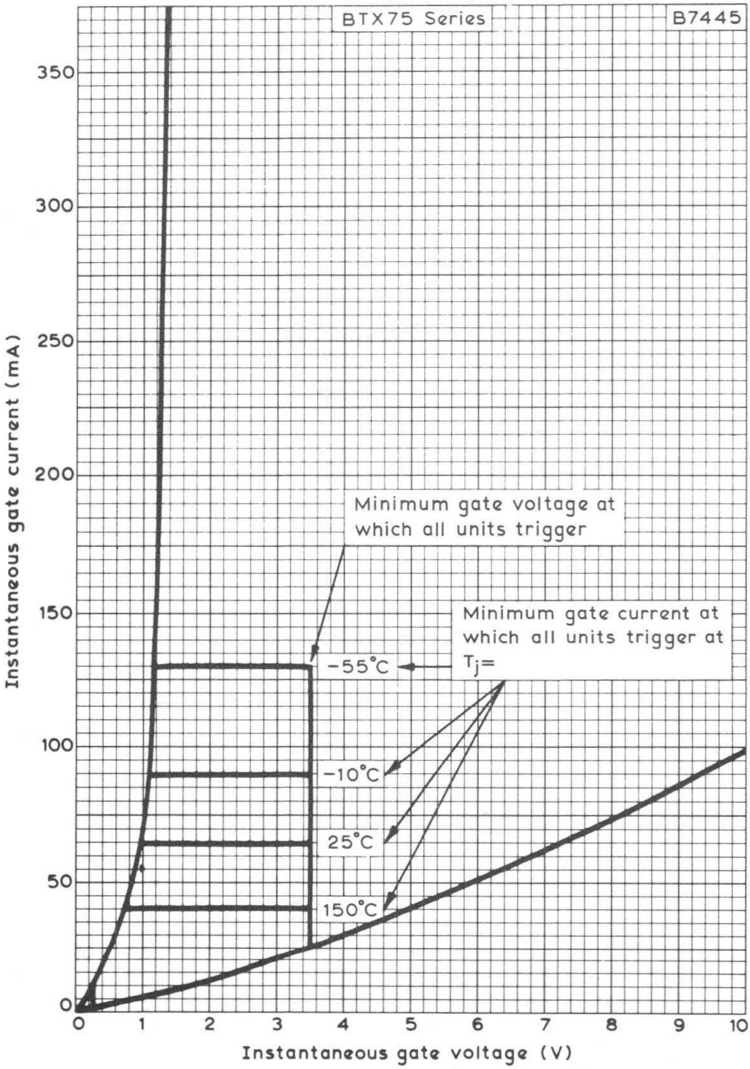
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



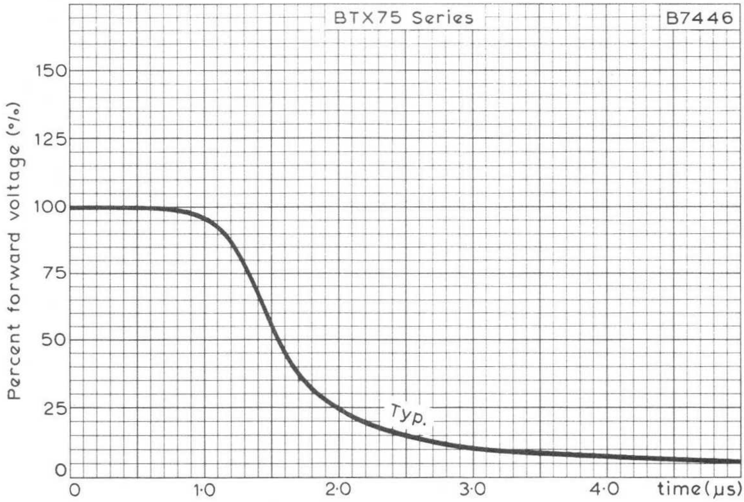
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE
DURATION FOR SELECTING PROTECTIVE DEVICES
(FUSES, CIRCUIT BREAKERS ETC.)



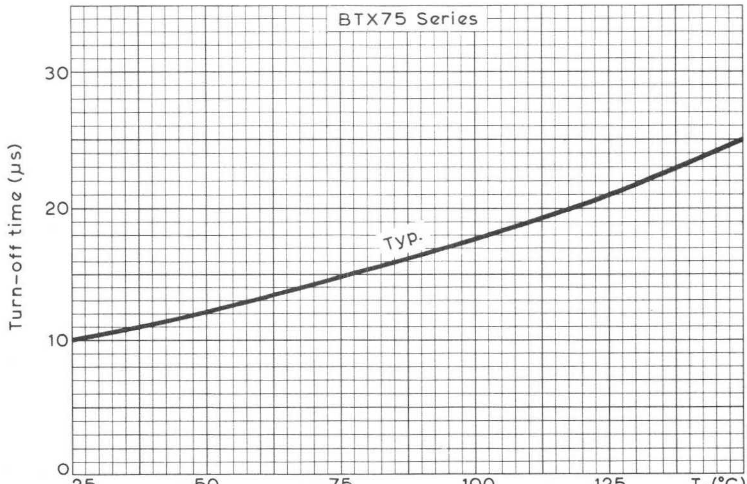
CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT



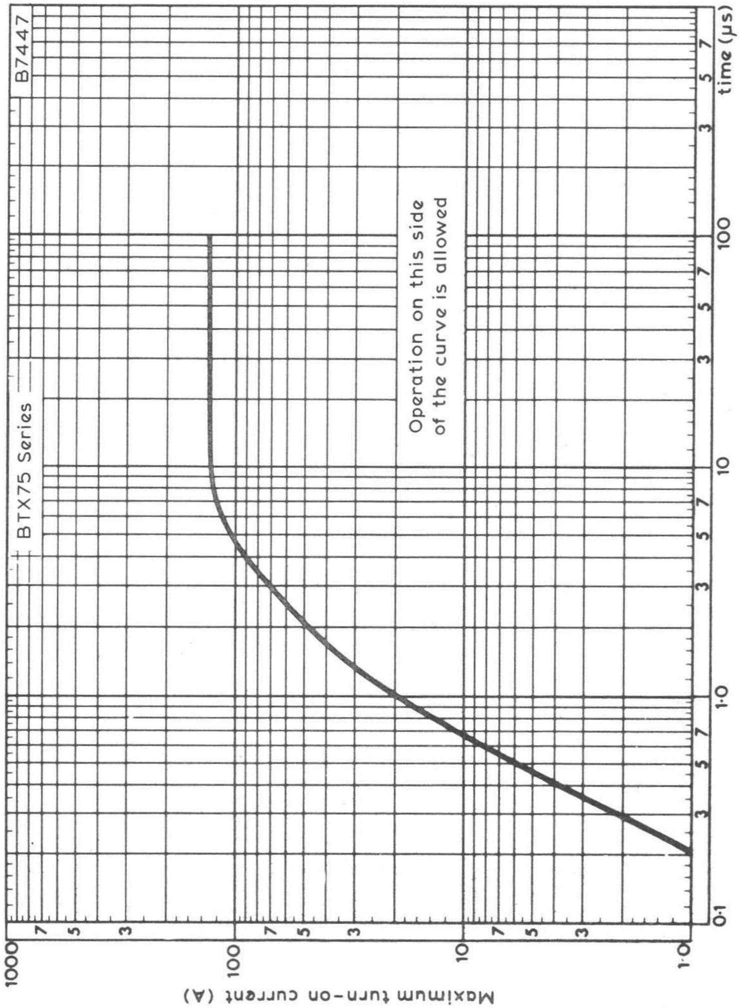
GATE CHARACTERISTIC



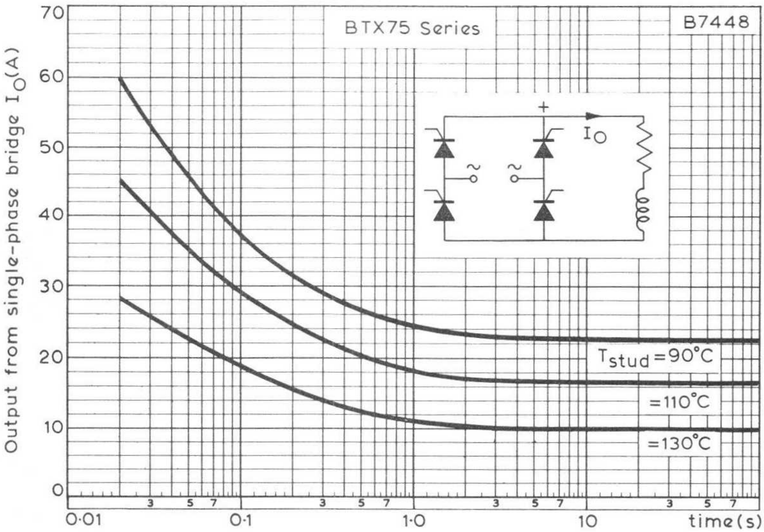
TYPICAL TURN-ON CHARACTERISTIC

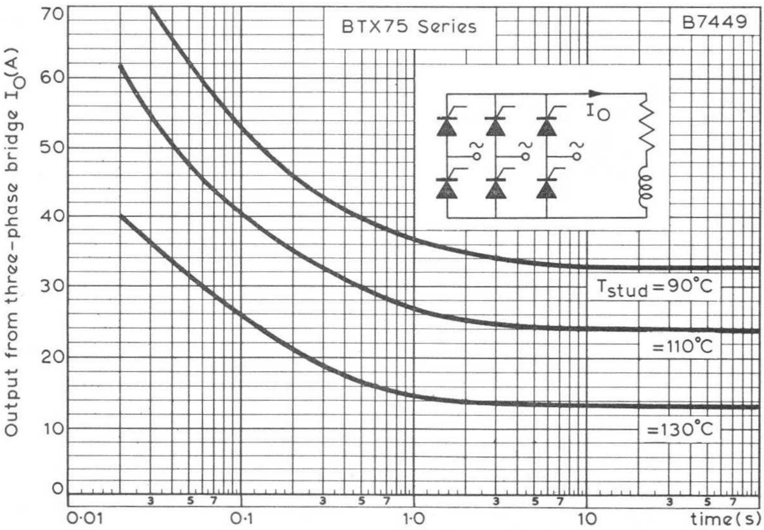


VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE



MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME





STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN SINGLE AND THREE PHASE BRIDGES

THYRISTORS

BTX76 Series

TENTATIVE DATA

The BTX76 is a range of p-gate reverse blocking thyristors for use in power control circuits. They have a maximum junction temperature of 150°C and are therefore suitable for operating in high ambient temperatures. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

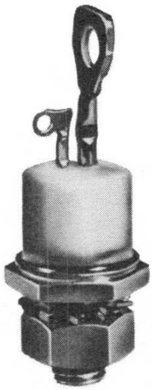
	BTX76-	100R	200R	300R	400R	
V_{BO} min.		100	200	300	400	V
V_{RRM} max.		100	200	300	400	V
$I_{T(AV)}$ max. (T_{stud} = 110°C)					12	A
$I_{T(RMS)}$ max.					25	A
T_j max.					150	°C

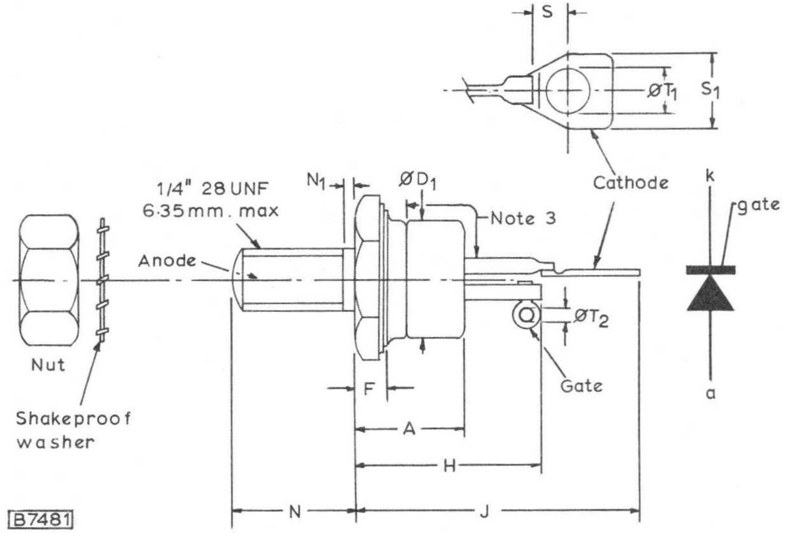
Unless otherwise shown data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page D2





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.522").
2. Minimum flat.
3. Minimum creepage path 6mm (0.236").

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX76-	100R	200R	300R	400R	
V_R	Continuous reverse voltage	100	200	300	400	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	V
V_D	Continuous off-state voltage (see note 2)	100	200	300	400	V
V_{DWM}	Crest working off-state voltage (see note 2)	100	200	300	400	V
V_{DRM}	Repetitive peak off-state voltage (see note 2)	100	200	300	400	V
V_{DSM}	Non-repetitive peak off-state voltage	500	500	500	500	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 9degC/W for a.c. operation and 4.5degC/W for d.c. operation.

2. This voltage may be exceeded up to the maximum non-repetitive peak forward voltage V_{DSM}, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

Current

I_T	Continuous on-state current	25	A
$I_{T(AV)}$	Mean on-state current (see page C2)	16	A
$I_{T(RMS)}$	R.M.S. on-state current	25	A
I_{TRM}	Repetitive peak on-state current	150	A
I_{TSM}	Maximum on-state surge current peak of half-sine at maximum operating conditions (see page C4)	200	A
I^2t	I^2t for fusing (<10ms)	200	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current	20	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	150	^oC
T_j min.	Junction temperature min.	-55	^oC
T_j max.	Junction temperature max.	150	^oC

THERMAL CHARACTERISTICS

Θ_{j-mb}	Maximum thermal resistance from junction to mounting base	2.0	degC/W
Θ_i	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
$\Theta_{j-mb(transient)}$	Transient thermal resistance (1.0ms)	0.095	degC/W

ELECTRICAL CHARACTERISTICS (T_j = 150°C unless otherwise stated)

	BTX76-	100R	200R	300R	400R	
V_{BO}	Minimum forward break-over voltage	100	200	300	400	V
V_T	Maximum instantaneous on-state voltage at I_T = 50A, T_j = 25°C				2.0	V
i_D	Maximum off-state current at V_{DWM}	13	12	10	8.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	13	12	10	8.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at T_j = 25°C				3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25°C				40	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on				250	mV
I_H	Typical holding current				10	mA
I_L	Typical latching current				20	mA
t_{gt}	Typical turn-on time (see page C7)				3.0	µs
t_q	Typical turn-off time I_T = 10A, I_R = 5.0A (see page C7)				25	µs

MECHANICAL DATA

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in
Weight		
Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code no.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

	R-C in primary of transformer		R-C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

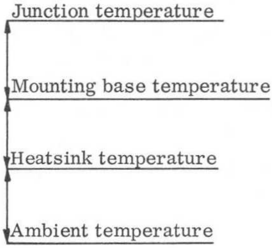
4. Dissipation and heat sink considerations.

   The various components of the rise of junction temperature above ambient are illustrated below.

$\Theta_{j\text{-}mb} = 2.0\text{degC/W}$

$\Theta_i = 0.2\text{degC/W}$

Θ_h



The method of using the curve on page C2 is as follows.

Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\Theta_i + \Theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

Θ_i is the contact thermal resistance for minimum torque, as given on page D4. Θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of Θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by

$$\Theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \Theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

b) The applied voltage must not exceed the nominal peak rating of the fuse.

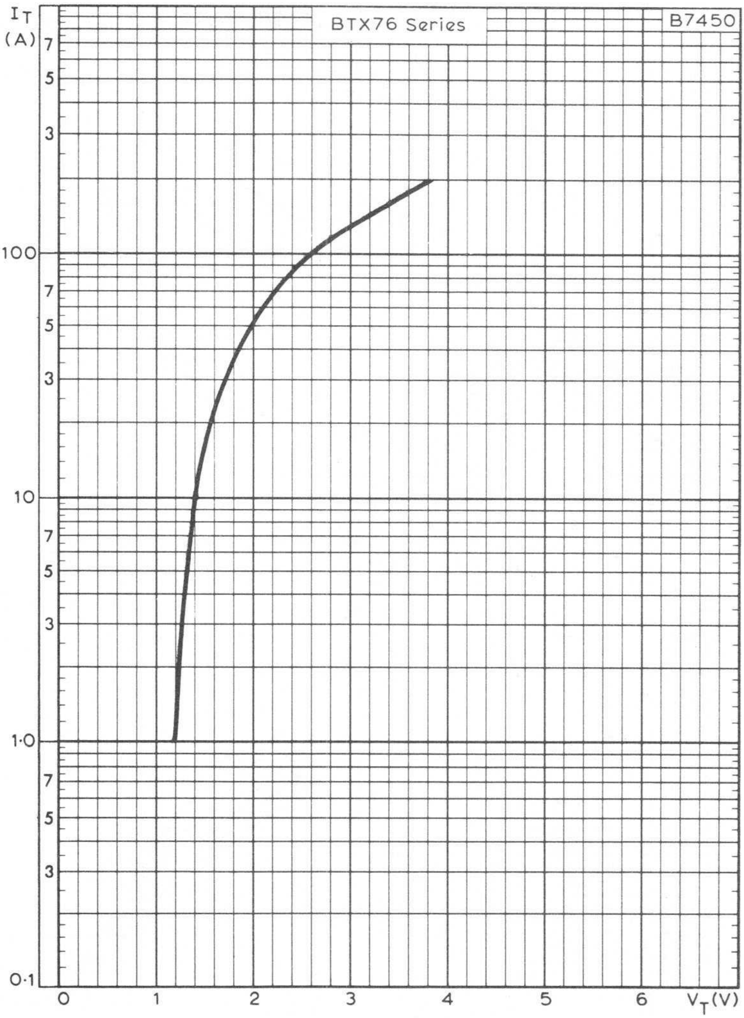
c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

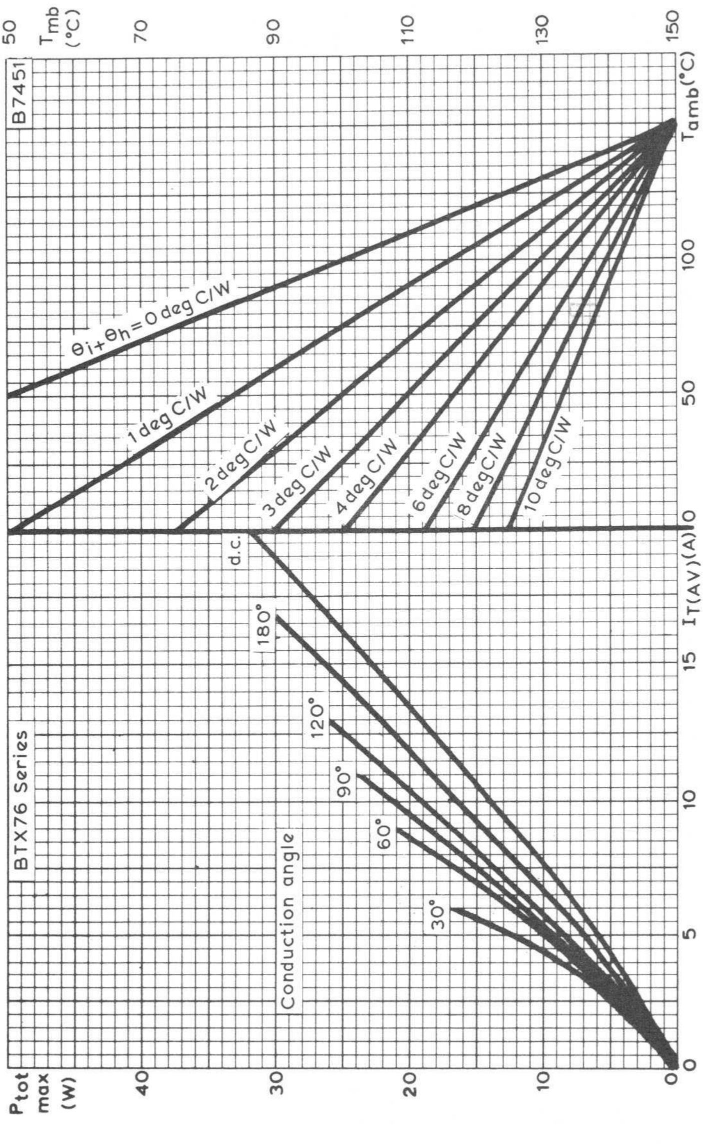
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

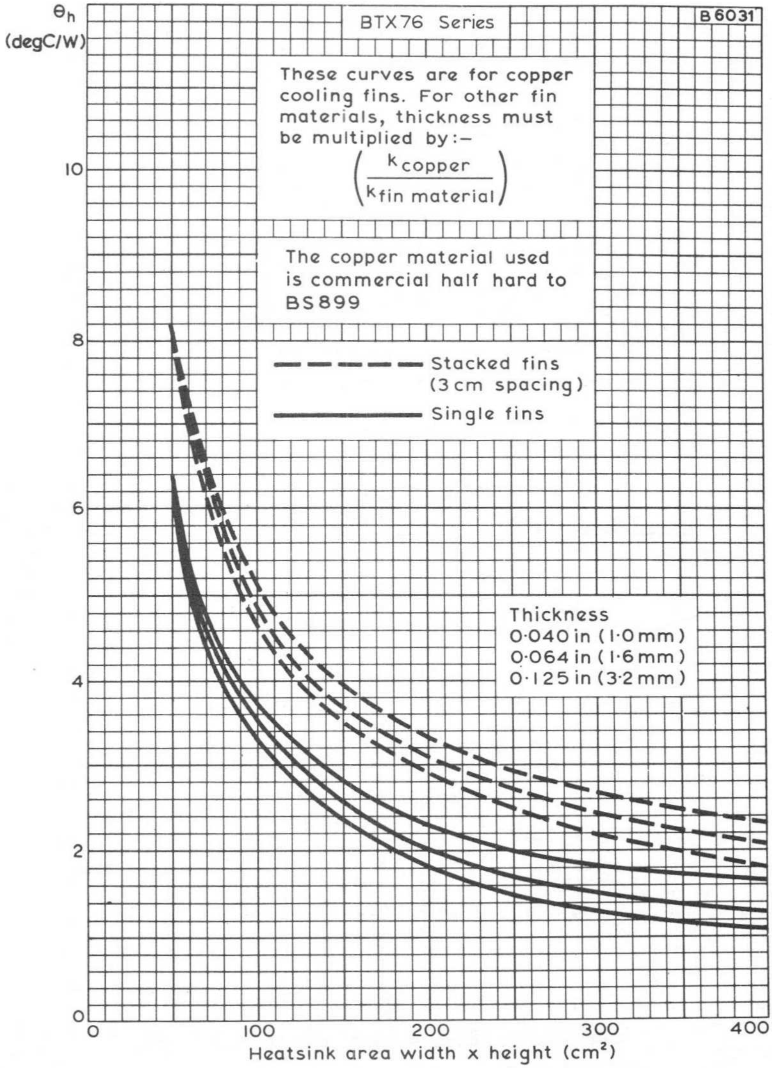
Where starting conditions are likely to exceed the current limits given on Page C2 the upper curve on Page C8 may be used. Upper curve, Page C8, refers to the output of a single phase bridge.



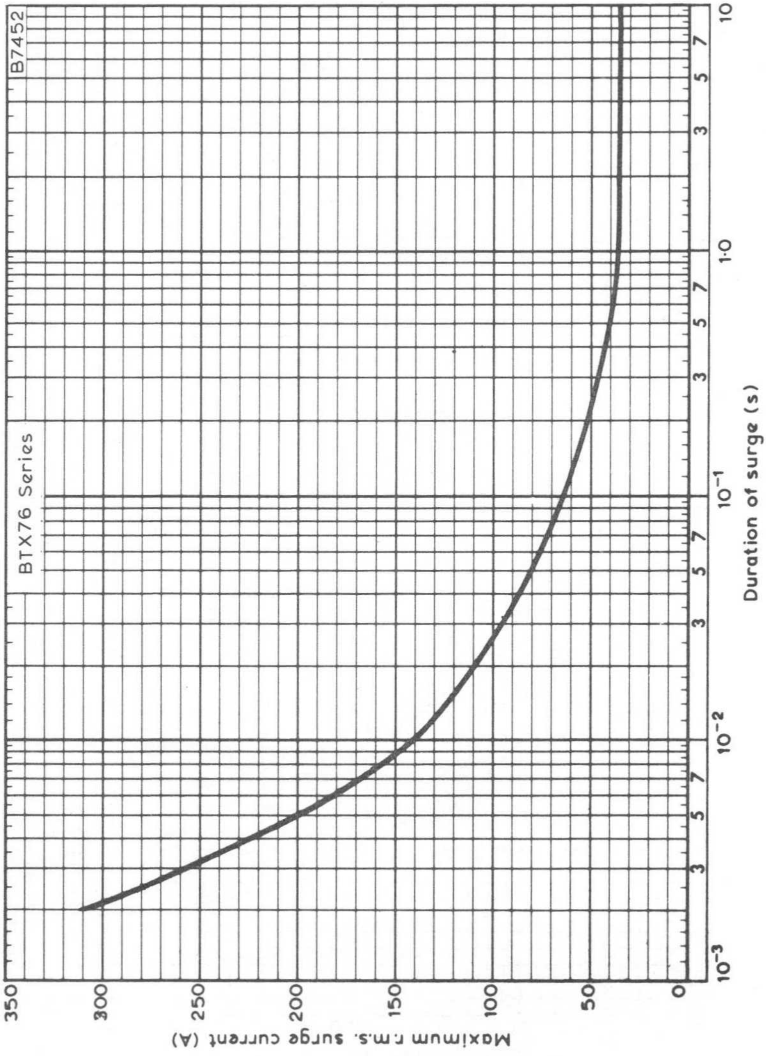
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



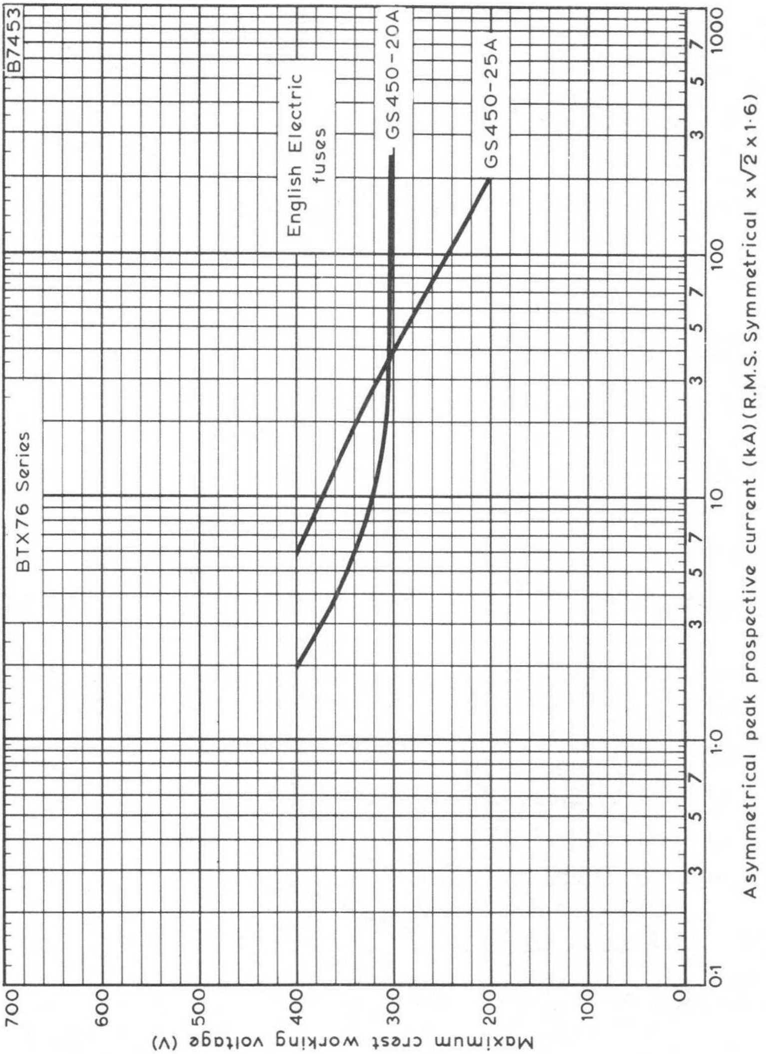
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



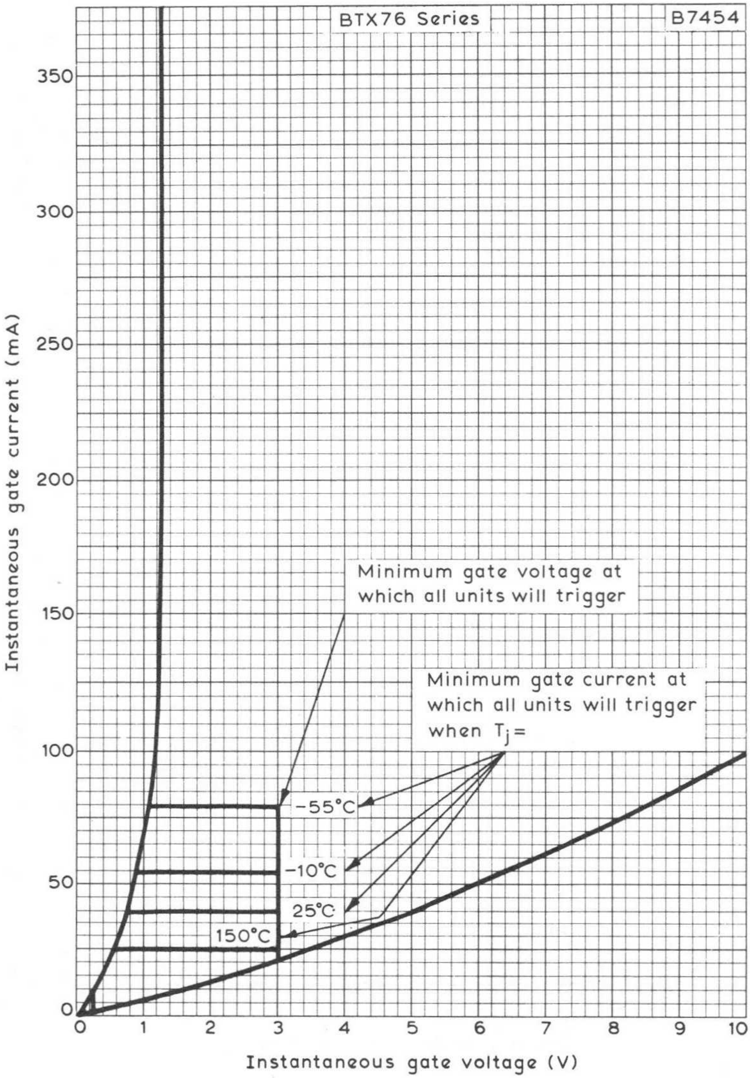
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



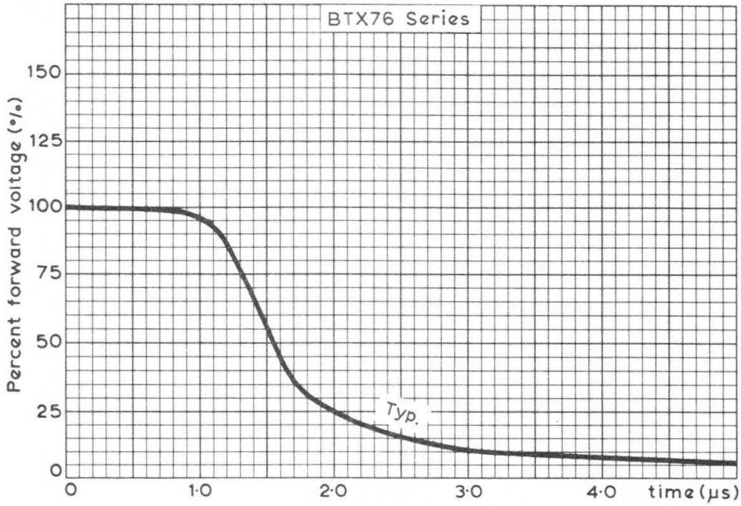
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)



CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT

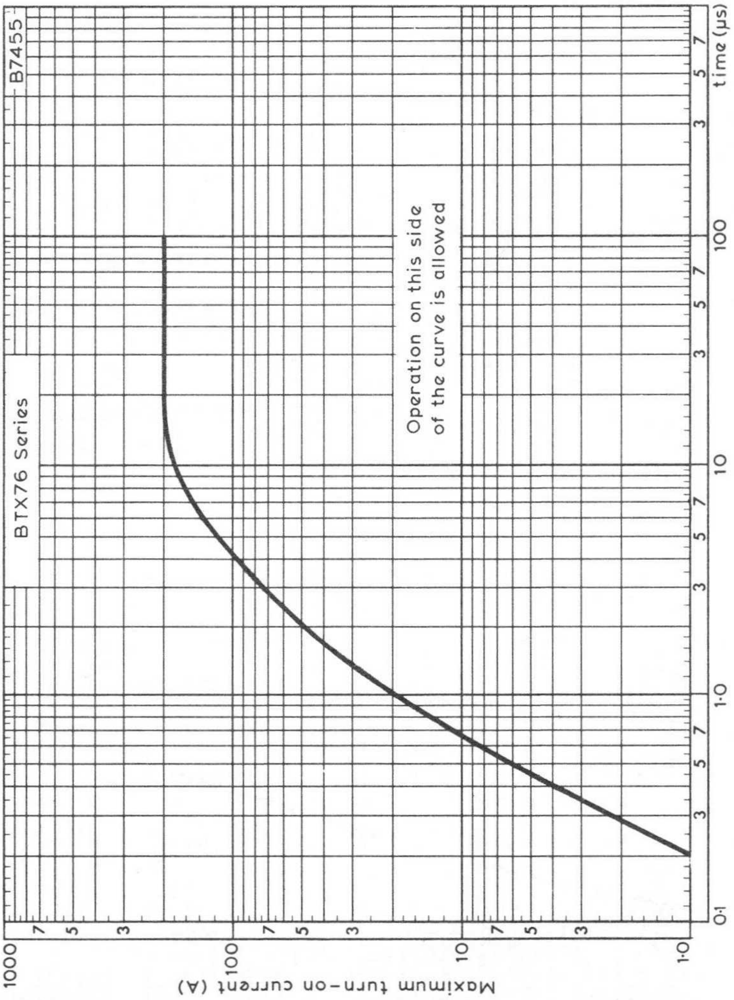


GATE CHARACTERISTIC

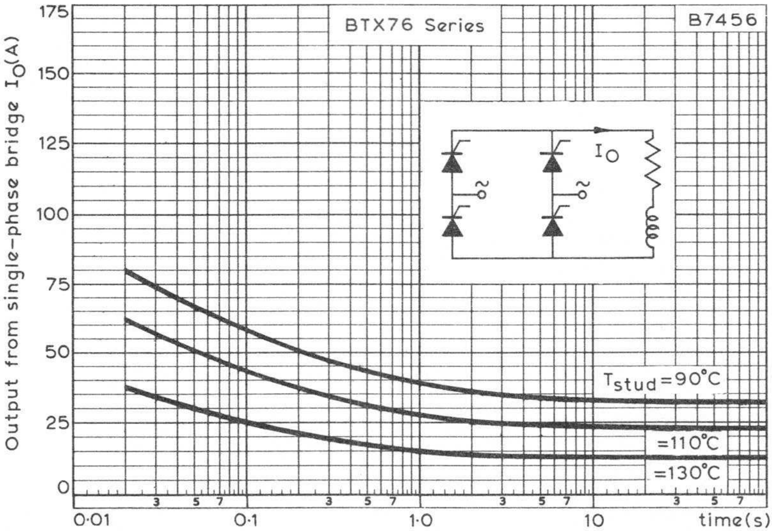


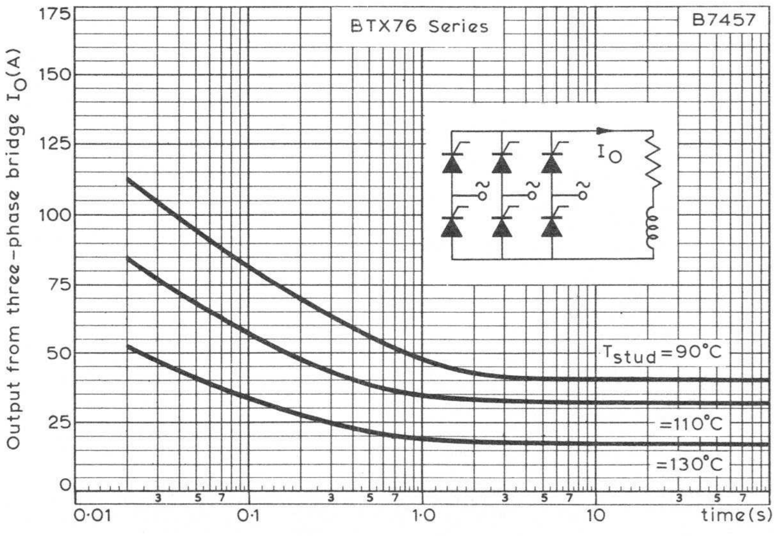
TYPICAL TURN-ON CHARACTERISTIC

VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE



MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME





STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN SINGLE AND THREE PHASE BRIDGES

THYRISTORS

BTX81
Series

TENTATIVE DATA

The BTX81 is a range of p-gate reverse blocking thyristors for medium power applications up to 20A average on-state current. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

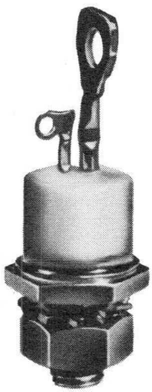
BTX81-	100R	200R	300R	400R	500R	600R	700R	800R	
V_{BO} min.	100	200	300	400	500	600	700	800	V
V_{RRM} max.	100	200	300	400	500	600	700	800	V
$I_{T(AV)}$ max. ($T_{stud} = 85^{o}C$)								20	A
$I_{T(RMS)}$								30	A
T_j max.								125	^{o}C
$R_{th(j-mb)}$								1.0	degC/W

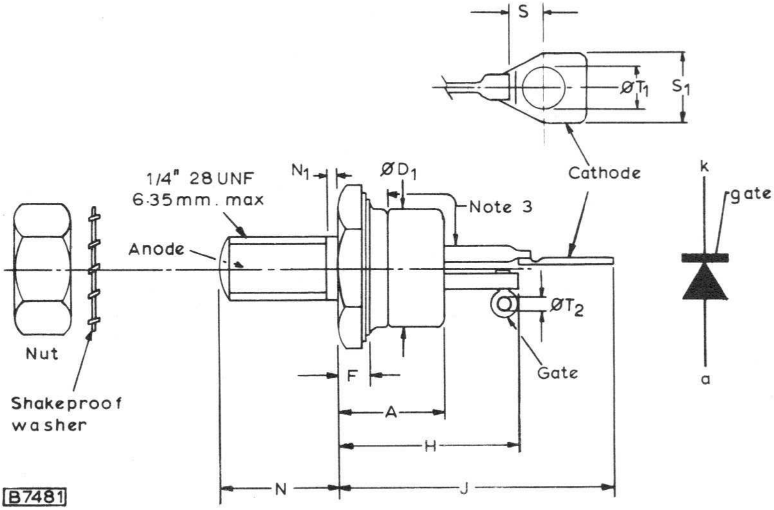
Unless otherwise stated data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page 2.





B7481

Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.522").
2. Minimum flat.
3. Minimum creepage path 6mm (0.236").

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply to the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX81-	100R	200R	300R	400R	500R	600R	700R	800R	
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	600	700	800	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	100	200	300	400	500	600	700	800	V
V_{RSM}	Non-repetitive peak reverse voltage ($t < 10ms$)	150	300	400	500	600	720	850	960	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	600	700	800	V
V_{DRM}	Repetitive peak off-state voltage (1% duty cycle at 50Hz)	100	200	300	400	500	600	700	800	V
V_{DSM}	Non-repetitive peak off-state voltage ($t < 10ms$)	500	500	500	500	850	850	850	850	V

NOTE

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 5.5degC/W for a.c. operation, and 3.0degC/W for d.c. operation.

Current

$I_{T(AV)}$	Mean on-state current (180° conduction, $T_{stud} = 85^{\circ}C$)	20	A
$I_{T(RMS)}$	R.M.S. on-state current	30	A
I_{TRM}	Repetitive peak on-state current	200	A
I_{TSM}	Non-repetitive peak on-state current (t = 10ms, half sinewave, see page 13)	400	A
I^2t	I^2t for fusing	800	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current	20	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward gate current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	1.0	W

Temperature

T_{stg} min.	Storage temperature min.	-55	°C
T_{stg} max.	Storage temperature max.	125	°C
T_j max.	Junction temperature max.	125	°C

THERMAL CHARACTERISTICS

$R_{th(j-mb)}$	Maximum thermal resistance from junction to mounting base	1.0	degC/W
$R_{th(i)}$	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
$R_{th(t)}$	Transient thermal resistance junction to mounting base (1ms)	0.05	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

	BTX81-	100R	200R	300R	400R	500R	600R	700R	800R	
V_{BO}	Min. forward breakover voltage	100	200	300	400	500	600	700	800	V
V_T	Max. instantaneous on-state voltage at $I_T = 50A$, $T_j = 25^oC$								1.8	V
i_D	Max. off-state leakage current at V_{DWM}	11	11	11	10	8	8	7	6	mA
i_R	Max. reverse leakage current at V_{RWM}	11	11	11	10	8	8	7	6	mA
V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$								3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$								80	mA
V_{GD}	Max. continuous gate voltage which will not initiate turn-on (see page 14)								250	mV
I_H	Max. holding current at $T_j = 25^oC$								100	mA
I_L	Max. latching current at $T_j = 25^oC$								200	mA
t_{gt}	Typ. turn-on time								5.0	μs

MECHANICAL DATA

Weight		
Without accessories	10 0.35	g oz
With accessories	15 0.53	g oz
Maximum torque on nut	35 2.5	kg cm lb ft
Minimum torque on nut for good thermal contact	17 1.25	kg cm lb ft
Recommended diameter of hole in heatsink	6.5 0.25	mm in

ACCESSORIES

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer	56297	Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{RSM}}{V_{RRM}}$	R-C in primary of transformer C (μF)	R×C (μs)	R-C in secondary of transformer C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

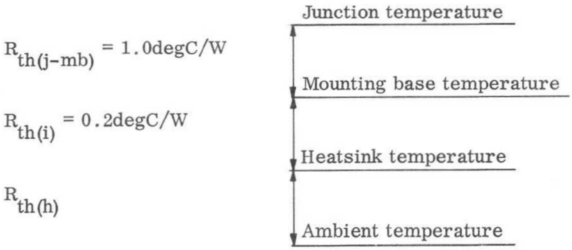
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below



The method of using the curve on page 11 is as follows

Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $R_{th(i)} + R_{th(h)}$ is reached. Finally trace downwards to determine the maximum ambient temperature.

$R_{th(i)}$ is the contact thermal resistance for minimum torque, as given on page 4. $R_{th(h)}$ is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of $R_{th(h)}$ for blackened vertical heatsinks see the curve on page 12.

Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page 11. Thus, knowing the maximum ambient temperature the maximum value of $R_{th(h)}$ is given by

$$R_{th(h)} = \frac{T_{mb} - T_{amb}}{P_{tot}\ max.} - R_{th(i)}$$

The size of heatsink required may be found from the graph on page 12.

5. FUSING

The curve given on page 13 is intended for selecting suitable fuses or circuit breakers.

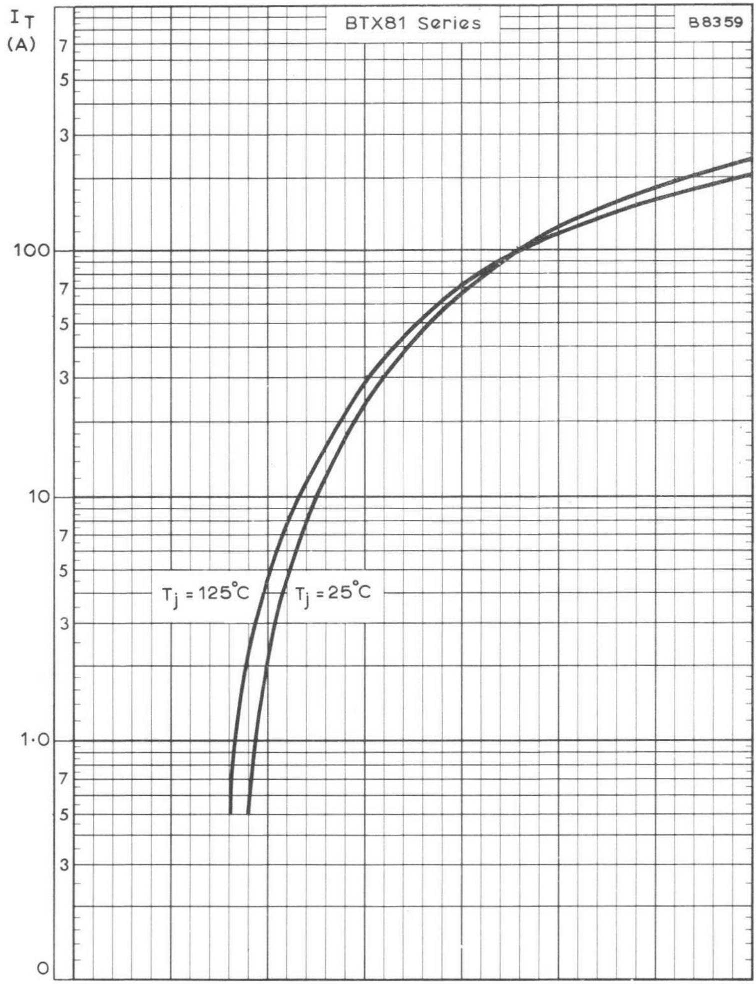
When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

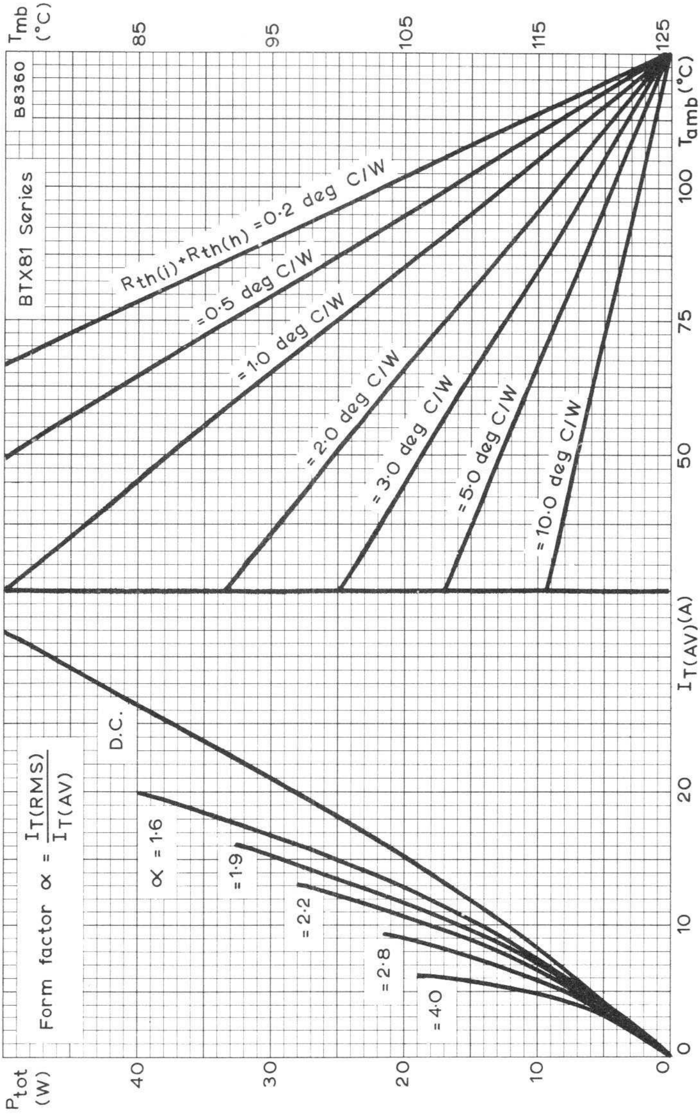
b) The applied voltage must not exceed the nominal peak rating of the fuse.

c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

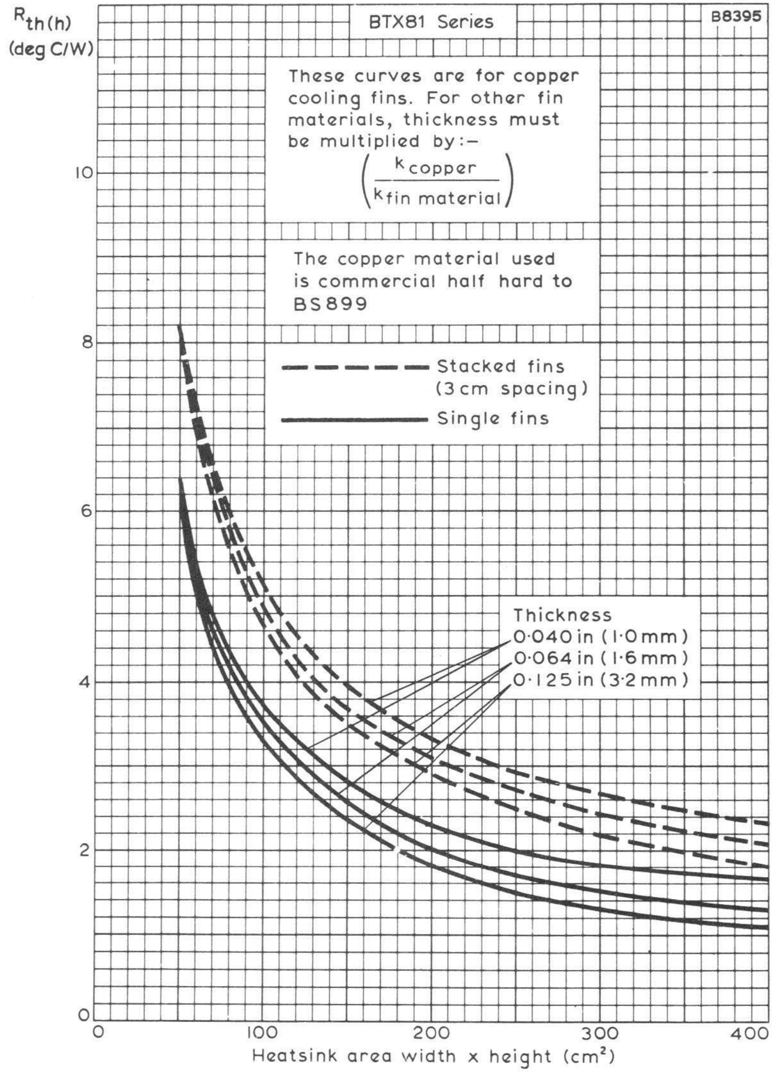
d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.



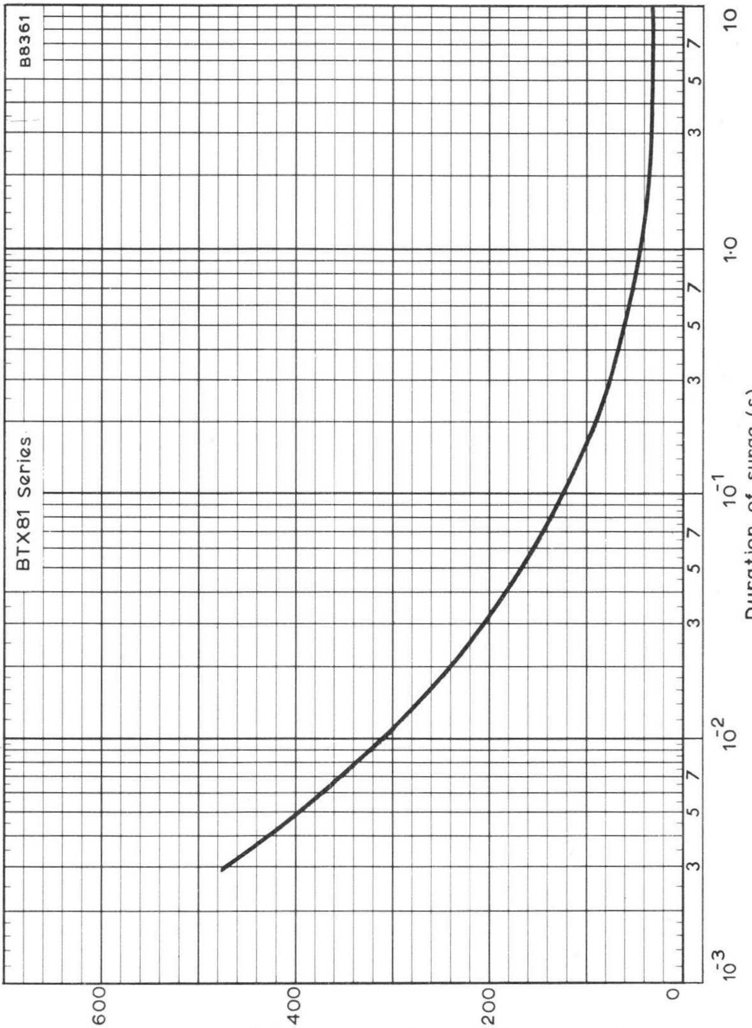
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



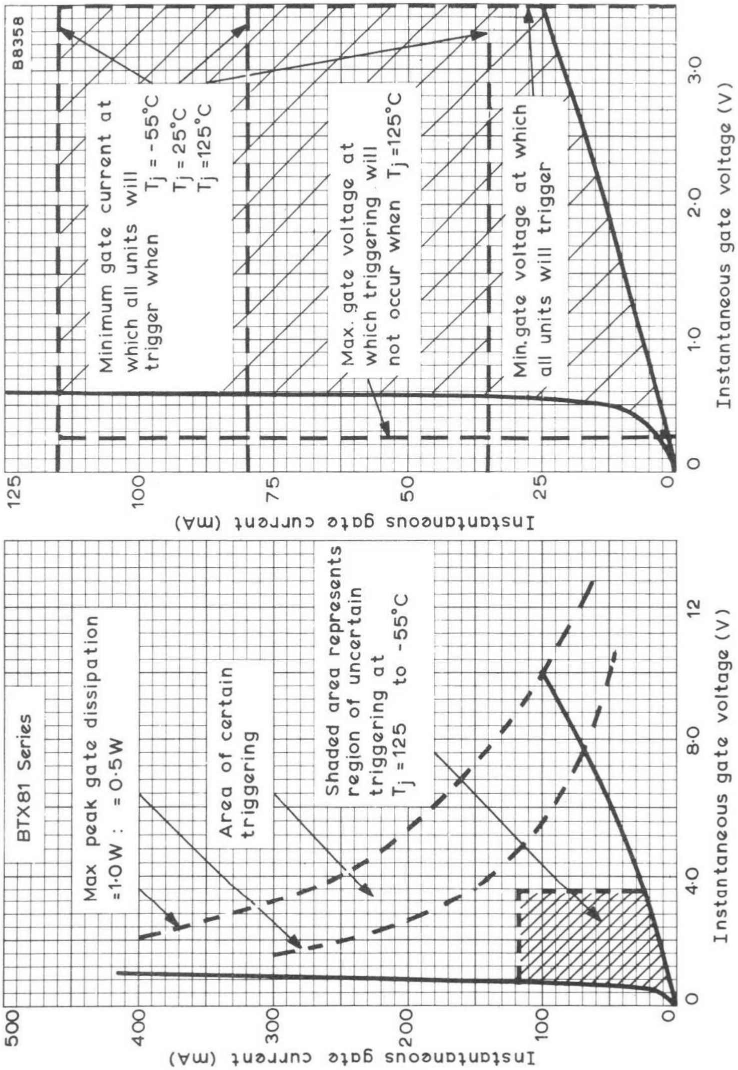
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)



THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THYRISTORS

BTX82
Series

TENTATIVE DATA

The BTX82 is a range of p-gate reverse blocking thyristors for medium power applications up to 26A average on-state current. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

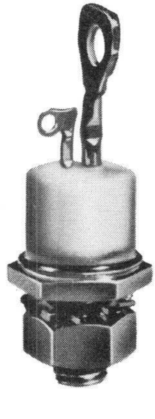
BTX82-	100R	200R	300R	400R	500R	600R	700R	800R	
V_{BO} min.	100	200	300	400	500	600	700	800	V
V_{RRM} max.	100	200	300	400	500	600	700	800	V
$I_{T(AV)}$ max. (T_{stud} = 85°C)								26	A
$I_{T(RMS)}$								40	A
T_j max.								125	°C
$R_{th(j-mb)}$								1.0	degC/W

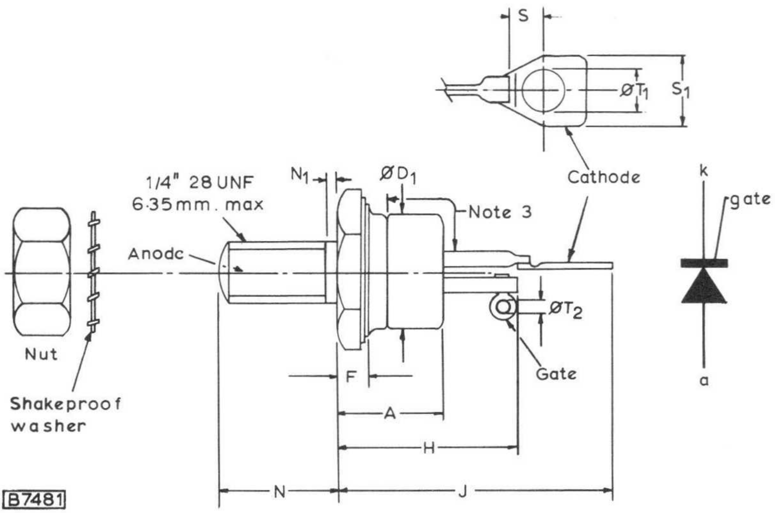
Unless otherwise stated data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page 2.





Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.522").
2. Minimum flat.
3. Minimum creepage path 6mm (0.236").

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply to the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

	BTX82-	100R	200R	300R	400R	500R	600R	700R	800R	
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	600	700	800	V
V_{RRM}	Repetitive peak reverse voltage (1% duty cycle at 50Hz)	100	200	300	400	500	600	700	800	V
V_{RSM}	Non-repetitive peak reverse voltage (t< 10ms)	150	300	400	500	600	720	850	960	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	500	600	700	800	V
V_{DRM}	Repetitive peak off-state voltage (1% duty cycle at 50Hz)	100	200	300	400	500	600	700	800	V
V_{DSM}	Non-repetitive peak off-state voltage (t< 10ms)	500	500	500	500	850	850	850	850	V

NOTE

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 5.5degC/W for a.c. operation, and 3.0degC/W for d.c. operation.

Current

$I_{T(AV)}$	Mean on-state current (180^{o} conduction, $T_{stud} = 85^{o}C$)	26	A
$I_{T(RMS)}$	R.M.S. on-state current	40	A
I_{TRM}	Repetitive peak on-state current	350	A
I_{TSM}	Non-repetitive peak on-state current (t=10ms, half sinewave, see page 13)	550	A
I^2t	I^2t for fusing	1500	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current	20	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward gate current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
$P_{G(AV)}$	Average gate power	1.0	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^{o}C
T_{stg} max.	Storage temperature max.	125	^{o}C
T_j max.	Junction temperature max.	125	^{o}C

THERMAL CHARACTERISTICS

$R_{th(j-mb)}$	Maximum thermal resistance from junction to mounting base	1.0	degC/W
$R_{th(i)}$	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
$R_{th(t)}$	Transient thermal resistance junction to mounting base (1ms)	0.05	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

	BTX82-	100R	200R	300R	400R	500R	600R	700R	800R	
V_{BO}	Min. forward breakover voltage	100	200	300	400	500	600	700	800	V
V_T	Max. instantaneous on-state voltage at $I_T = 50A$, $T_j = 25^oC$								1.4	V
i_D	Max. off-state leakage current at V_{DWM}	11	11	11	10	8	8	7	6	mA
i_R	Max. reverse leakage current at V_{RWM}	11	11	11	10	8	8	7	6	mA
V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$								3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$								80	mA
V_{GD}	Max. continuous gate voltage which will not initiate turn-on (see page 14)								250	mV
I_H	Max. holding current at $T_j = 25^oC$								100	mA
I_L	Max. latching current at $T_j = 25^oC$								200	mA
t_{gt}	Typ. turn-on time								5.0	μs

MECHANICAL DATA

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz
Maximum torque on nut	35	kg cm
	2.5	lb ft
Minimum torque on nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in

ACCESSORIES

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer	56297	Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{RSM}}{V_{RRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

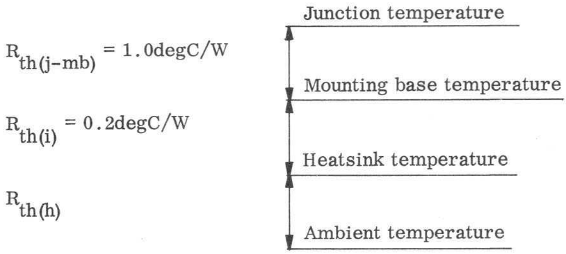
2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below



The method of using the curve on page 11 is as follows

Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $R_{th(i)} + R_{th(h)}$ is reached. Finally trace downwards to determine the maximum ambient temperature.

$R_{th(i)}$ is the contact thermal resistance for minimum torque, as given on page 4. $R_{th(h)}$ is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of $R_{th(h)}$ for blackened vertical heatsinks see the curve on page 12.

Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page 11. Thus, knowing the maximum ambient temperature the maximum value of $R_{th(h)}$ is given by

$$R_{th(h)} = \frac{T_{mb} - T_{amb}}{P_{tot}\ max.} - R_{th(i)}$$

The size of the heatsink required may be found from the graph on page 12.

5. FUSING

The curve given on page 13 is intended for selecting suitable fuses or circuit breakers.

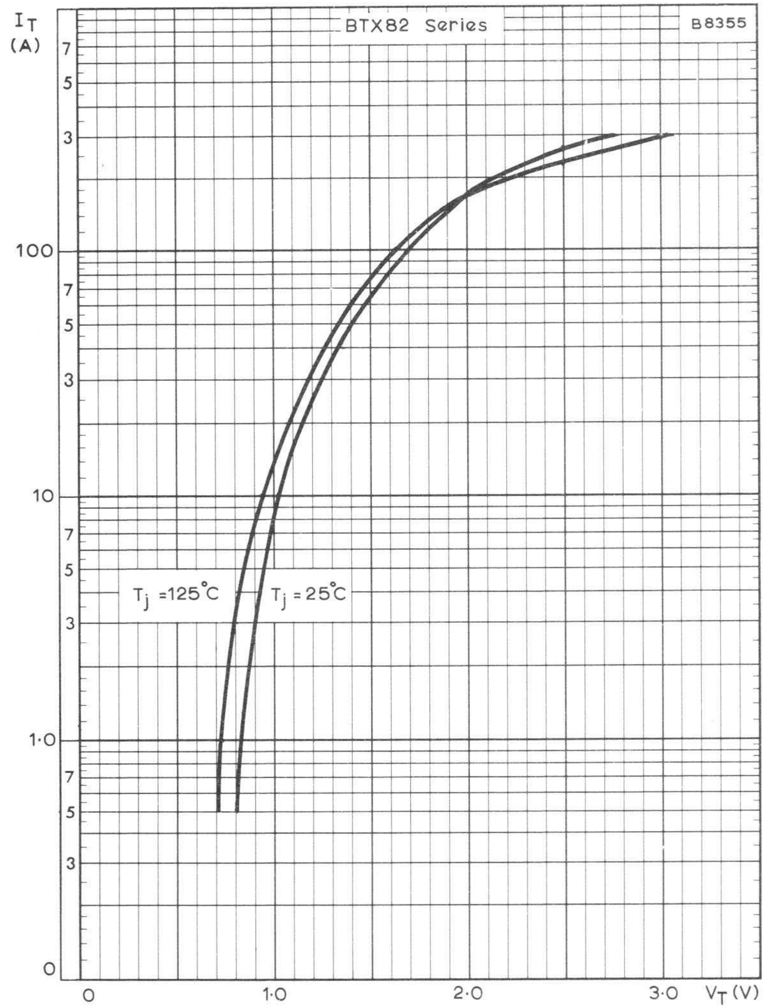
When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

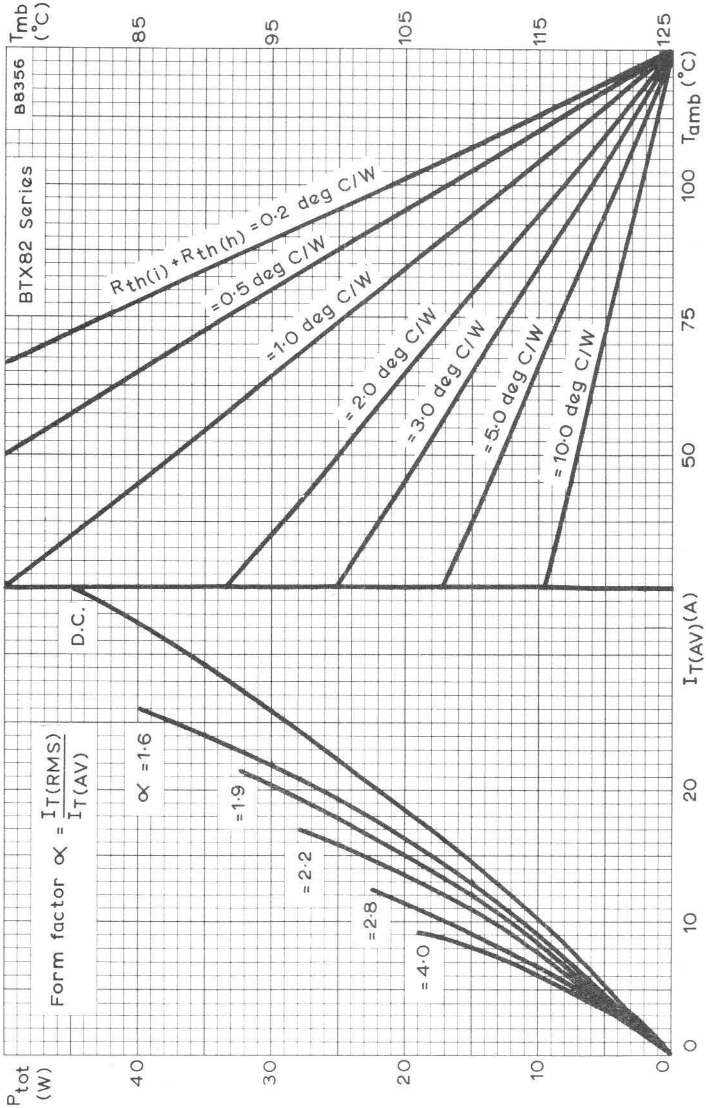
b) The applied voltage must not exceed the nominal peak rating of the fuse.

c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

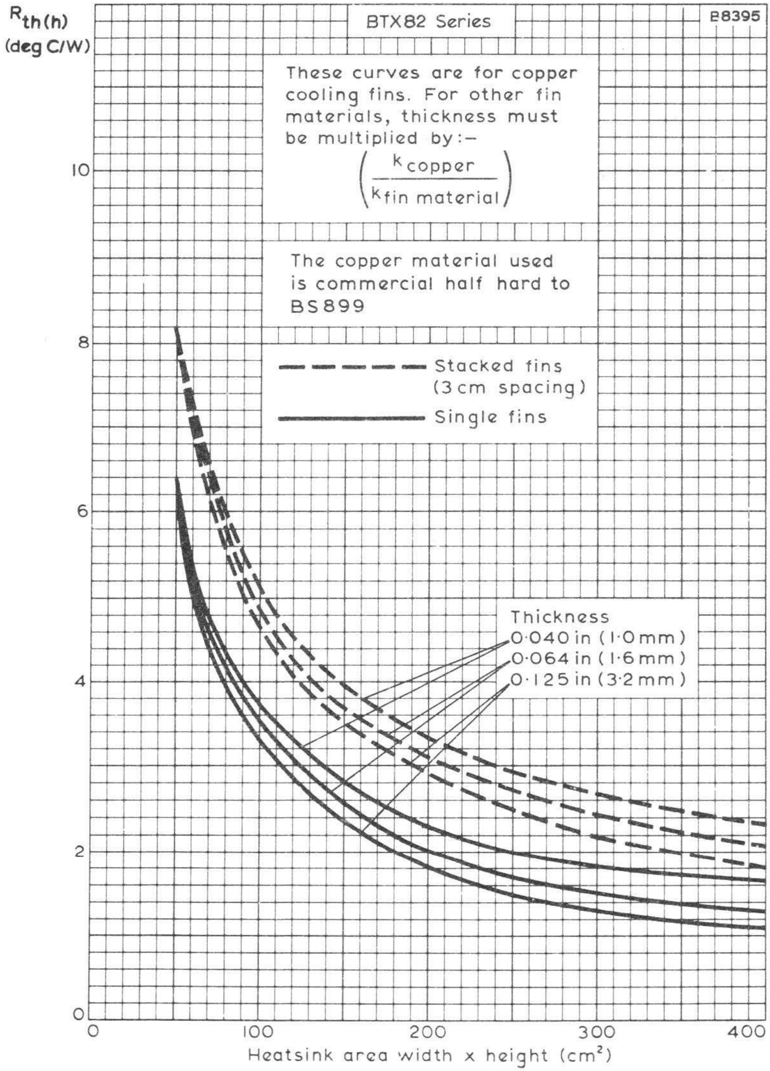
d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.



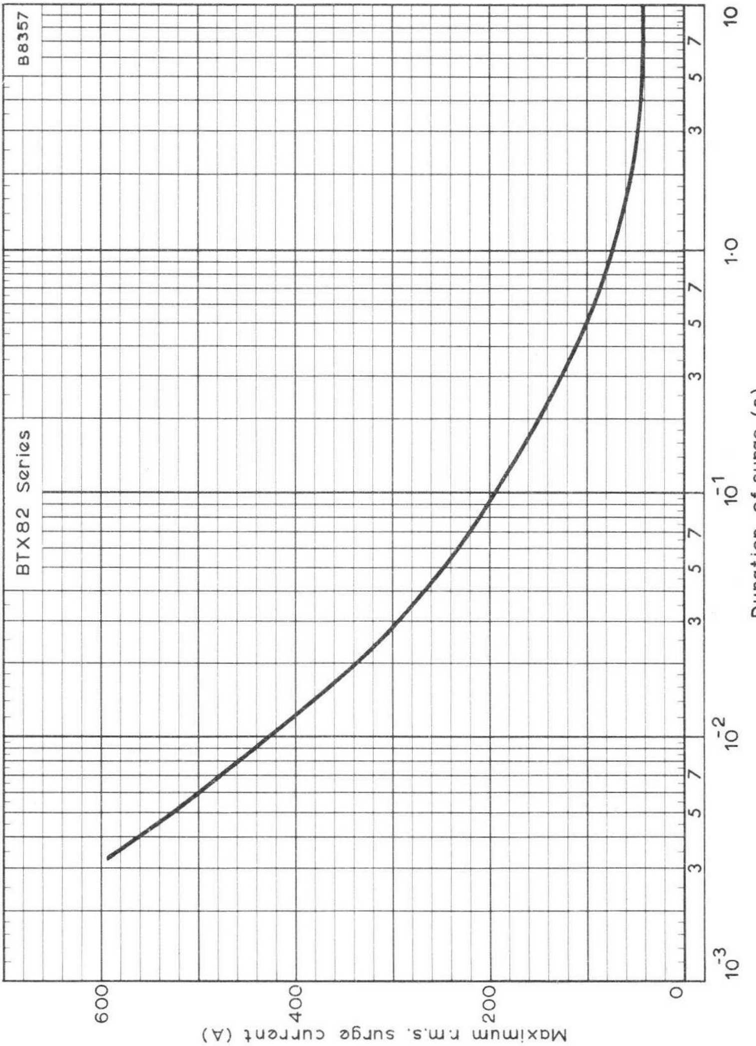
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



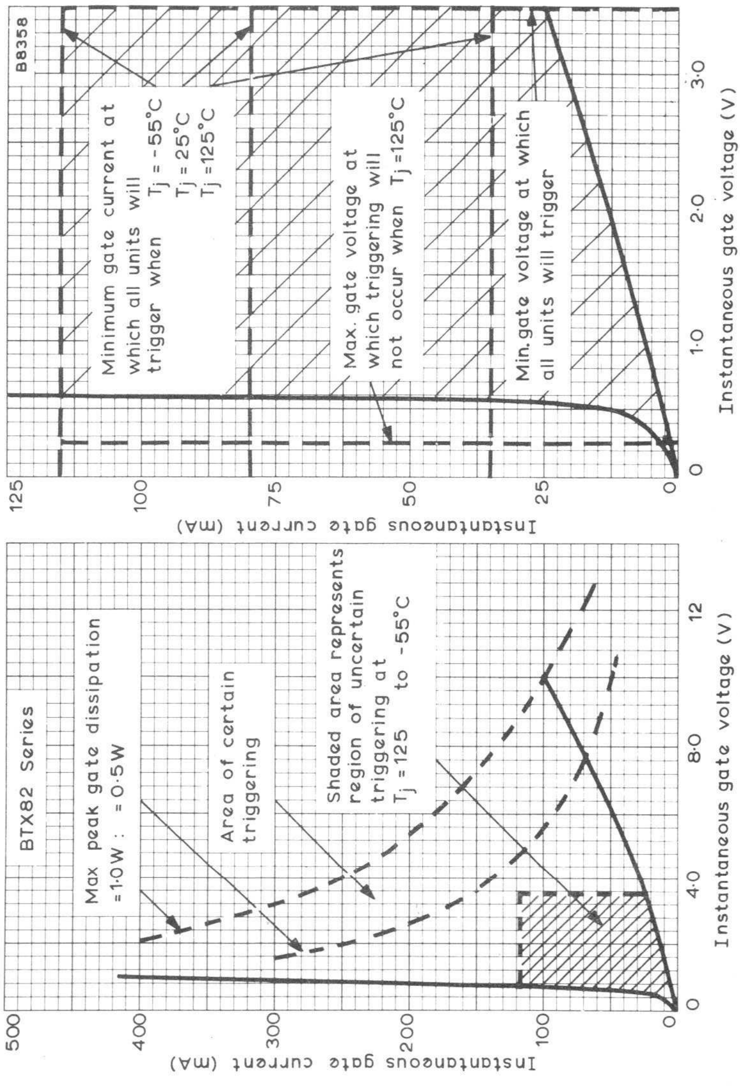
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)



THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THYRISTORS

BTX92 Series

The BTX92 is a range of p-gate reverse blocking thyristors for medium power applications up to 16A average forward current ($T_{mb} = 85^{o}C$). The device is designed with high dV/dt and di/dt capabilities, and is also capable of absorbing reverse transients due to its avalanche properties. Typical applications include the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

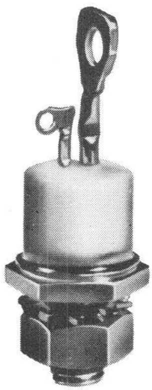
BTX92-	800R	900R	1000R	1100R	1200R	
V_{BO} min.	900	1000	1100	1200	1300	V
$V_{(BR)R}$ min.	900	1000	1100	1200	1300	V
V_{RWM} max.	800	900	1000	1100	1200	V
V_{DWM} max.	800	900	1000	1100	1200	V
$I_{T(AV)}$ max. 180° conduction, $T_{mb} = 85^{o}C$			16			A
$I_{T(RMS)}$ max.			25			A

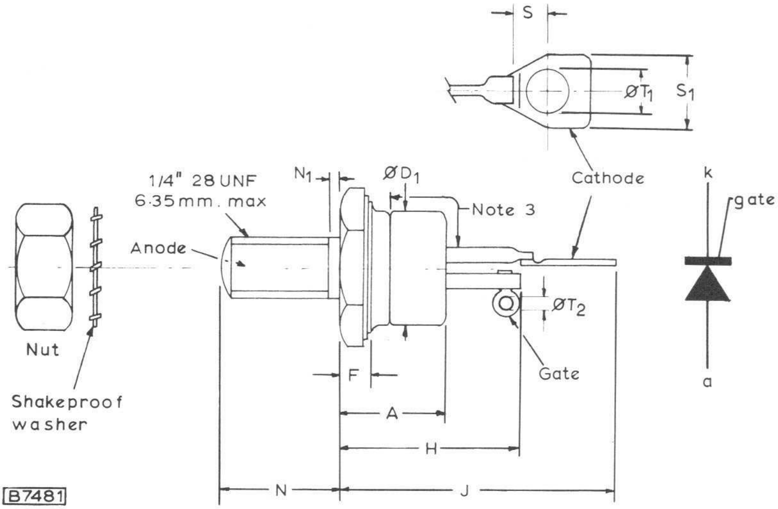
Unless otherwise stated data is applicable to all types

OUTLINE AND DIMENSIONS

Conforms to B.S. 3934 SO-36

For details see page 2





B7481

Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.552").
2. Minimum flat
3. Minimum creepage path 6mm (0.236").

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

		BTX92-	800R	900R	1000R	1100R	1200R	
Reverse								
V_{RWM}	Crest working reverse voltage		800	900	1000	1100	1200	V
Forward								
V_{DWM}	Crest working off-state voltage		800	900	1000	1100	1200	V
$\frac{dV}{dt}$	Rate of rise of off-state voltage not to trigger the device (see page 16)						200	V/μs

Power

P_{RSM}	Maximum non-repetitive reverse avalanche power (duration = 10μs, $T_j = 25^oC$)	10	kW

NOTES

1. These ratings do not apply when the gate is more positive than 200mV with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 3degC/W for a.c. operation.

RATINGS (cont'd)

ANODE TO CATHODE

Current

I_T	Continuous on-state current	25	A
$I_{T(AV)}$	Mean on-state current (see page 11)	16	A
$I_{T(RMS)}$	R.M.S. on-state current	25	A
I_{TRM}	Repetitive peak on-state current	150	A
I_{TSM}	Maximum on-state surge current peak of half-sine at maximum operating conditions (see page 13)	280	A
I^2t	I^2t for fusing (< 10ms) (see pages 13 and 14)	400	A^2s
$\frac{di}{dt}$ (V_{BO})	Rate of rise of on-state current after breakover (see page 17)	100	A/μs
$\frac{di}{dt}$ (gate)	$I_G = I_{GT}$ (see page 17)	200	A/μs
I_{RRM}	Repetitive peak reverse current	20	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	10	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Maximum total gate power (forward and reverse)	5.0	W
$P_{G(AV)}$	Average gate power	1.0	W

Temperature

T_{stg}	Storage temperature range	-55 to +125	°C
T_j max.	Junction temperature max.	125	°C

THERMAL CHARACTERISTICS

$R_{th(j-mb)}$	Maximum thermal resistance for junction to mounting-base	1.0	degC/W
$R_{th(i)}$	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W
$R_{th(t)}$	Transient thermal resistance from junction to mounting-base (1ms)	0.1	degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125^{o}C$ unless otherwise stated)

	BTX92-	800R	900R	1000R	1100R	1200R	
V_{BO}	Minimum forward break-over voltage (see note 2)	900	1000	1100	1200	1300	V
$V_{(BR)R}$	Minimum reverse break-down voltage	900	1000	1100	1200	1300	V
V_T	Maximum instantaneous on-state voltage at $I_T = 50A$, $T_j = 25^{o}C$					2.7	V
i_D	Maximum forward leakage current at V_{DWM}	10	8.0	8.0	7.0	7.0	mA
i_R	Maximum reverse leakage current at V_{RWM}	10	8.0	8.0	7.0	7.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$ (see page 15)					3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$ (see page 15)					150	mA
V_{GD}	Maximum continous gate voltage which will not initiate turn-on (see page 15)					200	mV
I_H	Maximum holding current ($T_j = 25^{o}C$)					200	mA
I_L	Maximum latching current ($T_j = 25^{o}C$)					200	mA
t_{gt}	Typical turn-on time (see page 18)					2.0	μs

NOTES

2. The device may breakover into the maximum repetitive peak on-state current at the maximum rate of rise of on-state current.

MECHANICAL DATA

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Tag Insulating bush Mica washer	56264A	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core, where this may exceed the avalanche surge rating of the thyristor.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

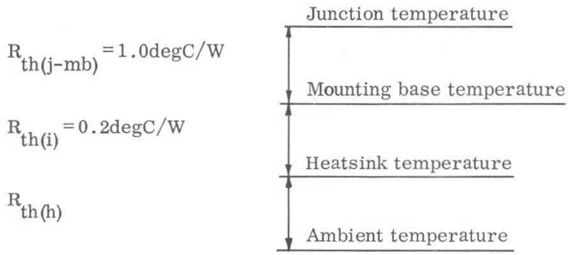
   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.
   A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

   The various components of the rise of junction temperature above ambient are illustrated below:



   The method of using the curve on page 11 is as follows.

   Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $R_{th(i)} + R_{th(h)}$ is reached. Finally trace downwards to determine the maximum ambient temperature.

   $R_{th(i)}$ is the contact thermal resistance for minimum torque, as given on page 6. $R_{th(h)}$ is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of $R_{th(h)}$ for blackened vertical heatsinks see the curve on page 12.

   Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page 11. Thus, knowing the maximum ambient temperature the maximum value of $R_{th(h)}$ is given by

$$R_{th(h)} = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - R_{th(i)}$$

   The size of the heatsink required may be found from the graph on page 12.

OPERATING NOTES (cont'd)

5. **Fusing**

The curve given on page 13 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:

a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

b) The applied voltage must not exceed the nominal peak rating of the fuse.

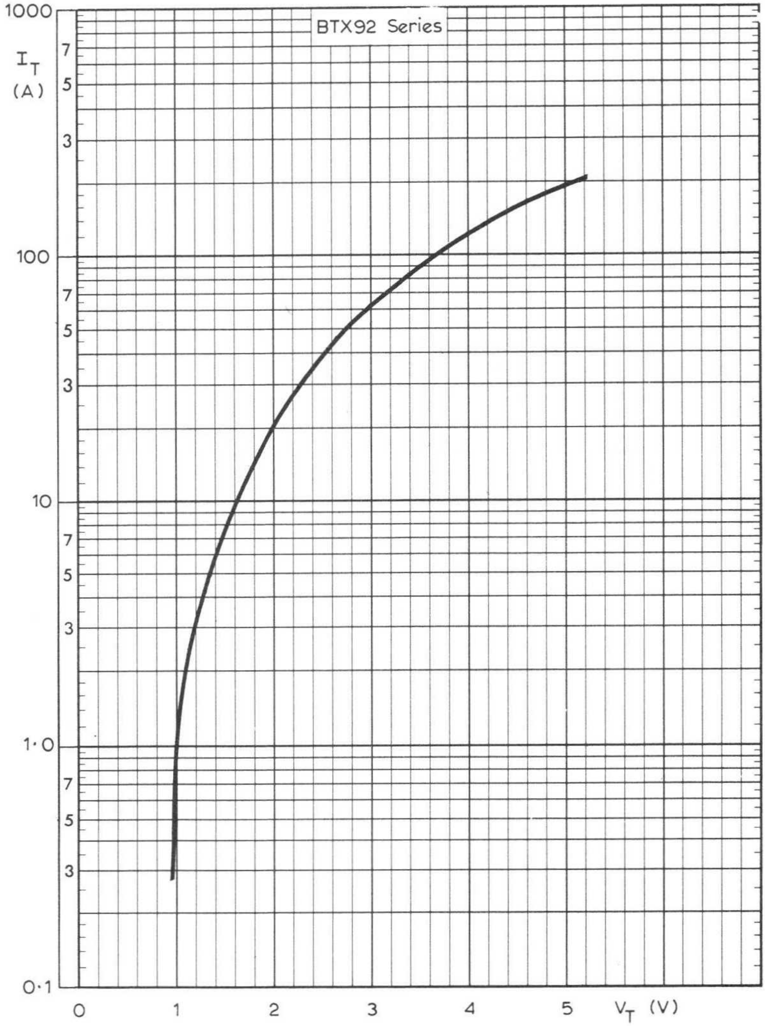
c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being supplied.

d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

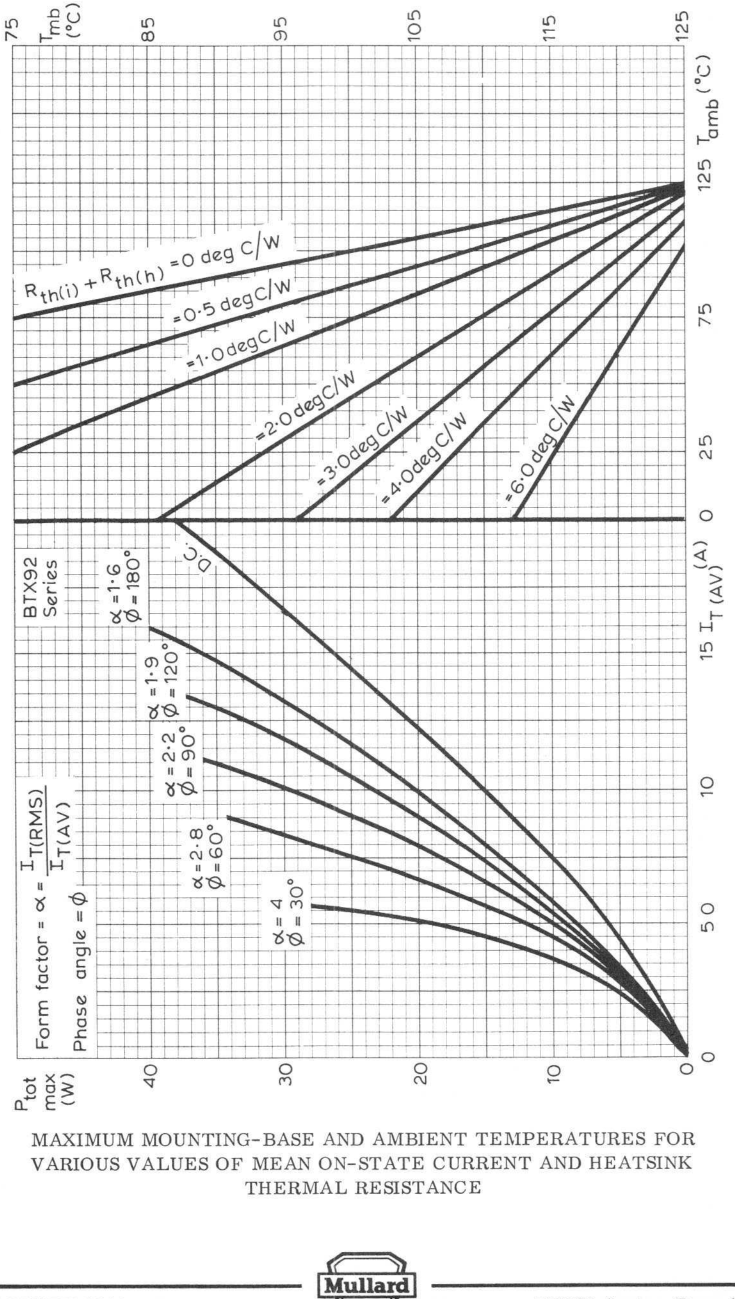
The curve shown on page 14 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. **Starting**

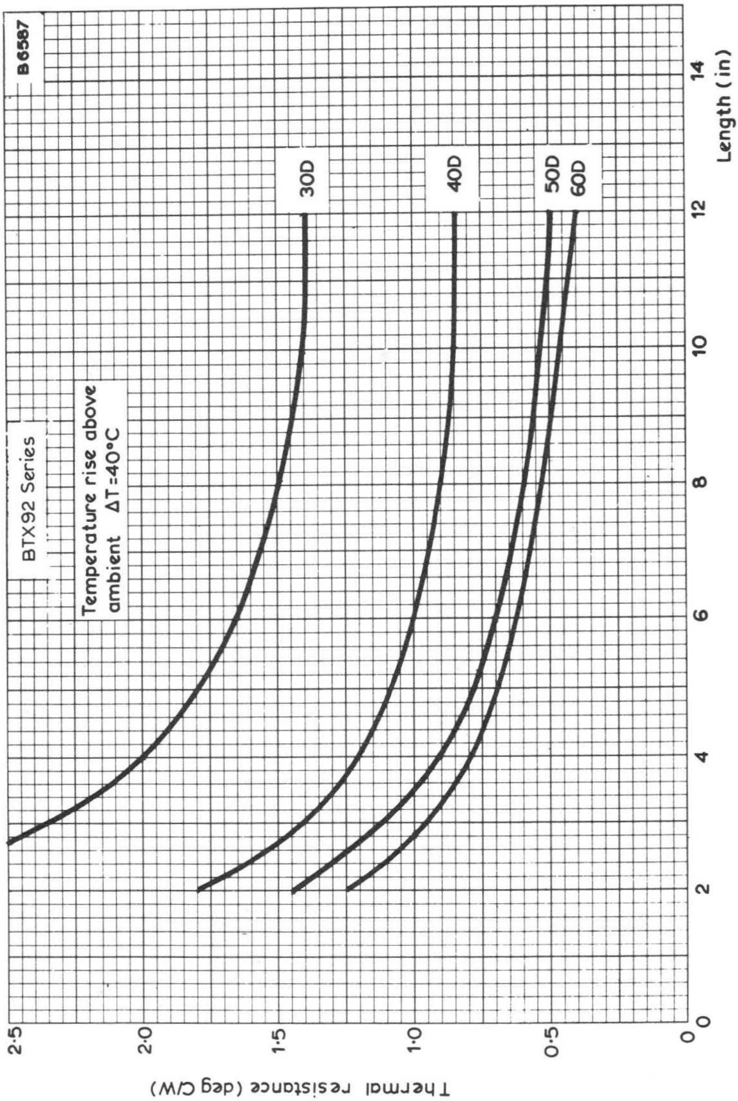
Where starting conditions are likely to exceed the current limits given on page 11, the curves on pages 19 and 20 may be used. Page 19 refers to the output of a single-phase bridge and page 20 to a three-phase bridge.



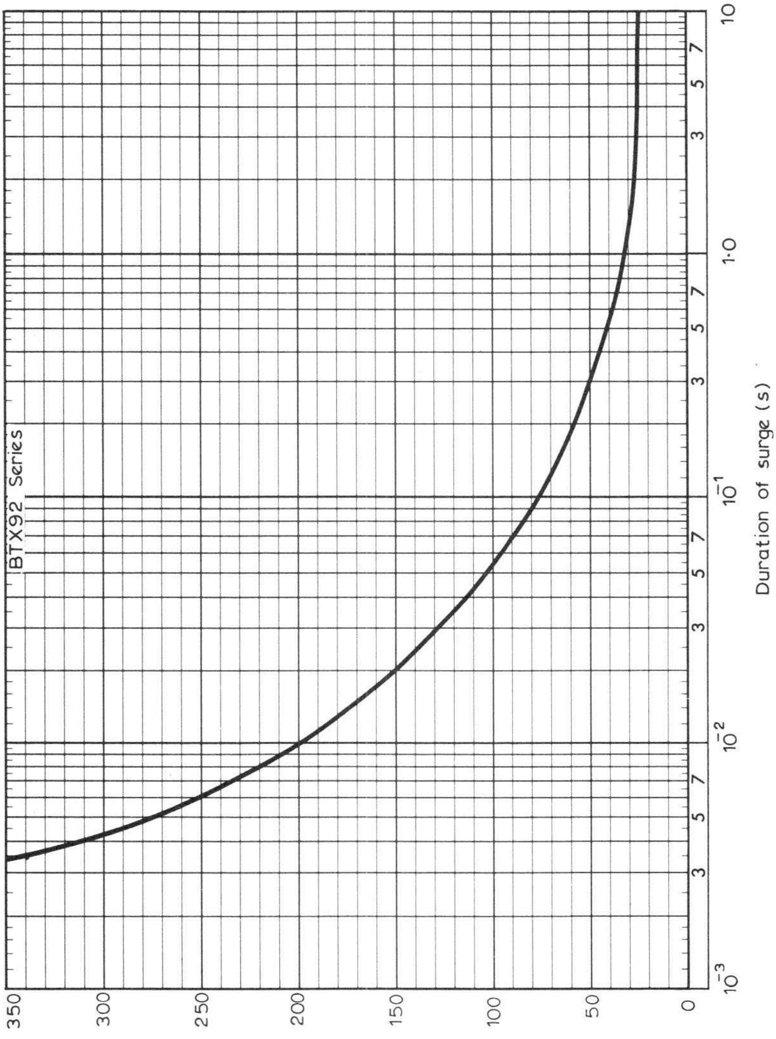
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



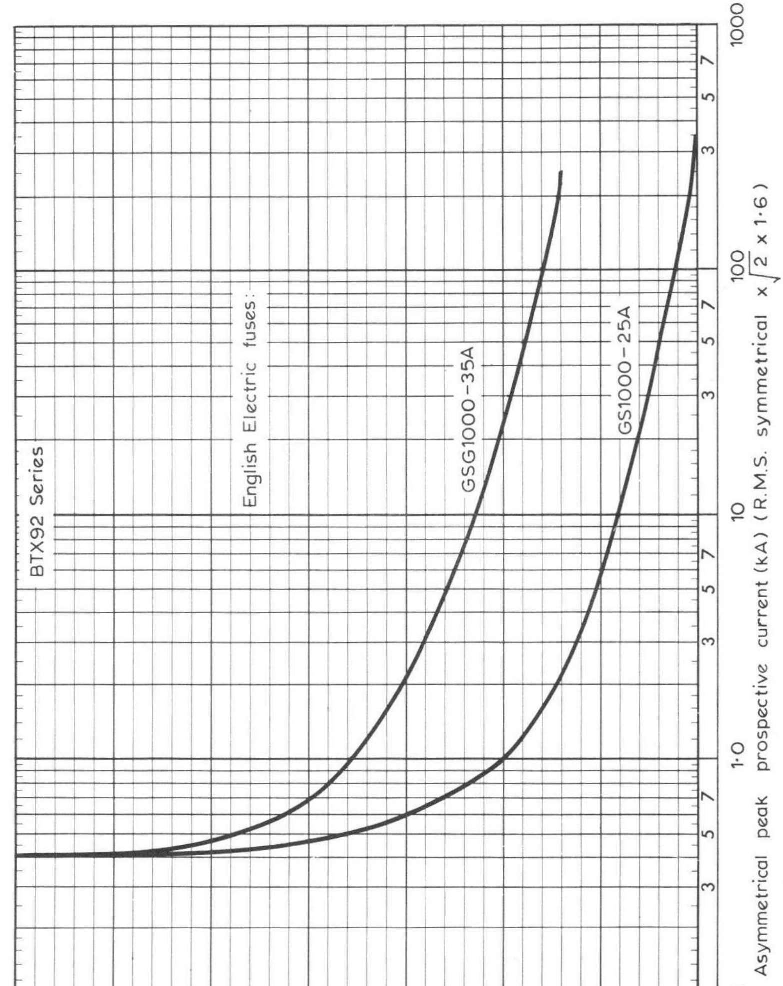
MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



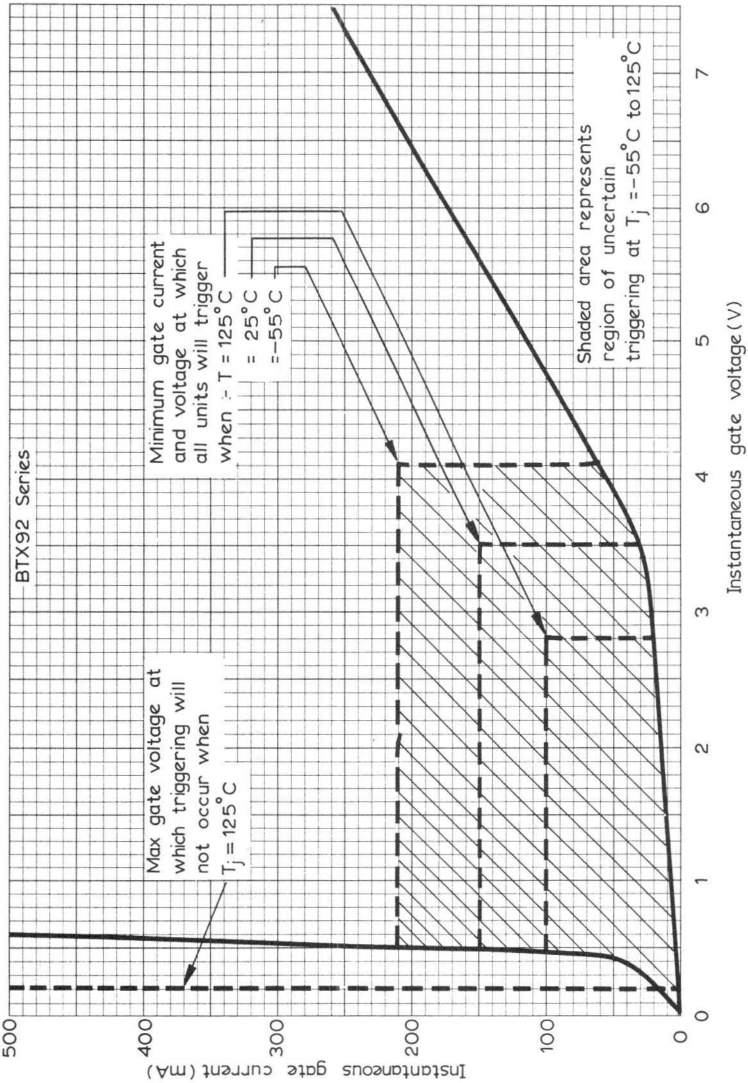
THERMAL RESISTANCE OF BLACKENED EXTRUSION PLOTTED AGAINST EXTRUSION LENGTH IN FREE AIR



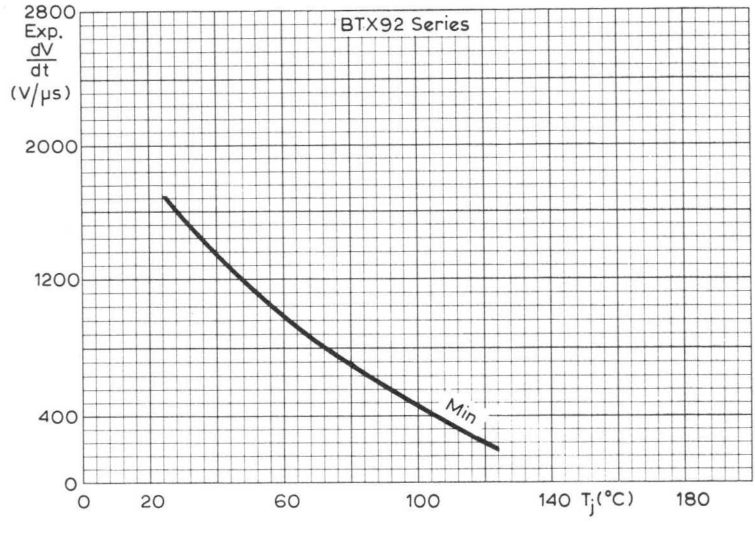
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC)

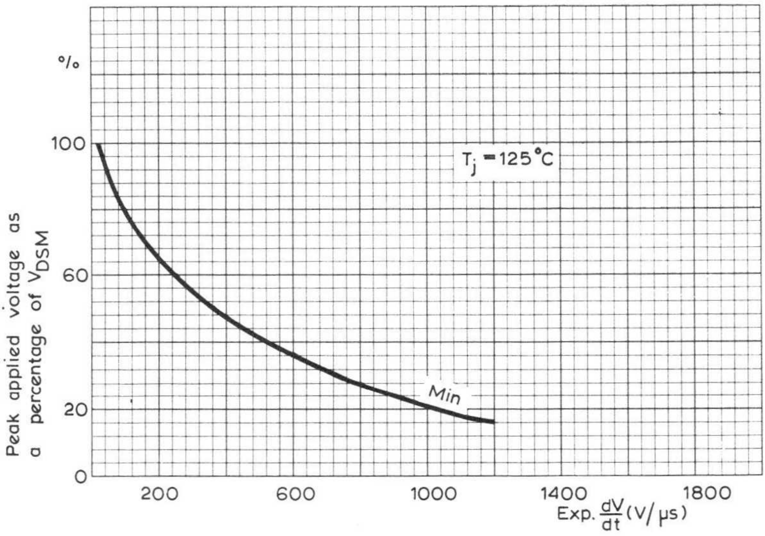


CREST WORKING VOLTAGE PLOTTED AGAINST
PROSPECTIVE CURRENT

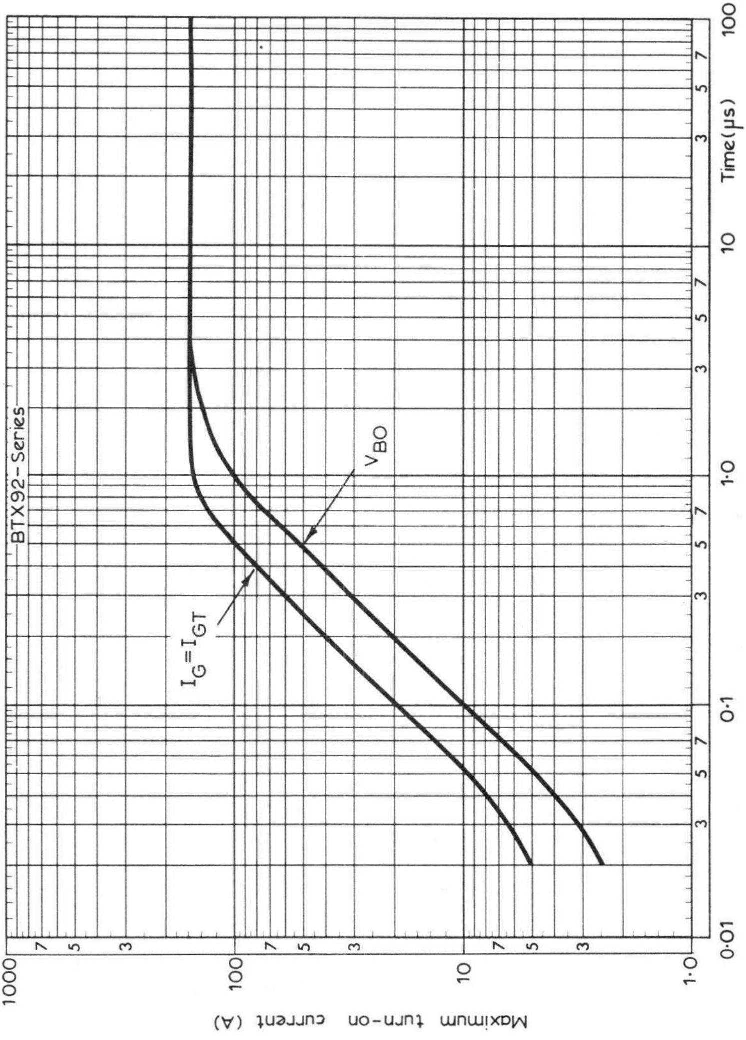


THYRISTOR GATE CHARACTERISTIC

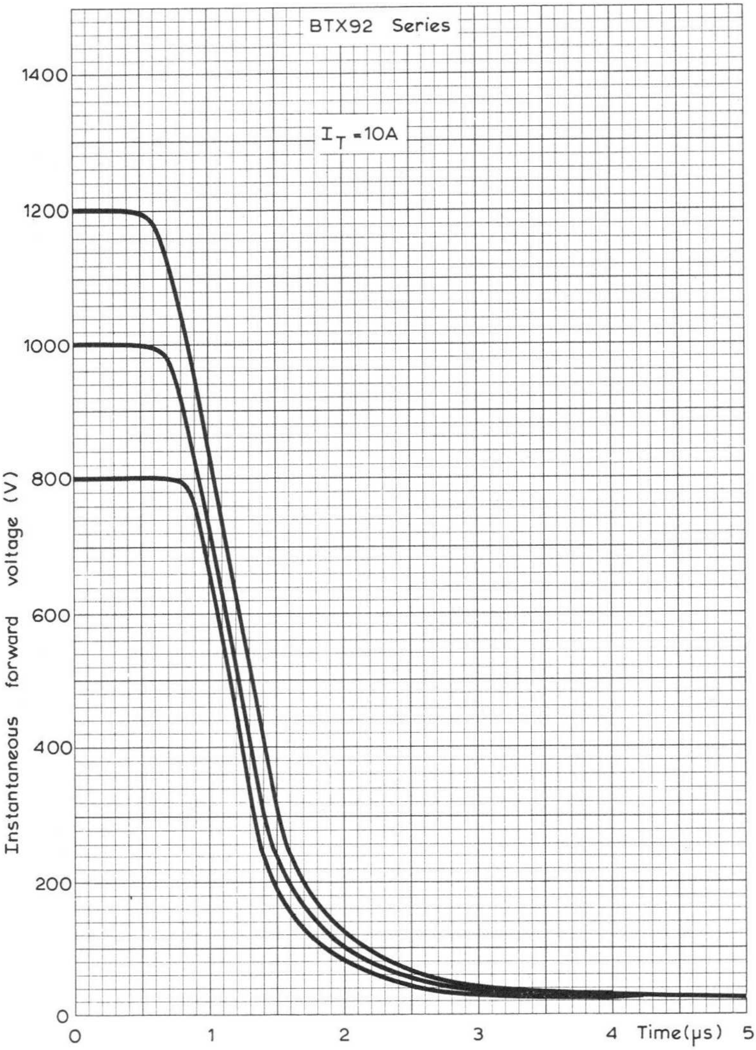




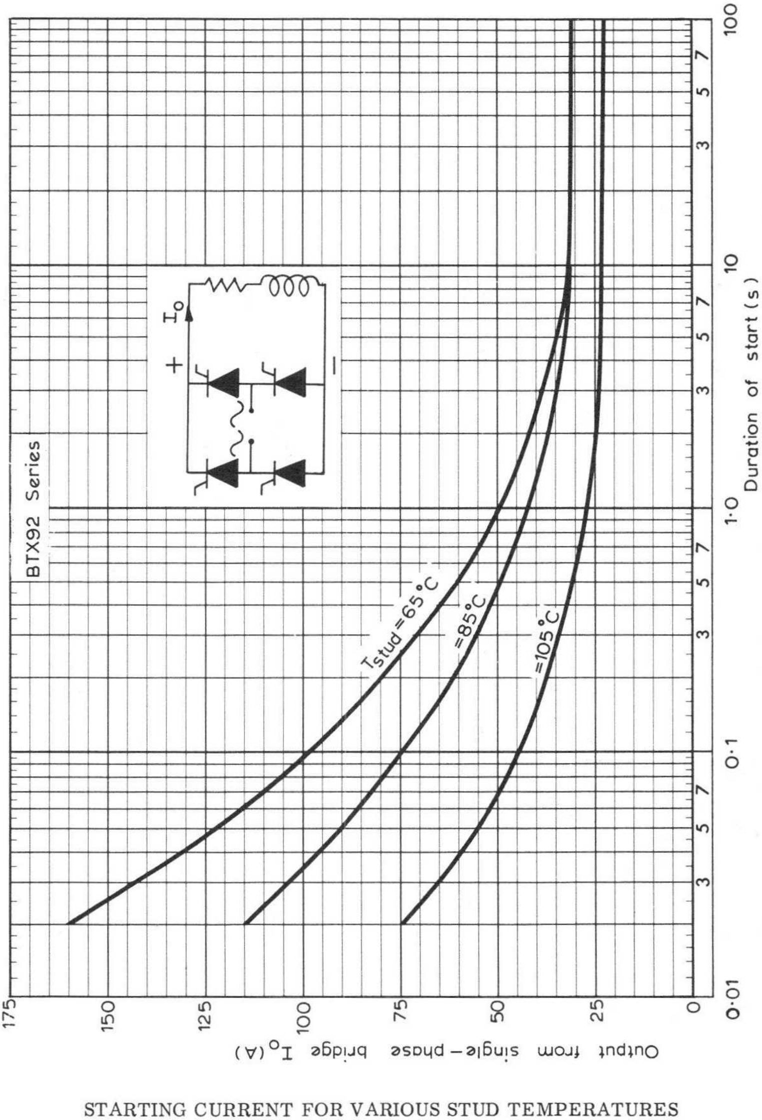
VARIATION OF MINIMUM EXPONENTIAL dV/dt (RATE OF RISE OF BLOCKING VOLTAGE) WITH TEMPERATURE AND PEAK APPLIED VOLTAGE RESPECTIVELY



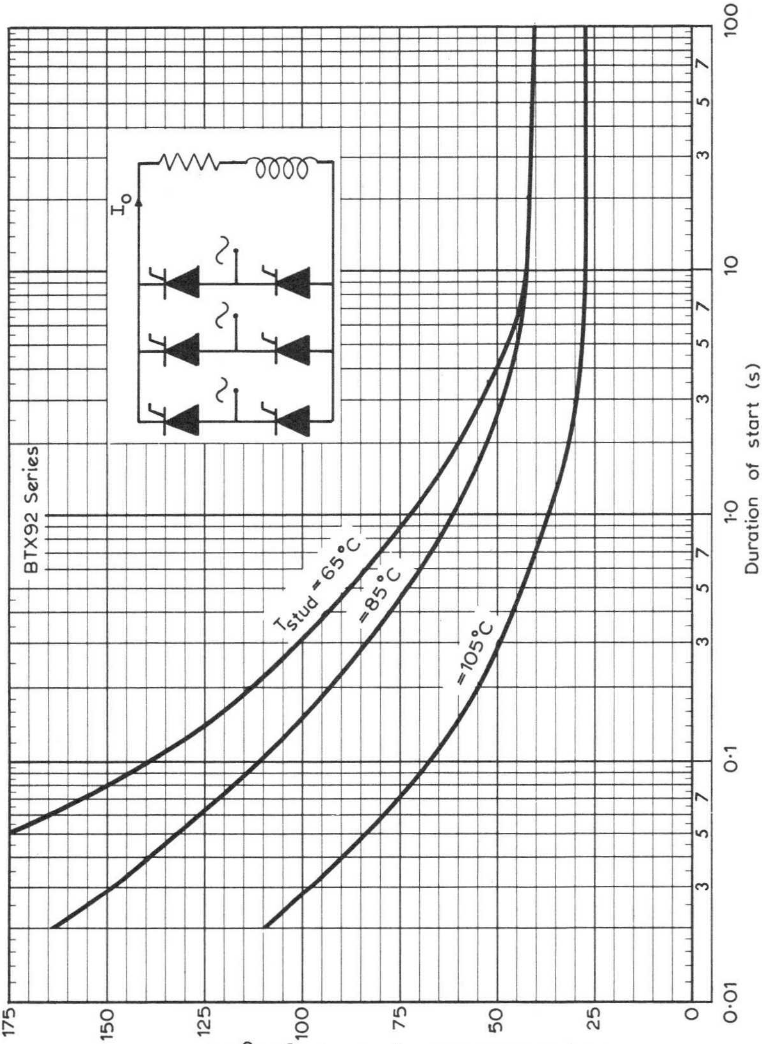
MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME



TYPICAL TURN-ON CHARACTERISTICS



STARTING CURRENT FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



STARTING CURRENT FOR VARIOUS STUD TEMPERATURES
PLOTTED AGAINST TIME, IN A THREE-PHASE BRIDGE

TRIAC

BTX94
Series

TENTATIVE DATA

The BTX94 is a range of bi-directional triode thyristors, (triacs), intended for industrial a.c. power control applications, such as furnace temperature control and static switching. The device is stud mounted and is similar in outline to SO-36. The positive direction for voltage and current is when the main terminal 2 is positive with respect to main terminal 1.

QUICK REFERENCE DATA

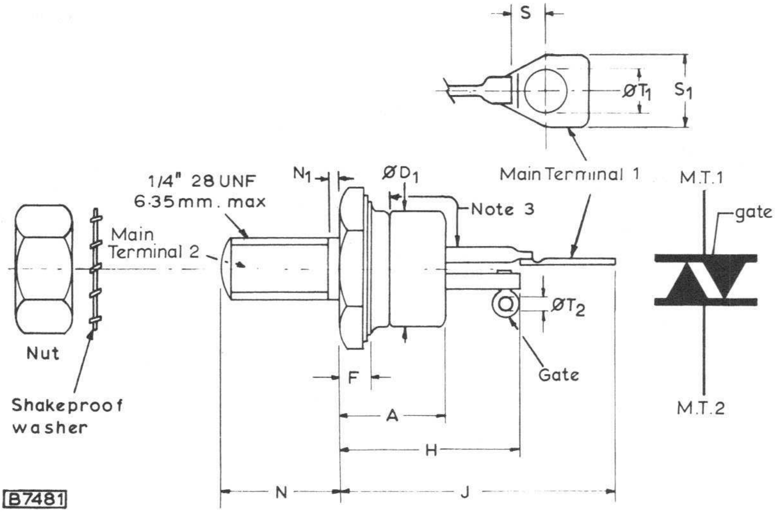
BTX94-	100	200	300	400	500	600	700	800	
V_{DWM} max.	±100	±200	±300	±400	±500	±600	±700	±800	V
V_{DRM} max.	±100	±200	±300	±400	±500	±600	±700	±800	V
$I_{T(RMS)}$ max. $T_{stud} = 85^{o}C$, 360^{o} conduction								25	A
I_{TSM} max. t = 10ms half sinewave, $T_j = 125^{o}C$								200	A
t = 20ms sinewave, $T_j = 125^{o}C$								200	A
T_j max.								125	^{o}C

Unless otherwise stated, data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Similar to B.S. 3934 SO-36
J.E.D.E.C. TO-48

For details see page 2



Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
A	-	12.8	-	0.504	
ØD1	-	12.4	-	0.488	
F	-	3.4	-	0.134	1
H	-	22.2	-	0.875	
J	-	30.3	-	1.192	
N	10.72	11.5	0.422	0.453	
N1	-	2.2	-	0.087	
S	3.1	-	0.122	-	2
S1	-	7.6	-	0.299	
ØT1	3.2	4.2	0.126	0.165	
ØT2	1.6	1.9	0.063	0.075	

NOTES

1. This zone includes a 9/16" hexagon, across flats dimension nominally 14mm (0.522").
2. Minimum flat.
3. Minimum creepage path 6mm (0.236").

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

ANODE TO CATHODE

Voltage (see note 1)

	BTX94-	100	200	300	400	500	600	700	800	
V_{DWM}	Crest working off-state voltage	±100	±200	±300	±400	±500	±600	±700	±800	V
V_{DRM}	Repetitive peak off-state voltage	±100	±200	±300	±400	±500	±600	±700	±800	V

NOTE
1. This voltage may be exceeded but the triac may conduct for the particular half cycle.

Current

$I_{T(RMS)}$	R.M.S. on-state current 360° conduction, $T_{stud} = 85^{\circ}C$	25	A
I_{TSM}	Non-repetitive peak current t = 10ms half sinewave, $T_j = 125^{\circ}C$	200	A
	t = 20ms sinewave, $T_j = 125^{\circ}C$	200	A
I^2t	I^2t for fusing, t = 10ms	200	A^2s
	t = 20ms	400	A^2s
$\frac{di}{dt}$	Rate of rise of forward current	±50	A/μs

GATE TO CATHODE

Voltage

V_{GM}	Peak gate voltage in all modes	10	V

Current

I_{GM}	Peak gate current in all modes	2.0	A

Power

P_G	Average gate power	1.0	W
P_{GM}	Peak gate power	5.0	W

Temperature

T_{stg}	Storage temperature	-55 to +125	°C
T_j max.	Junction temperature	+125	°C

THERMAL CHARACTERISTICS

$R_{th(j-mb)}$	Maximum thermal resistance from junction to mounting base	1.0	degC/W
$R_{th(i)}$	Maximum thermal resistance for a torque of 17kg cm on the nut	0.2	degC/W

ELECTRICAL CHARACTERISTICS

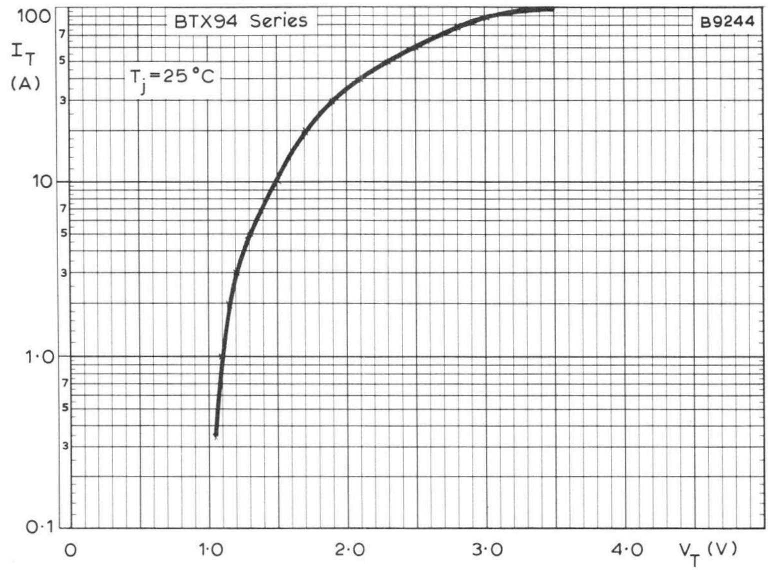
V_T	Max. on-state voltage $I_T = \pm 50A$, $T_j = 25^oC$		±2.3	V
I_D	Max. off-state current $\pm V_{DWM}$ max., $T_j = 125^oC$		±8.0	mA
I_{GT}	Min. current to trigger all devices $T_j = 25^oC$			
	MT1 negative w.r.t. MT2	Positive gate w.r.t. MT1	100	mA
		Negative gate w.r.t. MT1	100	mA
	MT1 positive w.r.t. MT2	Positive gate w.r.t. MT1	150	mA
		Negative gate w.r.t. MT1	100	mA
V_{GT}	Min. voltage to trigger all devices $T_j = 25^oC$			
	MT1 negative w.r.t. MT2	Positive gate w.r.t. MT1	3.0	V
		Negative gate w.r.t. MT1	3.0	V
	MT1 positive w.r.t. MT2	Positive gate w.r.t. MT1	5.0	V
		Negative gate w.r.t. MT1	3.0	V
$\frac{dV}{dt}$	Max. rate of rise of off-state voltage			
	Exponential rise		±100	V/μs
	After commutation (di/dt≤12A/ms)		±30	V/μs

MECHANICAL DATA

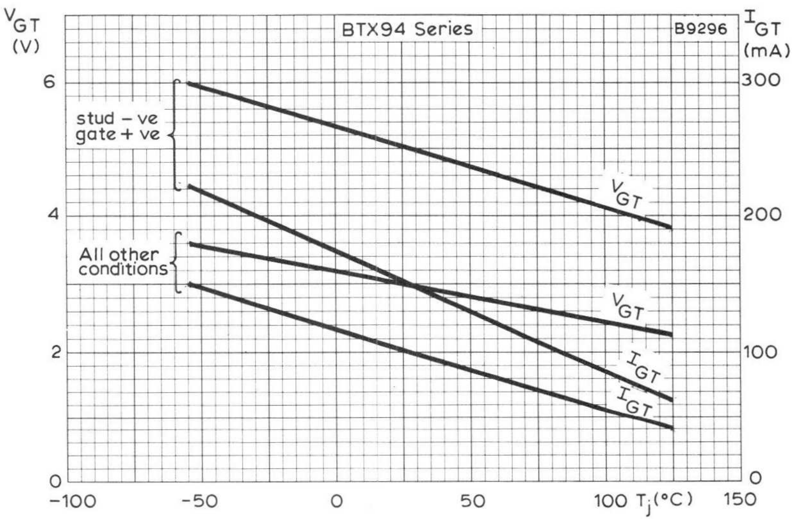
Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.25	in
Weight		
Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

Accessories

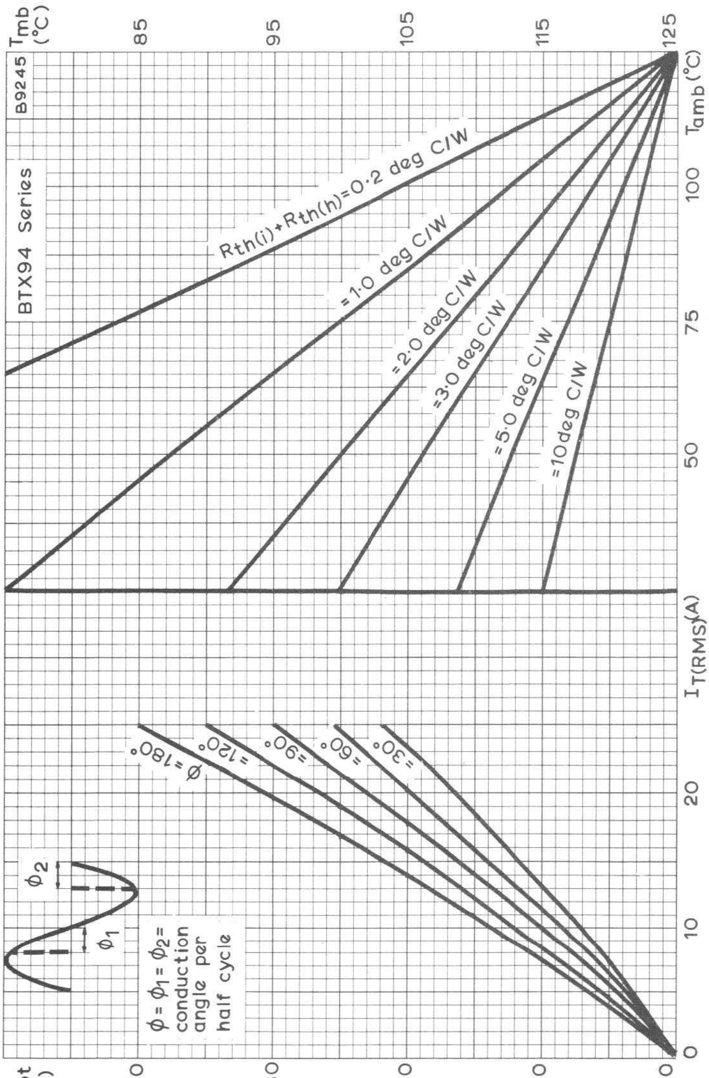
Accessory	Code No.	Note
1/4" UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush Mica washer Tag	56264A	Supplied on request



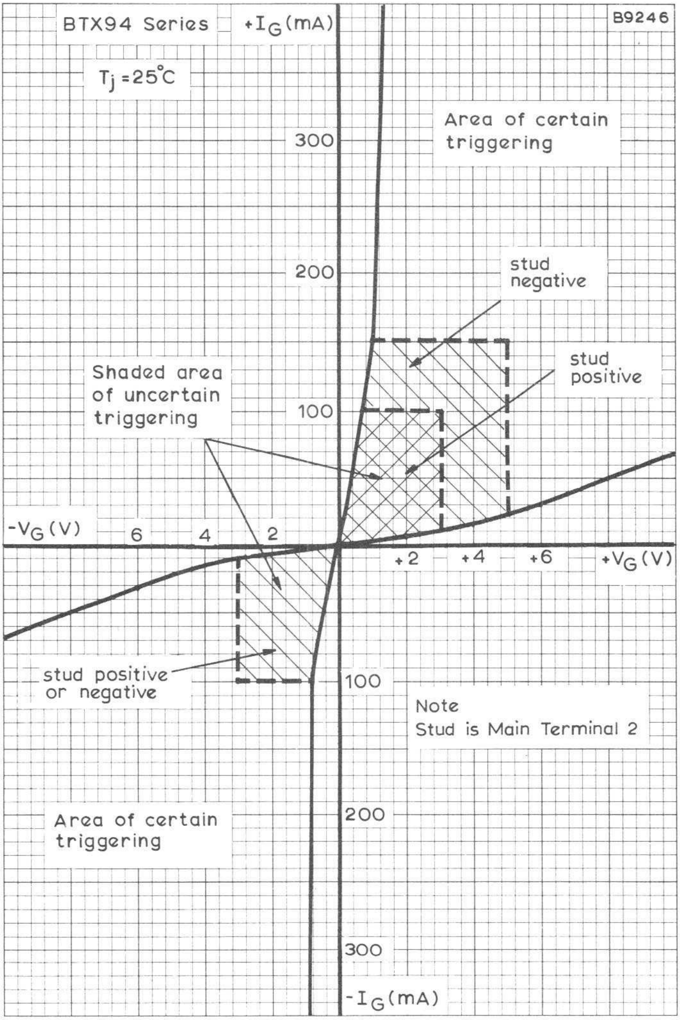
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



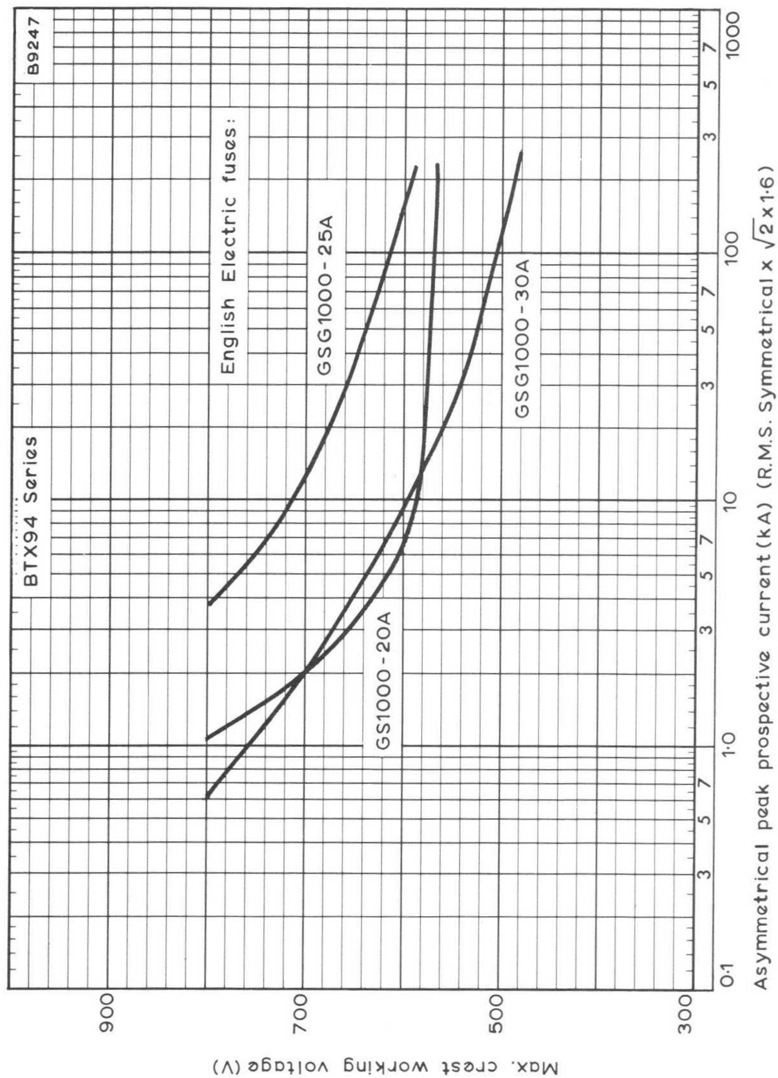
VARIATION OF MINIMUM INSTANTANEOUS TRIGGER VOLTAGE AND CURRENT WITH JUNCTION TEMPERATURE



MAXIMUM MOUNTING-BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF R.M.S. ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



GATE CHARACTERISTIC



CREST WORKING VOLTAGE PLOTTED AGAINST
PROSPECTIVE CURRENT

THYRISTORS

BTY34 Series

TENTATIVE DATA

The BTY34 is a range of p-gate reverse blocking thyristors for use in power control circuits. They have a maximum junction temperature of 150°C and are therefore suitable for operating in high ambient temperatures. Typical applications in the control of d.c. motors, furnaces and lighting.

QUICK REFERENCE DATA

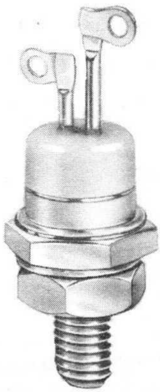
	BTY34-	100R	200R	300R	400R	
V_{BO} min.		100	200	300	400	V
V_{RRM} max.		100	200	300	400	V
$I_{T(AV)}$ max. (T_{stud} = 110 °C)					6.4	A
$I_{T(RMS)}$ max.					10	A
T_j max.					150	°C

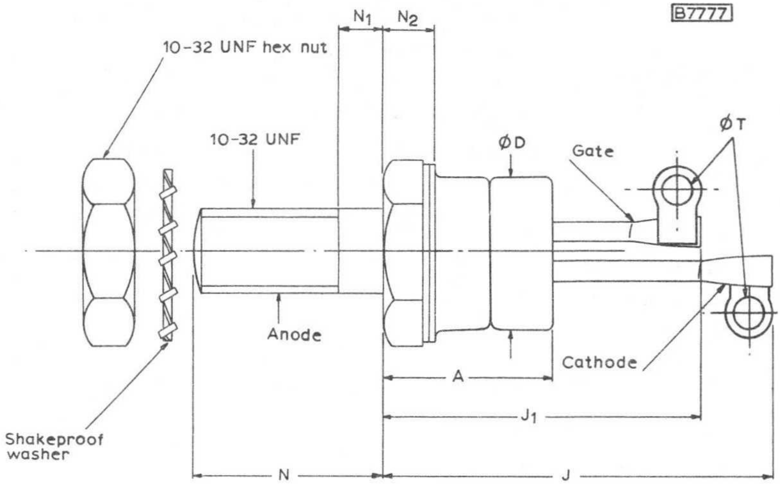
Unless otherwise shown data is applicable to all types in the series

OUTLINE AND DIMENSIONS

Conforming to B.S. 3934 SO-35A

For details see page D2





Inch dimensions derived from millimetre signals

	Millimetres			Inches			Note
Ref.	Min.	Nom.	Max.	Min.	Nom.	Max.	
A	-		10.28	-	-	0.405	
ØD	-	-	9.3	-	-	0.367	
J	-	-	21.72	-	-	0.856	
J_1	-	-	18.5	-	-	0.728	
N	10.72	11.1	11.5	0.423	0.437	0.453	
N_1	-	-	1.98	-	-	0.078	
N_2	-	-	3.5	-	-	0.138	1
ØT	1.6	-	1.9	0.063	-	0.075	

NOTES

1. This zone includes a 7/16in hexagon, across flats dimension 0.423in (10.75mm) minimum, 0.438in (11.12mm) maximum.
2. Devices with slight variations in lug pattern, still conforming to B.S.3934 SO-35A, may be supplied.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

	BTY34-	100R	200R	300R	400R	
V_R	Continuous reverse voltage	100	200	300	400	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	V
V_{RSM}	Non-repetitive peak reverse voltage (< 10ms)	150	300	400	500	V
V_D	Continuous off-state voltage	100	200	300	400	V
V_{DWM}	Crest working off-state voltage	100	200	300	400	V
V_{DRM}	Repetitive peak off-state voltage	100	200	300	400	V
V_{DSM}	Non-repetitive peak off-state voltage	500	500	500	500	V

NOTE

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 12degC/W for a.c. operation and 6.0degC/W for d.c. operation.

Current

I_T	Continuous on-state current	10	A
$I_{T(AV)}$	Mean on-state current (see page C2)	6.4	A
$I_{T(RMS)}$	R.M.S. on-state current	10	A
I_{TRM}	Repetitive peak on-state current	55	A
I_{TSM}	Maximum on-state fault current, peak of half-sinewave at maximum operating conditions	50	A
I^2t	I^2t for fusing (< 10ms) (see pages C4 and C5)	12	A^2s
$\frac{di}{dt}$	Rate of rise of forward current (see lower curve page C8)	10	A/μs
I_{RRM}	Repetitive peak reverse current	5.0	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
P_G	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature min.	-55	^oC
T_{stg} max.	Storage temperature max.	150	^oC
T_j min.	Junction temperature min.	-55	^oC
T_j max.	Junction temperature max.	150	^oC

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to mounting base	3.0	degC/W
θ_i	Maximum thermal resistance for a torque of 9.0kg cm on the nut	0.5	degC/W
$\theta_{j-mb(transient)}$	Transient thermal resistance (1.0ms)	0.16	degC/W

ELECTRICAL CHARACTERISTICS (T_j = 150°C unless otherwise stated)

	BYT34-	100R	200R	300R	400R	
V_{BO}	Minimum forward break-over voltage (see note 2)	100	200	300	400	V
V_T	Maximum instantaneous on-state voltage at I_T = 20A, T_j = 25°C (see page C1)				2.3	V
i_D	Maximum on-state leakage current at V_{DWM}				5.0	mA
i_R	Maximum reverse leakage current at V_{RWM}				5.0	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at T_j = 25°C (see page C6)				3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25°C (see page C6)				30	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)				200	mV
I_L	Typical latching current				10	mA
I_p	Typical pick-up current				20	mA
t_{gt}	Typical turn-on time Forward voltage before trigger = 50V, I_T = 10A (see page C7)				3.0	μs
t_q	Typical turn-off time I_T = 10A, I_R = 5.0A (see page C8)				20	μs

NOTE

2. This voltage may be exceeded up to the maximum peak forward voltage V_{DSM}, but the thyristor may conduct at any voltage over the maximum forward breakover voltage.

MECHANICAL DATA

Maximum torque on hexagon or nut	17	kg cm
	1.3	lb ft
Minimum torque on hexagon or nut for good thermal contact	9.0	kg cm
	0.6	lb ft
Recommended diameter of hole in heatsink	5.2	mm
	0.205	in
Weight		
Without accessories	5.3	g
	0.18	oz
With accessories	7.0	g
	0.25	oz

Accessories

Accessory	Code No.	Note
10-32 UNF Nut Shakeproof washer	56294	Supplied with thyristor
PTFE bush 2 Mica washers 2 BA washer Terminal	56295	Supplied on request

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core.
A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{RSM}}{V_{RWM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

Where I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

A range of trigger modules is available, and details of these modules will be supplied on request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

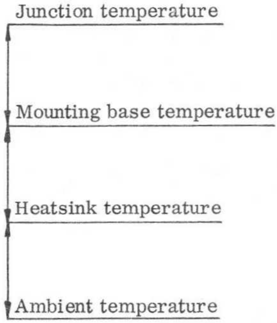
4. Dissipation and heatsink considerations.

The various components of the rise of junction temperature above ambient are illustrated below.

$\theta_{j-mb} = 3.0 \text{degC/W}$

$\theta_i = 0.5 \text{degC/W}$

θ_j



The method of using the curve on page C2 is as follows:

Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

Alternatively, for a given mean on-state current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot} \text{ max.}} - \theta_i$$

The size of the heatsink required may be found from the graph on page C3.

5. FUSING

The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.

When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:-

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rating of the fuse.

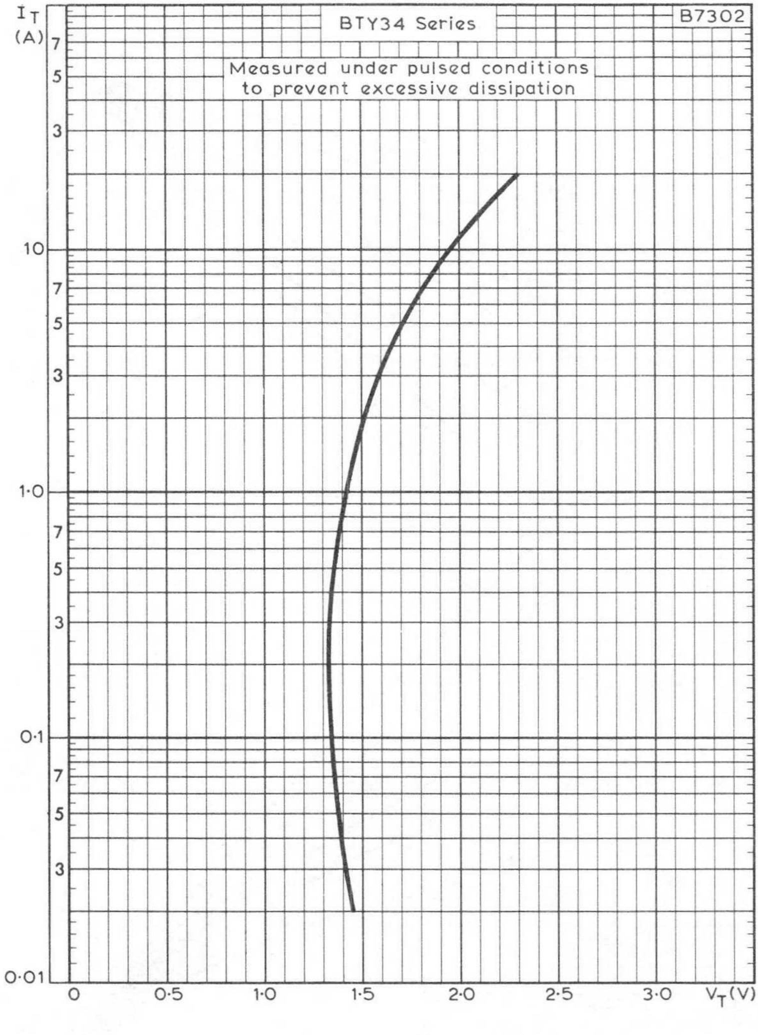
(c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.

(d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

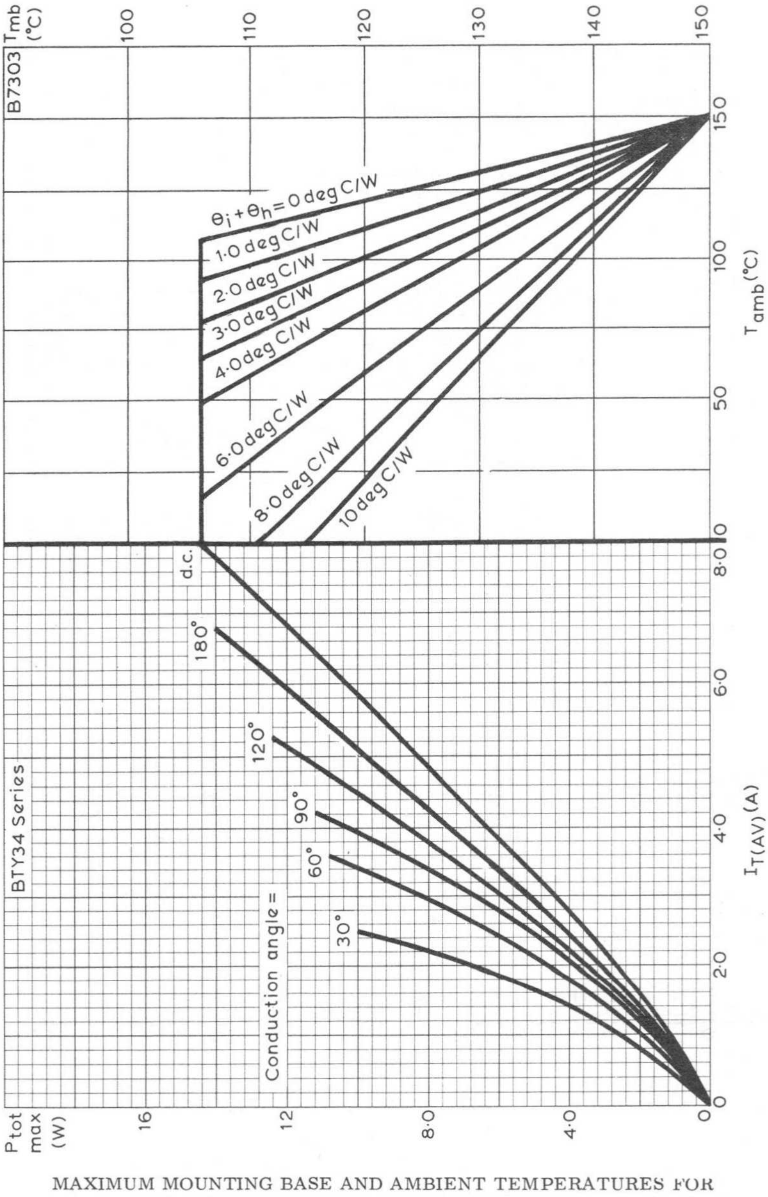
The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

6. STARTING

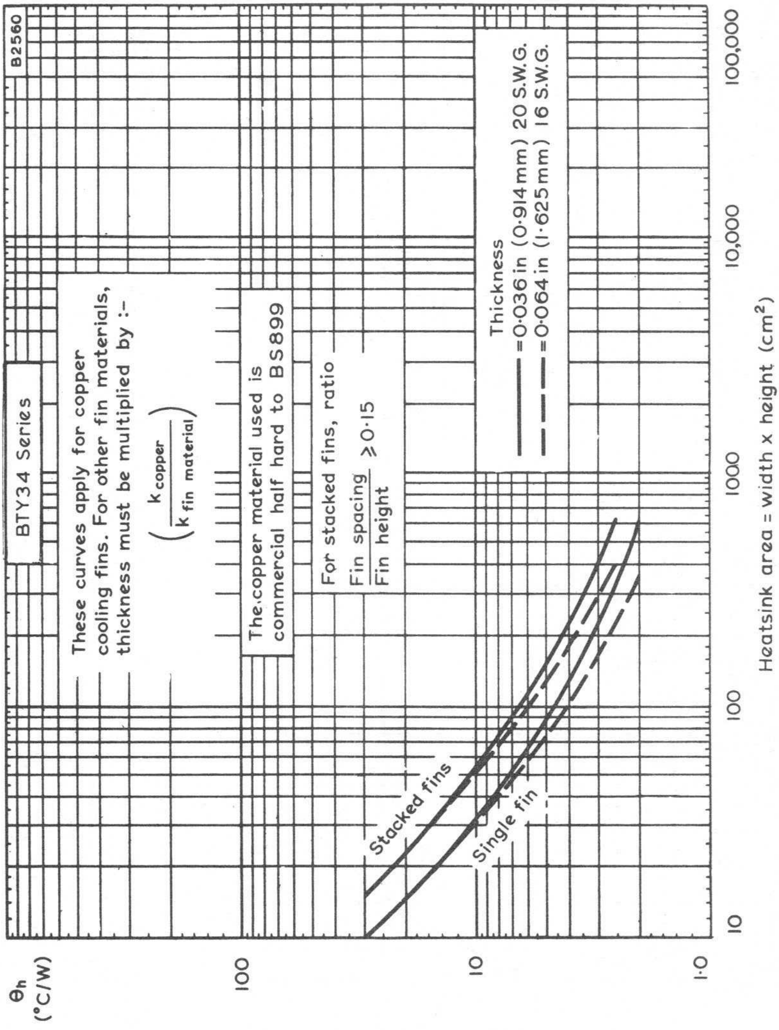
Where starting conditions are likely to exceed the current limits given on page C2 the upper curve on page C8 may be used. Upper curve on page C8 refers to the output of a single phase bridge.



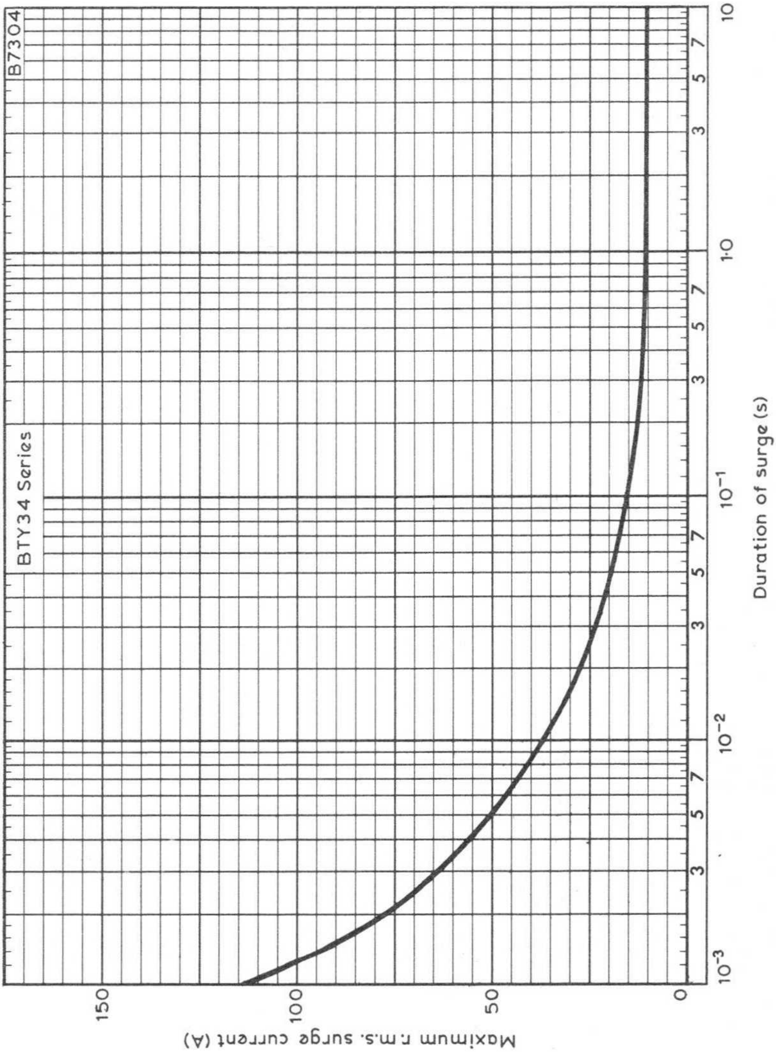
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



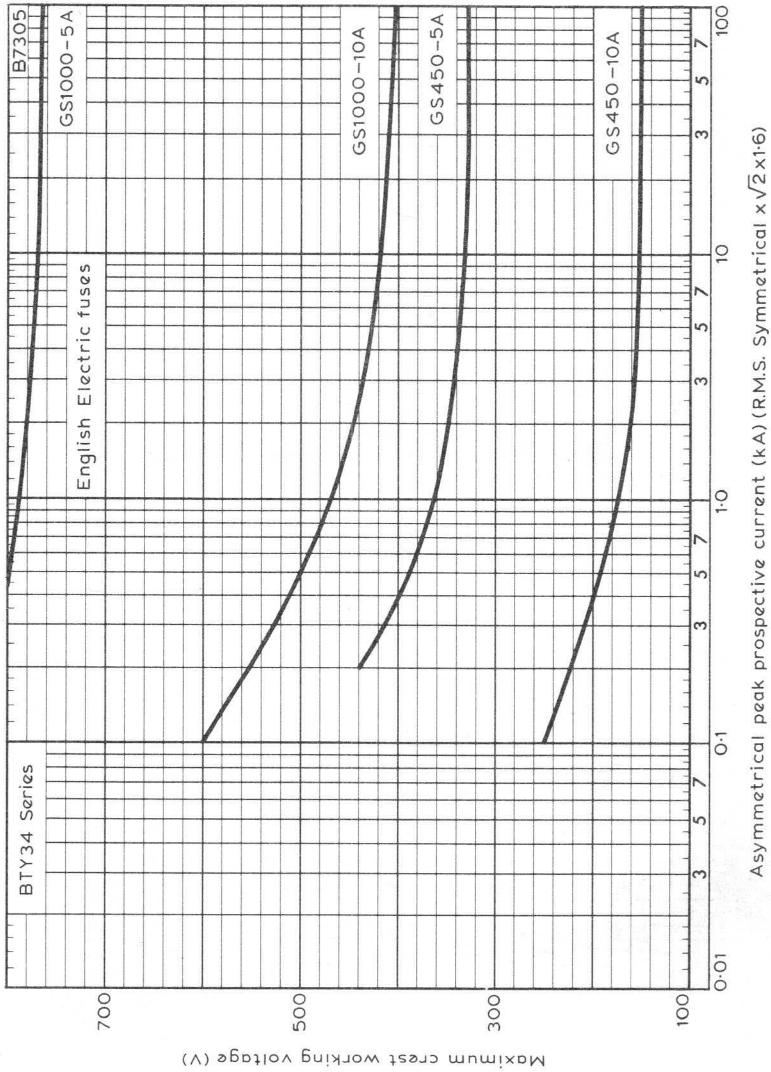
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



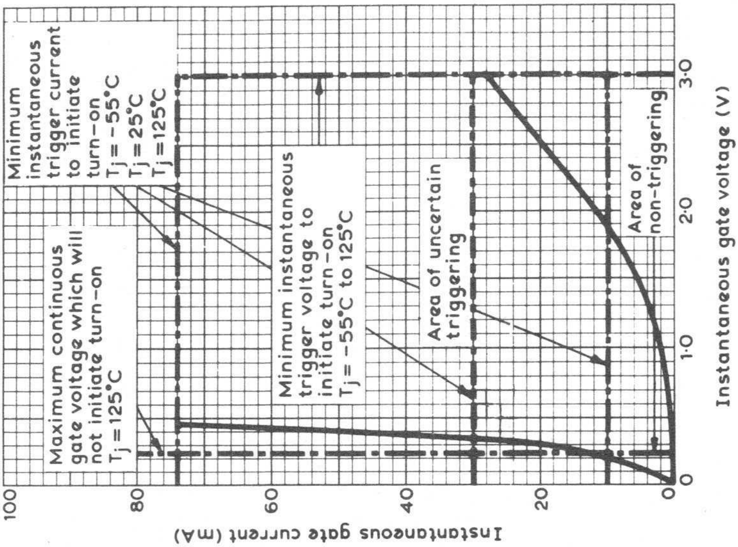
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA

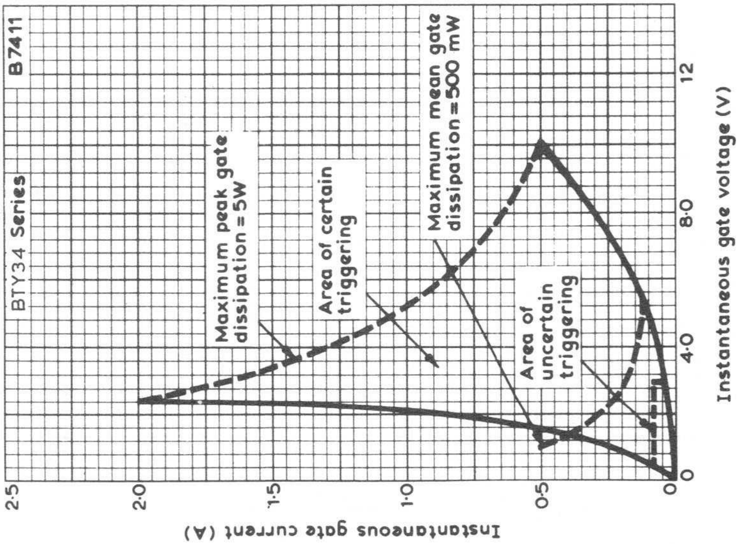


MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES FUSES, CIRCUIT BREAKERS ETC.

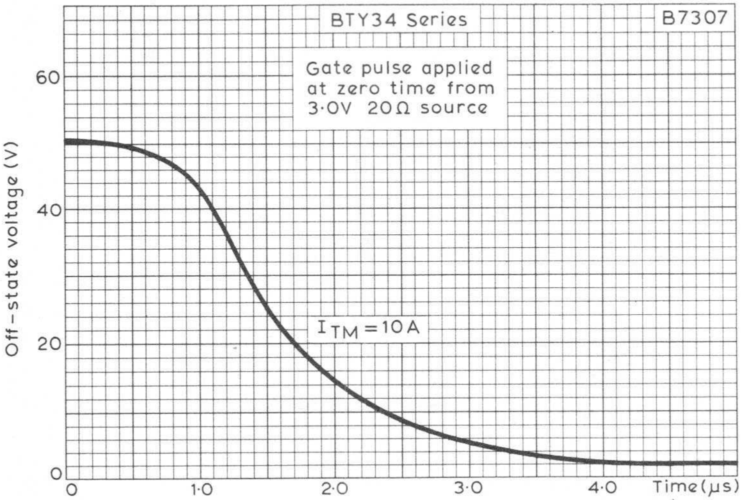


CREST WORKING VOLTAGE PLOTTED AGAINST
PROSPECTIVE CURRENT

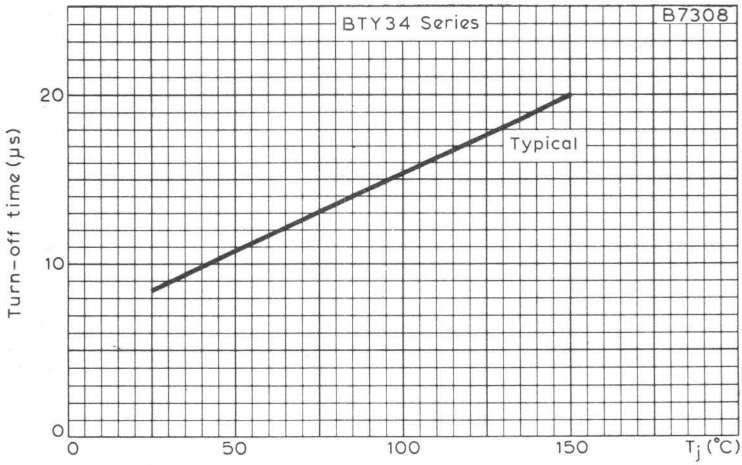




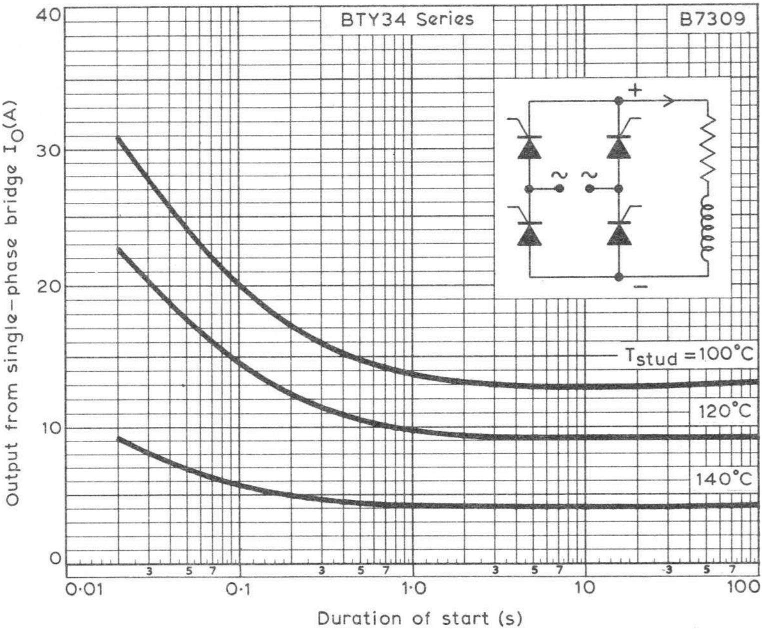
THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION
OF THE GRAPH NEAR THE ORIGIN



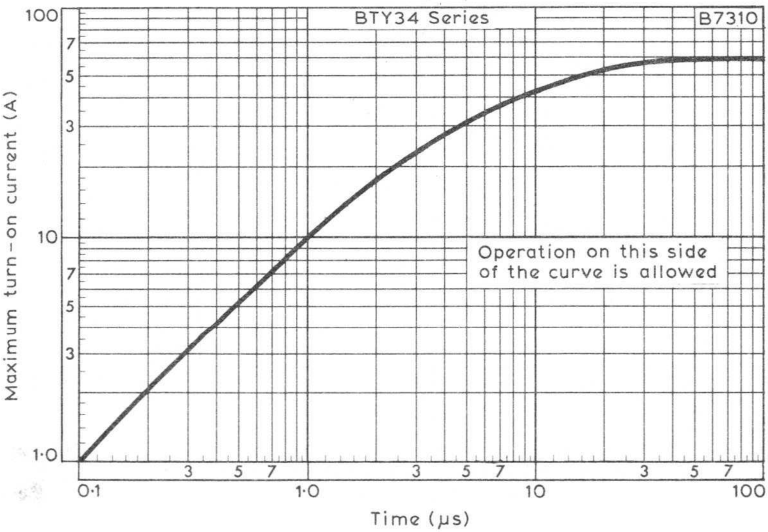
TYPICAL TURN-ON CHARACTERISTIC



TYPICAL VARIATION OF TURN-OFF TIME WITH JUNCTION TEMPERATURE



STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME

BTY79 Series

TENTATIVE DATA

The BTY79 is a range of p-gate reverse blocking thyristors for use in power control circuits. Typical applications include the control of d.c. motors, furnaces and lighting.

Unless otherwise shown, data is applicable to all types in the series.

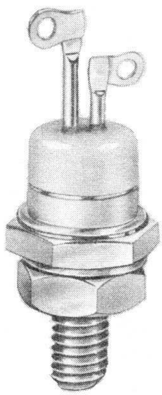
QUICK REFERENCE DATA

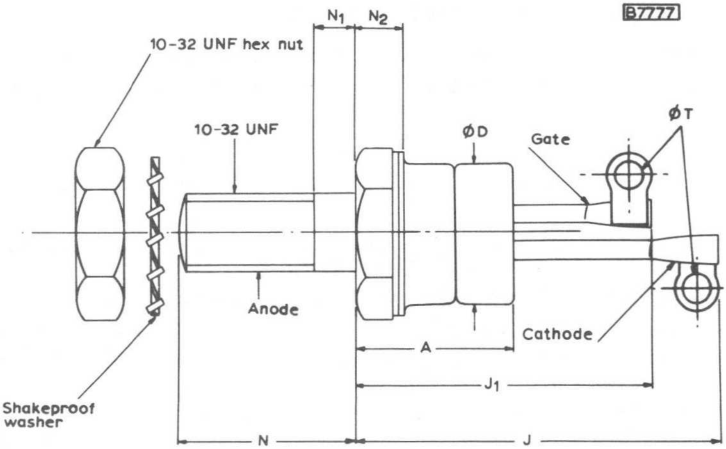
BTY79-	100R	200R	300R	400R	500R	600R	700R	800R	1000R		
V_{BO} min.	100	200	300	400	500	600	700	800	1000		V
V_{RRM} max.	100	200	300	400	500	600	700	800	1000		V
$I_{T(AV)}$ max. $T_{mb} = 85°C$										6.4	A
$I_{T(RMS)}$										10	A
T_j max.										125	°C
θ_{j-mb} max.										3.0	degC/W

OUTLINE AND DIMENSIONS

Conforming to B.S.3934 SO-35A

For details see page D2.





Inch dimensions derived from millimetre originals.

	Millimetres			Inches			Note
Ref.	*Min.*	*Nom.*	*Max.*	*Min.*	*Nom.*	*Max.*	
A	—	—	10.28	—	—	0.405	
ϕD	—	—	9.3	—	—	0.367	
J	—	—	21.72	—	—	0.856	
J_1	—	—	18.5	—	—	0.728	
N	10.72	11.1	11.5	0.423	0.437	0.453	
N_1	—	—	1.98	—	—	0.078	
N_2	—	—	3.5	—	—	0.138	1
ϕT	1.6	—	1.9	0.063	—	0.075	

NOTES

1. This zone includes a 7/16 in. hexagon, across flats dimension 0.423 in. (10.75 mm) minimum, 0.438 in. (11.12 mm) maximum.
2. Devices with slight variations in lug pattern, still conforming to B.S.3934 SO–35A, may be supplied.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 0 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE TO CATHODE

Voltage (see note 1)

		Type BTY79-									
		100R	200R	300R	400R	500R	600R	700R	800R	1000R	
V_R	Continuous reverse voltage	100	200	300	400	500	600	700	800	1000	V
V_{RWM}	Crest working reverse voltage	100	200	300	400	500	600	700	800	1000	V
V_{RRM}	Repetitive peak reverse voltage	100	200	300	400	500	600	700	800	1000	V
V_{RSM}	Non-repetitive peak reverse voltage	150	300	400	500	600	720	850	960	1100	V
V_D	Continuous off-state voltage (see note 2)	100	200	300	400	500	600	700	800	1000	V
V_{DWM}	Crest working off-state voltage (see note 2)	100	200	300	400	500	600	700	800	1000	V
V_{DRM}	Repetitive peak off-state voltage (see note 2)	100	200	300	400	500	600	700	800	1000	V
V_{DSM}	Non-repetitive peak off-state voltage	500	500	500	500	1100	1100	1100	1100	1100	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 6.0degC/W for d.c. operation and 12degC/W for a.c. operation.
2. This voltage may be exceeded up to the maximum peak off-state voltage V_{DSM}, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

Current

I_T	Continuous on-state current	10	A
$I_{T(AV)}$	Mean on-state current (see page C2)	6.4	A
$I_{T(RMS)}$	R.M.S. on-state current	10	A
I_{TRM}	Repetitive peak on-state current	60	A
I_{TSM}	Non-repetitive on-state fault current, peak of half-sinewave at maximum operating conditions	80	A
I^2t	I^2t for fusing ($<$ 10ms) (see pages C4 and C5)	32	A^2s
$\frac{di}{dt}$	Rate of rise of on-state current (see lower curve page C8)	20	A/μs
I_{RRM}	Repetitive peak reverse current	5.0	A

GATE TO CATHODE

Voltage

V_{FGM}	Peak forward gate voltage anode positive w.r.t. cathode	10	V
V_{RGM}	Peak reverse gate voltage	5.0	V

Current

I_{FGM}	Peak forward current	2.0	A

Power

P_{GM}	Peak gate power	5.0	W
P_G	Average gate power	0.5	W

Temperature

T_{stg} min.	Storage temperature	–55	°C
T_{stg} max.	Storage temperature	125	°C
T_j min.	Junction temperature	–55	°C
T_j max.	Junction temperature	125	°C

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to mounting base	3.0 degC/W
θ_i	Maximum thermal resistance for a torque of 9.0kg cm on the nut	0.5 degC/W
$\theta_{j-mb(transient)}$	Transient thermal resistance (1.0ms)	0.16degC/W

ELECTRICAL CHARACTERISTICS ($T_j = 125°C$ unless otherwise stated)

		Type BTY79-									
		100R	**200R**	**300R**	**400R**	**500R**	**600R**	**700R**	**800R**	**1000R**	
V_{BO}	Minimum forward breakover voltage	100	200	300	400	500	600	700	800	1000	V
V_T	Maximum instantaneous on-state voltage at $I_T = 20A$ and $T_j = 25°C$									2.3	V
i_D	Maximum off-state current at V_{DWM} max.	5.0	5.0	5.0	5.0	2.5	2.5	2.5	2.5	2.5	mA
i_R	Maximum reverse leakage current at V_{RWM} max.	5.0	5.0	5.0	5.0	2.5	2.5	2.5	2.5	2.5	mA
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25°C$ (see page C6)									3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25°C$ (see page C6)									30	mA
V_{GD}	Maximum continuous gate voltage which will not initiate turn-on (see page C6)									250	mV
I_H	Typical holding current									10	mA
I_L	Typical latching current									20	mA
t_{gt}	Typical turn-on time Forward voltage before trigger = 50V, $I_T = 10A$ (see page C7)									3.0	μs
t_q	Typical turn-off time $I_T = 10A$, $I_R = 5.0A$ (see page C7)									20	μs

MECHANICAL DATA

Maximum torque on hexagon or nut	17 kg cm 1.3 lb ft
Minimum torque on hexagon or nut for good thermal contact	9.0 kg cm 0.6 lb ft
Recommended diameter of hole in heatsink	5.2 mm 0.205 in
Weight	
Without accessories	5.3 g 0.18 oz
With accessories	7.0 g 0.25 oz

ACCESSORIES

Accessory	*Code No.*	*Notes*
10-32 UNF nut Shakeproof washer	56294	Supplied with thyristor
PTFE bush 2 Mica washers Plain washer Tag	56295	Supplied on request

OPERATING NOTES

1. SUPPRESSION OF TRANSIENT VOLTAGE SURGE DUE TO STORED ENERGY IN TRANSFORMER CORE

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:—

	R–C in primary of transformer		R–C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values, and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   A range of trigger modules is available, and details of these modules will be supplied upon request.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations:—
The various components of the rise of junction temperature above ambient are illustrated below:

Junction temperature

$\theta_{j-mb} = 3.0$degC/W

Mounting base temperature

$\theta_i = 0.5$degC/W

Heatsink temperature

θ_h

Ambient temperature

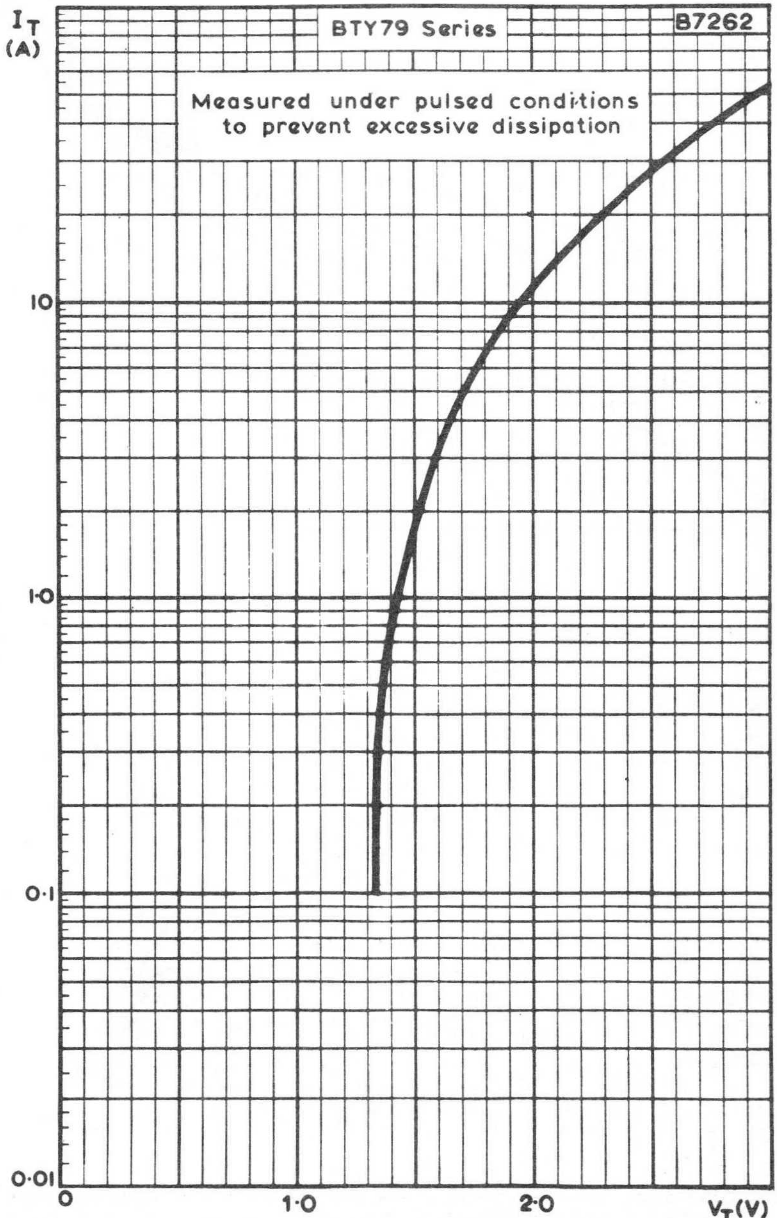
The method of using the curve on page C2 is as follows:—
Starting with the curve of maximum dissipation as a function of mean on-state current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

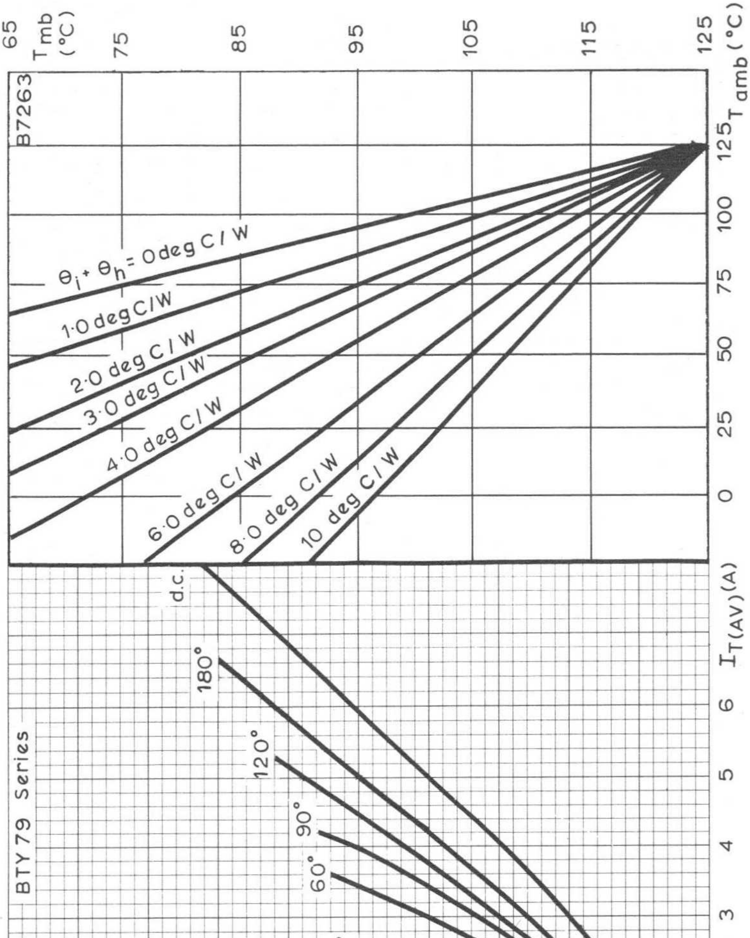
5. FUSING
The curve given on page C4 is intended for selecting suitable fuses or circuit breakers.
When selecting a fuse to protect the thyristor against short circuit, the following rules must be adhered to:—
   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.
   (b) The applied voltage must not exceed the nominal peak rating of the fuse.
   (c) The thyristor must have a transient reverse voltage in excess of the arc voltage of the fuse at the supply voltage being applied.
   (d) The prospective currents must be limited to ensure that I^2t let through will not exceed the I^2t for the thyristor.

The curve shown on page C5 gives the maximum permissible prospective current for various values of applied voltage, using English Electric fuses.

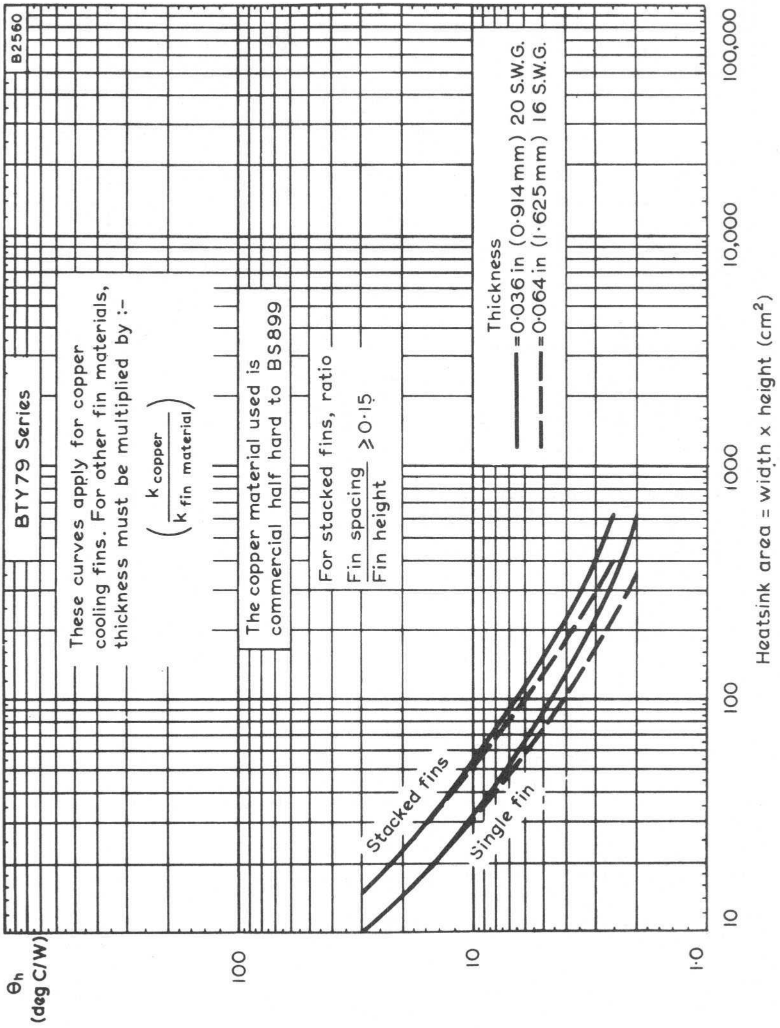
6. STARTING
Where starting conditions are likely to exceed the current limits given on page C2, the upper curve on page C8 may be used. The upper curve on page C8 refers to the output of a single phase bridge.



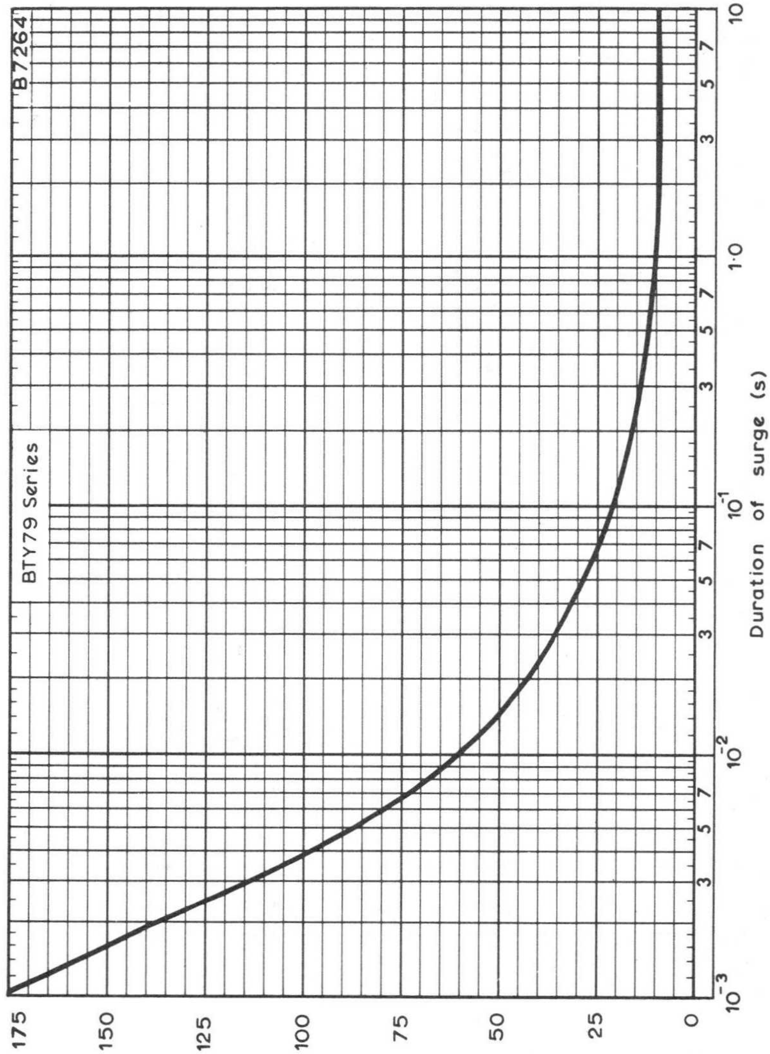
MAXIMUM ON-STATE CONDUCTING CHARACTERISTIC



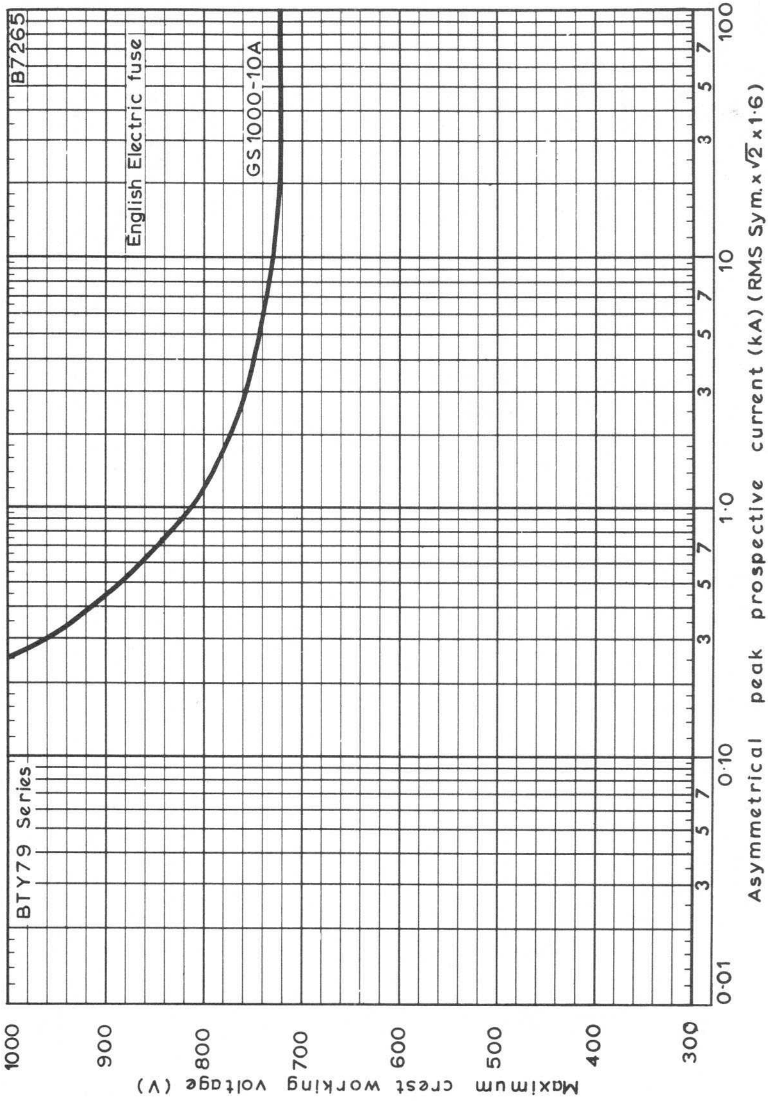
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN ON-STATE CURRENT AND HEATSINK THERMAL RESISTANCE



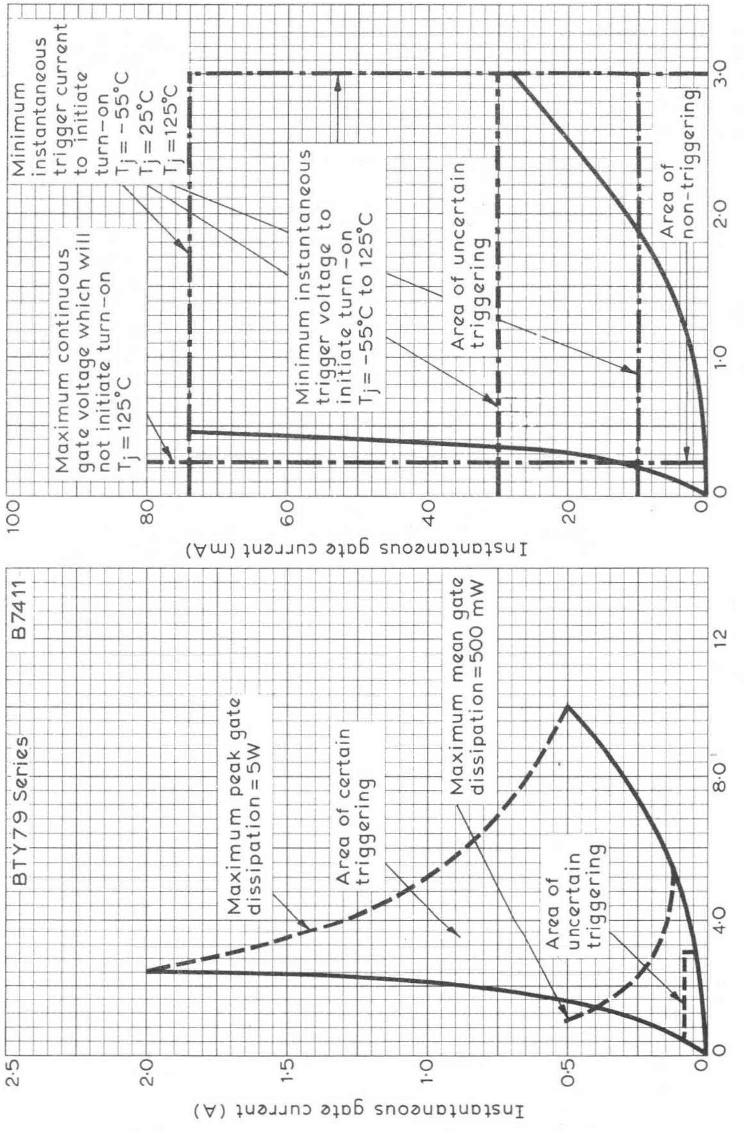
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



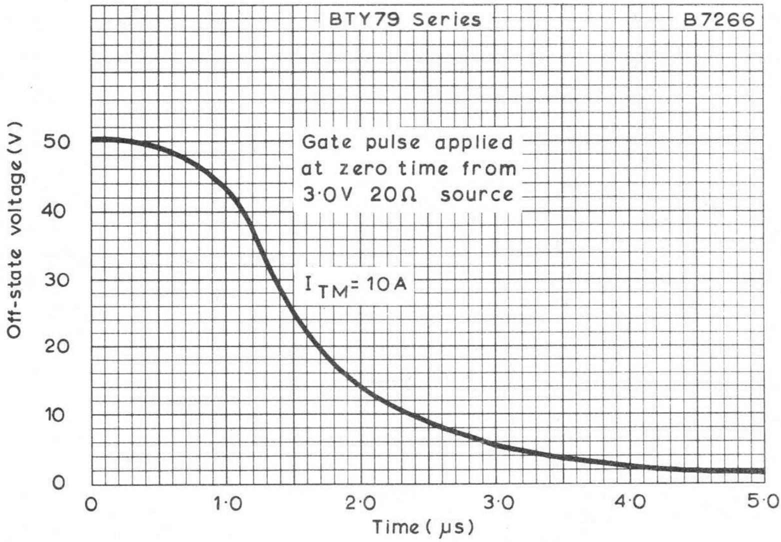
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION FOR SELECTING PROTECTIVE DEVICES (FUSES, CIRCUIT BREAKERS ETC.)



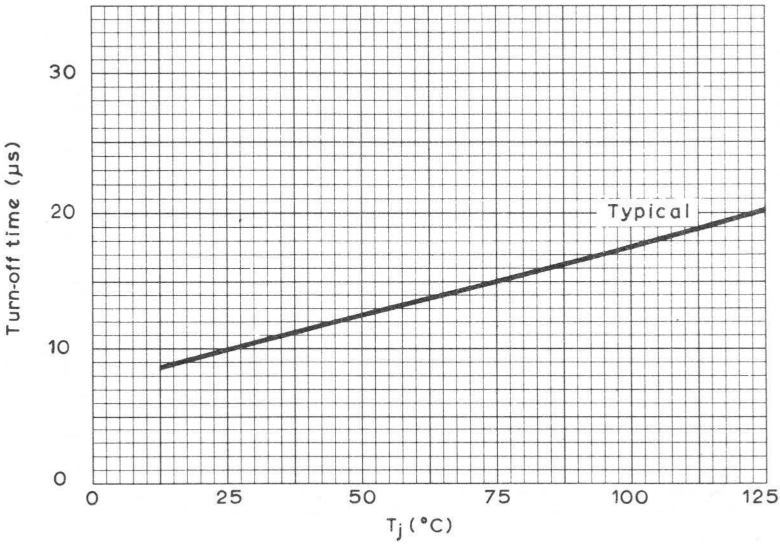
CREST WORKING VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT

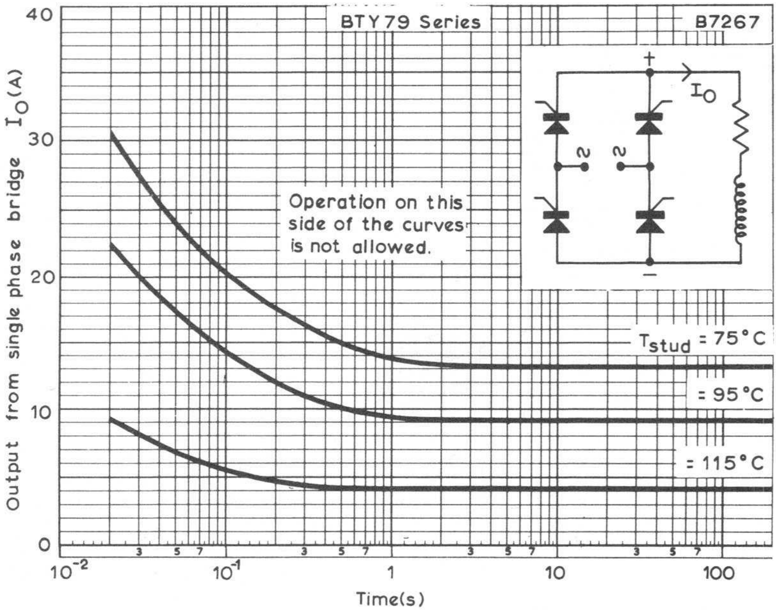


THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

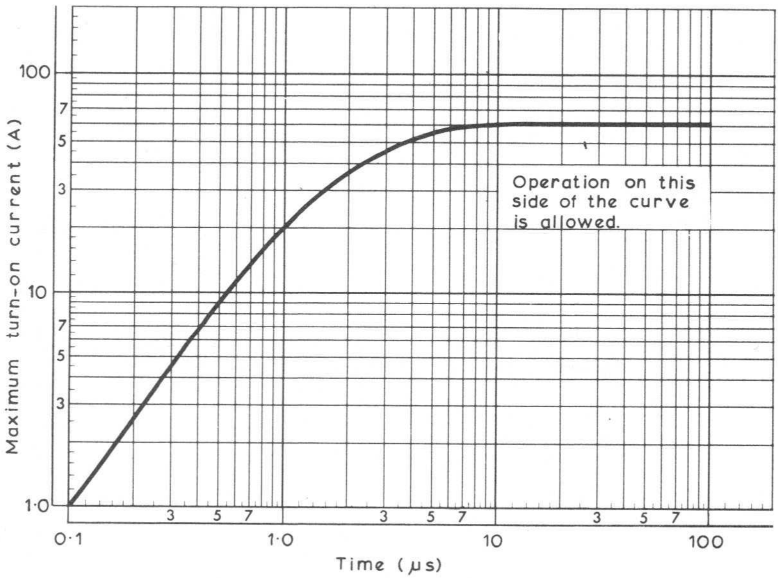


TYPICAL TURN-ON CHARACTERISTIC





STARTING CURRENTS FOR VARIOUS STUD TEMPERATURES PLOTTED AGAINST TIME, IN A SINGLE-PHASE BRIDGE



MAXIMUM TURN-ON CURRENT PLOTTED AGAINST TIME

BTY87 Series

The BTY87 is a range of p-gate reverse blocking thyristors (silicon controlled rectifiers) for use in power control circuits. Further figures and the letter R are added to the basic type number after a hyphen, to identify individual types within the range. The group of figures indicates the rated maximum repetitive peak reverse voltage for each type. The final letter R denotes stud-anode connection.

Unless otherwise shown data is applicable to all types in the series.

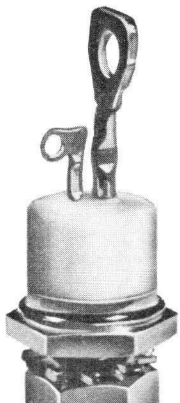
QUICK REFERENCE DATA

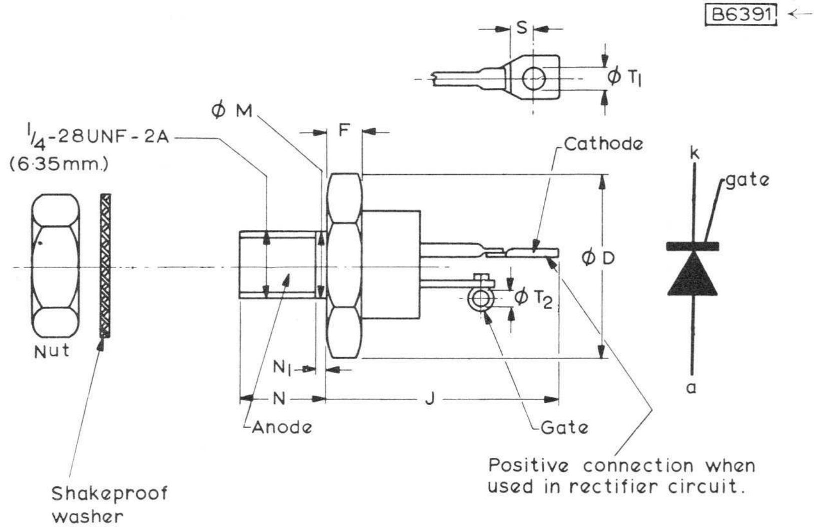
	100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{BO} min.	100	150	200	250	300	400	500	600	700	800	V
V_{RRM} max.	100	150	200	250	300	400	500	600	700	800	V
$I_{F(AV)}$ max.										12	A
θ_{j-mb} max.										2.0	degC/W
T_j max.										125	°C

OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-36

For details see page D2





Millimetre dimensions derived from inch originals

Dimensions

	Millimetres		Inches		Notes
	Min.	*Max.*	*Min.*	*Max.*	
ϕD		16.51		0.650	
F	2.9	5.5	0.113	0.220	1
J		30.48		1.200	
ϕM	4.91	6.35	0.193	0.250	2
N	10.72	11.50	0.422	0.453	
N_1		2.26		0.089	2
S	3.05		0.120		3
ϕT_1	3.18	4.44	0.125	0.175	
ϕT_2	1.53		0.060		

NOTES 1. This zone includes a 9/16″ hexagon, across flats dimension (13.82mm) 0.544″ min. (14.27mm) 0.562″ max.

2. ϕM refers to length N_1

3. Minimum flat.

BTY87 Series

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE

Voltage

		Type BTY87–										
		100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{RWM}	Max. crest working reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RRM}	Max. repetitive peak reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RSM}	Max. non-repetitive peak reverse voltage (fault conditions only, max. duration = 5ms) See note 1	150	225	300	350	400	500	600	720	850	960	V
V_{DWM}	Crest working off-state voltage See notes 1 and 2	100	150	200	250	300	400	500	600	700	800	V
V_{surge}	Max. peak forward voltage	500	500	500	500	500	500	850	850	850	850	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 11degC/W.

2. This rating applies when the rate of rise of forward voltage is less than 20V/μs.

Current

I_F	Maximum continuous forward current	15	A
$I_{F(AV)}$	Maximum mean forward current See note 3 and curve on page C2	12	A
I_{FRM}	Maximum repetitive peak forward current	115	A
I_{FSM}	Maximum surge forward current, for one cycle at 50c/s See note 4 and curve on page C4	106	A
I^2t	Surge current capability for fusing (1.5ms to 10ms) See curve on page C5	55	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	20	A

Dissipation

P_{tot} max.	Max. total power dissipation	see page C2

NOTES

3. Single-phase half-wave circuit with resistive load and 180° conduction angle.
4. The surge current rating applies when the thyristor is fully loaded before the application of the surge, i.e. with continuous application of the maximum crest reverse working voltage, the maximum crest working off-state voltage.

GATE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward gate current Anode positive w.r.t. cathode	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power, maximum averaging time = 20ms	500	mW

Thermal

T_j max.	125	°C
T_j min.	–55	°C
T_{stg} max.	125	°C
T_{stg} min.	–55	°C

Mechanical

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.26	in

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to stud	2.0 degC/W
θ_i	Contact thermal resistance for a torque of 17kg cm on the nut	0.2 degC/W
θ_i	Contact thermal resistance with mica washer	4.0 degC/W

CHARACTERISTICS ($T_j = 125°C$ unless otherwise stated)

ANODE

Symbol	Parameter	Type BTY87– 100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	Unit
V_{BO}	Minimum forward breakover voltage See note 5	100	150	200	250	300	400	500	600	700	800	V
V_F	Maximum instantaneous forward voltage drop, at $I_F = 50A$, and $T_j = 25°C$										3.0	V
I_D	Maximum forward leakage current at V_{DWM} max.	13	13	12	11	10	8.0	6.0	5.0	4.5	4.0	mA
I_R	Maximum reverse leakage current at V_{RWM} max. See note 6	13	13	12	11	10	8.0	6.0	5.0	4.5	4.0	mA

NOTES

5. This voltage may be exceeded up to the maximum peak forward voltage, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.
6. These limits do not apply when the gate is positive with respect to cathode.

GATE

Symbol	Parameter	Value	Unit
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25°C$	3.5	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25°C$	65	mA
V_{GNT}	Maximum continuous gate non-trigger voltage	300	mV

CHARACTERISTICS ($T_j = 125°C$ unless otherwise stated)

		Typical	
I_H	Holding current (anode current to maintain conduction)	10	mA
$\frac{dv}{dt}$	Rate of rise of forward voltage not to trigger the device See curve on page C10	100	V/µs
t_{on}	Turn-on time (delay time + rise time) See curves on page C7		
	Forward voltage before triggering = 50V, I_F = 1.0A	2.5	µs
	= 10A	3.0	µs
	= 50A	4.4	µs
	Forward voltage before triggering = 400V, I_F = 1.0A	1.0	µs
	= 10A	1.5	µs
	= 50A	2.0	µs
t_{off}	Turn-off time. See curve on page C9 Rate of rise of applied forward voltage = 20V/µs, Forward current before recovery = 10A, reverse current = 5.0 to 20A	15	µs

MECHANICAL DATA

Weight

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

ACCESSORIES

Accessory	*Code No.*	*Notes*
¼in. UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. SUPPRESSION OF TRANSIENT VOLTAGE SURGE DUE TO STORED ENERGY IN TRANSFORMER CORE

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:—

	R–C in primary of transformer		R–C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

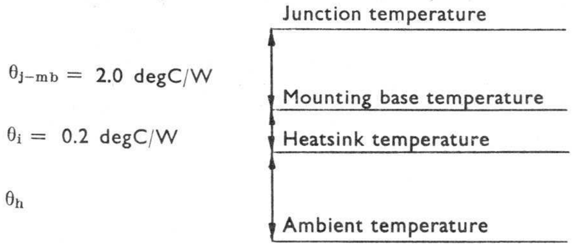
   The capacitance values calculated from the above table are minimum values, and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations:—

The various components of the rise of junction temperature above ambient are illustrated below:



The method of using the curve on page C2 is as follows:

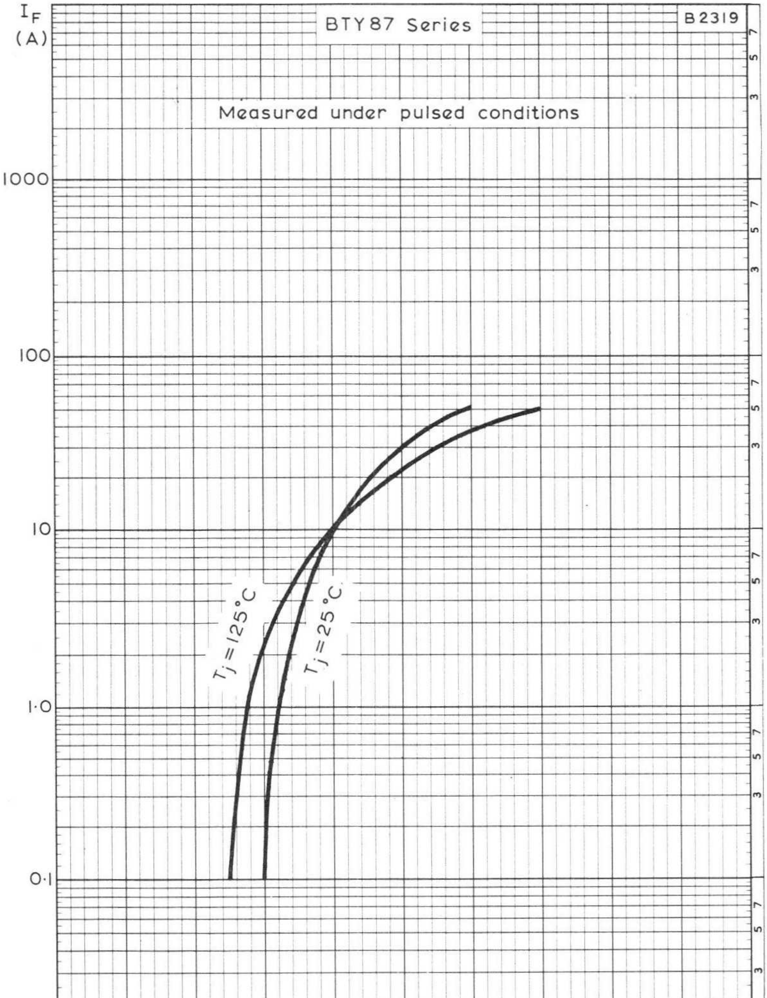
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

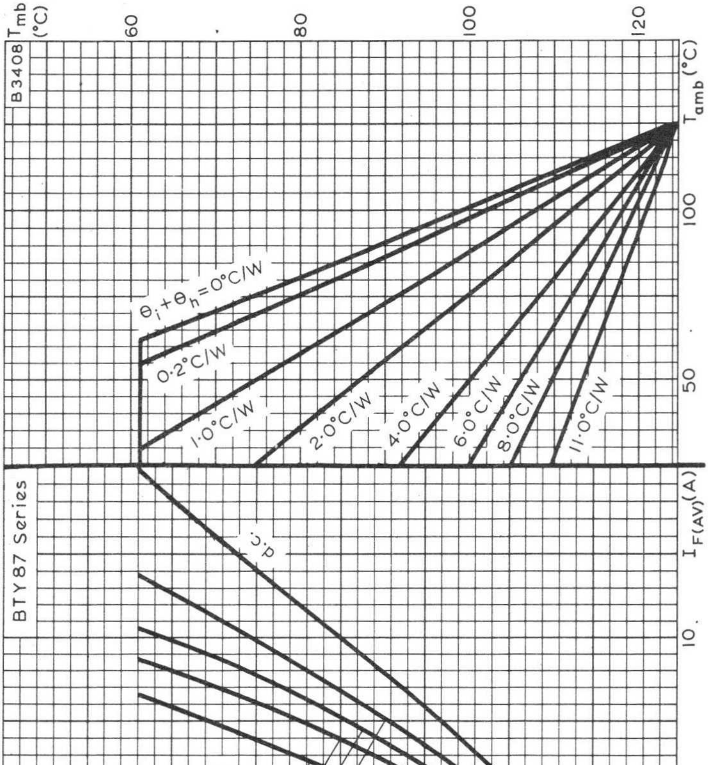
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \theta_i$$

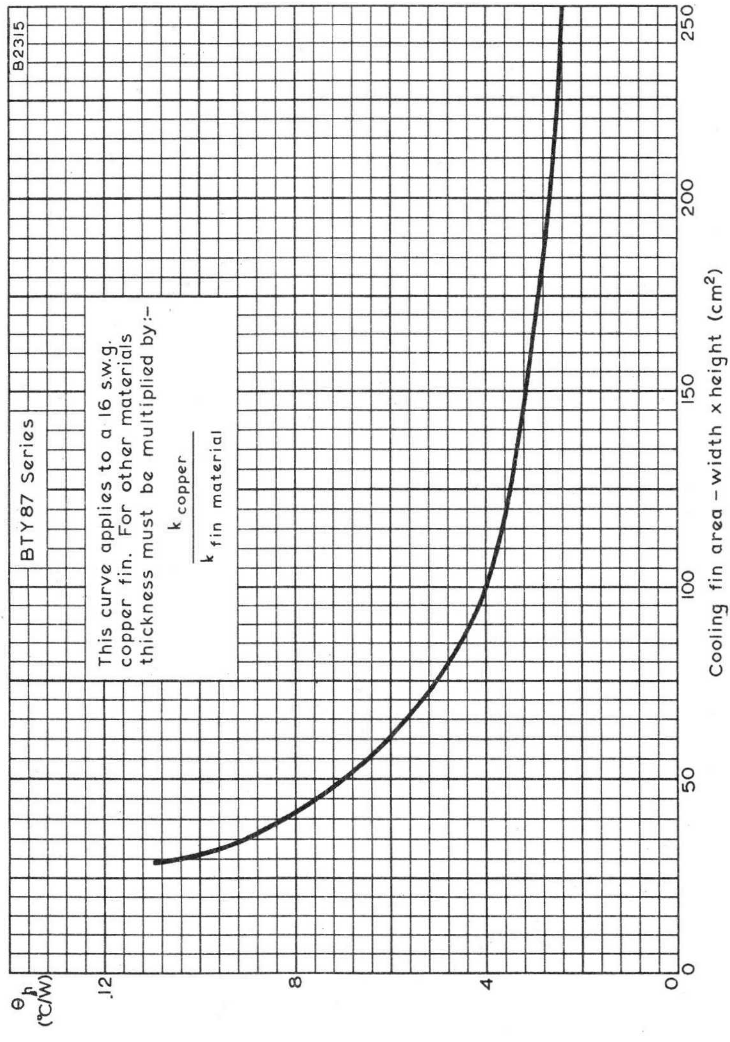
The size of the heatsink required may be found from the graph on page C3.



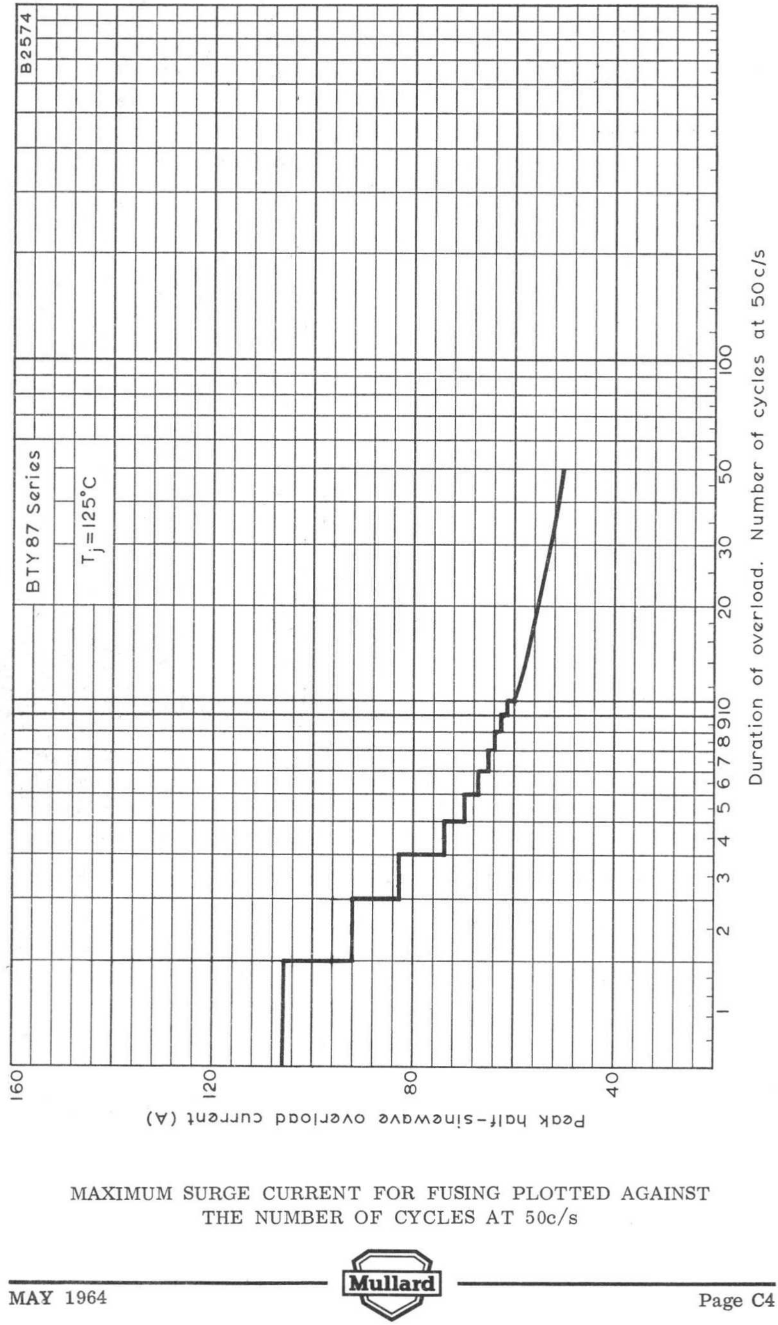
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



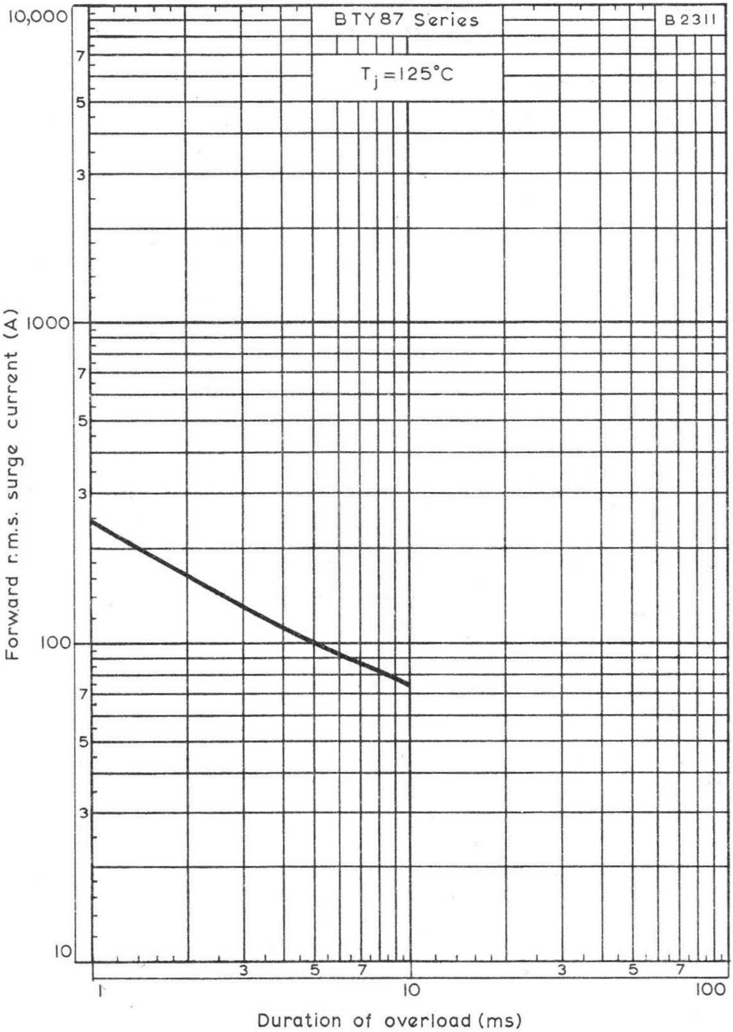
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



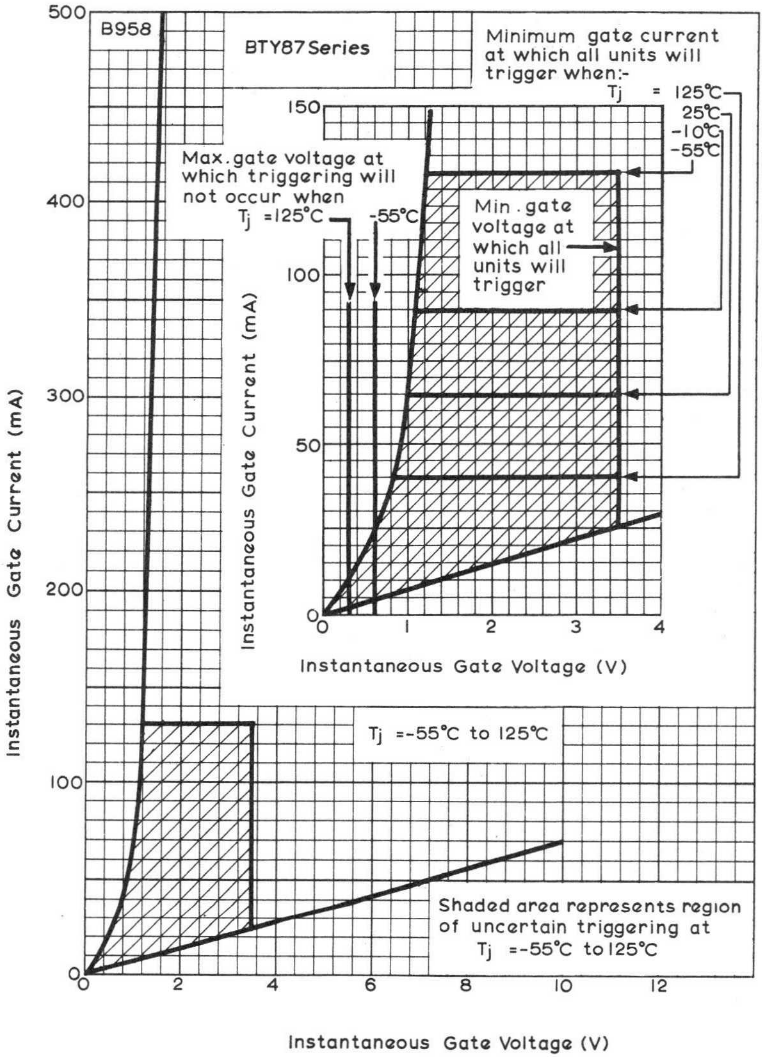
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



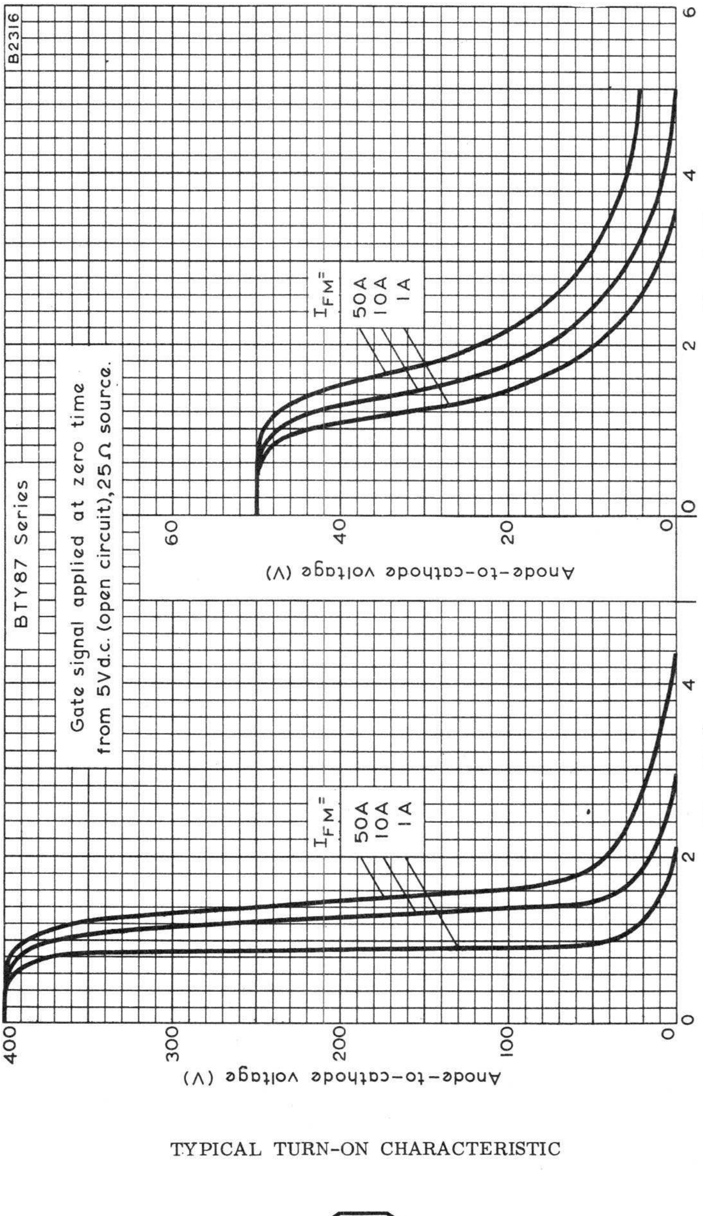
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST THE NUMBER OF CYCLES AT 50c/s



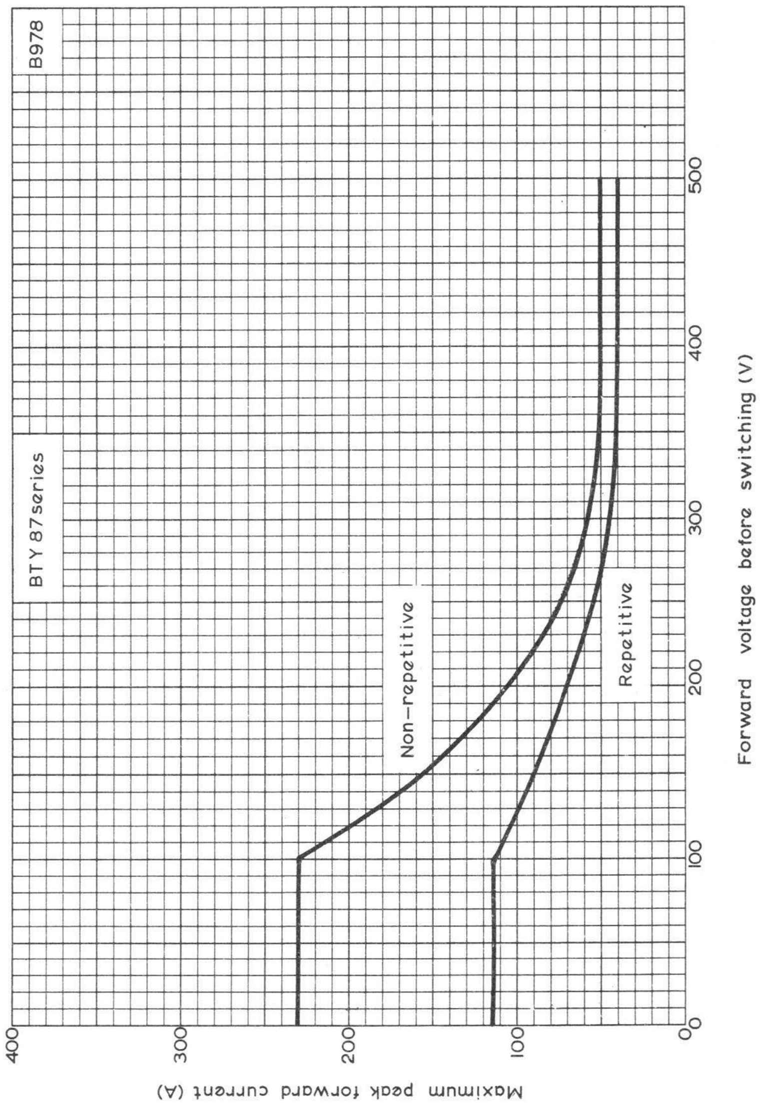
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50 c/s



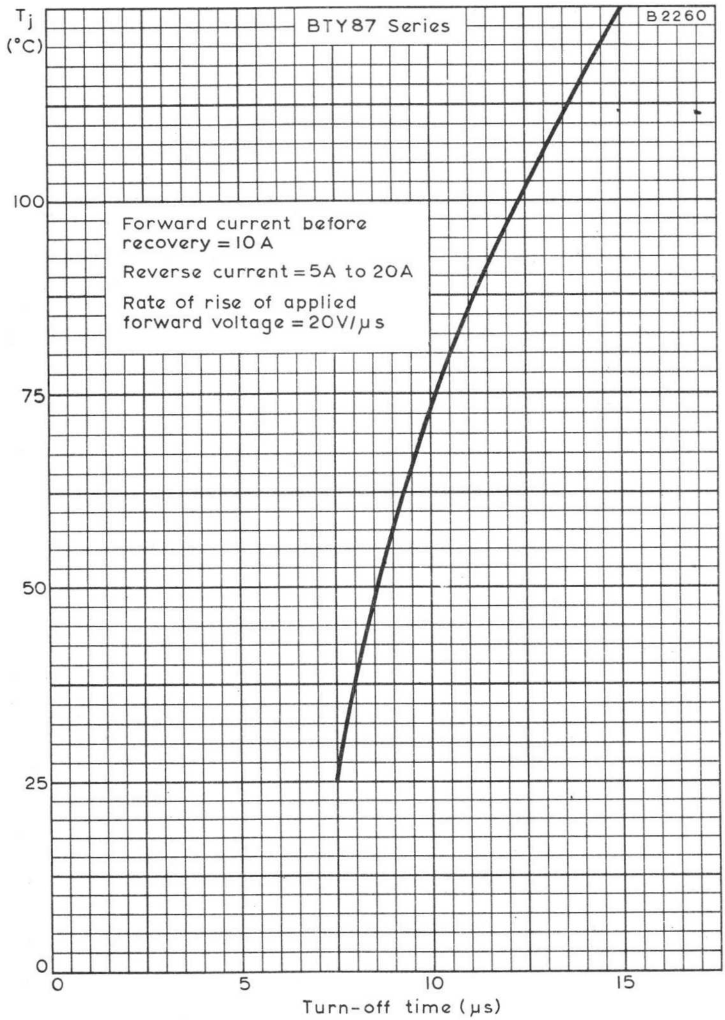
GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



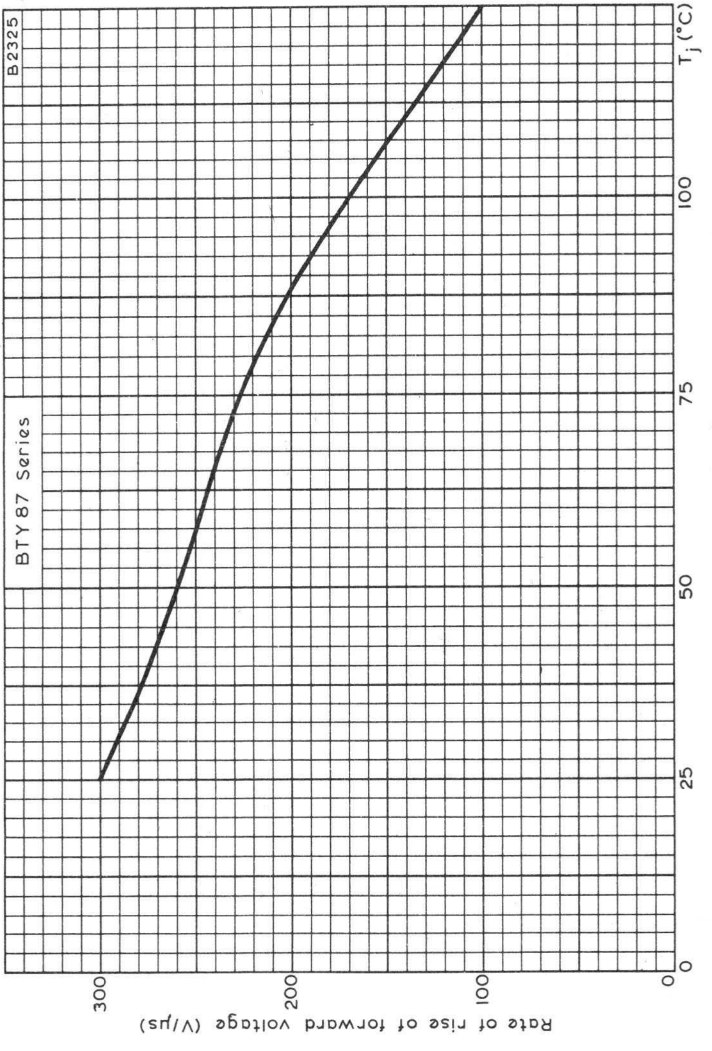
TYPICAL TURN-ON CHARACTERISTIC



PEAK FORWARD CURRENT DURING TURN-ON PLOTTED AGAINST FORWARD VOLTAGE BEFORE SWITCHING



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE



TYPICAL RATE OF RISE OF FORWARD VOLTAGE NOT TO TRIGGER THE THYRISTOR PLOTTED AGAINST JUNCTION TEMPERATURE

THYRISTOR BTY87 Series

The BTY87 is a range of p-gate reverse blocking thyristors (silicon controlled rectifiers) for use in power control circuits. Further figures and the letter R are added to the basic type number after a hyphen, to identify individual types within the range. The group of figures indicates the rated maximum repetitive peak reverse voltage for each type. The final letter R denotes stud-anode connection. The mechanical outline conforms to SO-36.

Unless otherwise shown data is applicable to all types.

QUICK REFERENCE DATA

Type BTY87-	100R	150R	200R	250R	300R	400R	
V_{BO} min.	100	150	200	250	300	400	V
V_{RRM} max.	100	150	200	250	300	400	V
$I_{F(AV)}$ max.						12	A
Θ_j-stud max.						2.0	$^oC/W$
T_j max.						125	^oC

MAJOR CHARACTERISTICS ($T_j = 125^oC$ unless otherwise stated)

ANODE

Type BTY87-		100R	150R	200R	250R	300R	400R	
Minimum forward breakover voltage. See note 1.	V_{BO}	100	150	200	250	300	400	V
Max. instantaneous forward voltage drop, at $I_F = 50A$, and $T_j = 25^oC$	V_F						3.0	V
Maximum forward leakage current at V_{BR} max.		13	13	12	11	10	8.0	mA
Maximum reverse leakage current at V_{RWM} max. See note 2.	I_R	13	13	12	11	10	8.0	mA

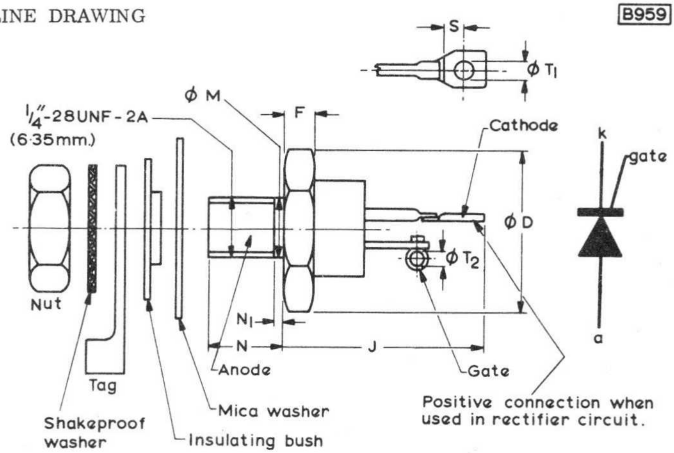
Note 1 This voltage may be exceeded up to the maximum repetitive peak forward blocking voltage, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

Note 2 These limits do not apply when the gate is positive with respect to cathode.

GATE

Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	V_{GT}	3.5	V
Minimum instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	I_{GT}	65	mA
Maximum instantaneous gate voltage which will not initiate turn-on	V_{GNT}	300	mV

OUTLINE DRAWING



Millimetre dimensions derived from inch originals

Ref.	Millimetres		Inches		Notes
	Min.	Max.	Min.	Max.	
ØD		16.51		.650	
F	2.9	5.5	.113	.220	1
J		30.48		1.200	
ØM	4.91	6.35	.193	.250	2
N	10.72	11.50	.422	.453	
N_1		2.26		.089	2
S	3.05		.120		3
ØT_1	3.18	4.44	.125	.175	
ØT_2	1.53		.060		

NOTES 1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) .544" min, (14.27mm) .562" max.

2. ØM refers to length N_1.

3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system as defined in I.E.C. publication 134 of the International Electrotechnical Commission.

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE

Voltage

	Type BTY87-	100R	150R	200R	250R	300R	400R	500R	600R	700R	
Max. crest working reverse voltage. See note 3.	V_{RWM}	100	150	200	250	300	400	500	600	700	V
Max. repetitive peak reverse voltage. See note 3.	V_{RRM}	100	150	200	250	300	400	500	600	700	V
Max. non-repetitive peak reverse voltage (fault conditions only, max. duration = 5ms). See note 3.	V_{RSM}	150	225	300	350	400	500	600	720	850	V
Max. peak working forward blocking voltage. See notes 3 and 4.	V_{BRM}	100	150	200	250	300	400	500	600	700	V
Max. peak forward voltage	V_{BSM}	500	500	500	500	500	500	850	850	850	V

Note 3 These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than $11^{\circ}C/W$.

Note 4 This rating applies when the rate of rise of forward voltage is less than $20V/\mu s$

Current

Maximum continuous forward current	I_F	15	A
Maximum mean forward current. See note 5 and curve on page C2	$I_{F(AV)}$	12	A
Maximum repetitive peak forward current	I_{FRM}	115	A
Maximum surge forward current, for one cycle at 50c/s. See note 6 and curve on page C4.	I_{FSM}	106	A
I^2t for fusing (1.5ms to 10ms). See curve on page C5.	I^2t	55	A^2s
Maximum repetitive peak reverse current during turn-off interval	I_{RRM}	20	A

Note 5. Single-phase half-wave circuit with resistive load and 180° conduction angle.

Note 6. The surge current rating applies when the thyristor is fully loaded before the application of the surge, i.e. with continuous application of the maximum crest reverse working voltage, the maximum peak forward blocking voltage.

GATE

Voltage

→ Maximum peak forward gate voltage (anode positive w.r.t. cathode)	V_{GFM}	10	V
→ Maximum peak reverse gate voltage	V_{GRM}	5.0	V

Current

→ Maximum peak forward gate current (anode positive w.r.t. cathode)	I_{GFM}	2.0	A

Dissipation

Maximum peak gate power	P_{GM}	5.0	W
Maximum average gate power, maximum averaging time = 20ms	$P_{G(AV)}$	500	mW

Thermal

T_j max.	125	^oC
T_j min.	-55	^oC
T_{stg} max.	125	^oC
T_{stg} min.	-55	^oC

Mechanical

Maximum torque on hexagon or nut	35	kg. cm
	2.5	lb. ft
Minimum torque on hexagon or nut for good thermal contact	17	kg. cm
	1.25	lb. ft
Recommended diameter of hole in heatsink	6.5	mm
	0.26	in

THERMAL CHARACTERISTICS

Maximum thermal resistance from junction to stud	$\theta_{j\text{-stud}}$	2.0	$^oC/W$
Contact thermal resistance for a torque of 17kg. cm on the nut	θ_i	0.2	$^oC/W$
Contact thermal resistance with mica washer		4.0	$^oC/W$

MAJOR CHARACTERISTICS (T_j = 125°C unless otherwise stated)

ANODE

Type BTY87-		100R	150R	200R	250R	300R	400R	
Minimum forward breakover voltage. See note 1.	V_{BO}	100	150	200	250	300	400	V
Max. instantaneous forward voltage drop, at I_F = 50A, and T_j = 25°C	V_F						3.0	V
Maximum forward leakage current at V_{BR} max.		13	13	12	11	10	8.0	mA
Maximum reverse leakage current at V_{RWM} max. See note 2.	I_R	13	13	12	11	10	8.0	mA

Note 1 This voltage may be exceeded up to the maximum repetitive peak forward blocking voltage, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

Note 2 These limits do not apply when the gate is positive with respect to cathode.

GATE

Min. instantaneous trigger voltage to initiate turn-on at T_j = 25°C	V_{GT}	3.5	V
Min. instantaneous trigger current to initiate turn-on at T_j = 25°C	I_{GT}	65	mA
Max. instantaneous gate voltage which will not initiate turn-on	V_{GNT}	300	mV

TYPICAL CHARACTERISTICS (T_j = 125°C unless otherwise stated)

Holding current (anode current to maintain conduction)	I_H	10	mA
Turn-on time. (Delay time + rise time). See curves on page C7.	t_{on}		
Forward voltage before triggering = 50V, I_F = 1A		2.5	μs
10A		3.0	μs
50A		4.4	μs
Forward voltage before triggering = 400V, I_F = 1A		1.0	μs
10A		1.5	μs
50A		2.0	μs
Turn-off time. See curve on page C9.	t_{off}		
Rate of rise of applied forward voltage = 20V/μs. Forward current before recovery = 10A, reverse current = 5A to 20A		15	μs
Rate of rise of forward voltage not to trigger the device. See curve on page C10.		100	V/μs

MECHANICAL DATA

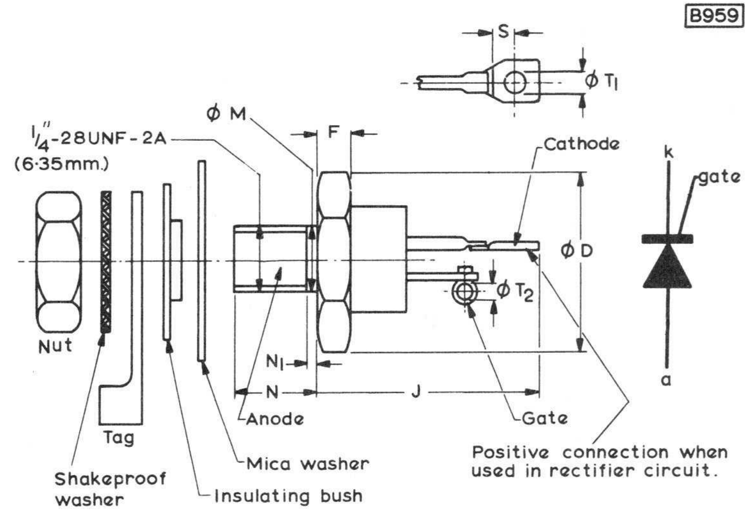
WEIGHT

Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

ACCESSORIES

Accessory	Notes
1/4 in UNF nut Shakeproof washer Tag	Supplied with thyristor
Insulating bush Mica washer	Supplied on request

OUTLINE DRAWING



Millimetre dimensions derived from inch originals

Dimensions

Ref.	Millimetres Min.	Millimetres Max.	Inches Min.	Inches Max.	Notes
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S	3.05		.120		3
ØT_1	3.18	4.44	.125	.175	
ØT_2	1.53		.060		

NOTES
1. This zone includes a 9/16" hexagon, across flats dimension (13.82mm) .544" min., (14.27mm) .562" max.
2. ØM refers to length N_1
3. Minimum flat.

OPERATING NOTES

1. SUPPRESSION OF TRANSIENT VOLTAGE SURGE DUE TO STORED ENERGY IN TRANSFORMER CORE

A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows:-

	R-C in primary of transformer		R-C in secondary of transformer		
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R x C (μs)	C (μF)	R x C (μs)	
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200	←
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275	←
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350	←

Where I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

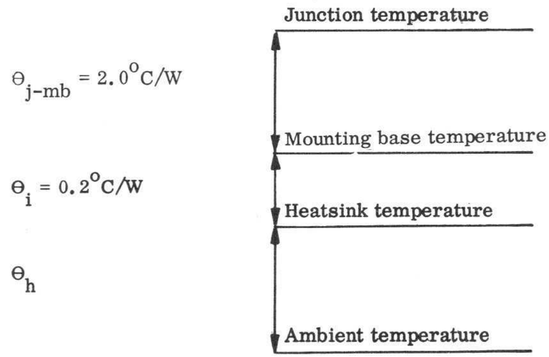
The capacitance values calculated from the above table are minimum values, and should be increased to take account of circuit variations such as component tolerances. ←

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations

The various components of the rise of junction temperature above ambient are illustrated below:



The method of using the curve on page C2 is as follows:

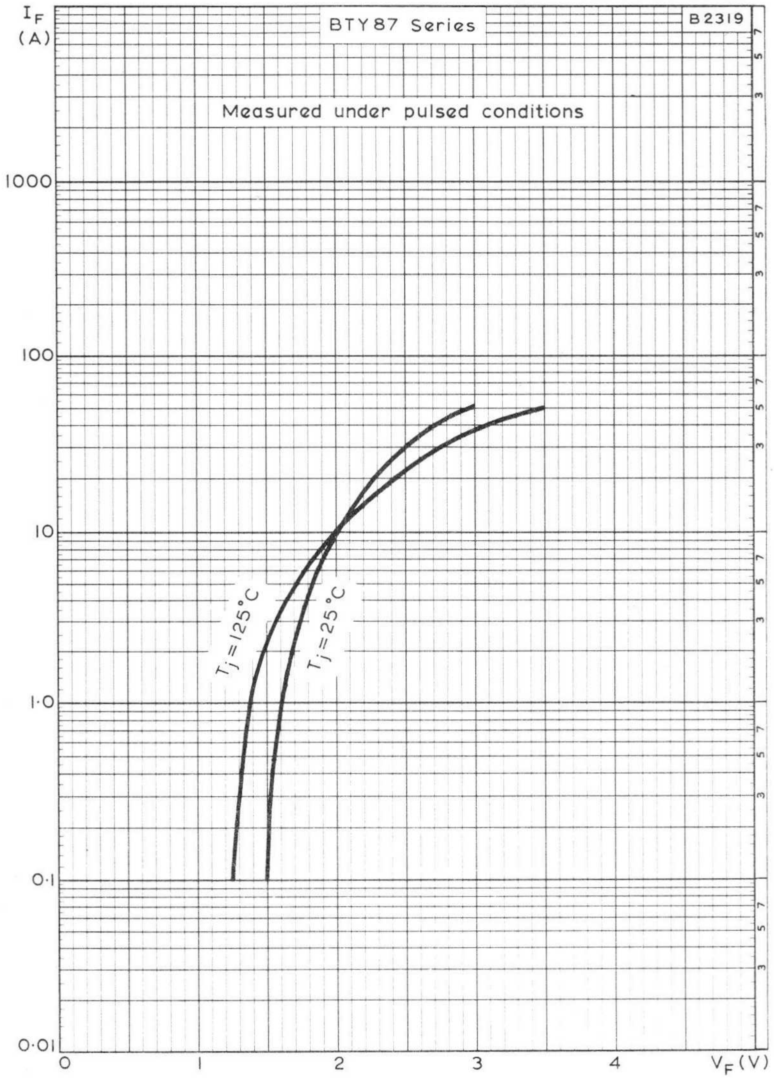
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D5. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

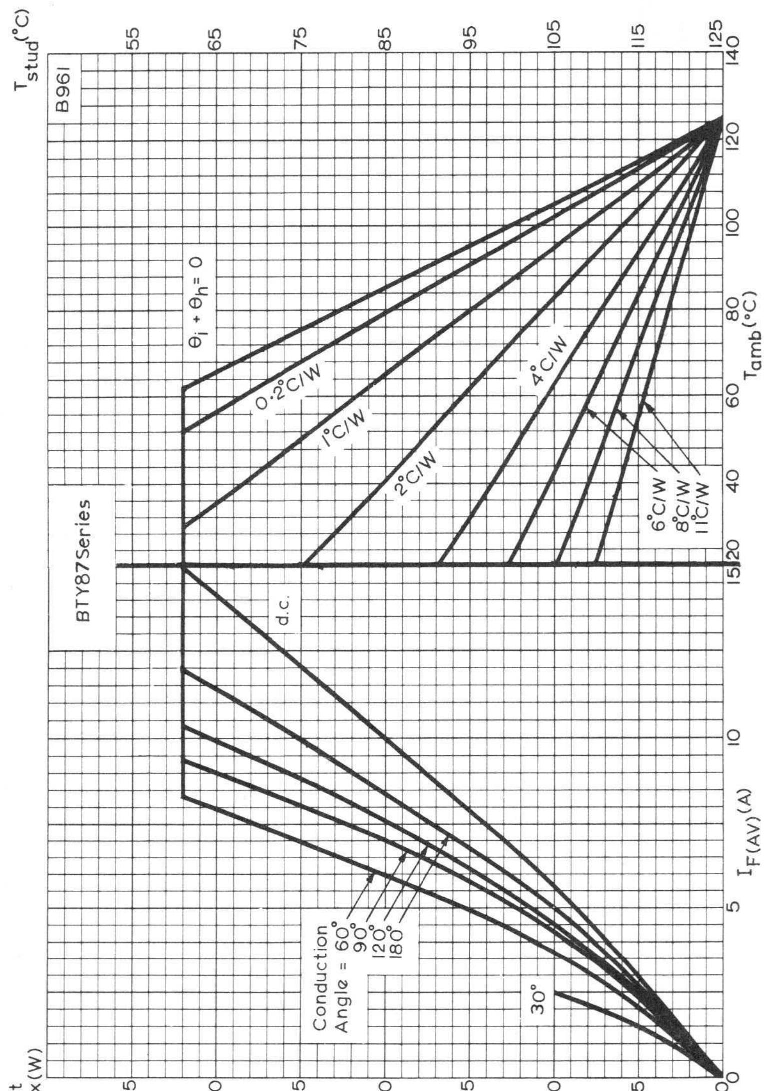
Alternatively, for a given mean forward current and conduction angle the stud temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of Θ_h is given by:

$$\Theta_h = \frac{T_{stud} - T_{amb}}{P_{tot}\ max.} - \Theta_i$$

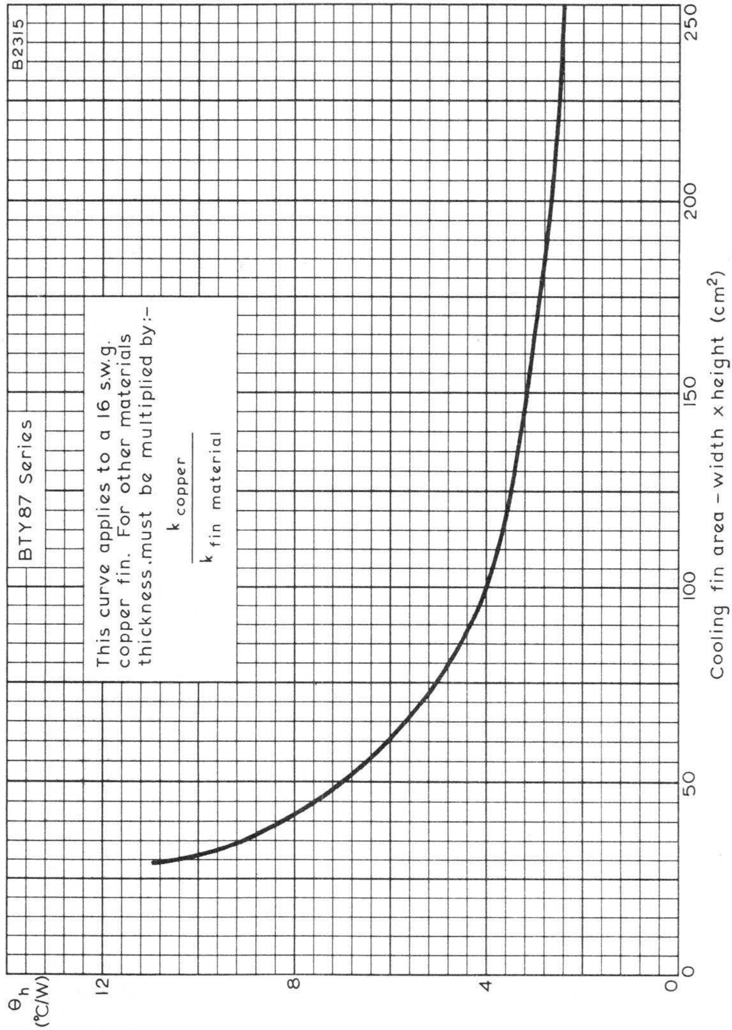
The size of the heatsink required may be found from the graph on page C3.



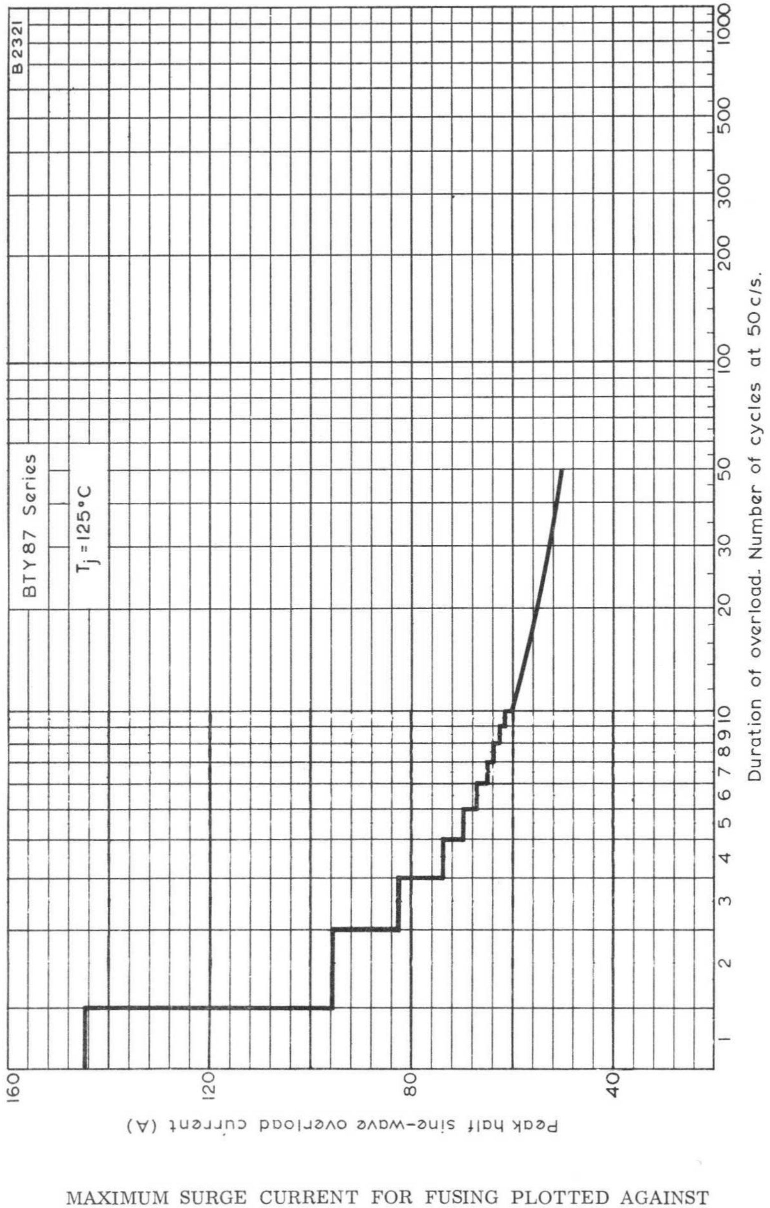
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



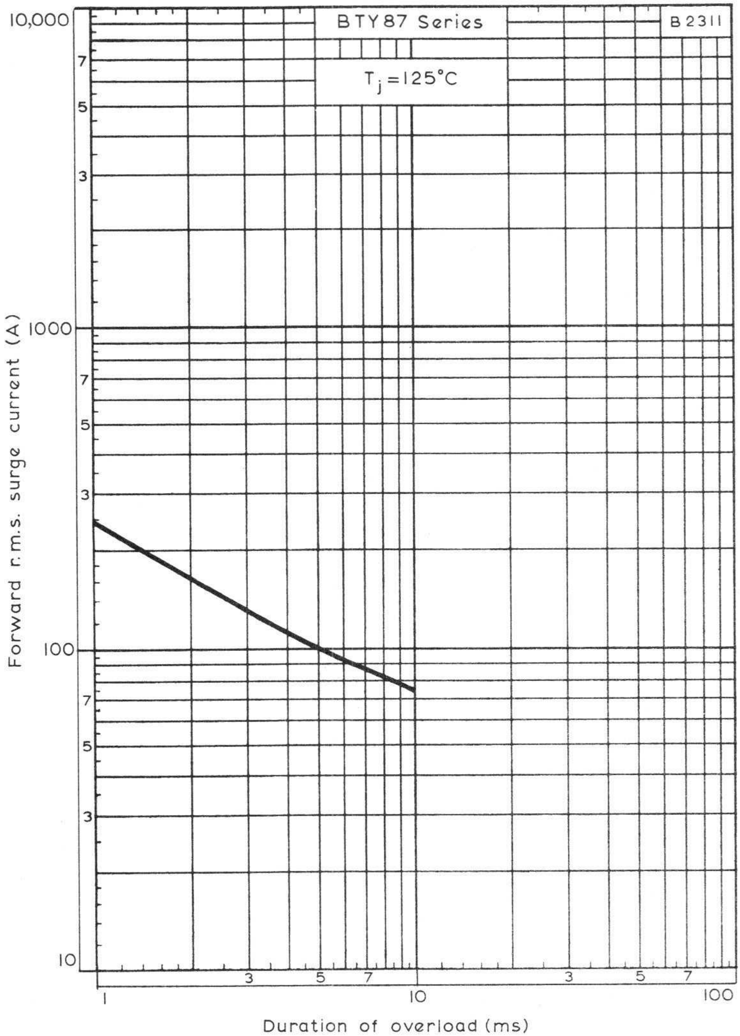
MAXIMUM ALLOWABLE STUD AND AMBIENT TEMPERATURES
FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND $\Theta_i + \Theta_h$



THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA

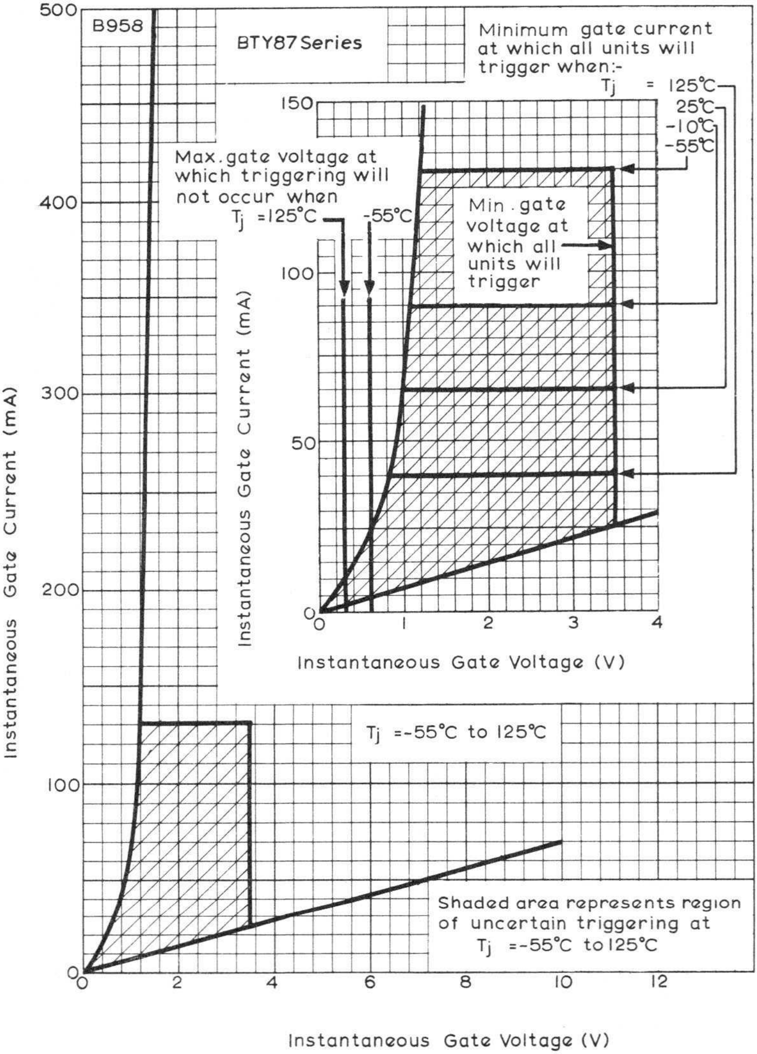


MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST THE NUMBER OF CYCLES AT 50c/s

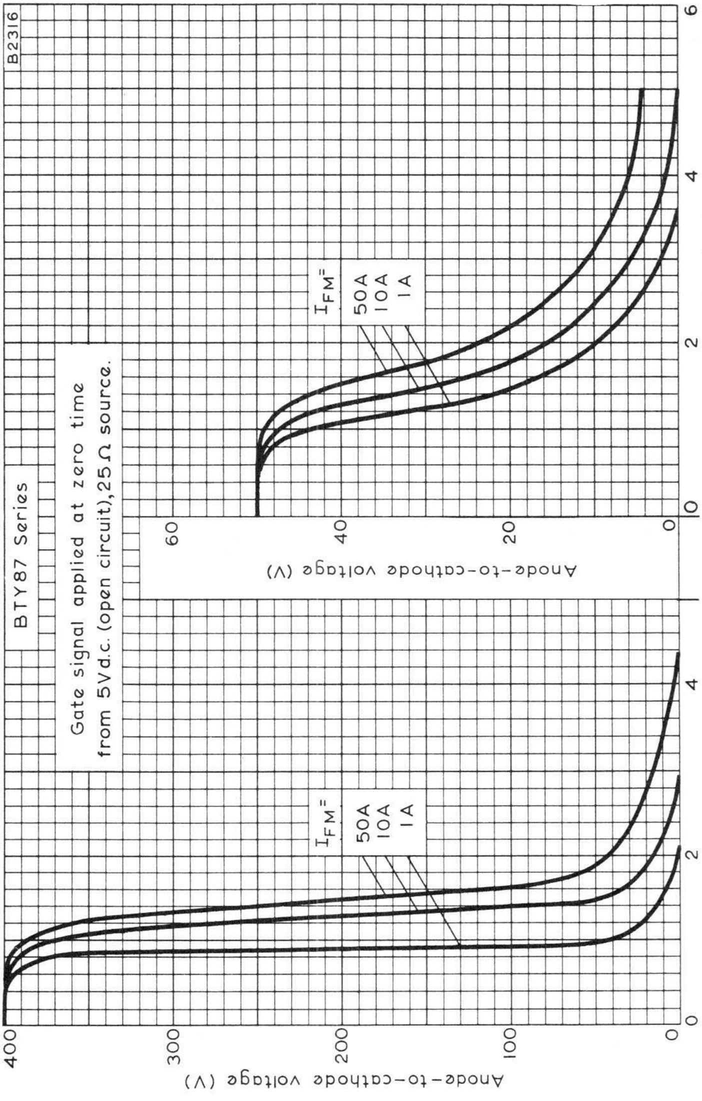


MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION

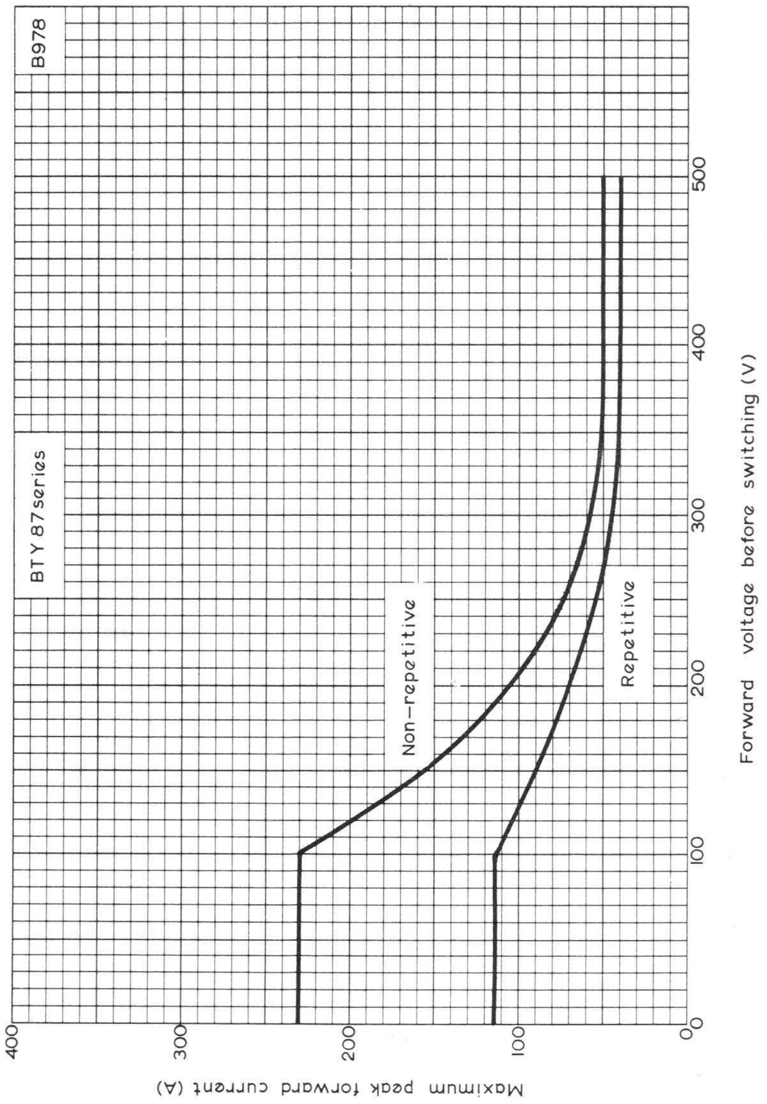
AT 50c/s



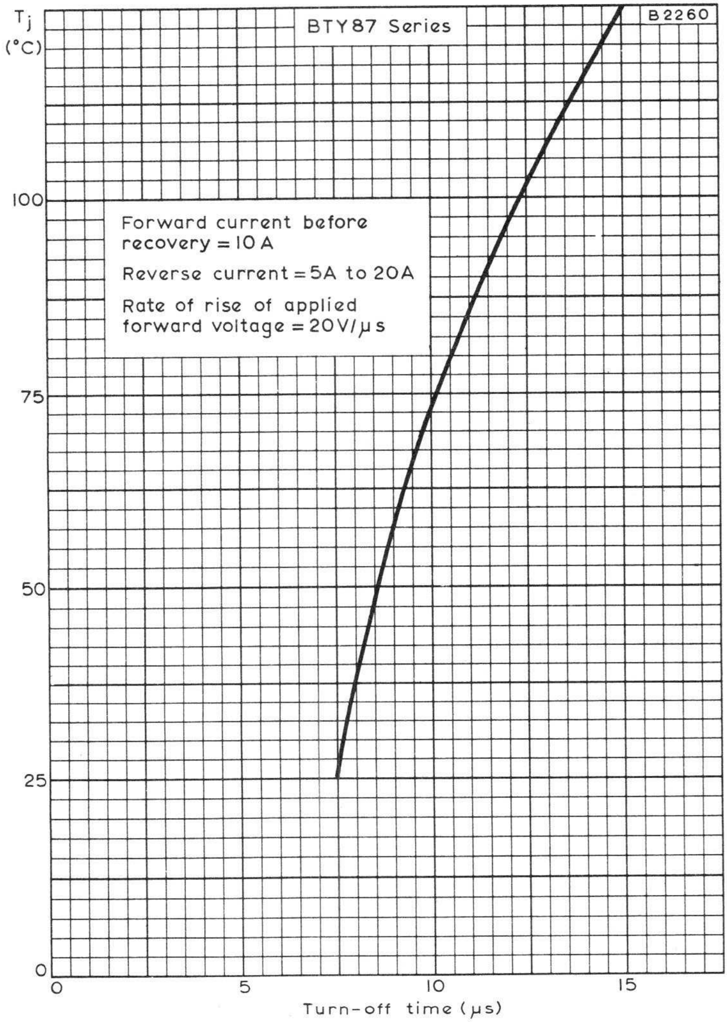
GATE CHARACTERISTIC



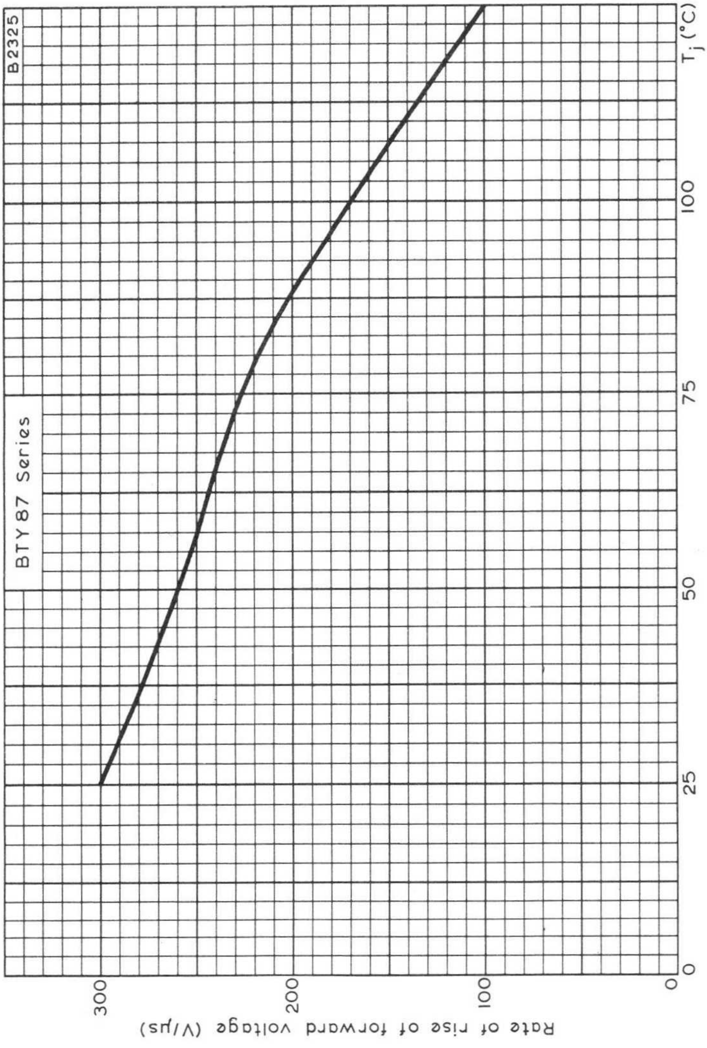
TYPICAL TURN-ON CHARACTERISTIC



PEAK FORWARD CURRENT DURING TURN-ON PLOTTED AGAINST FORWARD VOLTAGE BEFORE SWITCHING



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE



TYPICAL RATE OF RISE OF FORWARD VOLTAGE NOT TO TRIGGER
THE THYRISTOR PLOTTED AGAINST JUNCTION TEMPERATURE

BTY91 Series

The BTY91 is a range of p-gate reverse blocking thyristors (silicon controlled rectifiers) for use in power control circuits. Further figures and the letter R are added to the basic type number after a hyphen, to identify individual types within the range. The group of figures indicates the rated maximum repetitive peak reverse voltage for each type. The final letter R denotes stud-anode connection.

Unless otherwise shown data is applicable to all types in the series.

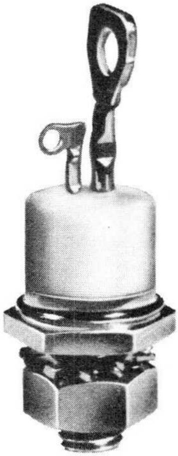
QUICK REFERENCE DATA

	100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{BO} min.	100	150	200	250	300	400	500	600	700	800	V
V_{RRM} max.	100	150	200	250	300	400	500	600	700	800	V
$I_{F(AV)}$ max.										16	A
θ_{j-mb} max.										2.0	degC/W
T_j max.										125	°C

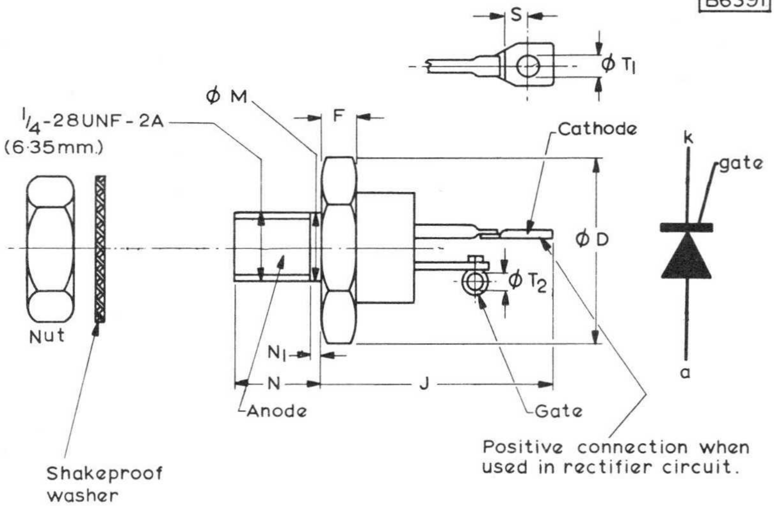
OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-36

For details see page D2



B6391 ←



Millimetre dimensions derived from inch originals

Dimensions

	Millimetres		Inches		Notes
	Min.	*Max.*	*Min.*	*Max.*	
ϕD		16.51		0.650	
F	2.9	5.5	0.113	0.220	1
J		30.48		1.200	
ϕM	4.91	6.35	0.193	0.250	2
N	10.72	11.50	0.422	0.453	
N_1		2.26		0.089	2
S	3.05		0.120		3
ϕT_1	3.18	4.44	0.125	0.175	
ϕT_2	1.53		0.060		

NOTES 1. This zone includes a 9/16″ hexagon, across flats dimension (13.82mm) 0.544″ min. (14.27mm) 0.562″ max.

2. ϕM refers to length N_1

3. Minimum flat.

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE

Voltage

		Type BTY91–										
		100R	**150R**	**200R**	**250R**	**300R**	**400R**	**500R**	**600R**	**700R**	**800R**	
V_{RWM}	Max. crest working reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RRM}	Max. repetitive peak reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RSM}	Max. non-repetitive peak reverse voltage (fault conditions only, max. duration = 5ms) See note 1	150	225	300	350	400	500	600	720	850	960	V
V_{DWM}	Crest working off-state voltage See notes 1 and 2	100	150	200	250	300	400	500	600	700	800	V
V_{surge}	Max. peak forward voltage	500	500	500	500	500	500	850	850	850	850	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 11degC/W.

2. This rating applies when the rate of rise of forward voltage is less than 20V/μs.

Current

I_F	Maximum continuous forward current	19	A
$I_{F(AV)}$	Maximum mean forward current See note 3 and curve on page C2	16	A
I_{FRM}	Maximum repetitive peak forward current	140	A
I_{FSM}	Maximum surge forward current, for one cycle at 50c/s See note 4 and curve on page C4	136	A
I^2t	Surge current capability for fusing (1.5ms to 10ms) See curve on page C5	75	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	20	A

Dissipation

P_{tot} max. Max. total power dissipation — see page C2

NOTES

3. Single-phase half-wave circuit with resistive load and **180°** conduction angle.
4. The surge current rating applies when the thyristor is fully loaded before the application of the surge, i.e. with continuous application of the maximum crest reverse working voltage, the maximum crest working off-state voltage.

GATE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward gate current Anode positive w.r.t. cathode	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power, maximum averaging time = 20ms	500	mW

Thermal

T_j max.	125	°C
T_j min.	–55	°C
T_{stg} max.	125	°C
T_{stg} min.	–55	°C

Mechanical

Maximum torque on hexagon or nut	35	kg cm
	2.5	lb ft
Minimum torque on hexagon or nut for good thermal contact	17	kg cm
	1.25	lb ft
Recommended diameter of hole in heatsink	6.5	mm
	0.26	in

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to stud	2.0 degC/W
θ_i	Contact thermal resistance for a torque of 17kg cm on the nut	0.2 degC/W
θ_i	Contact thermal resistance with mica washer	4.0 degC/W

CHARACTERISTICS ($T_j = 125°C$ unless otherwise stated)

ANODE

		Type BTY91–										
		100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{BO}	Minimum forward breakover voltage See note 5	100	150	200	250	300	400	500	600	700	800	V
V_F	Maximum instantaneous forward voltage drop, at $I_F = 50A$, and $T_j = 25°C$										2.0	V
I_D	Maximum forward leakage current at V_{DWM} max.	13	13	12	11	10	8.0	6.0	5.0	4.5	4.0	mA
I_R	Maximum reverse leakage current at V_{RWM} max. See note 6	13	13	12	11	10	8.0	6.0	5.0	4.5	4.0	mA

NOTES

5. This voltage may be exceeded up to the maximum peak forward voltage, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.
6. These limits do not apply when the gate is positive with respect to cathode.

GATE

V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25°C$	3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25°C$	40	mA
V_{GNT}	Maximum continuous gate non-trigger voltage	250	mV

CHARACTERISTICS (T_j = 125°C unless otherwise stated)

		Typical	
I_H	Holding current (anode current to maintain conduction)	10	mA
$\frac{dv}{dt}$	Rate of rise of forward voltage not to trigger the device See curve on page C10	100	V/μs
t_{on}	Turn-on time (delay time + rise time) See curves on page C7		
	Forward voltage before triggering = 50V, I_F = 1.0A	2.5	μs
	= 10A	3.0	μs
	= 50A	4.4	μs
	Forward voltage before triggering = 400V, I_F = 1.0A	1.0	μs
	= 10A	1.5	μs
	= 50A	2.0	μs
t_{off}	Turn-off time. See curve on page C9 Rate of rise of applied forward voltage = 20V/μs, Forward current before recovery = 10A, reverse current = 5.0 to 20A	20	μs

MECHANICAL DATA

Weight		
Without accessories	10	g
	0.35	oz
With accessories	15	g
	0.53	oz

ACCESSORIES

Accessory	*Code No.*	*Notes*
¼in. UNF nut Shakeproof washer		Supplied with thyristor
Insulating bush mica washer Tag	56264A	Supplied on request

OPERATING NOTES

1. SUPPRESSION OF TRANSIENT VOLTAGE SURGE DUE TO STORED ENERGY IN TRANSFORMER CORE

   A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:—

	R–C in primary of transformer		R–C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

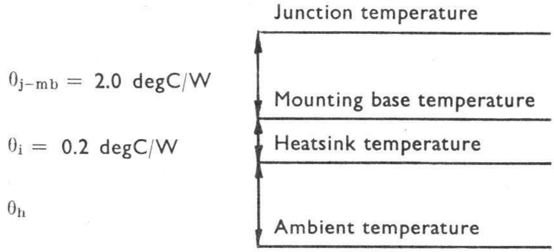
The capacitance values calculated from the above table are minimum values, and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations:—

The various components of the rise of junction temperature above ambient are illustrated below:



The method of using the curve on page C2 is as follows:

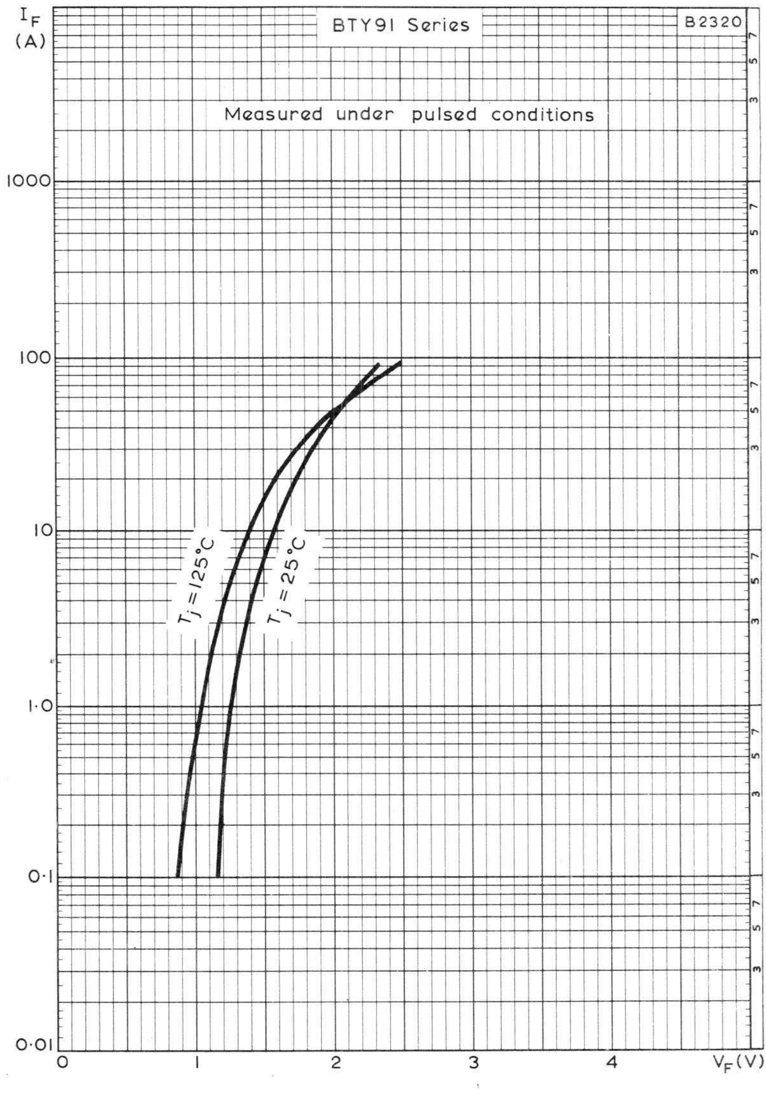
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

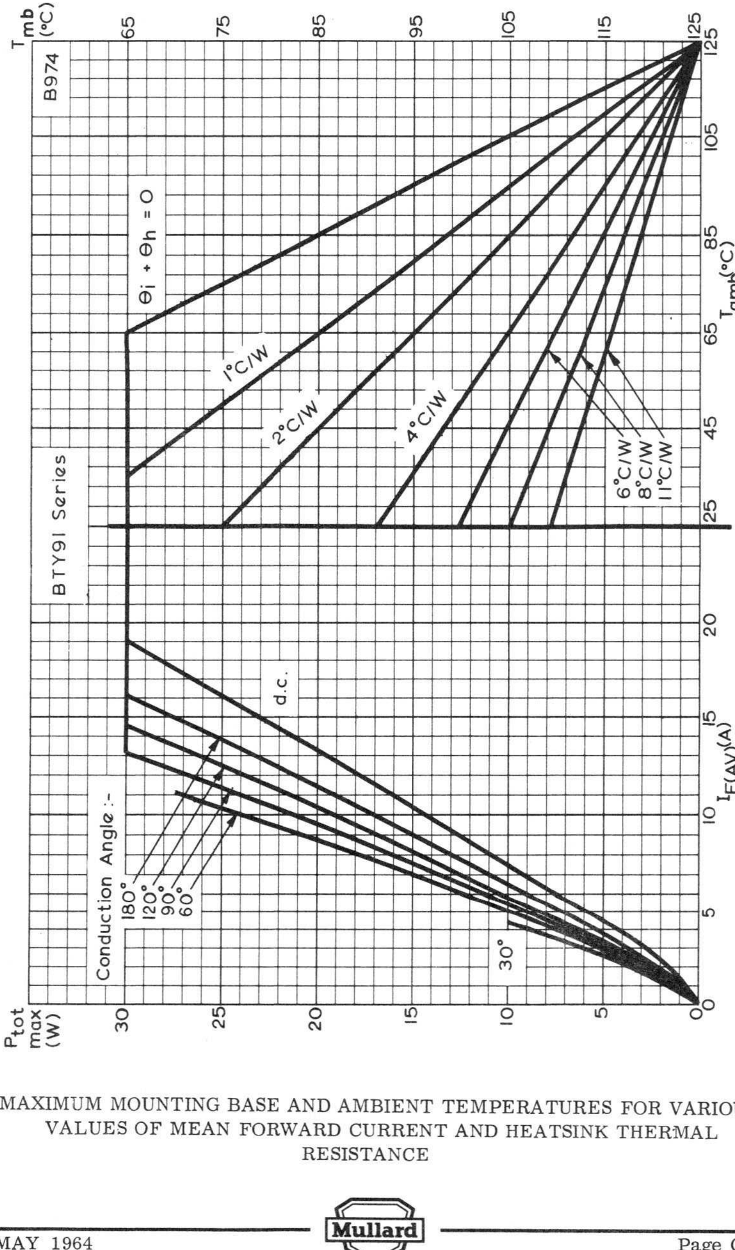
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \theta_i$$

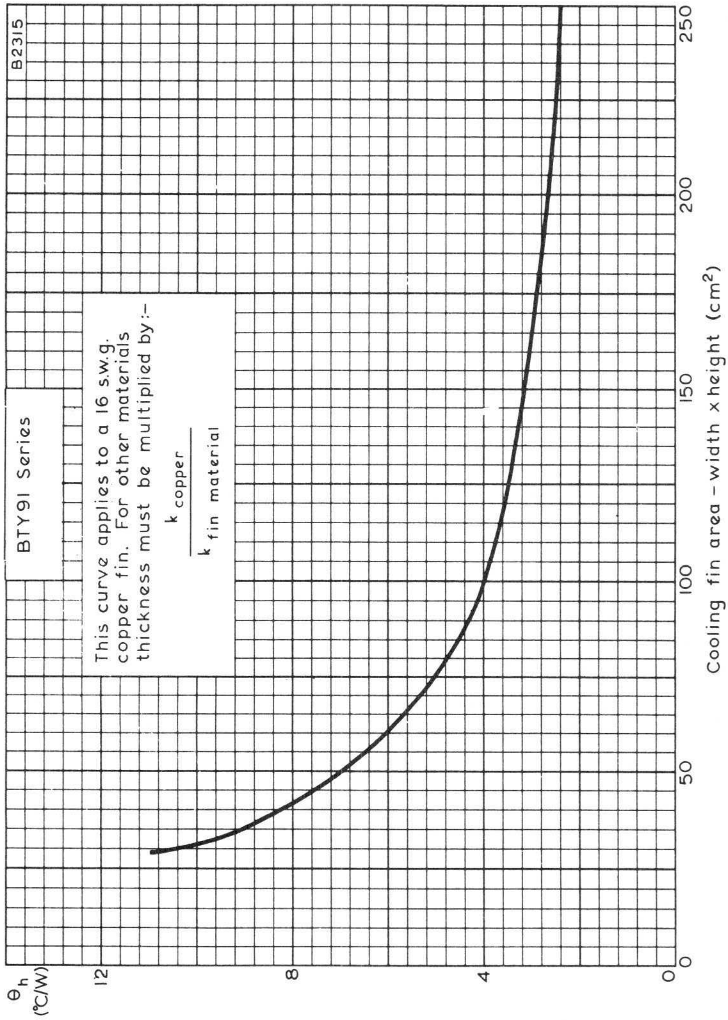
The size of the heatsink required may be found from the graph on page C3.



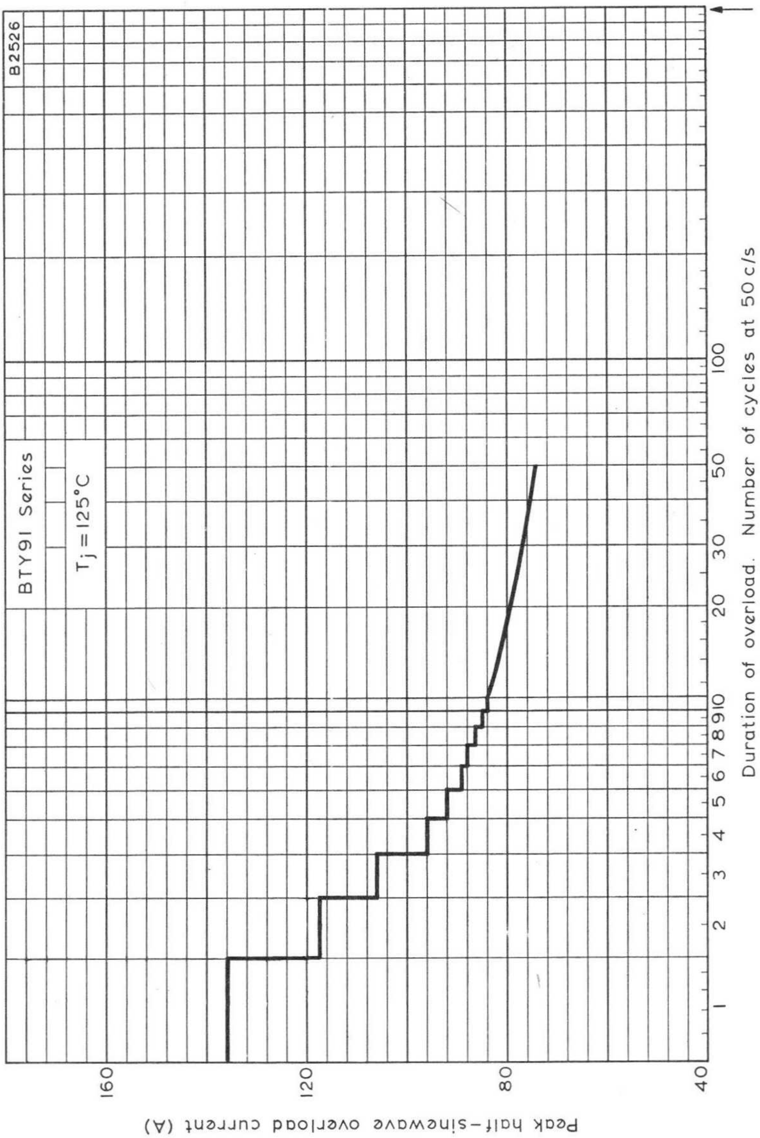
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



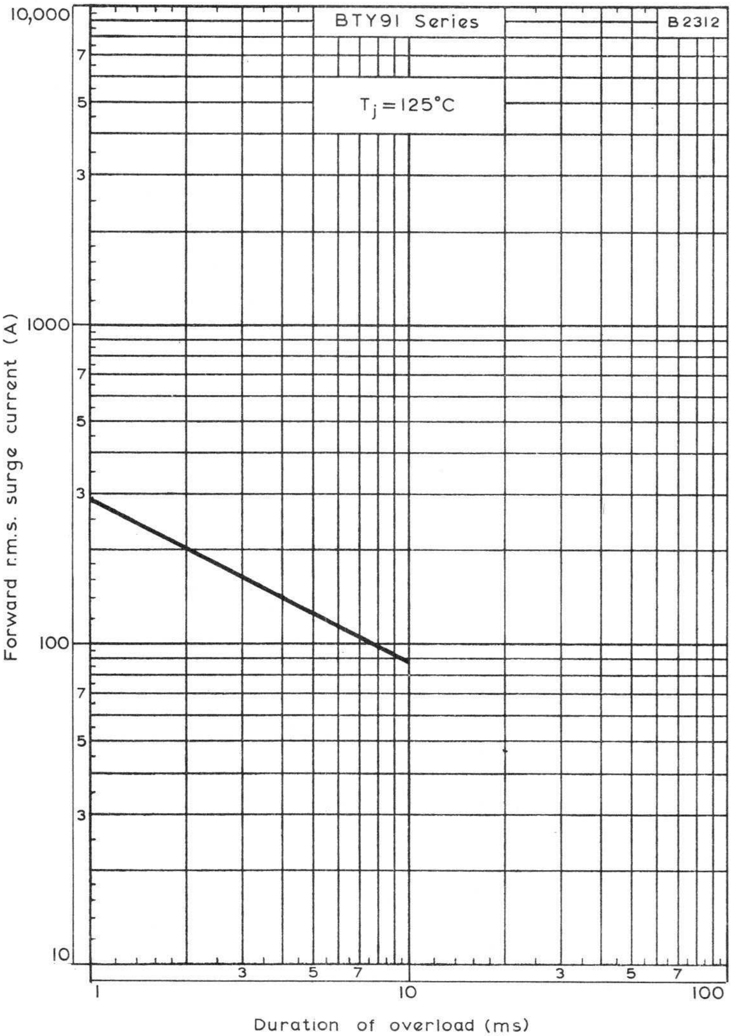
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



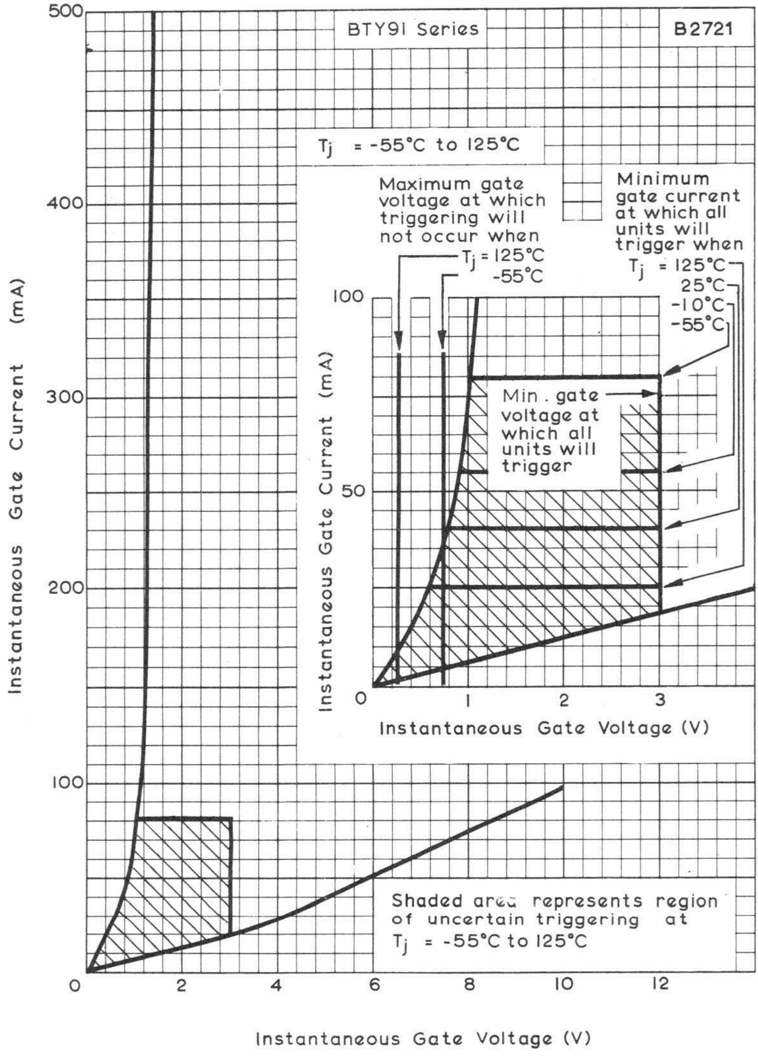
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



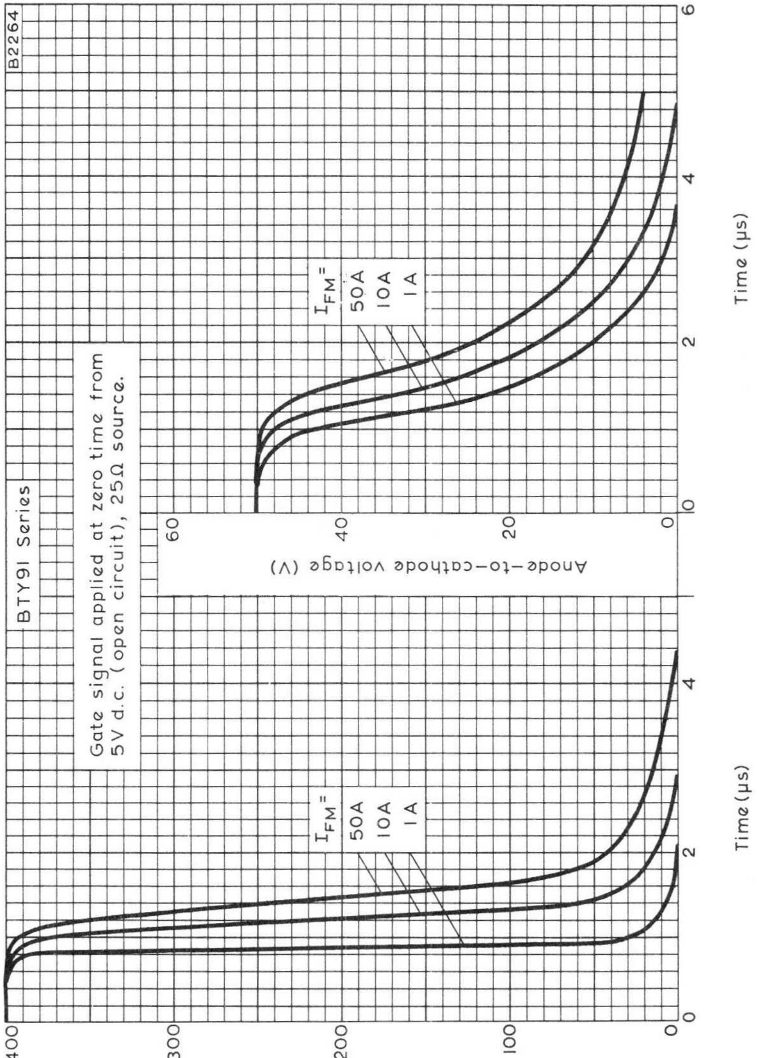
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST THE NUMBER OF CYCLES AT 50c/s



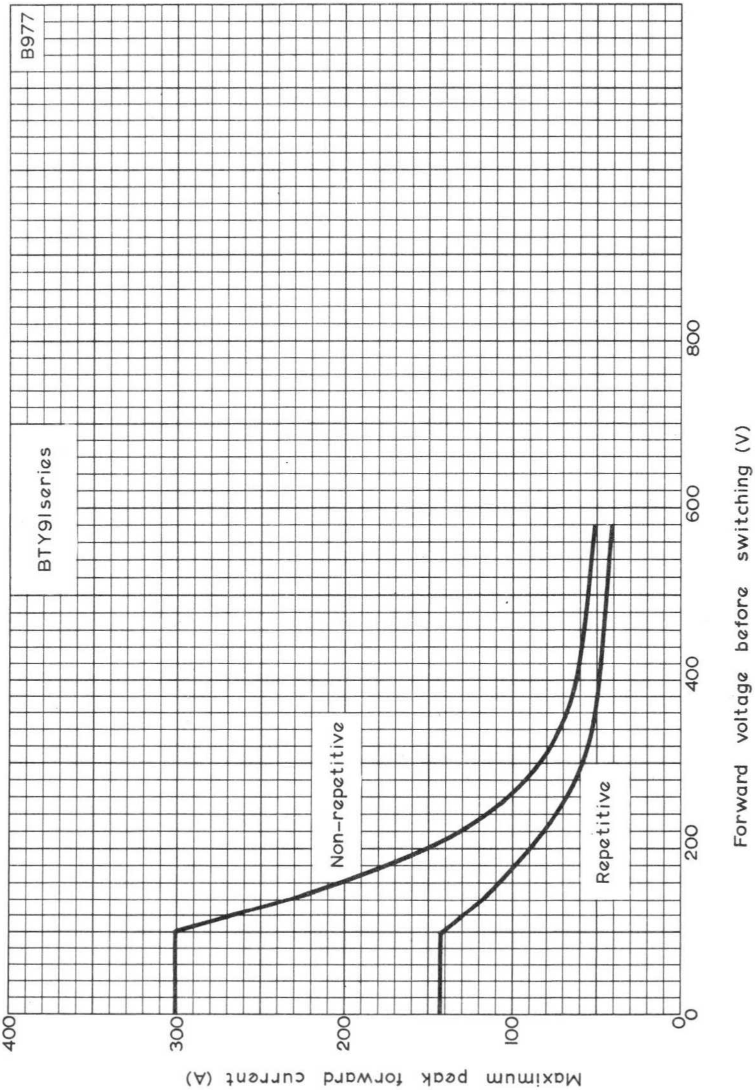
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50 c/s



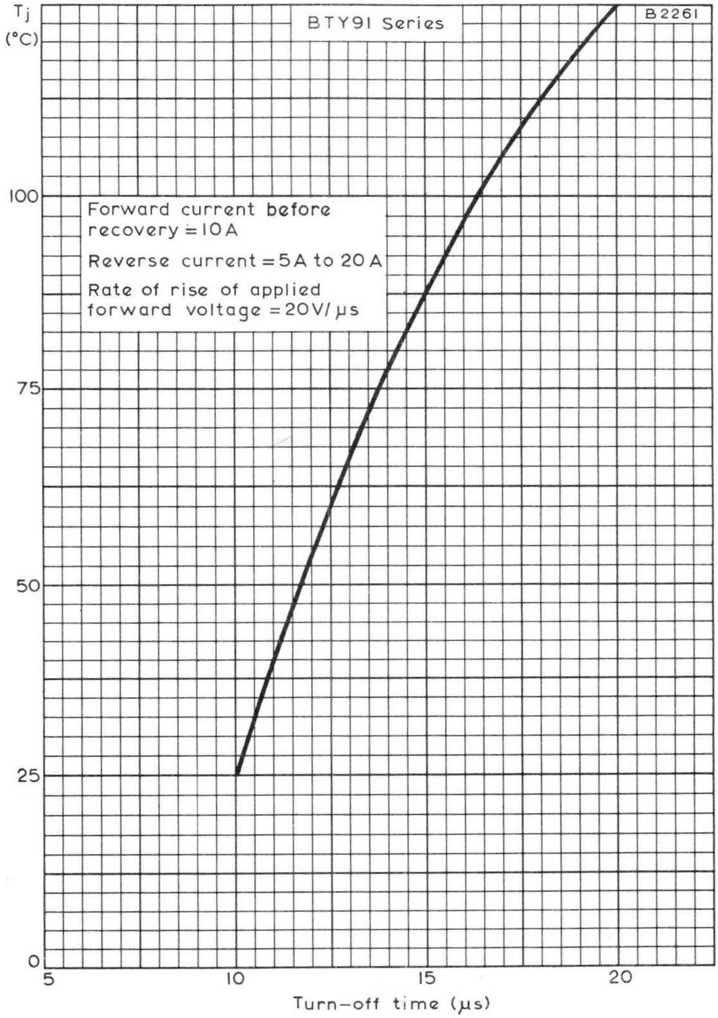
GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



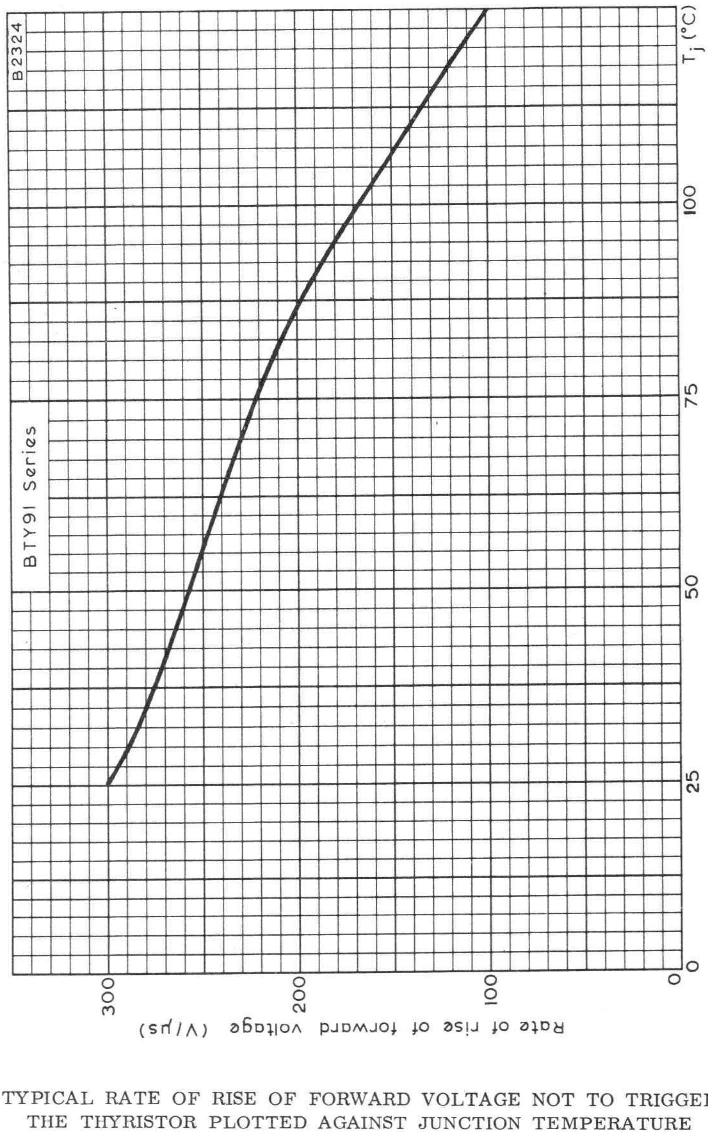
TYPICAL TURN-ON CHARACTERISTIC



PEAK FORWARD CURRENT DURING TURN-ON PLOTTED AGAINST FORWARD VOLTAGE BEFORE SWITCHING



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE



TYPICAL RATE OF RISE OF FORWARD VOLTAGE NOT TO TRIGGER THE THYRISTOR PLOTTED AGAINST JUNCTION TEMPERATURE

BTY95 Series

TENTATIVE DATA

The BTY95 is a range of p-gate reverse blocking thyristors (silicon controlled rectifiers) for use in power control circuits. Further figures and the letter R are added to the basic type number after a hyphen, to identify individual types within the range. The group of figures indicates the rated maximum repetitive peak reverse voltage for each type. The final letter R denotes stud-anode connection.

Unless otherwise shown data is applicable to all types in the series.

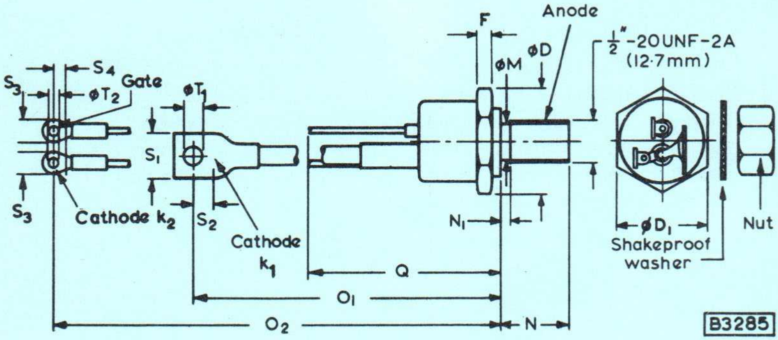
QUICK REFERENCE DATA

	100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{BO} min.	100	150	200	250	300	400	500	600	700	800	V
V_{RRM} max.	100	150	200	250	300	400	500	600	700	800	V
$I_{F(AV)}$ max.										50	A
θ_{j-mb} max.										0.6	degC/W
T_j max.										125	°C

OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-30A or SO-30C

For details see page D2.



Thyristors without the cathode lead k_2 conform to V.A.S.C.A. outline SO-30A. Those with k_2 conform to SO-30C.

Dimensions in millimetres

	Min.	*Max.*	*Notes*		*Min.*	*Max.*	*Notes*
A		28.57		Q		63.5	1
ϕD		31.24		S_1		16.51	
ϕD_1	26.19	26.97	1	S_2	6.35		3
F	4.4	8.8		S_3		7.62	
ϕM	10.55	12.70	2	S_4	3.81		3
N	18.5	21.0					
N_1		3.17	2	ϕT_1	6.35	8.40	
O_1	140	203		ϕT_2	2.80	3.93	
O_2	166	228					

NOTES

1. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter ϕD_1. Q allows for the leads to be bent at right angles.
2. ϕM refers to the unthreaded length N_1.
3. Minimum flat.

BTY95 Series

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE

Voltage

		Type BTY95-										
		100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{RWM}	Max. crest working reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RRM}	Max. repetitive peak reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RSM}	Max. non-repetitive peak reverse voltage (fault conditions only, max. duration = 5ms) See note 1	150	225	300	350	400	500	600	720	850	960	V
V_{DWM}	Crest working off-state voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{surge}	Max. peak forward voltage										850	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 11degC/W for BTY95-100R to 400R, and 4.0degC/W for BTY95-500R to 800R.

Current

I_F	Maximum continuous forward current	75	A
$I_{F(AV)}$	Maximum mean forward current. See note 2 and curve on page C2	50	A
I_{FRM}	Maximum repetitive peak forward current	700	A
I_{FSM}	Maximum surge forward current, for one cycle at 50c/s. See note 3 and curve on page C4	680	A
I^2t	Surge current capability for fusing (1.5ms to 10ms) See curve on page C5	2000	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	30	A

Dissipation

P_{tot} max.	Max. total power dissipation	see page C2

NOTES

2. Single-phase half-wave circuit with resistive load and 180° conduction angle.
3. The surge current rating applies when the thyristor is fully loaded before the application of the surge, i.e. with continuous application of the maximum crest reverse working voltage, the crest working off-state voltage.

GATE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward gate current		
	Anode positive w.r.t. cathode	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power, maximum averaging time = 20ms	500	mW

Thermal

T_j max.	125	°C
T_j min.	−55	°C
T_{stg} max.	125	°C
T_{stg} min.	−55	°C

Mechanical

Maximum torque on hexagon or nut	175	kg cm
	13	lb ft
Minimum torque on hexagon or nut for good thermal contact	90	kg cm
	6.5	lb ft
Recommended diameter of hole in heatsink	13	mm
	0.51	in

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to stud	0.6 degC/W
θ_i	Contact thermal resistance for a torque of 90kg cm on the nut	0.1 degC/W

BTY95 Series

CHARACTERISTICS ($T_j = 125°C$ unless otherwise stated)

ANODE

		Type BTY95-											
		100R	150R	200R	250R	300R	400R	500R	600R	700R	800R		
V_{BO}	Minimum forward breakover voltage See note 4	100	150	200	250	300	400	500	600	700	800		V
V_F	Maximum instantaneous forward voltage drop, at $I_F = 500A$, and $T_j = 25°C$											3.3	V
I_D	Maximum forward leakage current at V_{DWM} max.	13	13	12	11	10	8.0	12	12	12	10		mA
I_R	Maximum reverse leakage current at V_{RWM} max. See note 5	13	13	12	11	10	8.0	12	12	12	10		mA

NOTES

4. This voltage may be exceeded up to the maximum peak forward voltage, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

5. These limits do not apply when the gate is positive with respect to cathode.

GATE

V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at $T_j = 25°C$	3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at $T_j = 25°C$	80	mA
V_{GNT}	Maximum continuous gate non-trigger voltage	250	mV

CHARACTERISTICS (T_j = 125°C unless otherwise stated)

		Typical	
I_H	Holding current (anode current to maintain conduction)	10	mA
$\frac{dv}{dt}$	Rate of rise of forward voltage not to trigger the device	10	V/µs
t_{on}	Turn-on time (Delay time + rise time) See curves on page C7		
	Forward voltage before triggering = 50V, I_F = 50A	6.0	µs
	Forward voltage before triggering = 400V, I_F = 50A	3.0	µs
t_{off}	Turn-off time. See curve on page C8 Rate of rise of applied forward voltage = 5.0V/µs, Forward current before recovery = 50A, reverse current = 10 to 30A	20	µs

MECHANICAL DATA

Weight

Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

ACCESSORIES

Accessory	Code No.	Notes
½in. U.N.F. nut Shakeproof washer		Supplied with Thyristor

OPERATING NOTES

1. SUPPRESSION OF TRANSIENT VOLTAGE SURGE DUE TO STORED ENERGY IN TRANSFORMER CORE

A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows:—

	R–C in primary of transformer		R–C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

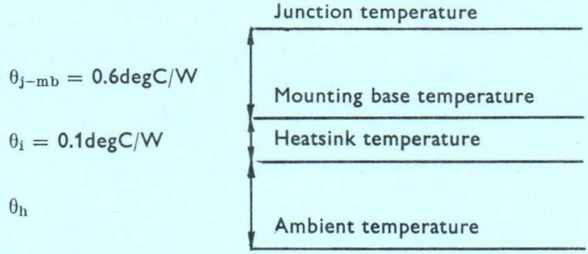
The capacitance values calculated from the above table are minimum values, and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations:—

The various components of the rise of junction temperature above ambient are illustrated below:



The method of using the curve on page C2 is as follows:

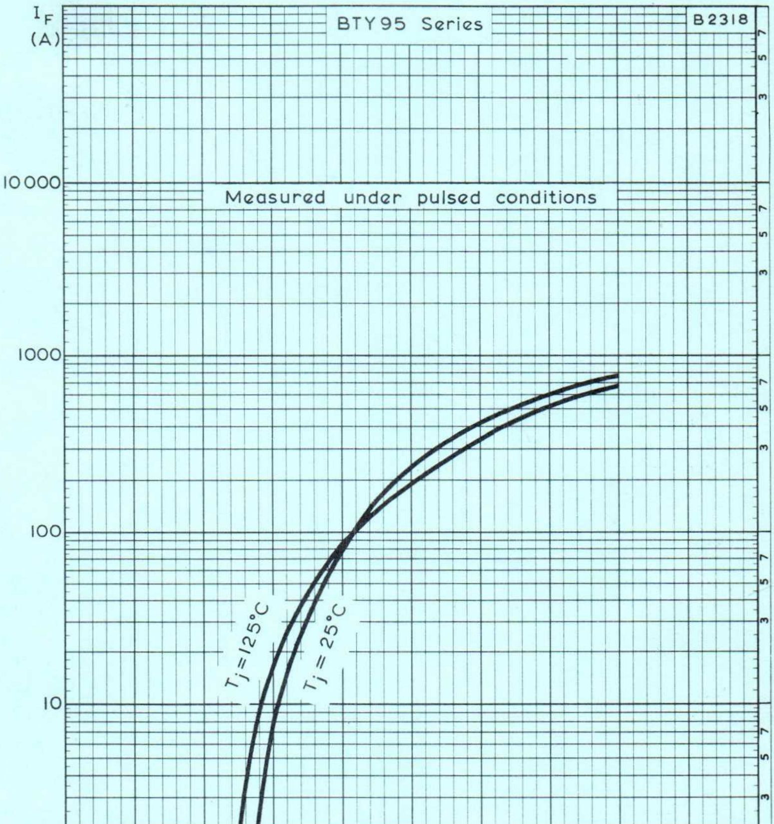
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

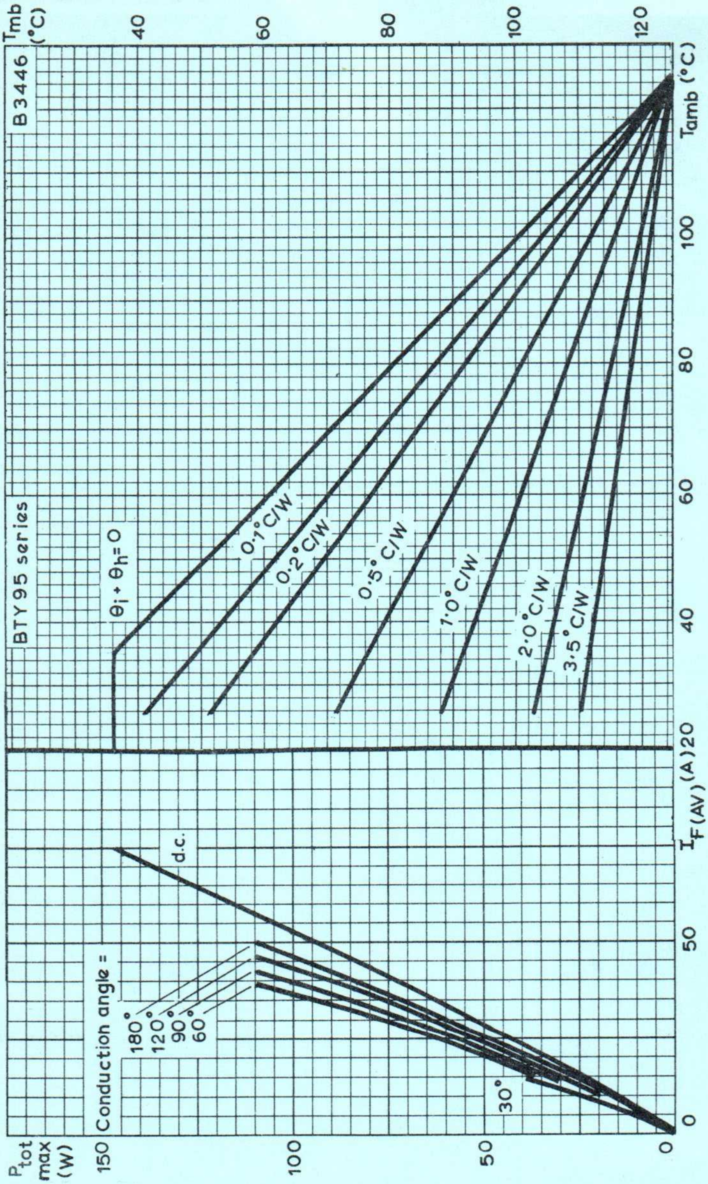
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \mathrm{max.}} - \theta_i$$

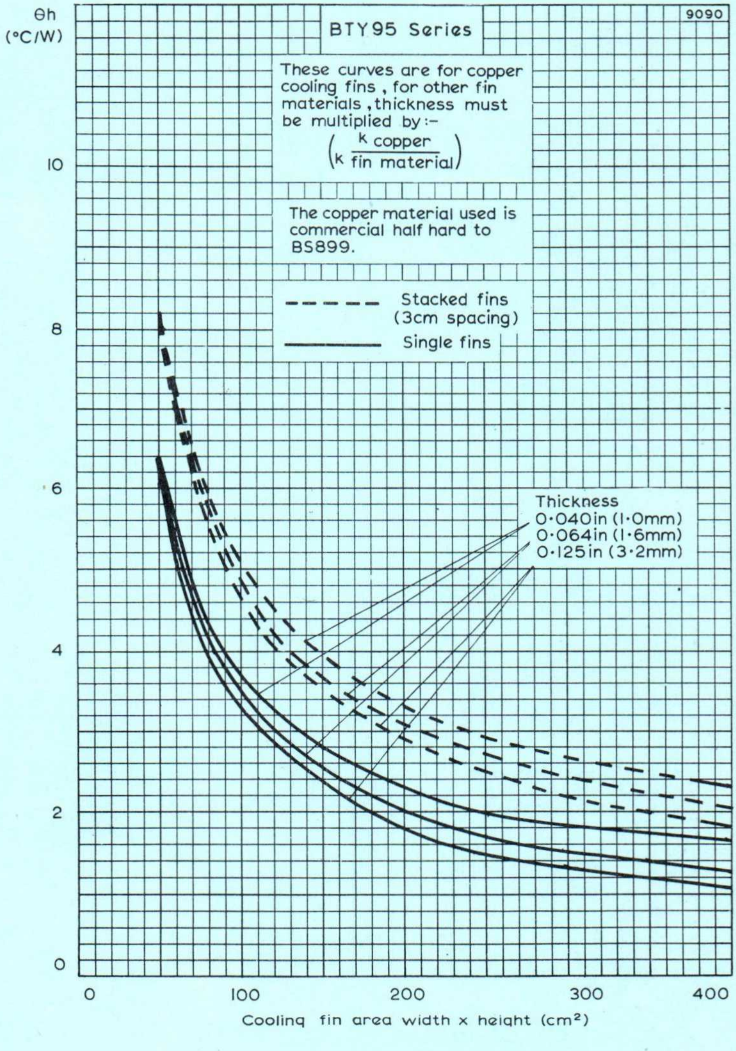
The size of the heatsink required may be found from the graph on page C3.



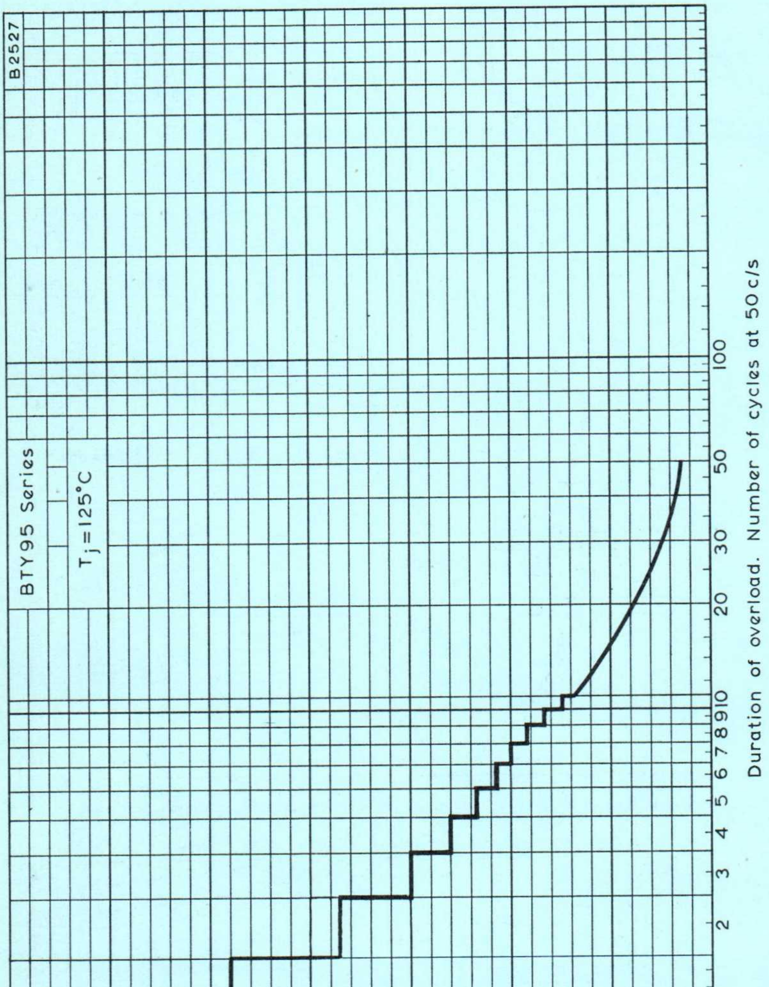
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



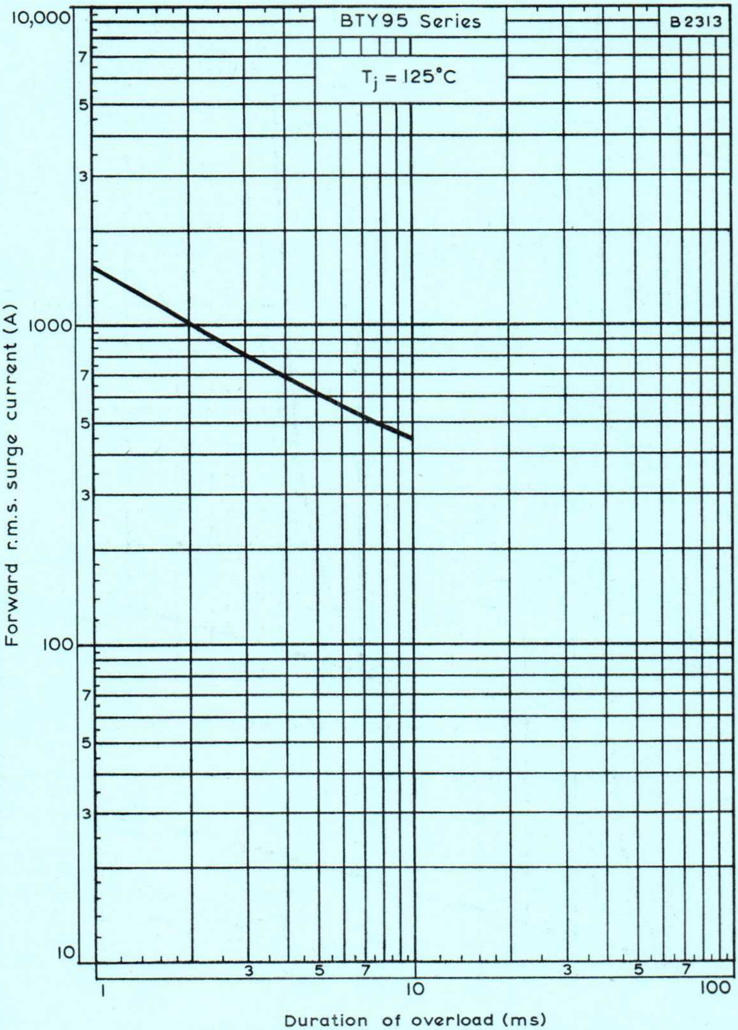
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



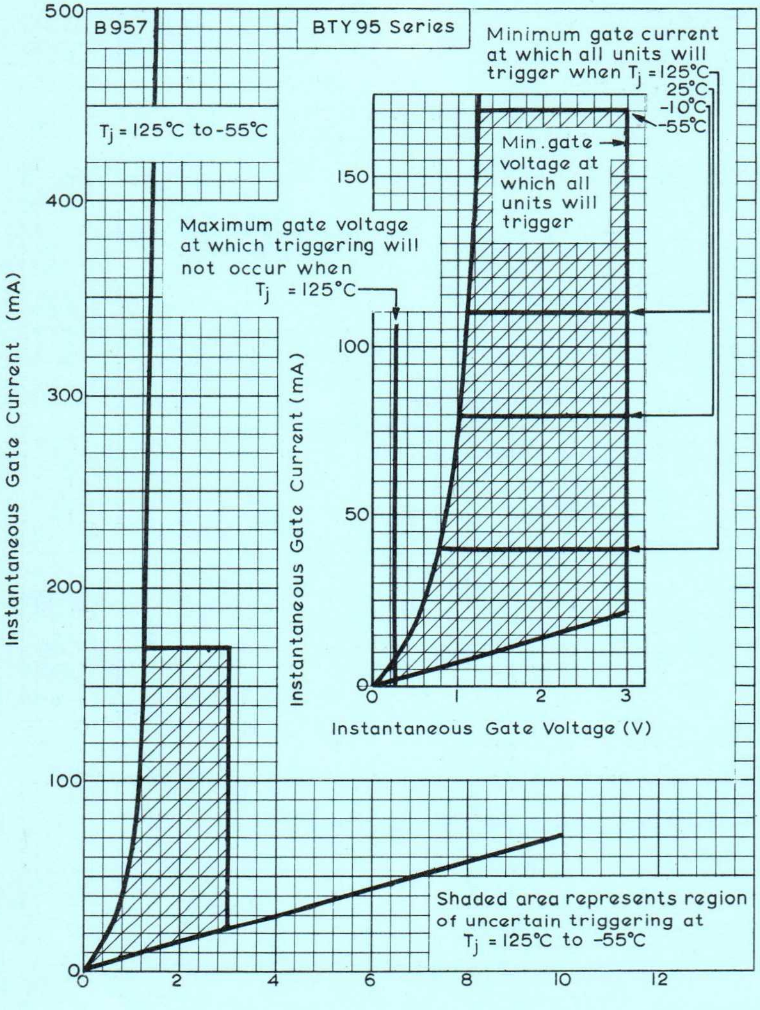
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



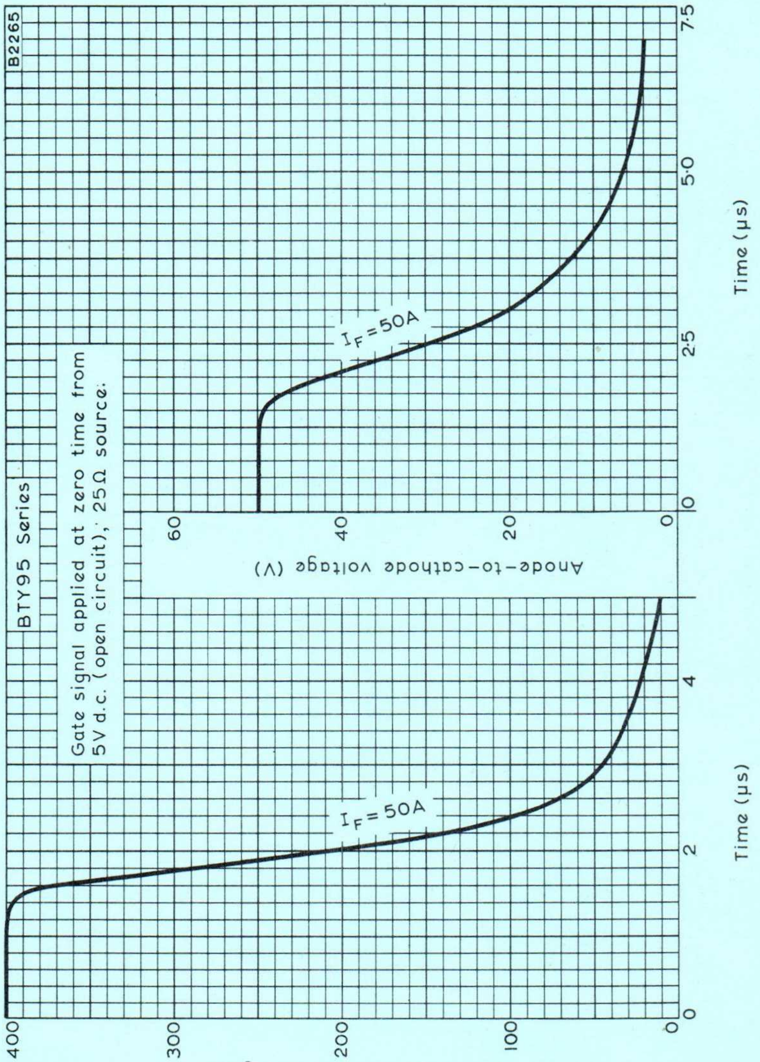
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST
THE NUMBER OF CYCLES AT 50c/s



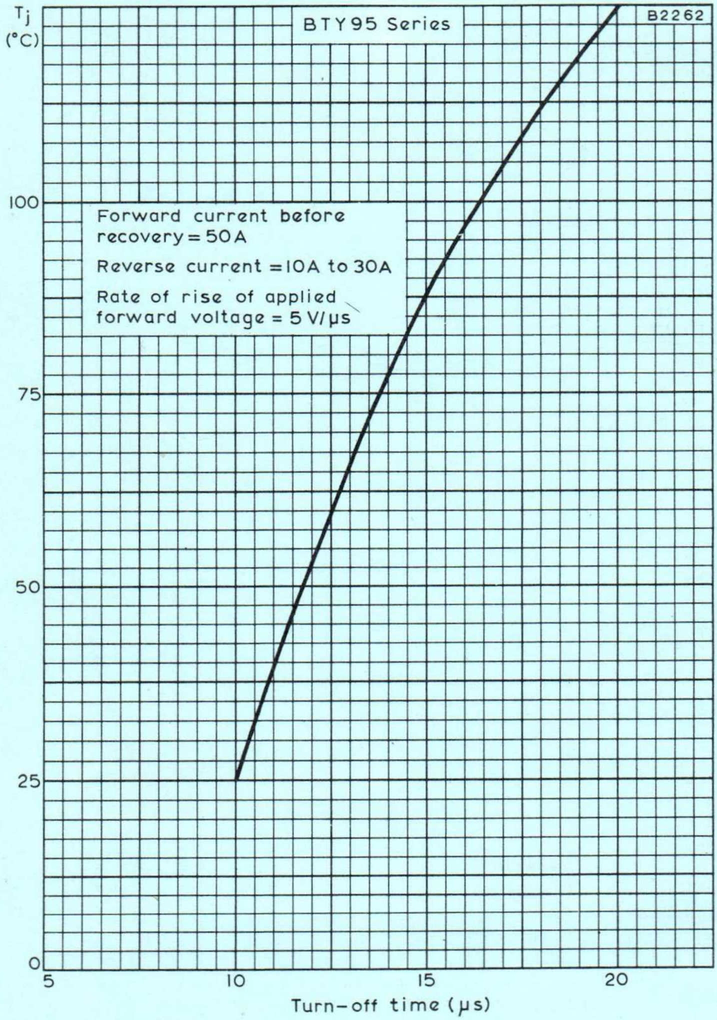
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50 c/s



GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



TYPICAL TURN-ON CHARACTERISITC



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE

BTY99 Series

TENTATIVE DATA

The BTY99 is a range of p-gate reverse blocking thyristors (silicon controlled rectifiers) for use in power control circuits. Further figures and the letter R are added to the basic type number after a hyphen, to identify individual types within the range. The group of figures indicates the rated maximum repetitive peak reverse voltage for each type. The final letter R denotes stud-anode connection.

Unless otherwise shown data is applicable to all types in the series.

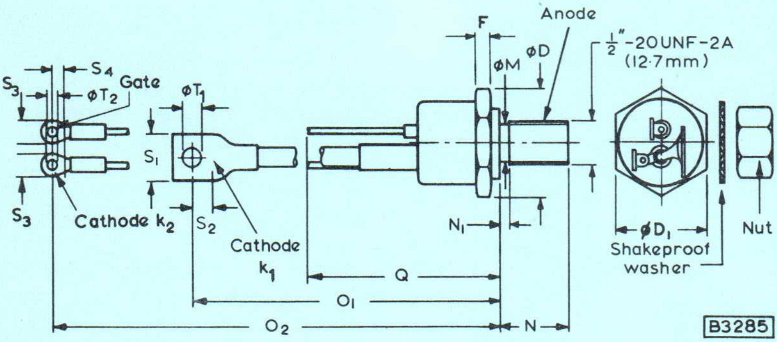
QUICK REFERENCE DATA

	100R	150R	200R	250R	300R	400R	500R	600R	700R	800R	
V_{BO} min.	100	150	200	250	300	400	500	600	700	800	V
V_{RRM} max.	100	150	200	250	300	400	500	600	700	800	V
$I_{F(AV)}$ max.										70	A
θ_{j-mb} max.										0.4	degC/W
T_j max.										125	°C

OUTLINE AND DIMENSIONS

Conforming to V.A.S.C.A. SO-30A or SO-30C

For details see page D2.



Thyristors without the cathode lead k_2 conform to V.A.S.C.A. outline SO-30A. Those with k_2 conform to SO-30C.

Dimensions in millimetres

	Min.	*Max.*	*Notes*		*Min.*	*Max.*	*Notes*
A		28.57		Q		63.5	1
ϕD		31.24		S_1		16.51	
ϕD_1	26.19	26.97	1	S_2	6.35		3
F	4.4	8.8		S_3		7.62	
ϕM	10.55	12.70	2	S_4	3.81		3
N	18.5	21.0					
N_1		3.17	2	ϕT_1	6.35	8.40	
O_1	140	203		ϕT_2	2.80	3.93	
O_2	166	228					

NOTES

1. The device, with the exception of the hexagon, stud and flexible leads, lies within length Q and diameter ϕD_1. Q allows for the leads to be bent at right angles.
2. ϕM refers to the unthreaded length N_1.
3. Minimum flat.

BTY99 Series

RATINGS

Limiting values of operation according to the absolute maximum system.

Electrical

The following ratings apply for the frequency range 50c/s to 400c/s. Simultaneous application of all ratings is inferred unless otherwise stated.

ANODE

Voltage

		Type BTY99-										
		100R	**150R**	**200R**	**250R**	**300R**	**400R**	**500R**	**600R**	**700R**	**800R**	
V_{RWM}	Max. crest working reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RRM}	Max. repetitive peak reverse voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{RSM}	Max. non-repetitive peak reverse voltage (fault conditions only, max. duration = 5ms) See note 1	150	225	300	350	400	500	600	720	850	960	V
V_{DWM}	Crest working off-state voltage See note 1	100	150	200	250	300	400	500	600	700	800	V
V_{surge}	Max. peak forward voltage										850	V

NOTES

1. These ratings do not apply when the gate is positive with respect to cathode. To ensure that no device will thermally run away at maximum voltage ratings, the total thermal resistance between junction and ambient must be less than 11degC/W for BTY99-100R to 400R, and 4.0degC/W for BTY99-500R to 800R.

Current

I_F	Maximum continuous forward current	100	A
$I_{F(AV)}$	Maximum mean forward current. See note 2 and curve on page C2	70	A
I_{FRM}	Maximum repetitive peak forward current	1000	A
I_{FSM}	Maximum surge forward current, for one cycle at 50c/s. See note 3 and curve on page C4	900	A
I^2t	Surge current capability for fusing (1.5ms to 10ms) See curve on page C5	4000	A^2s
I_{RRM}	Maximum repetitive peak reverse current during turn-off interval	30	A

Dissipation

P_{tot} max.	Max. total power dissipation	see page C2	

NOTES

2. Single-phase half-wave circuit with resistive load and 180° conduction angle.
3. The surge current rating applies when the thyristor is fully loaded before the application of the surge, i.e. with continuous application of the maximum crest reverse working voltage, the crest working off-state voltage.

GATE

Voltage

V_{GFM}	Maximum peak forward gate voltage		
	Anode positive w.r.t. cathode	10	V
	Anode negative w.r.t. cathode	250	mV
V_{GRM}	Maximum peak reverse gate voltage	5.0	V

Current

I_{GFM}	Maximum peak forward gate current		
	Anode positive w.r.t. cathode	2.0	A

Dissipation

P_{GM}	Maximum peak gate power	5.0	W
$P_{G(AV)}$	Maximum average gate power, maximum averaging time = 20ms	500	mW

Thermal

	T_j max.	125	°C
	T_j min.	−55	°C
	T_{stg} max.	125	°C
	T_{stg} min.	−55	°C

Mechanical

	Maximum torque on hexagon or nut	175	kg cm
		13	lb ft
	Minimum torque on hexagon or nut for good thermal contact	90	kg cm
		6.5	lb ft
	Recommended diameter of hole in heatsink	13	mm
		0.51	in

THERMAL CHARACTERISTICS

θ_{j-mb}	Maximum thermal resistance from junction to stud	0.4	degC/W
θ_i	Contact thermal resistance for a torque of 90kg cm on the nut	0.1	degC/W

CHARACTERISTICS (T_j = 125°C unless otherwise stated)

ANODE

Symbol	Parameter	BTY99-100R	150R	200R	250R	300R	400R	500R	600R	700R	800R		Unit
V_{BO}	Minimum forward breakover voltage See note 4	100	150	200	250	300	400	500	600	700	800		V
V_F	Maximum instantaneous forward voltage drop, at I_F = 500A, and T_j = 25°C											2.5	V
I_D	Maximum forward leakage current at V_{DWM} max.	13	13	12	11	10	8.0	12	12	12	10		mA
I_R	Maximum reverse leakage current at V_{RWM} max. See note 5	13	13	12	11	10	8.0	12	12	12	10		mA

NOTES

4. This voltage may be exceeded up to the maximum peak forward voltage, but the thyristor may conduct at any voltage over the minimum forward breakover voltage.

5. These limits do not apply when the gate is positive with respect to cathode.

GATE

Symbol	Parameter	Value	Unit
V_{GT}	Minimum instantaneous trigger voltage to initiate turn-on at T_j = 25°C	3.0	V
I_{GT}	Minimum instantaneous trigger current to initiate turn-on at T_j = 25°C	70	mA
V_{GNT}	Maximum continuous gate non-trigger voltage	250	mV

CHARACTERISTICS (T_j = 125°C unless otherwise stated)

		Typical	
I_H	Holding current (anode current to maintain conduction)	10	mA
$\frac{dv}{dt}$	Rate of rise of forward voltage not to trigger the device	10	V/μs
t_{on}	Turn-on time (Delay time + rise time) See curves on page C7		
	Forward voltage before triggering = 50V, I_F = 50A	6.0	μs
	Forward voltage before triggering = 400V, I_F = 50A	3.0	μs
t_{off}	Turn-off time. See curve on page C8 Rate of rise of applied forward voltage = 5.0V/μs, Forward current before recovery = 50A, reverse current = 10 to 30A	20	μs

MECHANICAL DATA

Weight		
Without accessories	88	g
	3.1	oz
With accessories	108	g
	3.8	oz

ACCESSORIES

Accessory	*Code No.*	*Notes*
½in. U.N.F. nut Shakeproof washer		Supplied with Thyristor

OPERATING NOTES

1. SUPPRESSION OF TRANSIENT VOLTAGE SURGE DUE TO STORED ENERGY IN TRANSFORMER CORE

A damping circuit should be placed across the transformer or thyristor if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows:—

	R–C in primary of transformer		R–C in secondary of transformer	
$\frac{V_{RSM}}{V_{RWM}}$	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

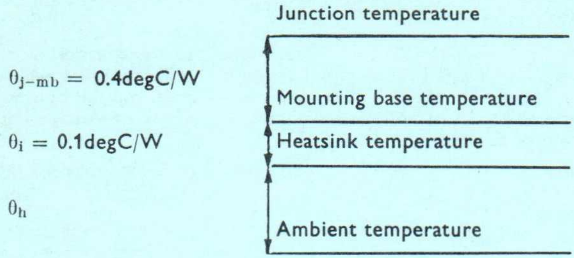
The capacitance values calculated from the above table are minimum values, and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

3. Thyristors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.

4. Dissipation and heatsink considerations:—

The various components of the rise of junction temperature above ambient are illustrated below:



The method of using the curve on page C2 is as follows:

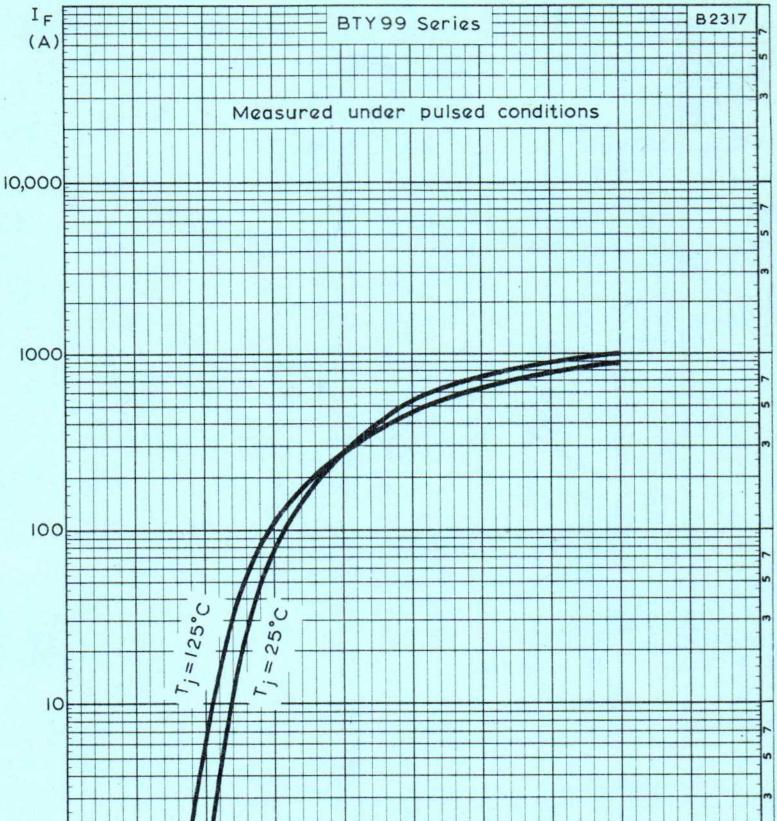
Starting with the curve of maximum dissipation as a function of mean forward current, for a particular current value trace upwards to meet the appropriate conduction angle curve. Then trace horizontally until the appropriate $\theta_i + \theta_h$ curve is reached. Finally trace downwards to determine the maximum ambient temperature.

θ_i is the contact thermal resistance for minimum torque, as given on page D4. θ_h is the thermal resistance of the heatsink and depends on the cooling conditions under which the thyristor is used. The dimensions, position and surface conditions of the heatsink should be considered. For values of θ_h for blackened vertical heatsinks see the curve on page C3.

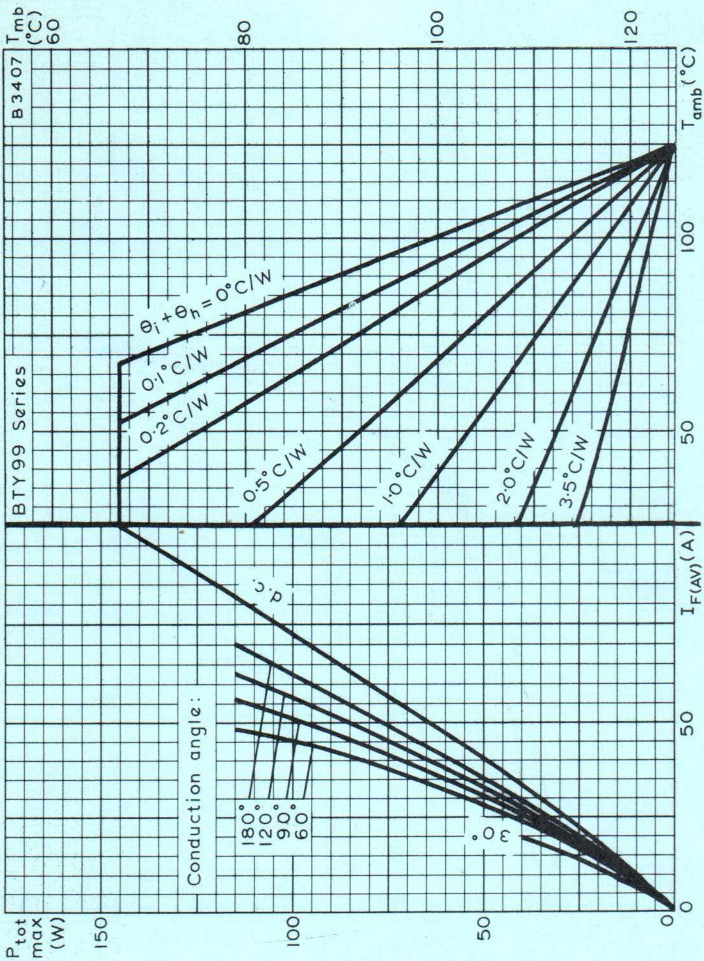
Alternatively, for a given mean forward current and conduction angle the mounting base temperature may be found from the right-hand scale of the graph on page C2. Thus, knowing the maximum ambient temperature the maximum value of θ_h is given by

$$\theta_h = \frac{T_{mb} - T_{amb}}{P_{tot}\ \text{max.}} - \theta_i$$

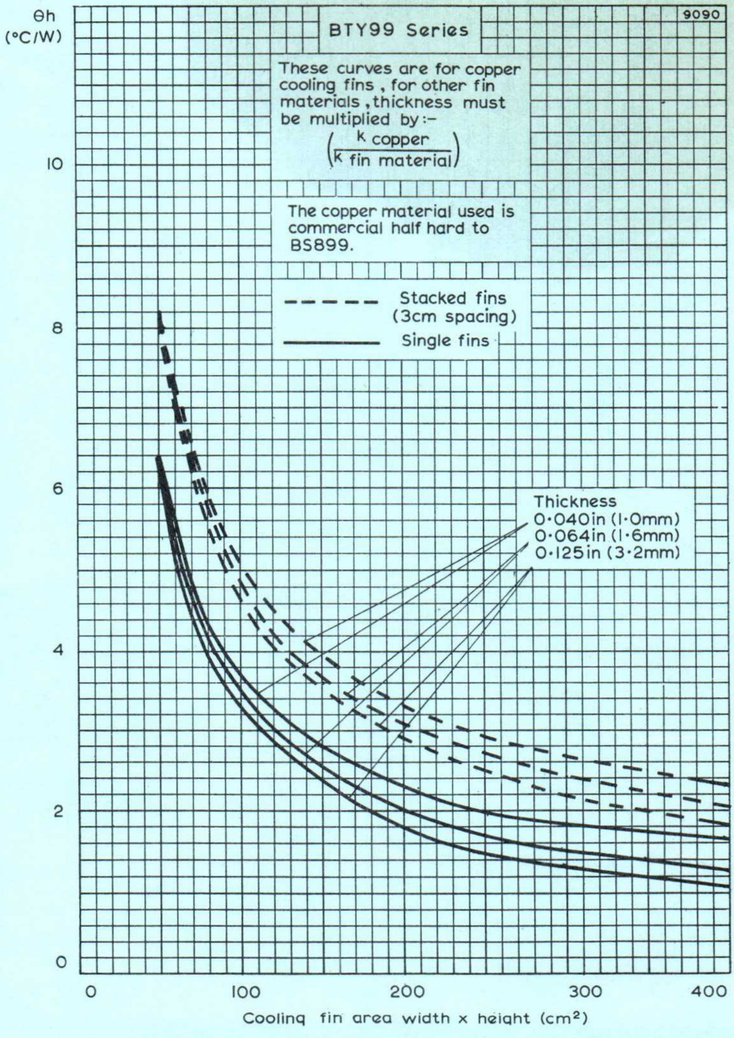
The size of the heatsink required may be found from the graph on page C3.



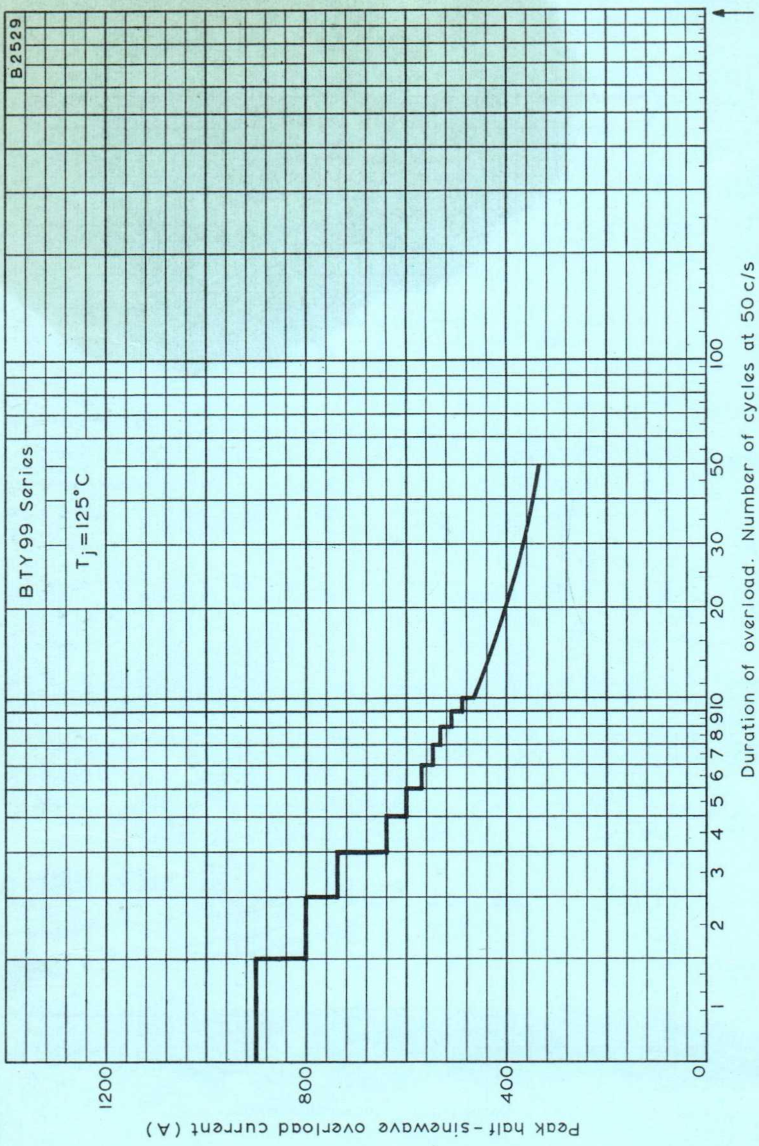
MAXIMUM FORWARD CONDUCTING CHARACTERISTIC



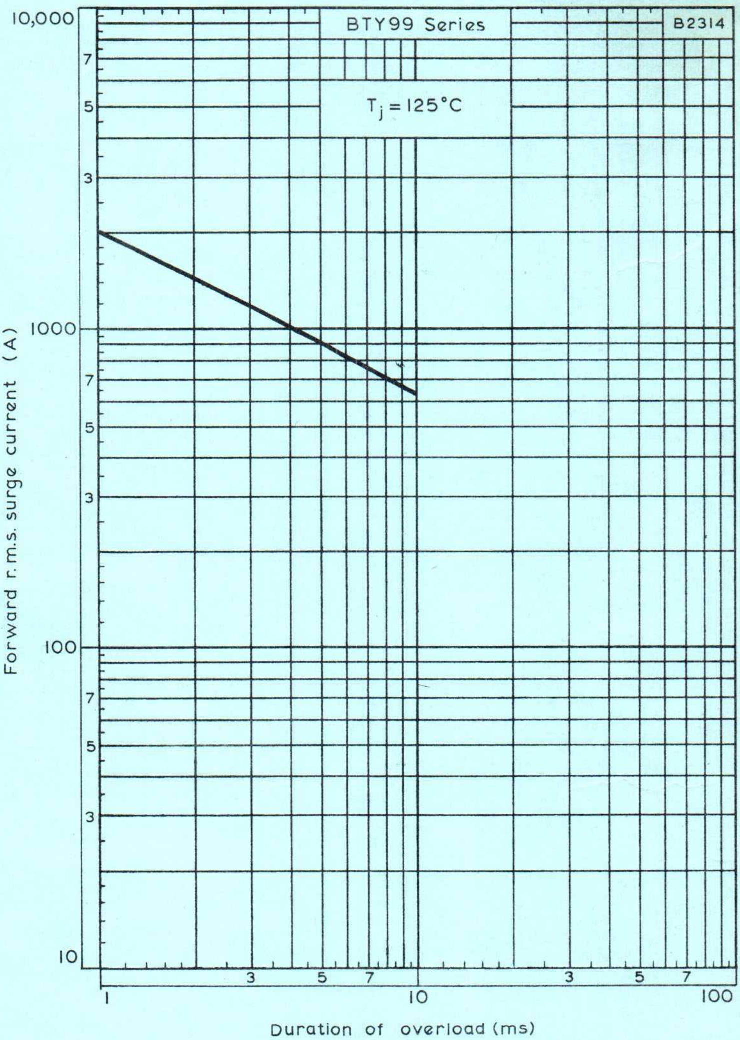
MAXIMUM MOUNTING BASE AND AMBIENT TEMPERATURES FOR VARIOUS VALUES OF MEAN FORWARD CURRENT AND HEATSINK THERMAL RESISTANCE



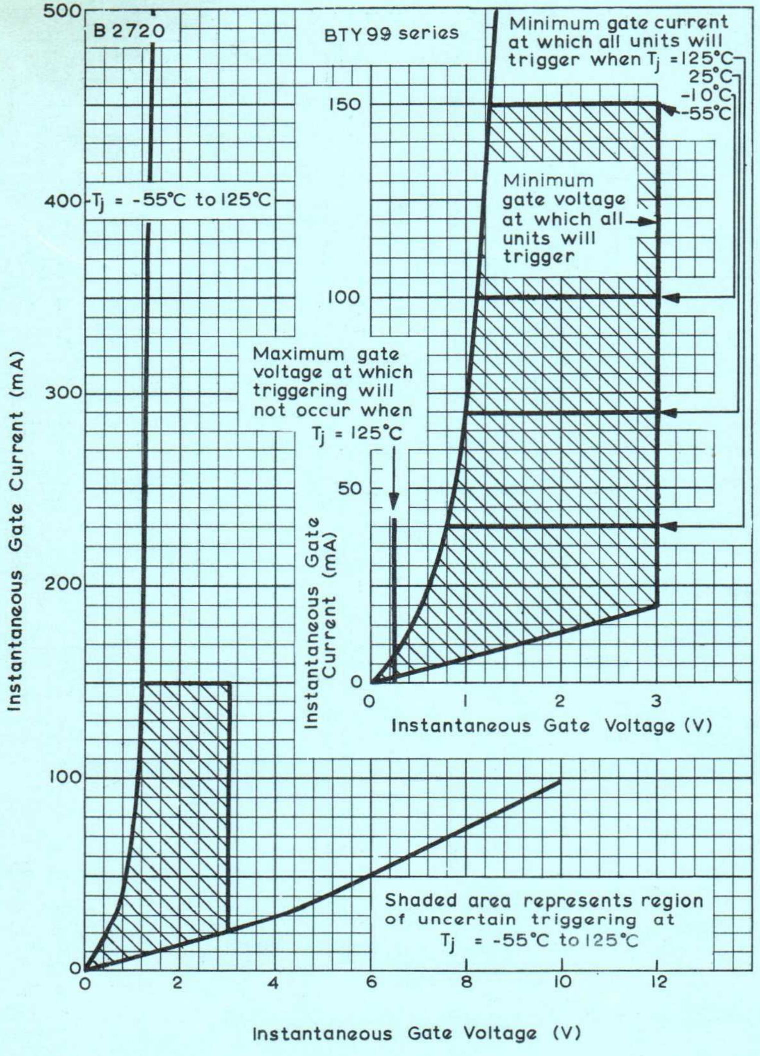
THERMAL RESISTANCE OF BLACKENED, VERTICAL, SQUARE HEATSINK WHEN USED IN FREE AIR PLOTTED AGAINST HEATSINK AREA



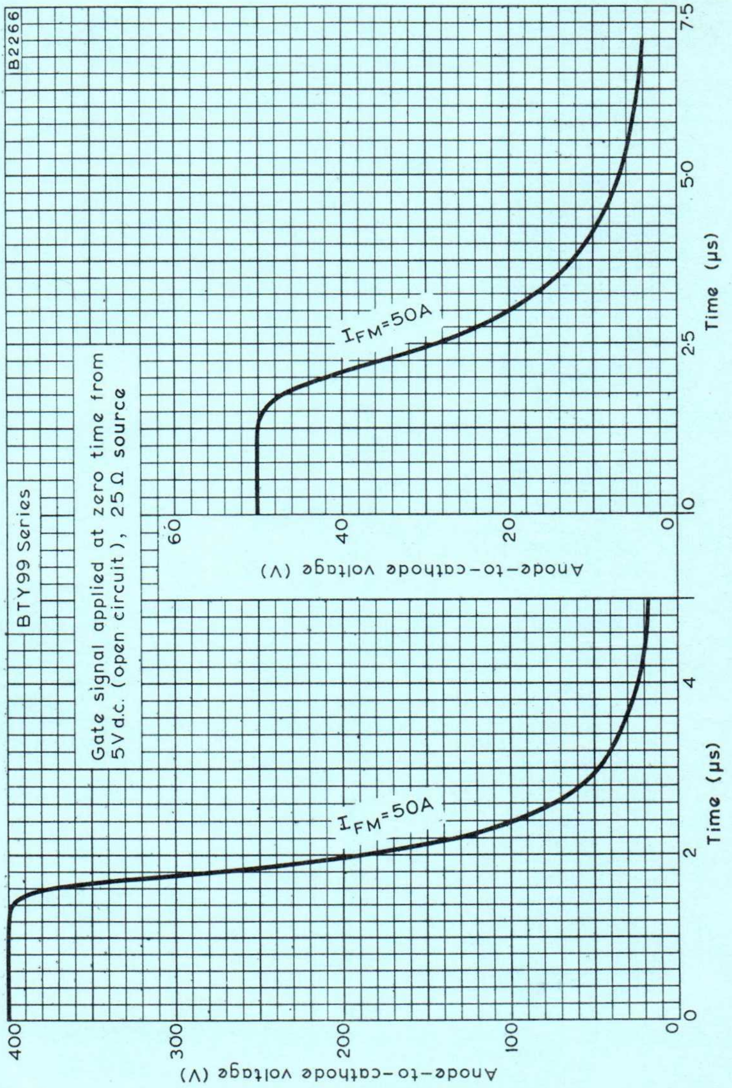
MAXIMUM SURGE CURRENT FOR FUSING PLOTTED AGAINST
THE NUMBER OF CYCLES AT 50c/s



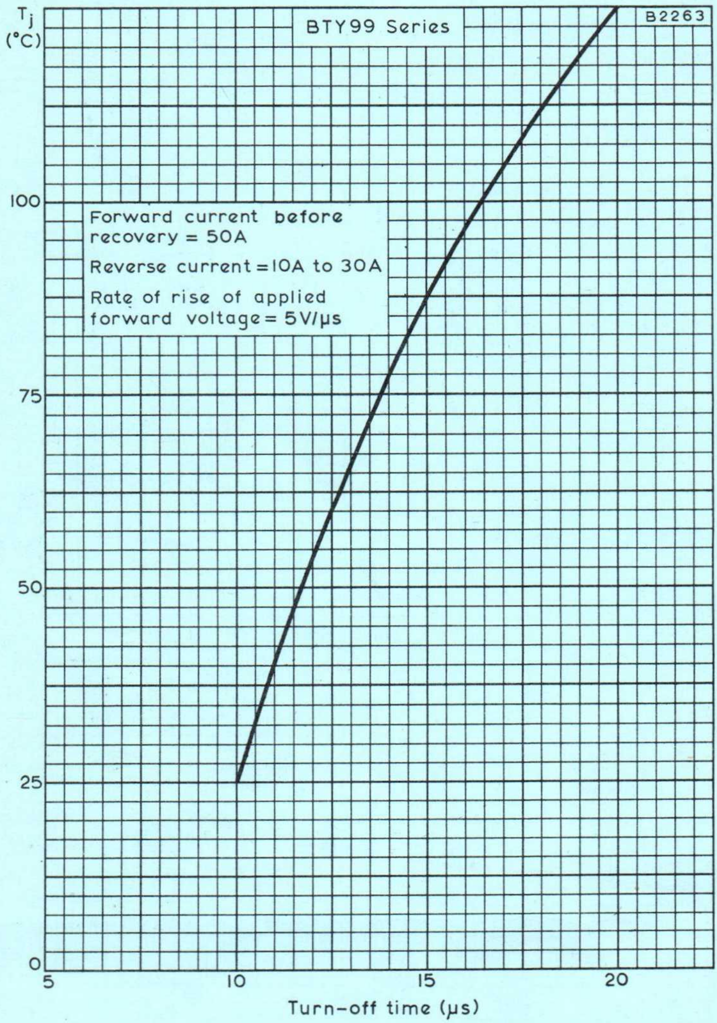
MAXIMUM SURGE CURRENT FOR THE DETERMINATION OF I^2t RATING FOR FUSING PLOTTED AGAINST SURGE DURATION AT 50 c/s



GATE CHARACTERISTIC
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



TYPICAL TURN-ON CHARACTERISTIC



TYPICAL TURN-OFF TIME, PLOTTED AGAINST JUNCTION TEMPERATURE

THYRISTOR TRIGGER MODULE

MY5011

TENTATIVE DATA

Trigger module suitable for triggering up to four thyristors in single-phase power control circuits.

Three modules may be used together for three-phase power control.

Terminals are provided to enable the trigger angle of each phase to be equalised accurately.

GENERAL

The MY5011 trigger module is suitable for triggering up to four thyristors in single-phase power control circuits. The trigger pulse rise times are such that thyristors, with the addition of normal voltage or current sharing components, can be triggered satisfactorily when connected in series or parallel.

The module can accept two signal inputs from current or voltage sources. The trigger angle can also be controlled by an external potentiometer.

The MY5011 trigger module is capable of triggering reliably all Mullard thyristors over their full operating temperature range.

OPERATING TEMPERATURE RANGE

T_{amb}	-20 to +65	^{o}C

The module body temperature should not exceed $70^{o}C$. Care must be taken when mounting the module in the vicinity of heatsinks.

POWER SUPPLY

The module should be supplied from a small isolating transformer with a centre-tapped secondary 27-0-27V, or with two separate secondaries, such as Mullard type MY5201 (see page D14 for details).

If the transformer taps are set so that 30V d.c. appears between terminals 17 and 21 and the module will continue to operate with mains variations +15 to -20%. The transformer should be connected to the module as shown in Fig.1.

It is important that the primary of the transformer be connected to the same phase as the thyristors being triggered.

Module input voltage	27-0-27	Vr.m.s.
Module input current	85	mAr.m.s.

FUSING

It is important that the supply transformer and wiring be protected against fault current by suitable fusing i.e. 1.0A in the primary of the MY5201 transformers.

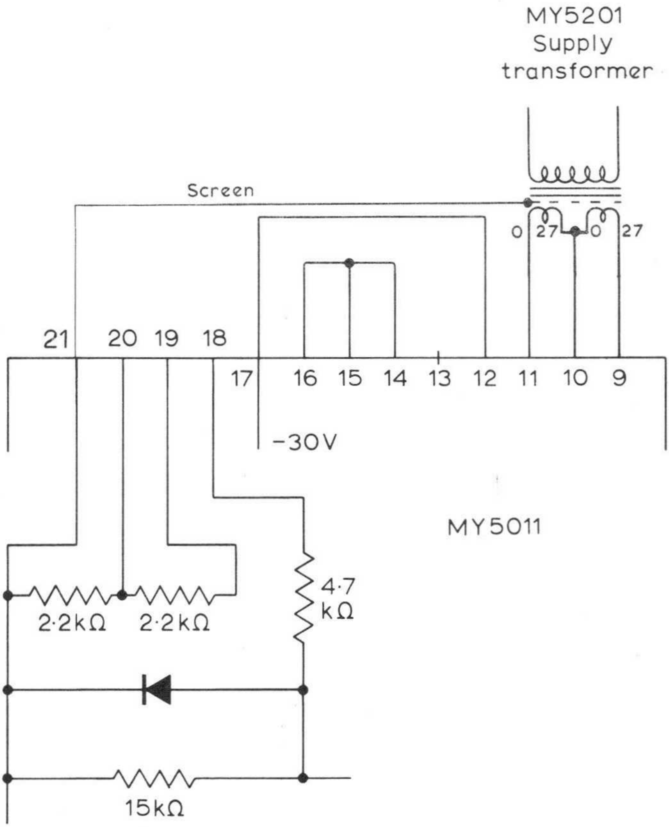


Fig. 1

B6294

Input circuit of MY5011

CONTROL INPUTS

A voltage swing of 0 to -10V on terminal 18 w.r.t. terminal 21 will give full control of the thyristor trigger angle. The resistor network between terminals 19 and 21 can be used to permit the application of two 5.0mA (nom.) control signals, the module responding to the algebraic sum of the voltages developed. One input can provide normal control while the other input is used for feedback or current limit control.
For potentiometer control, use is made of the 30V d.c. internal supply of the module.
Illustrations of input connections are shown in Figs. 2, 3 and 4 and the control characteristic is shown on page C1.

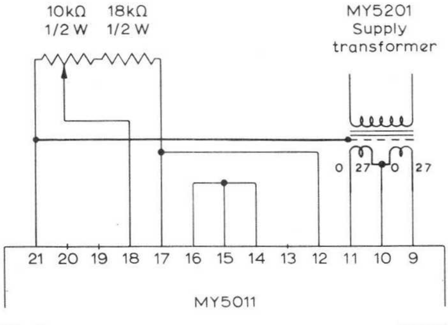


Fig. 2

B6296

Potentiometer controlled input

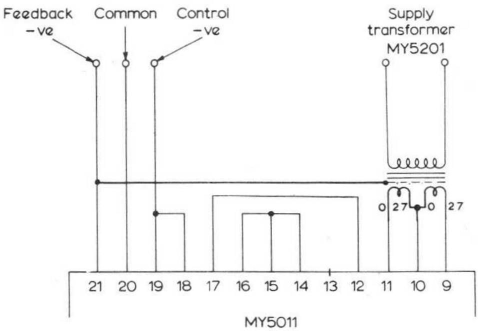


Fig. 3

B6297

Current or voltage controlled input with feedback

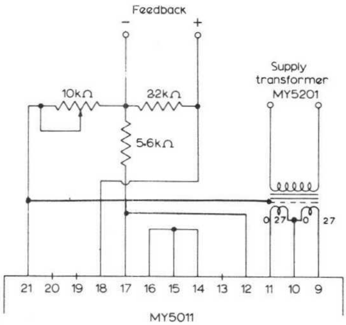


Fig. 4

B6298

Potentiometer controlled input with feedback

OUTPUTS

Four isolated outputs are provided, each capable of triggering one thyristor. The insulation between outputs is checked by a 2kV flash test.

The output takes the form of a chain of pulses, starting at the trigger angle determined by the control inputs and continuing to the end of the half cycle. This is repeated every half cycle.

*Typical pulse rise time (between 0.25 and 3.0V)	0.	0.5	μs
*Typical pulse width (above 3.0V)		40	μs
*Pulse amplitude		>3.5	V
*Pulse repetition rate		1.0	kHz
*Mark-space ratio (at nominal supply volts)		1:20	
Typical output impedance		24	Ω
Typical trigger angle range	5.0 to	167	deg
Equivalent range of power control in resistive load (see graph on page C2)	99.9 to	0.25	%

Note: Characteristics marked * will be conditioned by the gate impedance of the thyristor. The figures quoted were obtained with a load of 27Ω, the three remaining outputs being connected to 10Ω loads.

In service all unused outputs should be loaded with 15Ω, 1/4W resistors.

STABILITY

Temperature stability

Variation of trigger angle (at 90^{o} nominal) over the range -20 to +65°C	not greater than ±5^{o}

Mains voltage stability

If the control input is derived from a source which varies with the mains voltage then compensation occurs automatically and the trigger angle varies within the limits shown below.

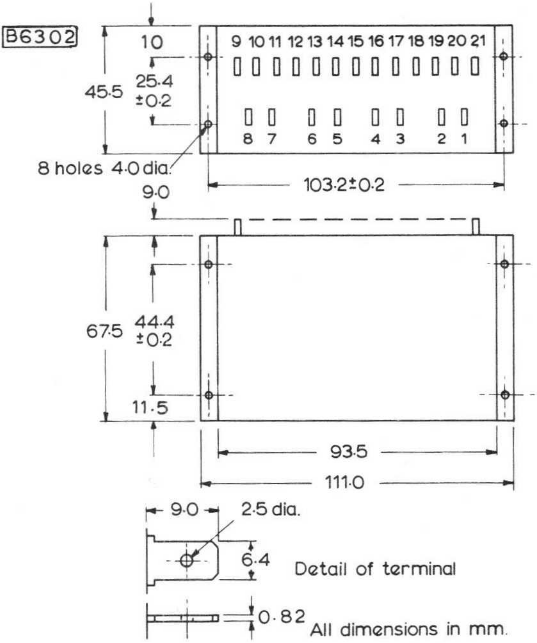
Variation of trigger angle (at 90^{o} nominal) for ±10% mains voltage excursions	not greater than ±2^{o}
Variation of trigger angle (at 90^{o} nominal) for mains voltage excursions	
+15%	not greater than +5^{o}
-20%	not greater than -5^{o}

If the control input is stabilised the trigger angle tends to increase with increasing mains voltage thus keeping the power in the load constant.

THYRISTOR TRIGGER MODULE

MY5011

DIMENSIONS



TERMINAL CONNECTIONS

1. Cathode 1
2. Gate 1
3. Cathode 2
4. Gate 2
5. Cathode 3
6. Gate 3
7. Cathode 4
8. Gate 4
9. Transformer input
10. Transformer centre-tap
11. Transformer input
12. Internal connection (see note)
13. Internal connection
14. Internal connection ⎫
15. Internal connection ⎬ equalisation for 3-phase operation (see note)
16. Internal connection ⎭
17. -30V internal supply
18. Control input
19. ⎫
20. ⎭ Input network
21. Common

Note: For single-phase operation, terminal 12 should be connected to terminal 17, and terminals 14, 15 and 16 should be connected together.

APPLICATION INFORMATION

Further information about these circuits is available on request

B6299

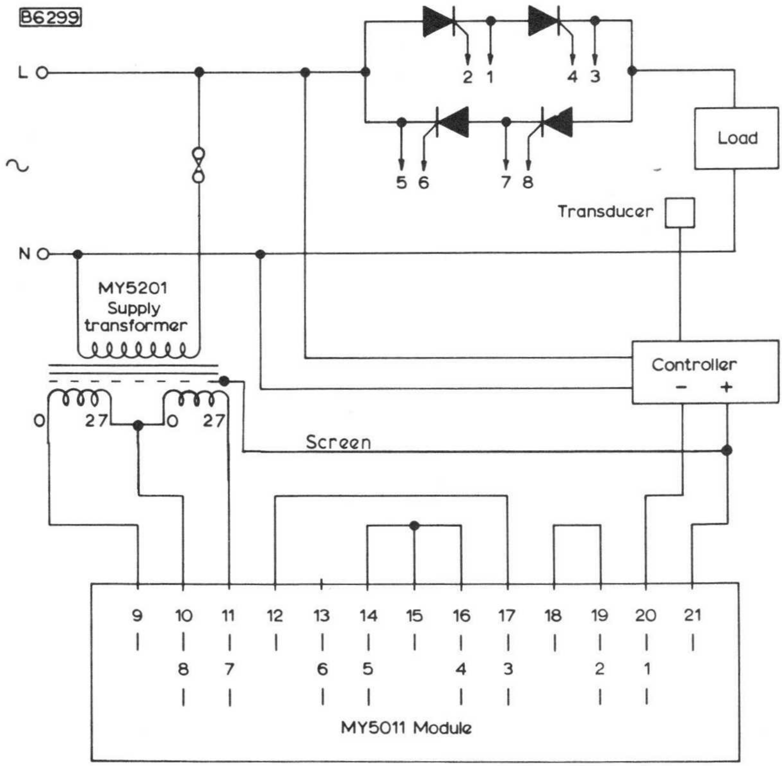


Fig. 5

Typical system using a controller

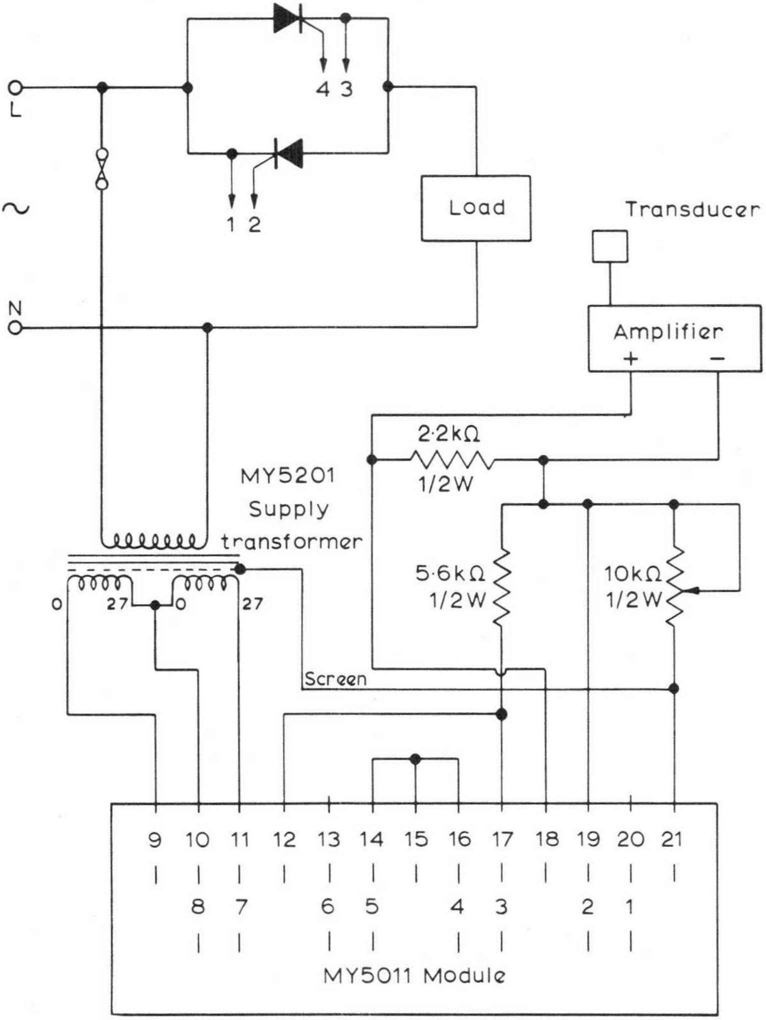


Fig. 6

Typical system using manual setting and feedback to stabilise load conditions

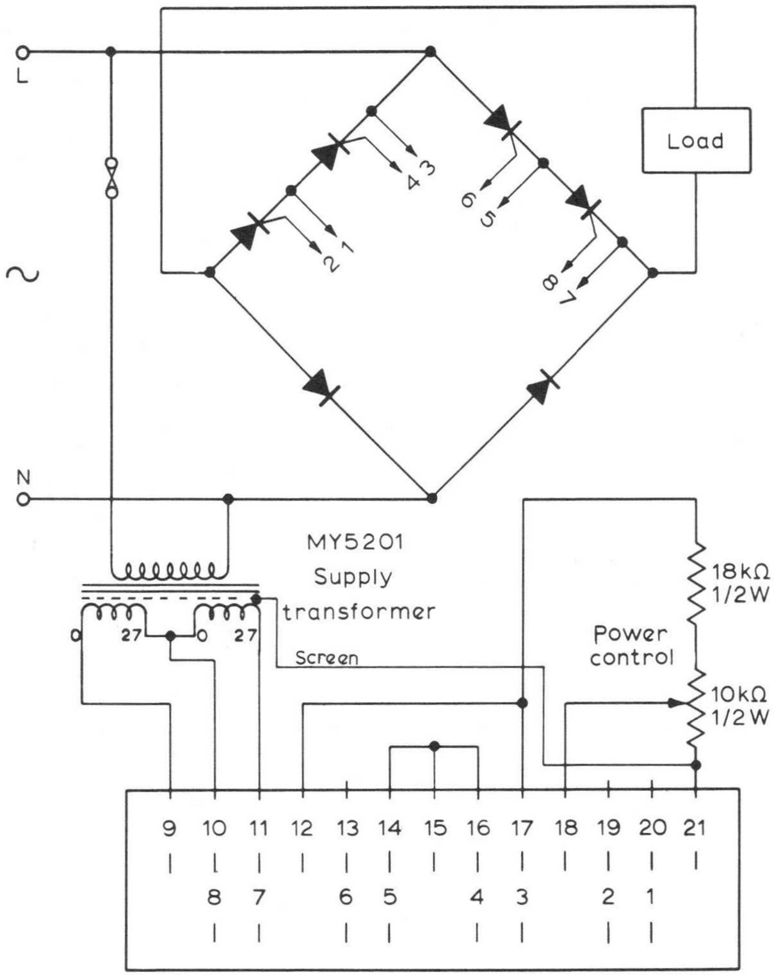


Fig. 7

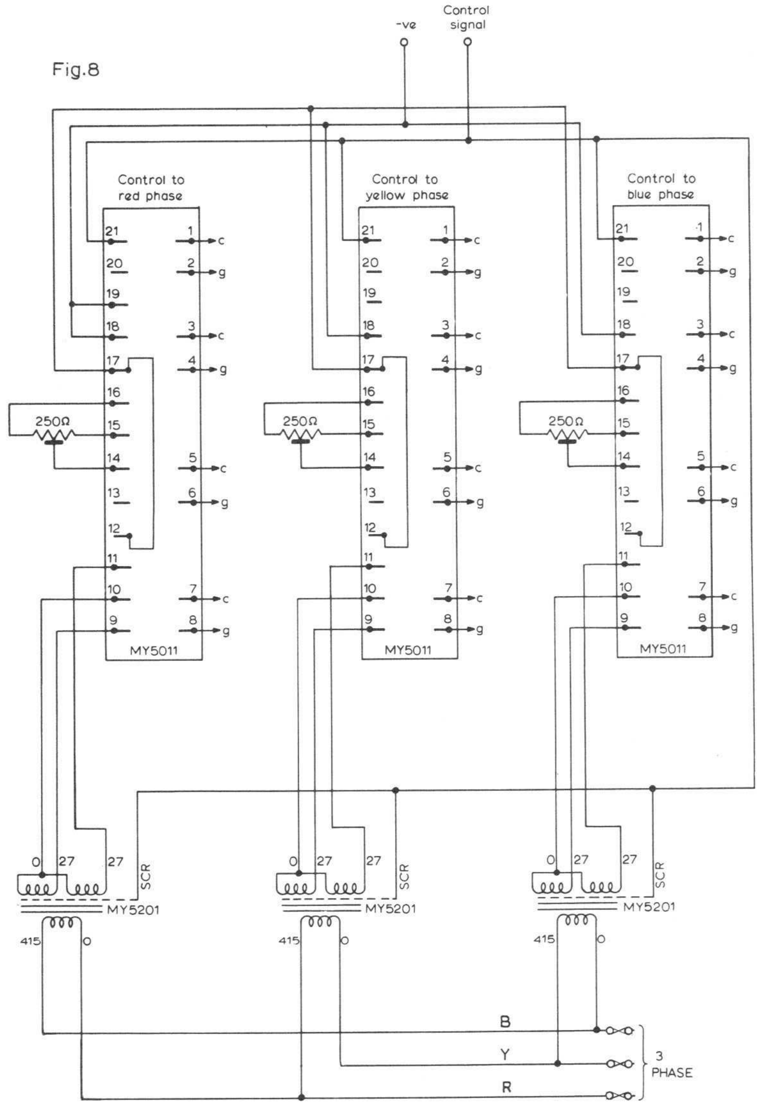
Typical system using a potentiometer to set power levels

APPLICATIONS INFORMATION (cont'd)

Three-phase Operation

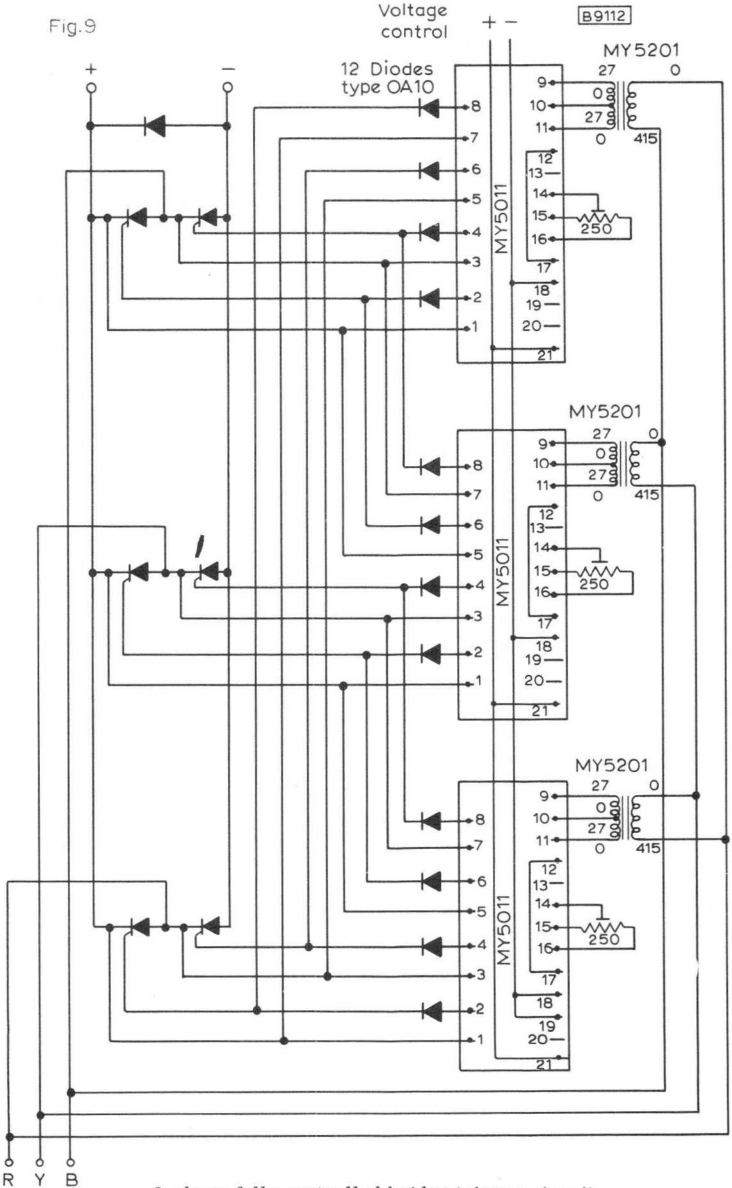
Three MY5011 modules can be operated in three-phase systems. A pre-set potentiometer (250Ω, w.w.) should be connected across terminals 14, 15 and 16 of each module to permit balancing of the phases.
Figures 8 and 9 illustrate applications using three-phase, half and fully controlled bridges. The power supplies to the modules are obtained from three MY5201 transformers. The three input terminals are connected in parallel and are controlled by a 0-5.0mA signal into approximately 2.0kΩ.
Figure 10 illustrates an application using a three-phase a.c. controller. In this application it is necessary to use three MY5201 transformers, the power input to each module is obtained from two of the phases so as to allow a range of firing angle control up to 210^{o}.
The outputs of the three phases should be compared by some suitable means, e.g. oscilloscope, load ammeters or lamp loads, and balanced by means of the three pre-set potentiometers.

Fig.8



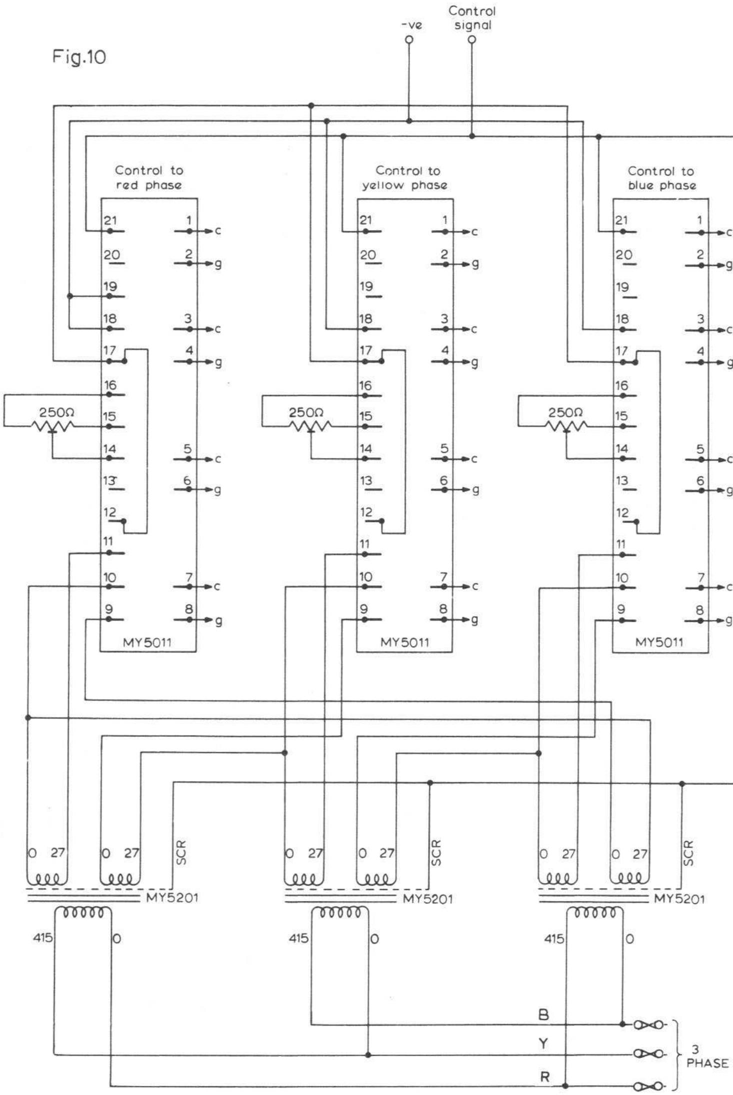
Interconnection of 3 MY5011 thyristor trigger modules and 3 MY5201 transformers for use with a three-phase half-controlled bridge

Fig.9



3-phase fully controlled bridge trigger circuit
for systems not required to regenerate into the supply

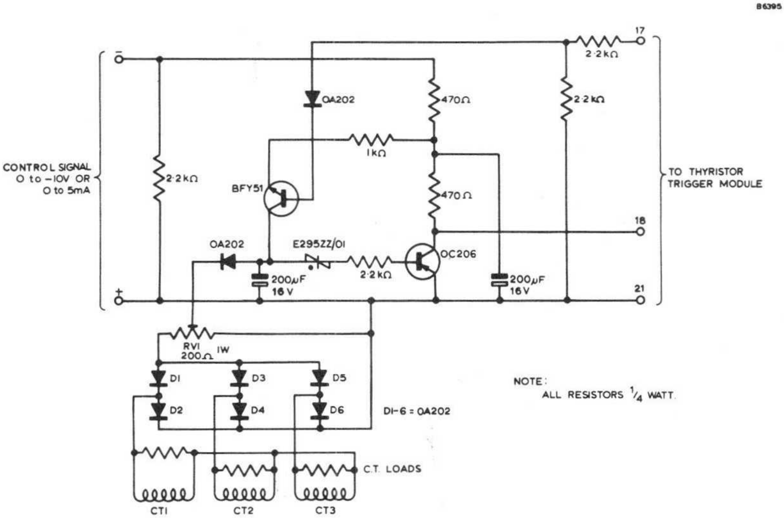
Fig.10



Interconnection of 3 MY5011 thyristor trigger modules and 3 MY5201 transformers for use with a three-phase a.c. controller

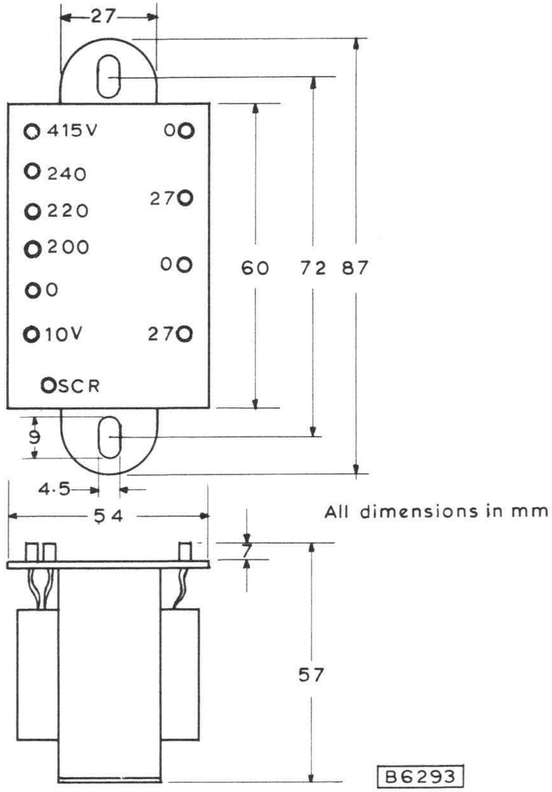
Current limit and surge suppression

A circuit for limiting maximum current in loads controlled by an MY5011 is shown below.
The C.T. loads should be selected to give a potential of 5.0V peak across RV1 at nominal full load current.
Current limit operating point is set by RV1.



Current limit and surge suppression circuit

SUPPLY TRANSFORMER MY5201



Specifications

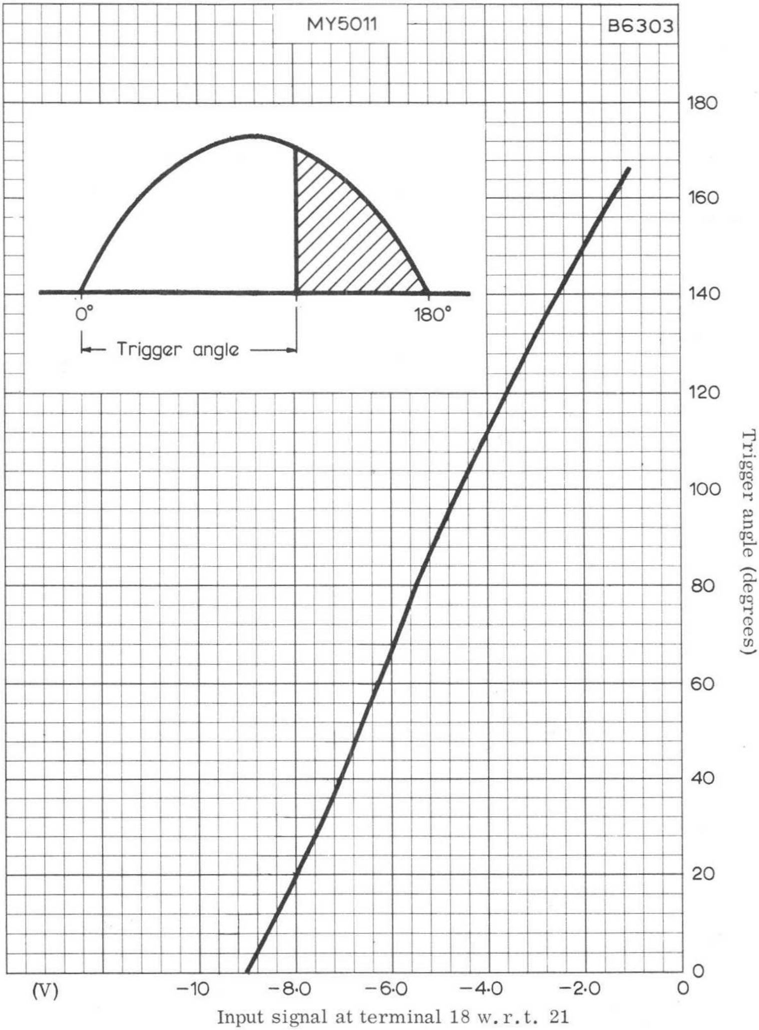
Primary windings

0-10-200-220-240-415 volts, 50Hz

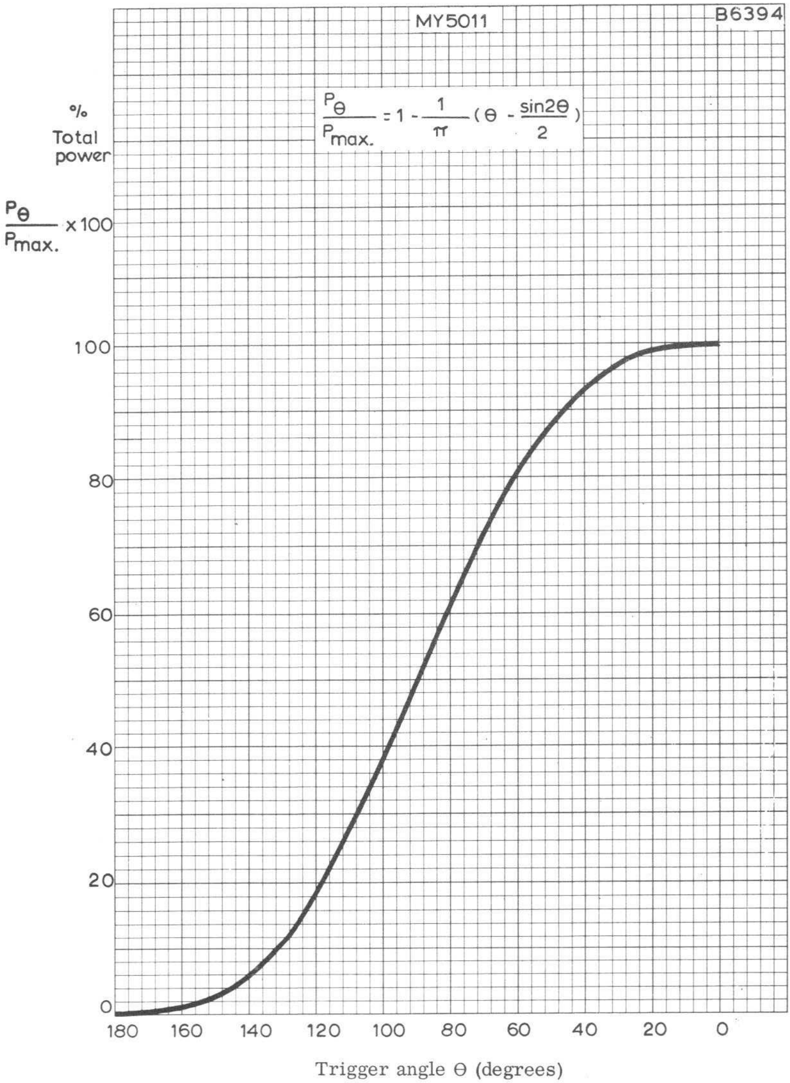
Secondary windings

Two separate windings 0-27 volts, 82mA

Weight 560gm



TYPICAL CONTROL CHARACTERISTIC



RELATIONSHIP BETWEEN POWER SUPPLIED TO A RESISTIVE LOAD AT A GIVEN TRIGGER ANGLE AND THE MAXIMUM POSSIBLE POWER

CURRENT OVERLOAD AND SURGE SUPPRESSION MODULE

MY5051

TENTATIVE DATA

For use in conjunction with thyristor trigger modules in applications requiring current limit and surge suppression.

GENERAL

The MY5051 is a circuit module specially designed to work with the MY5001 thyristor trigger module in power control systems. It may also be used with other thyristor trigger modules.

It requires an input signal which is proportional to the current in the load and which may be derived from a low series resistance or from a current transformer. The output of the MY5051 is used to control the thyristor trigger module such that the trigger angle is rapidly increased if the current in the power circuit exceeds a pre-determined value.

Initial surge currents which arise when power is first switched on are limited by the action of a thermistor which causes the thyristors to switch on at a large trigger angle and allows this trigger angle to reduce gradually over a period of about 100ms. This period is sufficient for the current sensing circuit to become properly charged, and in motor control applications allows the field excitation to become stabilised.

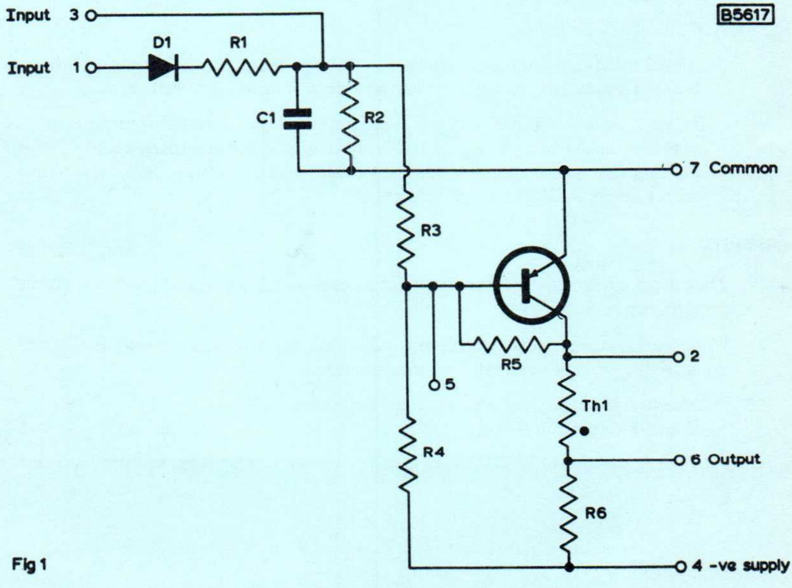


Fig.1 Basic circuit diagram showing terminal connections

OPERATING TEMPERATURE RANGE

T_{amb}	0 to 55	^oC

POWER SUPPLY

In most applications the power supply for the module is obtained from the thyristor trigger module which is being controlled. The negative side of the supply goes to terminal 4 and the positive side of the supply to terminal 7 (common)

Maximum voltage on terminal 4, with respect to terminal 7	-14	V

CONTROL INPUTS

It is important that the control signal be derived from a low impedance source (10Ω max.) since this impedance slows the speed of response of the MY5051. The input circuit is designed to have a charging time constant of 10ms ($R_1 = 10\Omega$ and $C_1 = 1000\mu F$) and a discharge constant greater than 500ms.

Adjustment of the point of control must be made by varying the amplitude of the control signal applied to the input terminal.

D.C. Control (see Fig. 2)

Where the control signal is derived from a d.c. source it should be applied to terminals 1 and 7 (terminal 1 positive). The internal diode D1 is to prevent capacitor C1 from discharging through the source.

A.C. Control (see Fig. 3)

A control signal derived from an a.c. source should be applied to terminals 3 and 7 via a full-wave rectifier bridge (terminal 3 positive).

In applications where current overloads are known to be symmetrical it may be satisfactory to apply the control signal to terminals 1 and 7, thus making use of the internal diode as a half-wave rectifier and dispensing with the external rectifier bridge.

OUTPUT

The output can be taken direct from terminals 6 and 7 to the MY5001 thyristor trigger module.

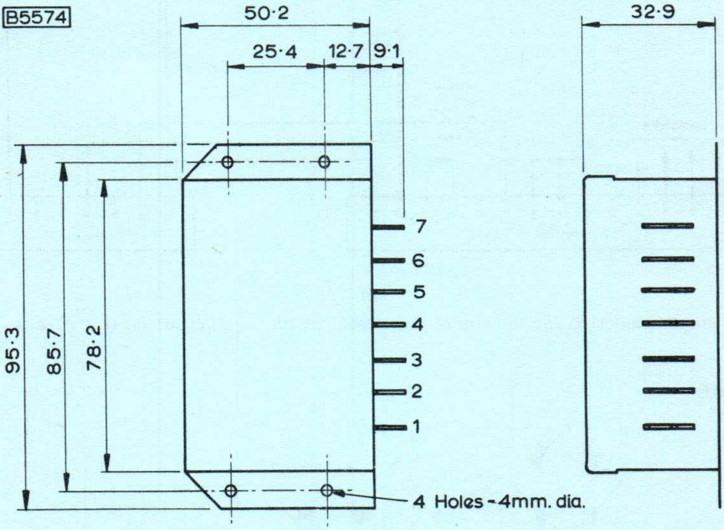
When initial surge protection is not required, the thermistor may be short-circuited by a link between terminals 2 and 6

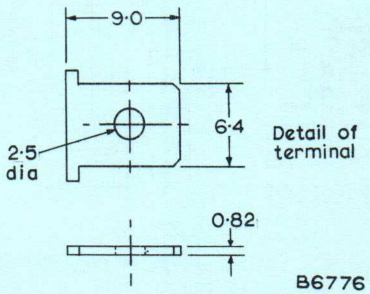
Maximum output current through terminals 6 and 7 (terminal 6 negative)	peak 60	mA
	r.m.s. 30	mA

CURRENT OVERLOAD AND SURGE SUPPRESSION MODULE

MY5051

OUTLINE AND DIMENSIONS





All dimensions in mm

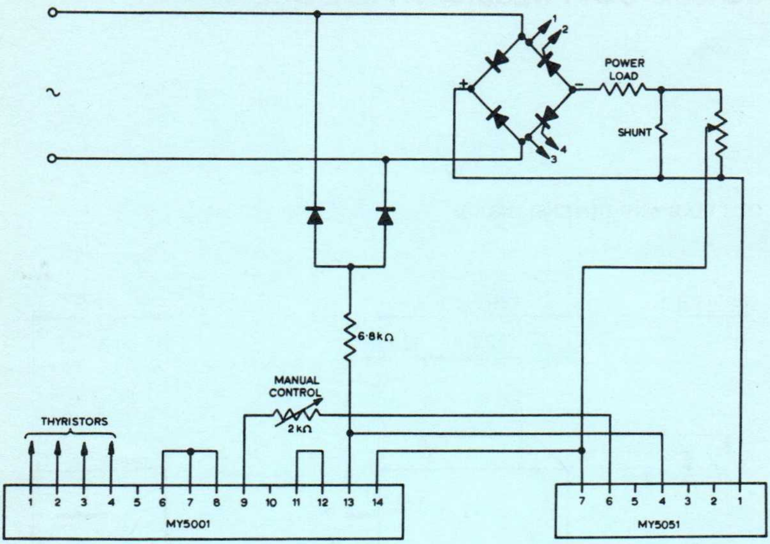


Fig.2

Interconnection for the use of the MY5051 with the MY5001 on D.C. loads

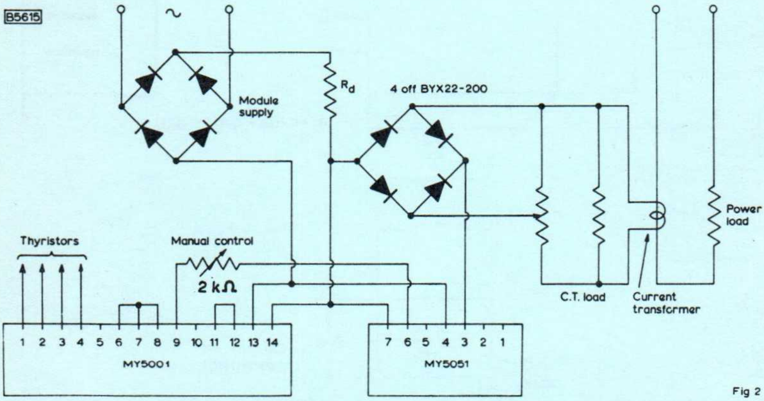


Fig. 3

Interconnection for the use of the MY5051 with the MY5001 on A.C. loads

Performance of MY5051 when used in the circuit shown in Fig.2 and 3

Peak voltage at input terminal Vpk	Thyristor trigger angle
0 to 3.7	72° min. (see below)
4.3	165.5°

The value of the C.T. load resistor or D.C. shunt should be such as to give approximately 4.0 to 5.0V peak at nominal full load. This voltage may be reduced to 3.7V peak via a suitable potentiometer (50Ω, 1.0W, w.w.). Current limitation will then occur at currents in excess of nominal values.

The output of the MY5051 is in series with the normal power control input to the MY5001 and the figures given above apply when that control is set for a low trigger angle.

The minimum trigger angle 72° is due to the combined impedance of the transistor and the thermistor in the output of the MY5051. If the initial surge protection is not wanted, the thermistor is short-circuited and a lower trigger angle is achieved. In some applications it might be convenient to short-circuit the thermistor after the power has been switched on.

Alternatively, a lower trigger angle will result if a resistance of up to 150Ω is inserted between terminals 11 and 12 of the MY5001.

Attention is drawn to the fact that, in most applications, the input terminals of the MY5001 are directly connected to the mains. If the control signal for the MY5051 is not isolated from the power line, great care must be taken to avoid short-circuits.

SINGLE-PHASE THYRISTOR STACKS

OTH10-608L
OTH10-1008L

TENTATIVE DATA

The OTH10 series are half-controlled bridge-connected thyristor stacks with flywheel diode, intended for 250 or 440V single-phase mains. They are capable of supplying up to 10A at an ambient temperature of 35°C.

QUICK REFERENCE DATA

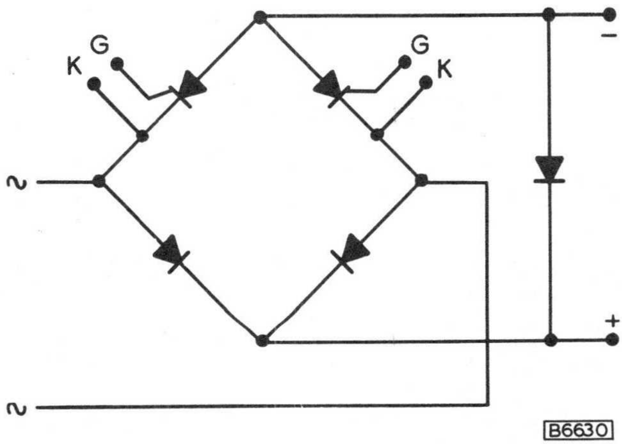
		OTH10 - 608L	1008L	
Input				
$V_{I(RMS)}$	Max. r.m.s. voltage	420	707	V
V_{IRM}	Max. repetitive peak voltage	600	1000	V
Output				
V_O	Max. average voltage	375	636	V
I_O	Max. average current (T_{amb} = 35°C, natural convection cooling)	10	10	A

Unless otherwise stated data is applicable to both types in the series

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

		OTH10 - 608L	1008L	
Input voltage				
$V_{I(RMS)}$	Max. r.m.s. voltage	420	707	V
V_{IWM}	Max. crest working voltage	600	1000	V
V_{IRM}	Max. repetitive peak voltage	600	1000	V
V_{ISM}	Max. non-repetitive peak voltage ($t < 10ms$)	720	1100	V
Output voltage				
V_O	Max. average voltage	375	636	V

Output current

I_O	Max. average current Resistive or inductive load 180^o conduction of thyristors and natural convection cooling		
	$T_{amb} \leq 35^oC$	10	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	40	A

Temperature

T_{stg} max.	100	^oC
T_{amb} (operating)	See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	2.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	25	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	244	g
	8.6	oz
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows:

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.
Trigger Modules are available for this stack (Type No. MY5001, MY5011)
3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:-

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack, it is protecting, must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:

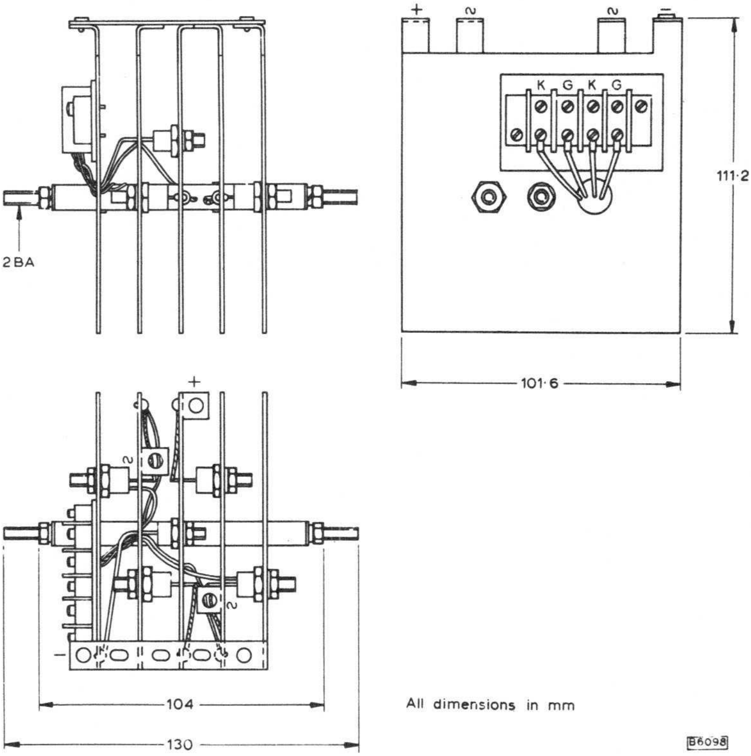
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$.
See also English Electric GS fuse data.

SINGLE-PHASE THYRISTOR STACKS

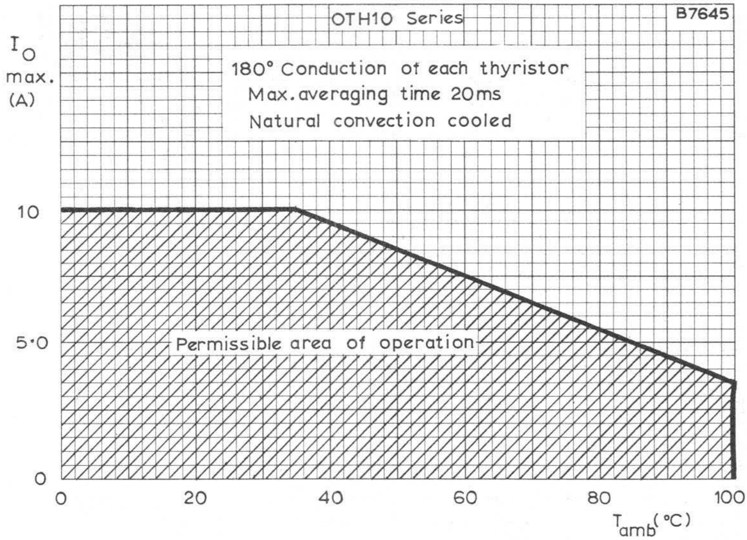
OTH10-608L OTH10-1008L

OUTLINE AND DIMENSIONS

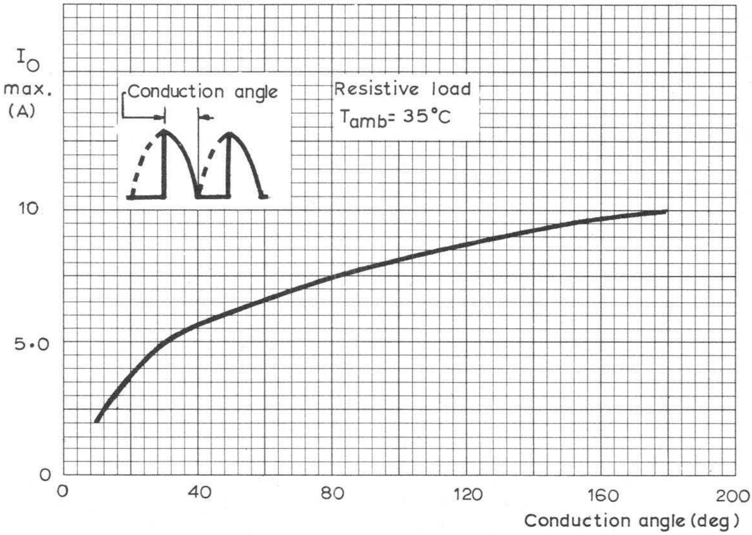


Suitable replacement devices

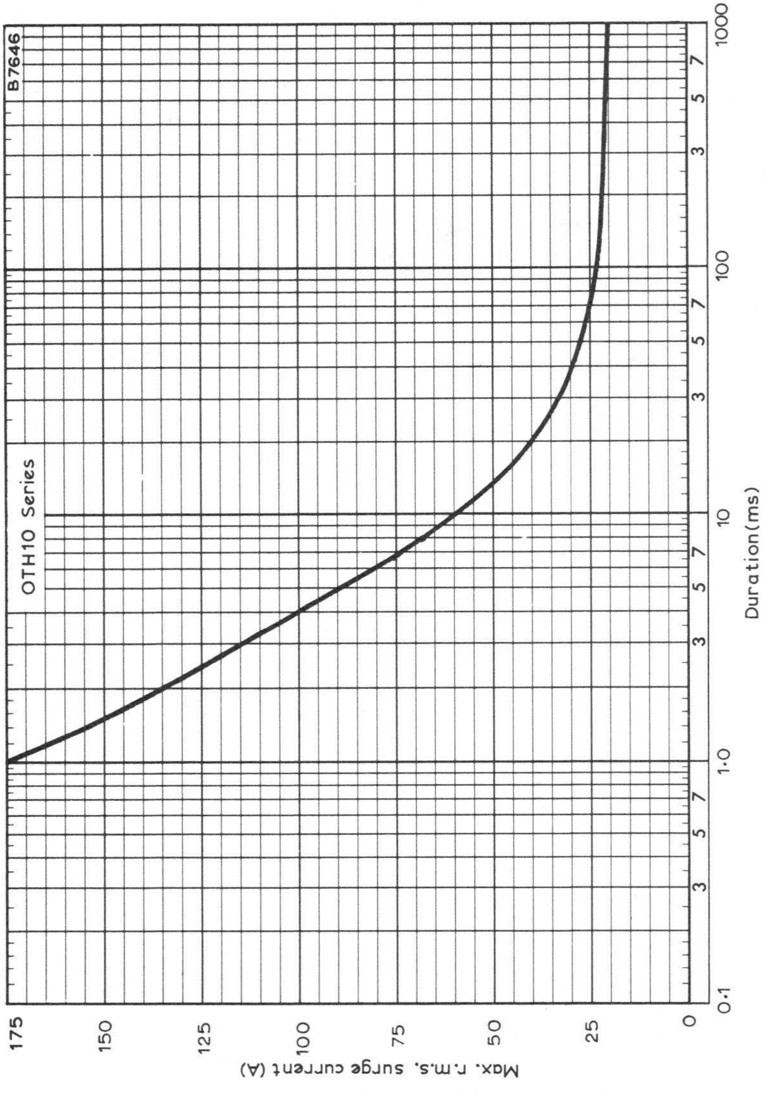
	OTH10 - 608L	OTH10 - 1008L
Thyristors	BTY79 - 600R	BTY79 - 1000R
Diodes in bridge circuit	BYX39 - 600R	BYX39 - 1000R
Flywheel diode	BYX39 - 600	BYX39 - 1000



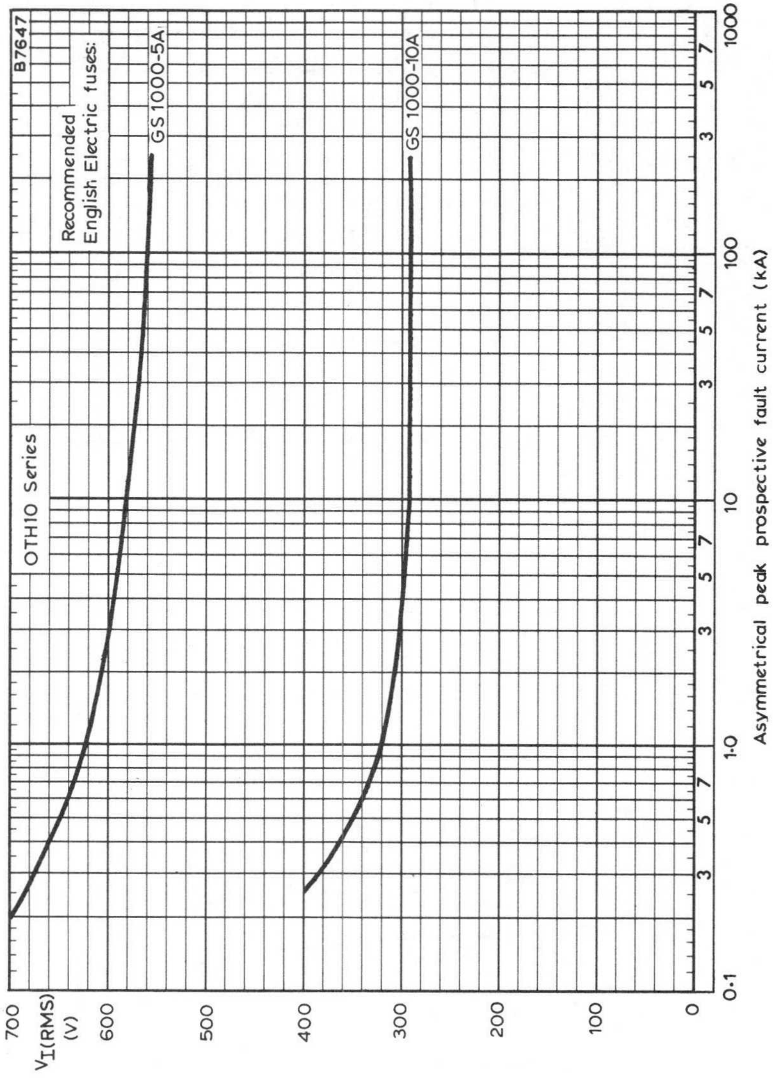
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



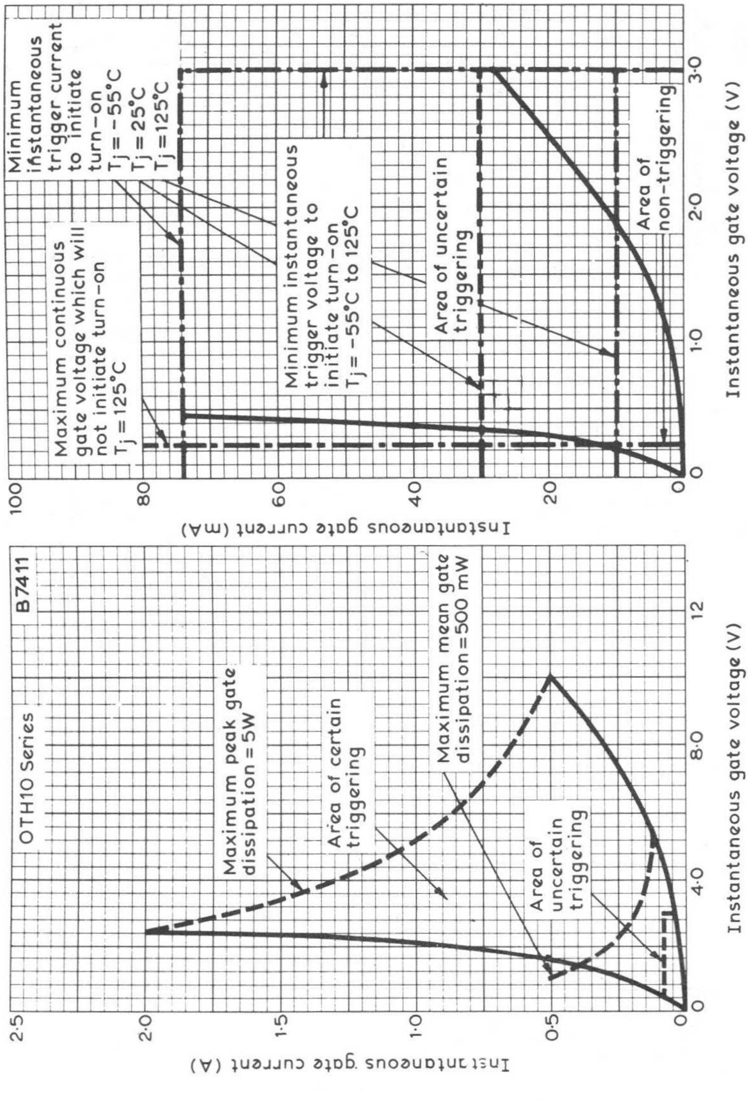
MAXIMUM MEAN OUTPUT CURRENT FOR A RESISTIVE LOAD PLOTTED AGAINST CONDUCTION ANGLE



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION
(FOR FUSE AND CIRCUIT-BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$×1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH11-609L

TENTATIVE DATA

The OTH11-609L is an a.c. controller thyristor stack, intended for 250V single-phase mains. It is capable of supplying up to 11A r.m.s. at an ambient temperature of 35°C.

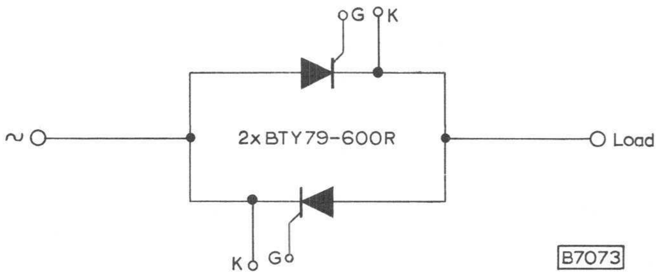
QUICK REFERENCE DATA

Input			
$V_{I(r.m.s.)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak voltage	600	V
Output			
I_O	Max. r.m.s. current ($T_{amb} = 35^{o}C$) (natural convection cooling)	11	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(rms)}$	Max. r.m.s. voltage	420	V
V_{IWM}	Max. crest working voltage	600	V
V_{IRM}	Max. repetitive peak voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (t < 10ms)	720	V

Output current

I_O	Max. r.m.s. current Resistive or inductive load 180^o conduction of thyristors and natural convection cooling		
	$T_{amb} \leq 35^oC$	11	A
	$T_{amb} > 35^oC$	See curve on page C1	

Temperature

T_{stg} max.	100	^oC
T_{amb} (operating)	See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C5)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	2.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	25	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	122	g
	4.3	oz
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.
Trigger Modules are available for this stack (Type No. MY5001, MY5011)
3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:-

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack, it is protecting, must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:

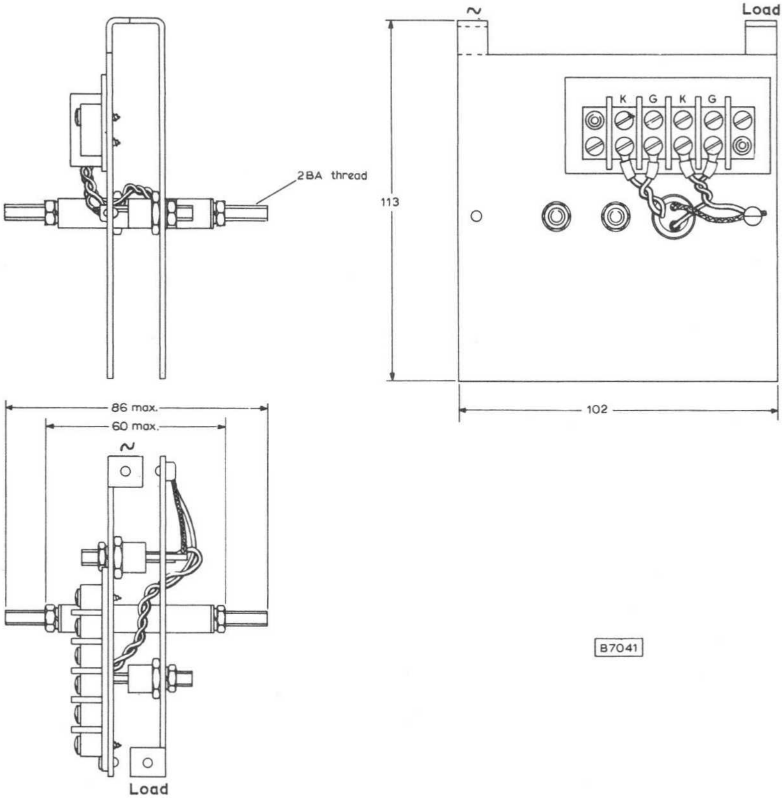
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$.
See also English Electric GS fuse data.

SINGLE-PHASE THYRISTOR STACK

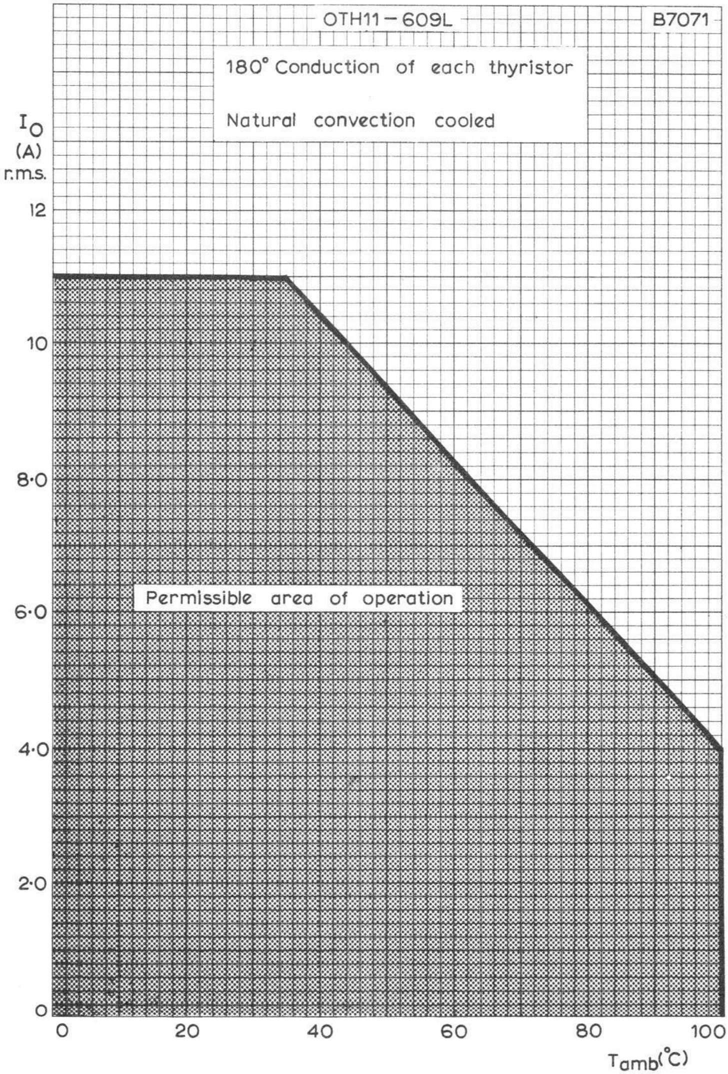
OTH11-609L

OUTLINE AND DIMENSIONS

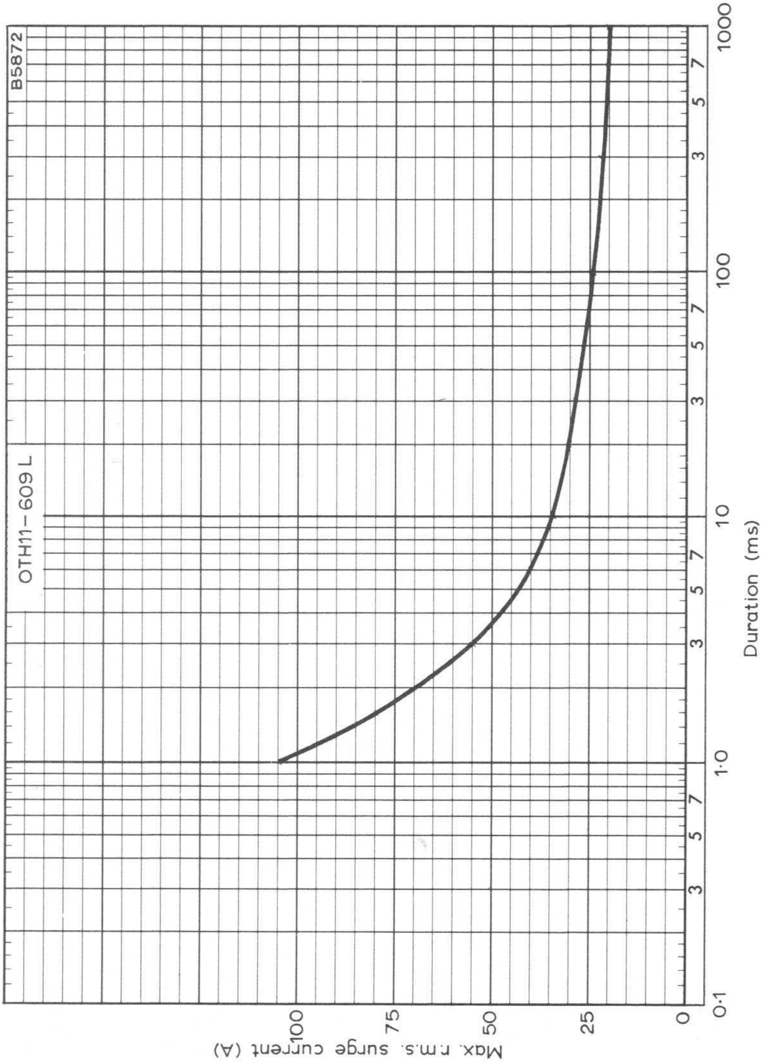


B7041

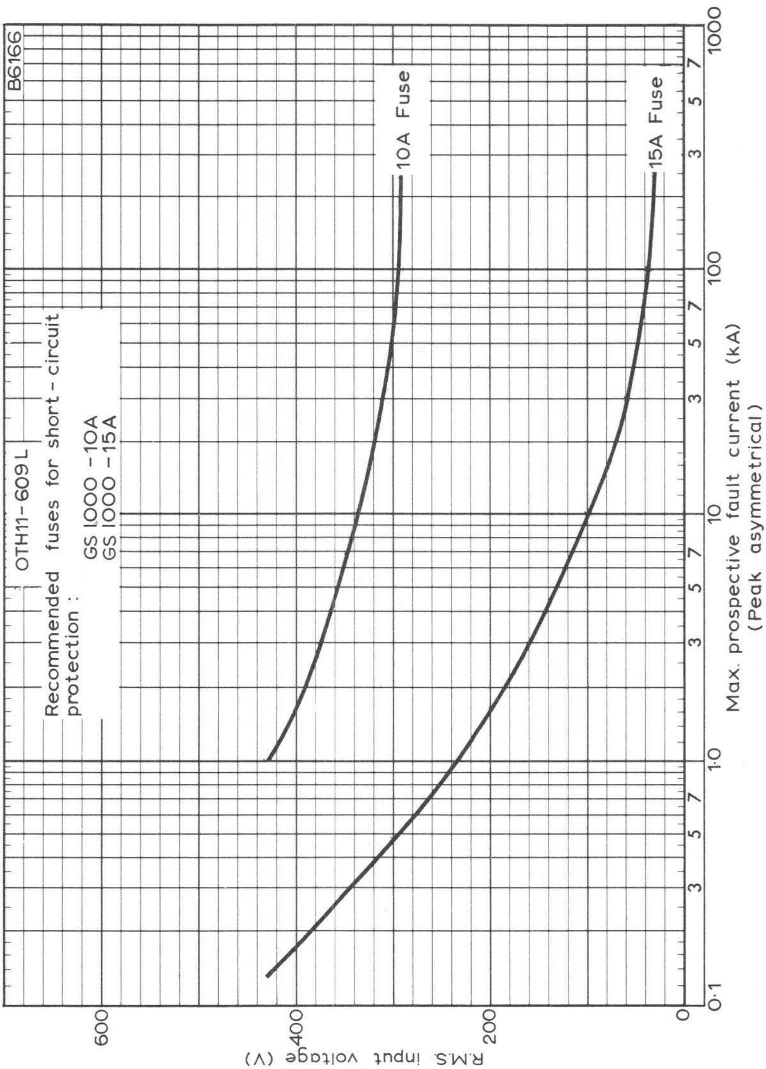
All dimensions in mm



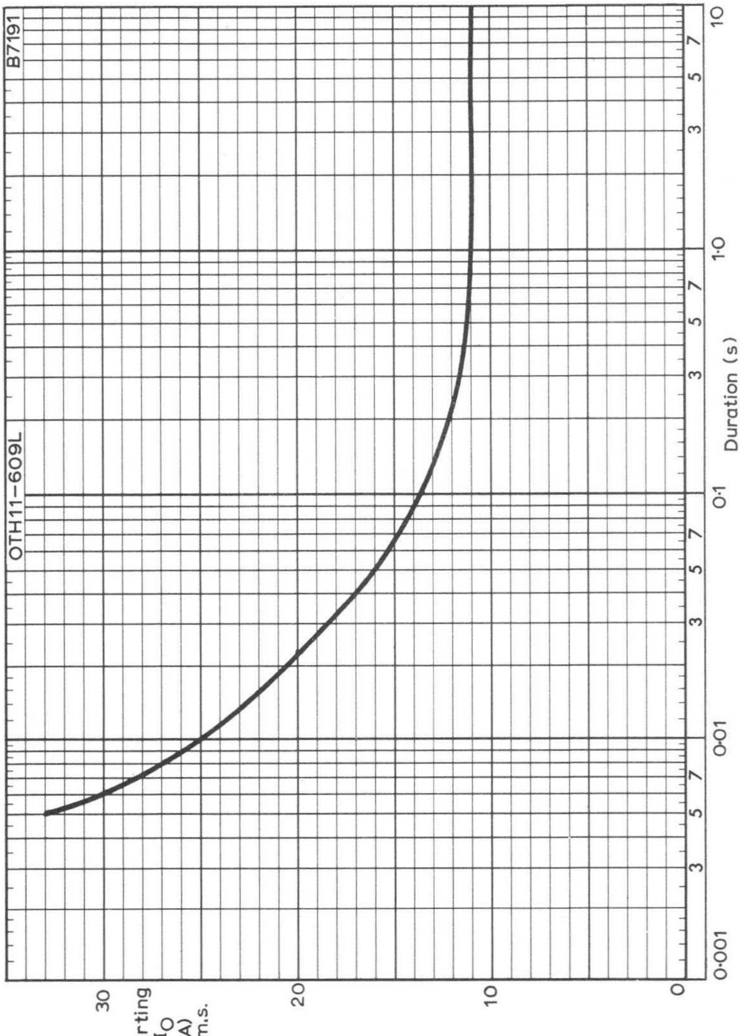
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



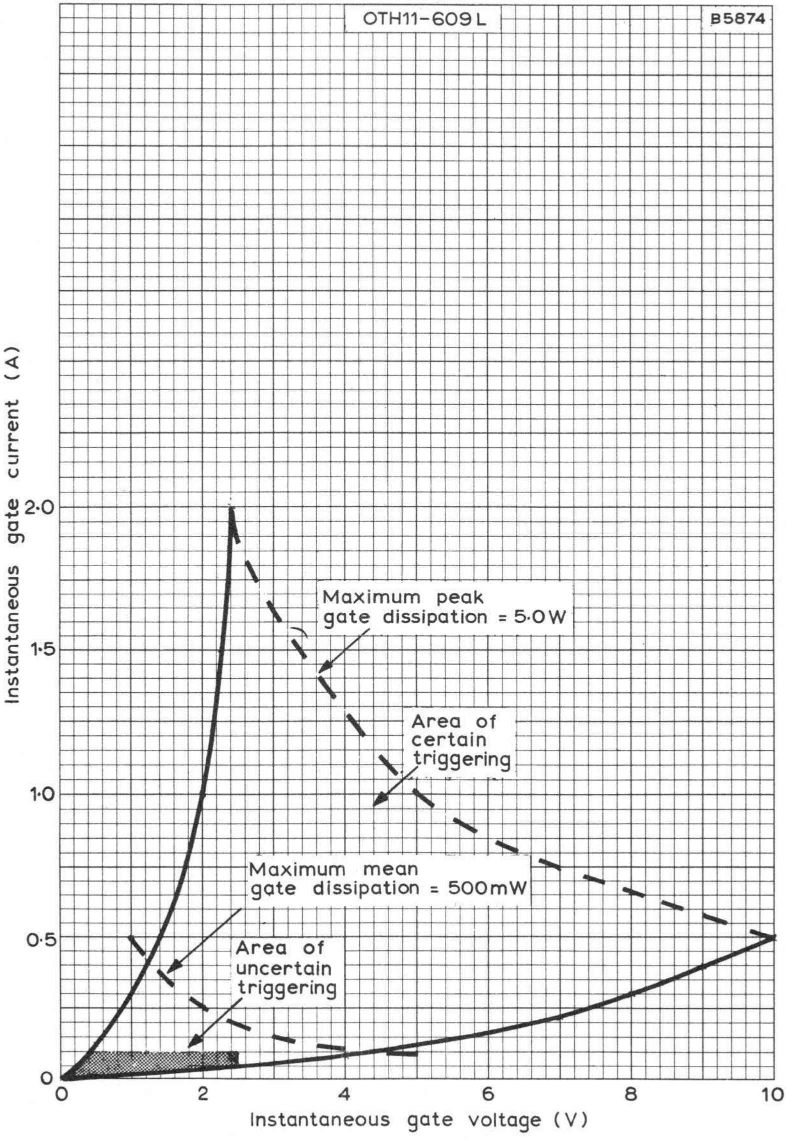
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION
(FOR FUSE AND CIRCUIT-BREAKER SELECTION)



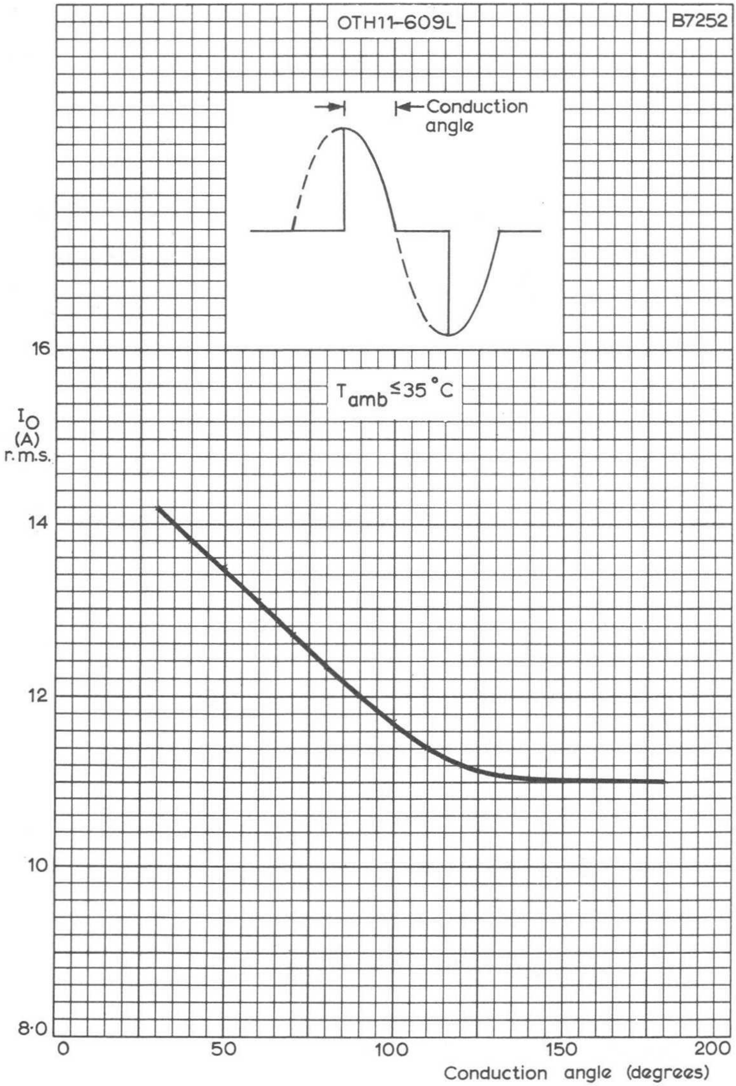
R.M.S. INPUT VOLTAGE PLOTTED AGAINST MAXIMUM PEAK ASYMMETRICAL PROSPECTIVE FAULT CURRENT



MAXIMUM STARTING CURRENT PLOTTED AGAINST
DURATION OF START



THYRISTOR GATE TRIGGERING CHARACTERISTICS



MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE

SINGLE-PHASE THYRISTOR STACK

OTH17-608

Half-controlled bridge-connected thyristor stack, suitable for 250V single-phase mains. It is suitable for natural convection or forced air cooling and is capable of supplying an output current of 17A at $T_{amb} = 35^{o}C$, with natural convection cooling and 180^{o} conduction of each thyristor.

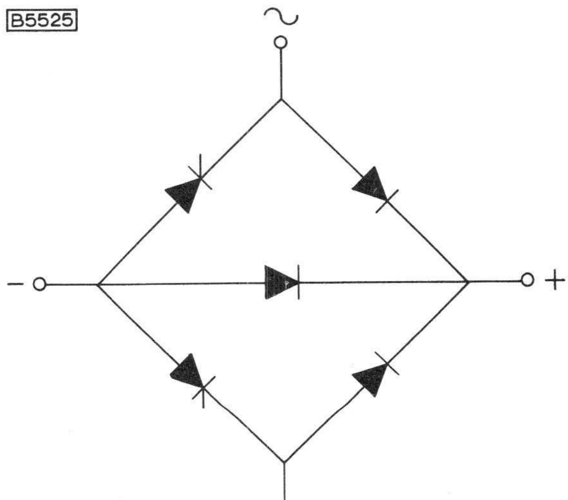
QUICK REFERENCE DATA		
Input		
Max. r.m.s. input voltage	420	V
Max. non-repetitive peak input voltage	720	V
Output		
Max. mean output current ($T_{amb} = 35^{o}C$) (natural convection cooling)	17	A
Max. repetitive peak output current	100	A

OUTLINE AND DIMENSIONS

For details see page D4

CIRCUIT DIAGRAM

B5525



RATINGS OF THE STACK

Limiting values of operation according to the absolute maximum system.

Electrical

Max. r.m.s. input voltage	420	V
Max. non-repetitive peak input voltage		
(fault conditions only, max. duration = 5ms)	720	V
*Max. mean output current, resistive or inductive load, 180^{o} conduction of each thyristor, with natural convection cooling		
$T_{amb} \leq 35^{o}C$	17	A
$T_{amb} > 35^{o}C$	See graph on page C1	
with an air flow of velocity 500ft/min.		
$T_{amb} \leq 35^{o}C$	24	A
$T_{amb} > 35^{o}C$	See graph on page C1	
For conduction angles other than 180^{o}	See graph on page C5	
Max. repetitive peak output current	100	A
Max. r.m.s. surge current for selecting protective devices	See graph on page C3	

Temperature

T_{stg} max.	125	^{o}C
T_{amb} max.	See graph on page C1	

ELECTRICAL RATINGS OF THYRISTOR GATES

Max. peak forward gate-to-cathode voltage, anode positive w.r.t. cathode	10	V
Max. peak reverse gate-to-cathode voltage	5.0	V
Max. peak forward gate current, anode positive w.r.t. cathode	2.0	A
Max. peak gate-to-cathode dissipation	5.0	W
*Max. average gate dissipation	500	mW

*Max. averaging time = 20ms.

TYPICAL CHARACTERISTICS OF THYRISTORS ($T_j = 125^oC$)

Thyristor gate characteristics	See graph on page C4	
Holding current	10	mA
Turn-on time		
forward voltage before triggering = 50V		
forward current = 1.0A	2.5	μs
= 10A	3.0	μs
= 50A	4.4	μs
forward voltage before triggering = 400V		
forward current = 1.0A	1.0	μs
= 10A	1.5	μs
= 50A	2.0	μs
Turn-off time		
rate of rise of applied forward voltage = 20V/μs		
forward current before recovery = 10A		
reverse current = 5 to 20A	15	μs

INSULATION

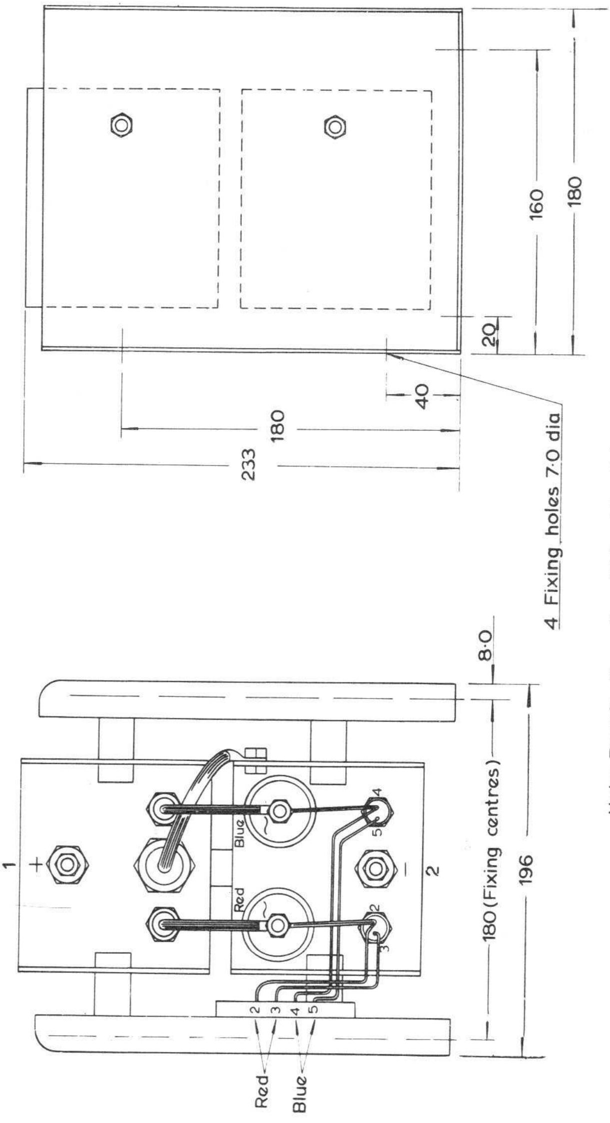
Designed to withstand 5kV (r.m.s.) between all electrical terminations joined together and the frame.

RECOMMENDED FUSES (For short circuit protection).

Fuse	Location
GSG1000/16A (English Electric)	A.C. input line
GSG1000/25A (English Electric)	See graph on page C2

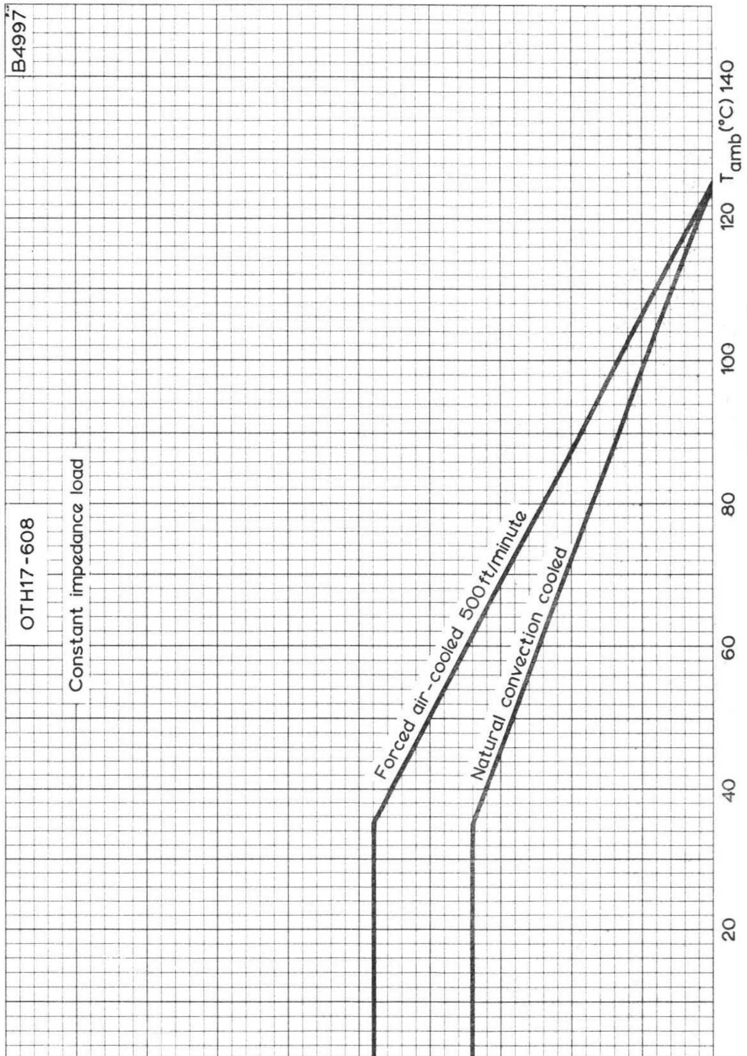
MECHANICAL DATA

Weight (approximately)	3.3	kg
	7.3	lb
Dimensions	See outline drawing on page D4	

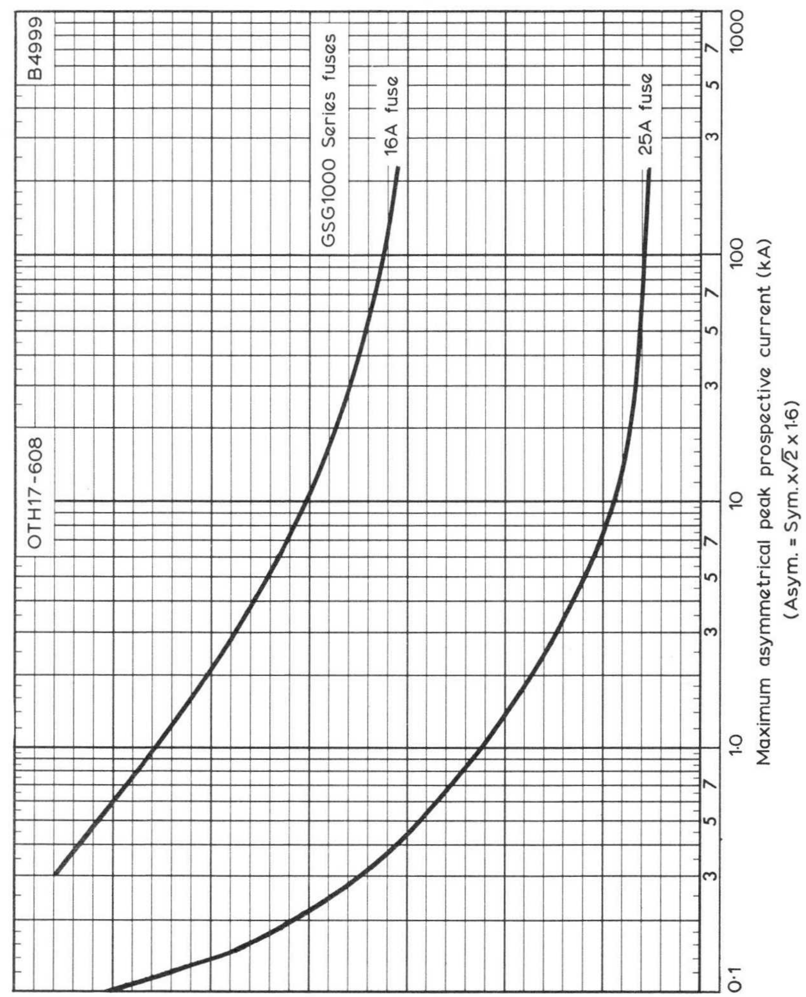


Note: Terminations lie within side-plate area, but clearance must be provided externally.
+ − and ~ terminations are $\frac{1}{4}$" U.N.F.

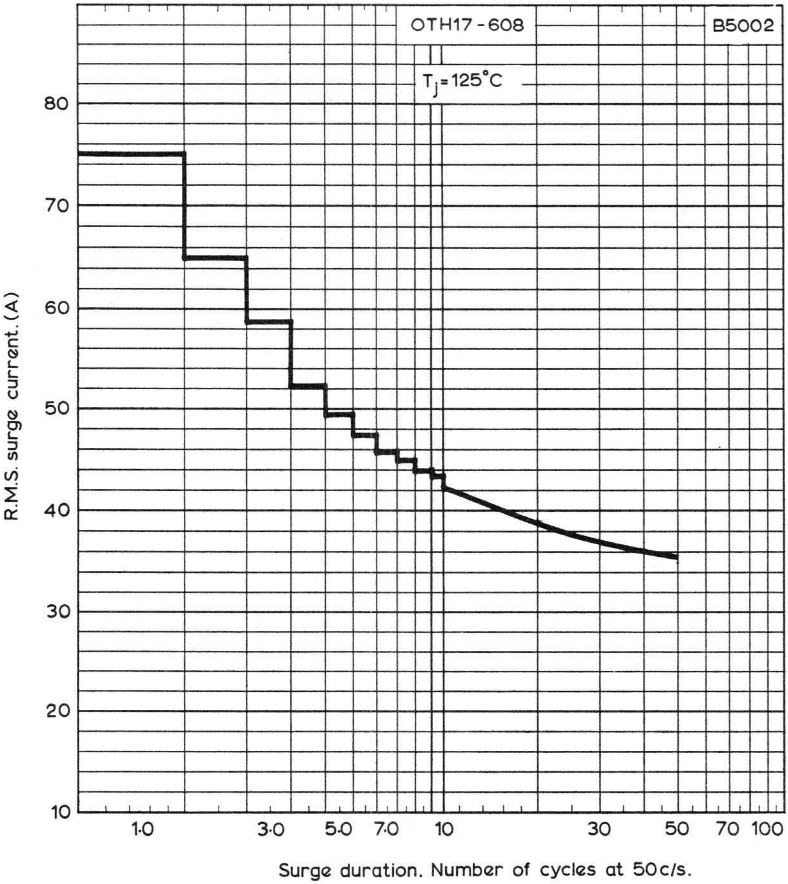
All dimensions in mm.



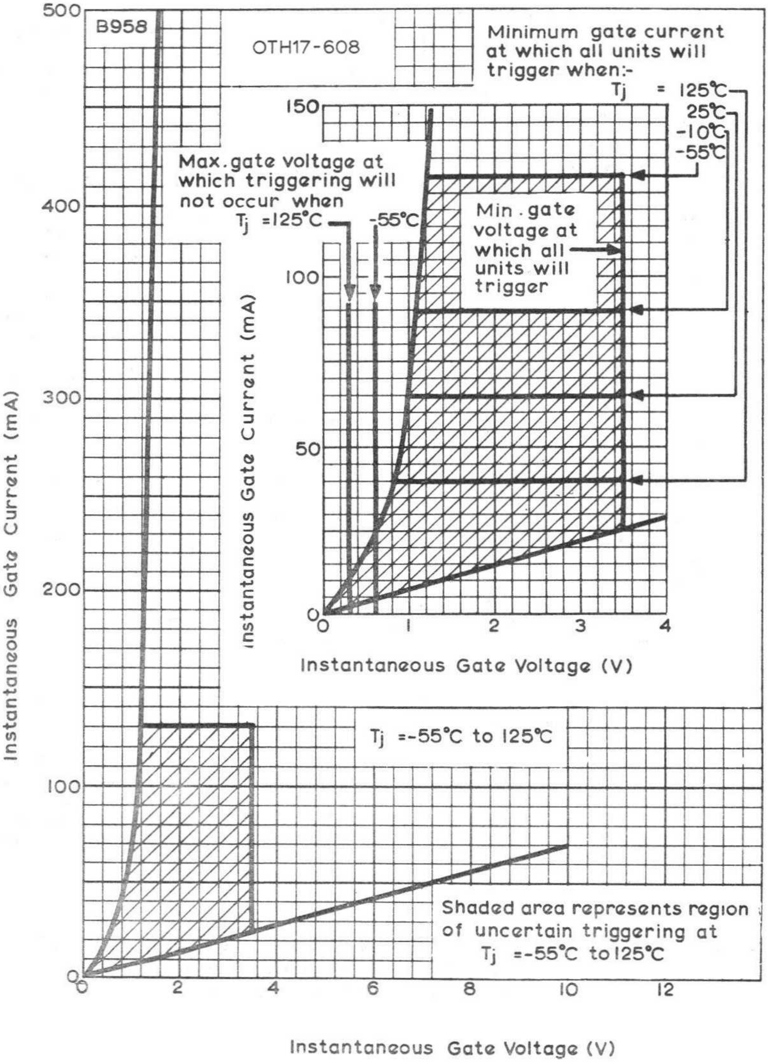
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE. 180° CONDUCTION OF EACH THYRISTOR, MAXIMUM AVERAGING TIME = 20ms



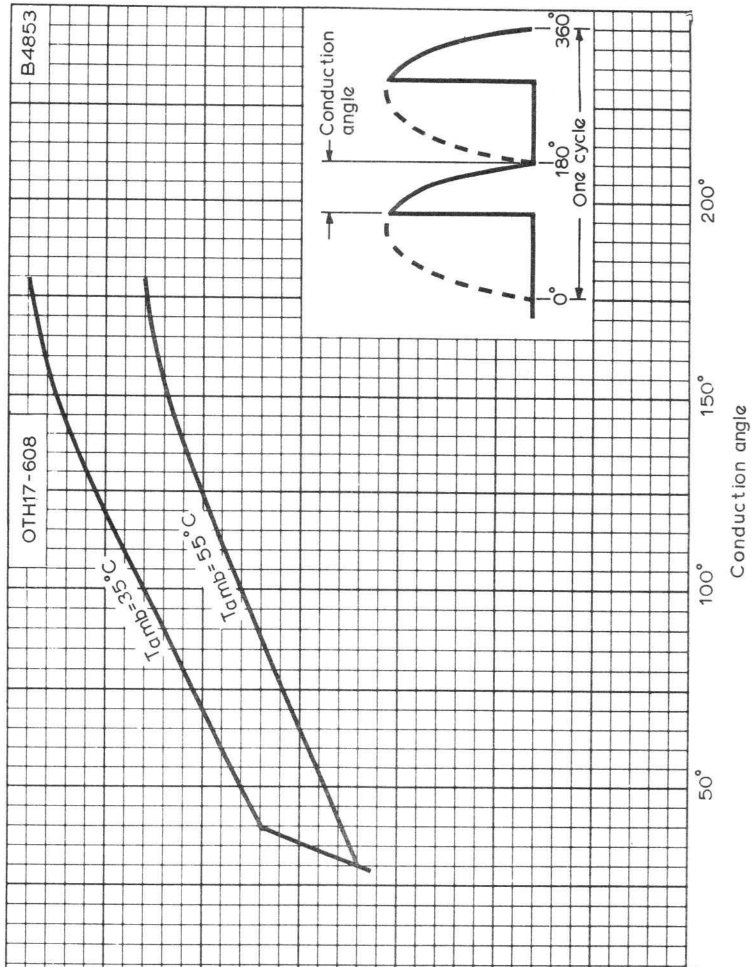
APPLIED VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT.
FOR SHORT CIRCUIT PROTECTION



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION.
FOR SELECTING PROTECTIVE DEVICES
(FUSES, CIRCUIT BREAKERS ETC.)



THYRISTOR GATE CHARACTERISTICS
THE TOP RIGHT-HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE, AT TWO AMBIENT TEMPERATURES

SINGLE-PHASE THYRISTOR STACK

OTH17-609

The OTH17-609 is a single-phase a.c. controller consisting of two thyristors mounted on two 30D heatsinks. It is capable of supplying an r.m.s. current of 19A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of up to 250Vr.m.s.

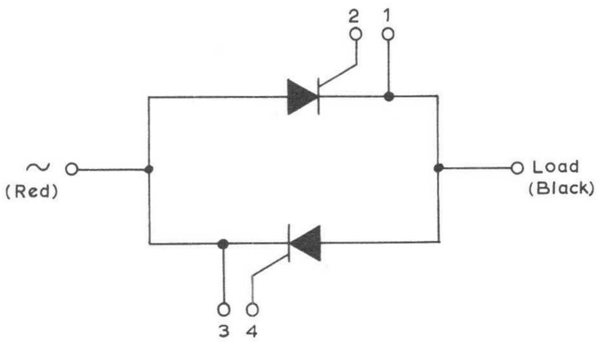
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5.0ms)	720	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^{\circ}C$	19	A

OUTLINE AND DIMENSIONS

For details see page D5.

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5ms)	720	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180^o conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^oC$	19	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	115	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max. (see also curves on page C1)		125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	300	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx)	1.5	kg
	3.4	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:-

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English G.S.G. Fuse Data.

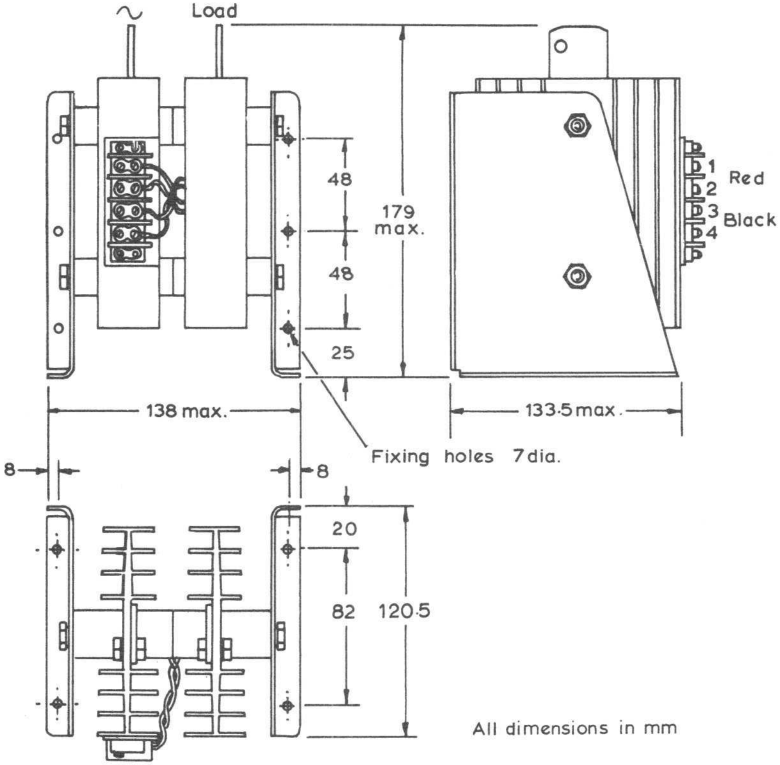
4. Suitable Replacement Devices

   Thyristors BTY87-600R

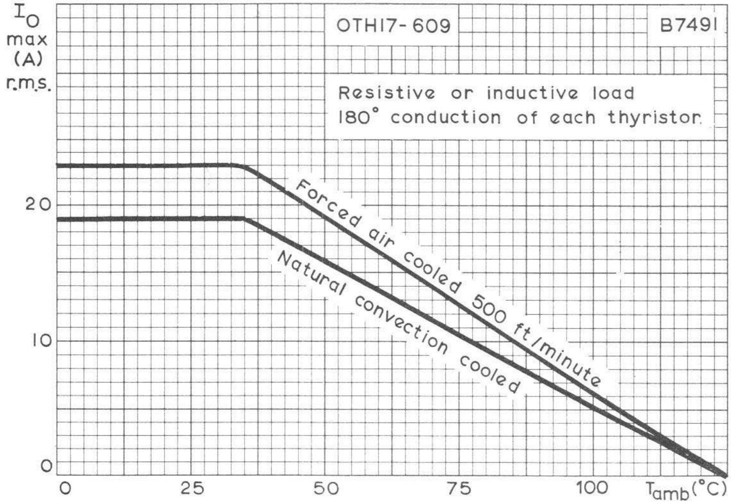
SINGLE-PHASE THYRISTOR STACK

OTH17-609

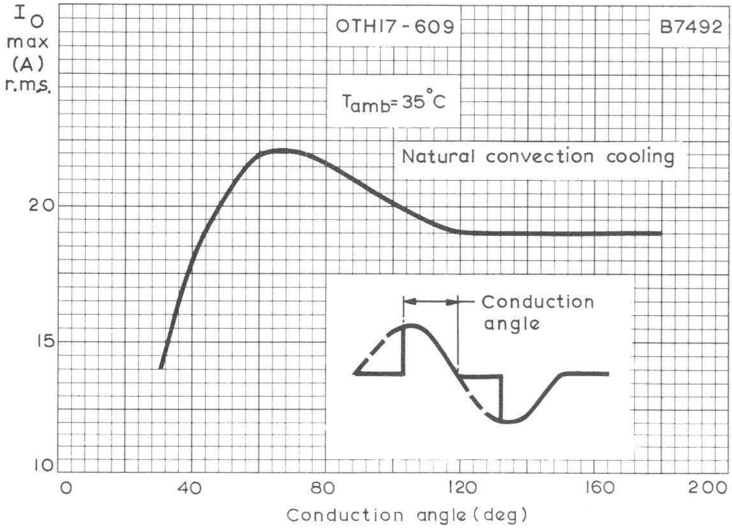
OUTLINE AND DIMENSIONS



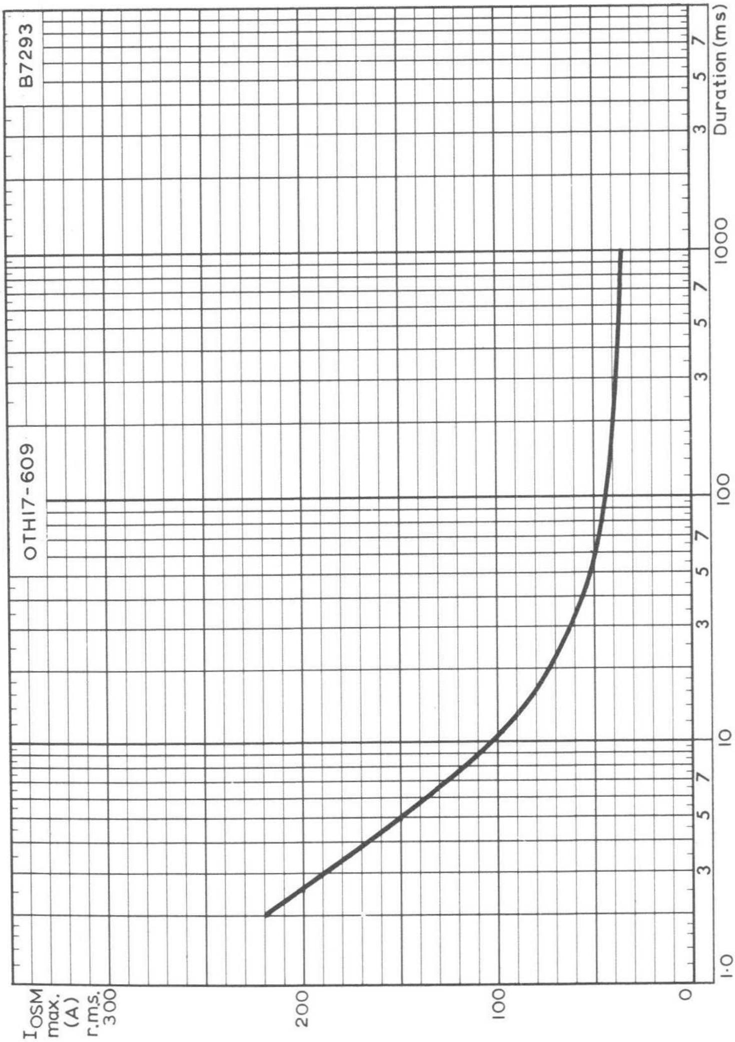
All dimensions in mm



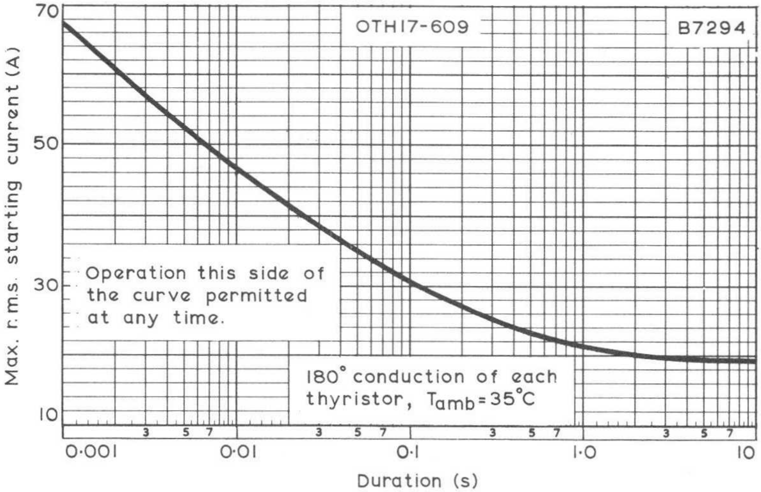
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



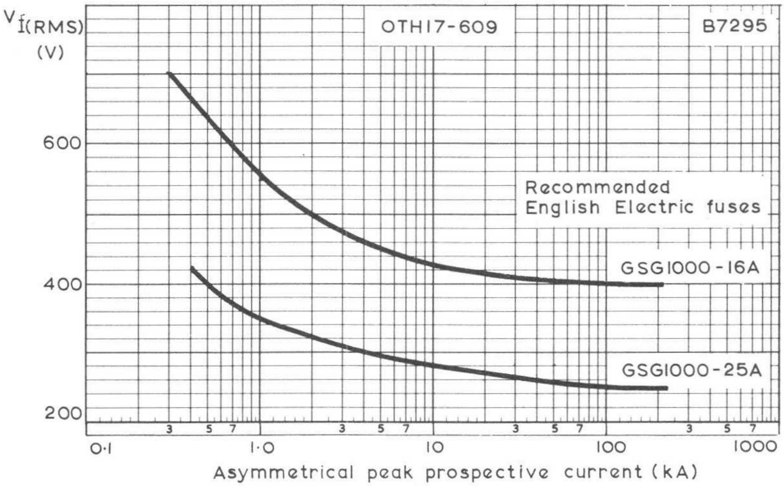
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



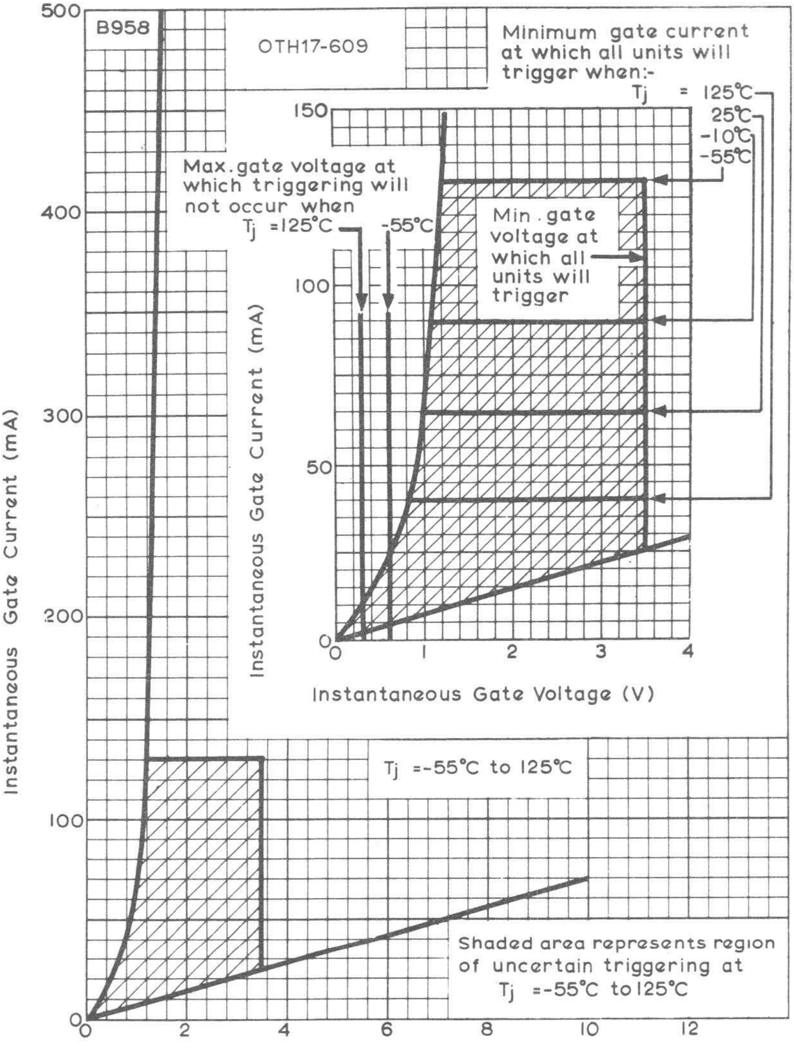
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

The OTH22-1208 is a half-controlled bridge connected thyristor stack with flywheel diode, intended for 440V single-phase mains. It is capable of supplying an output current of 22A at T_{amb} = 35°C with natural convection cooling and 180° conduction of each thyristor.

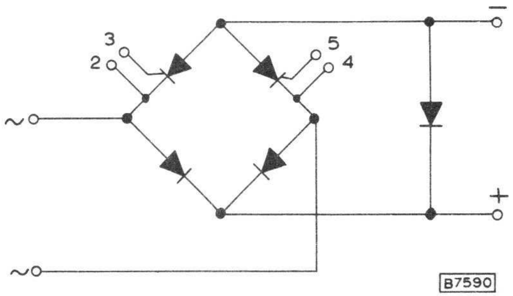
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak voltage	1100	V
Output			
V_O	Max. average voltage	505	V
I_O	Max. average current (T_{amb} = 35°C, natural convection cooling)	22	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak voltage	1100	V
V_{ISM}	Max. non-repetitive peak voltage, $t < 10ms$, see note 5	1100	V

Output voltage

V_O	Max. average voltage	505	V

Output current

I_O	Max. average current, resistive or inductive load, 180^o conduction of thyristors, natural convection cooled		
	$T_{amb} \leq 35^oC$	22	A
	$T_{amb} > 35^oC$	See curves on page C1	
	Forced air cooled at 500 ft/minute		
	$T_{amb} \leq 35^oC$	30	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	160	A

Temperature

T_{stg} max.		125	^oC
T_{amb} operating		See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	3.5	kg
	8	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. Suitable Replacement Devices

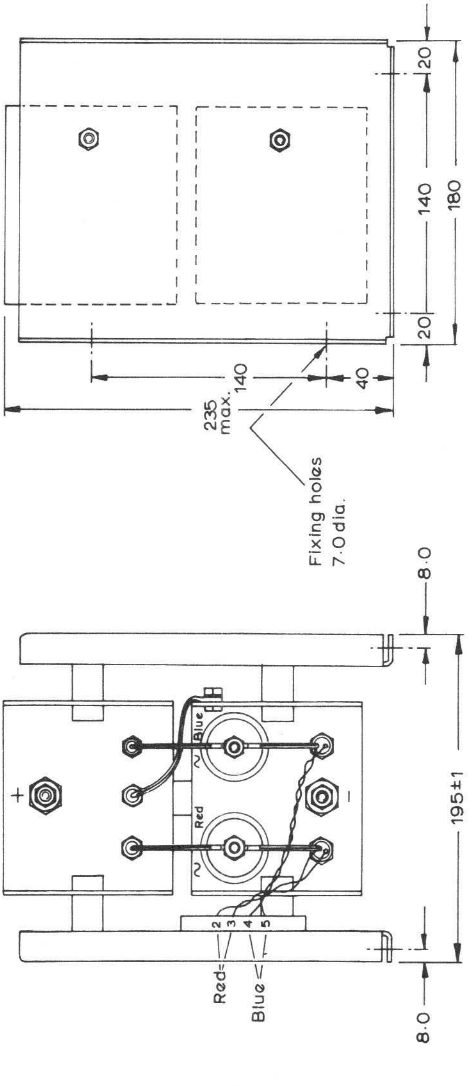
Bridge Diodes	BYX25 - 1000.
Bridge Thyristors	BTX47 - 1200R.
Flywheel Diode	BYX25 - 1000.

5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

SINGLE-PHASE THYRISTOR STACK

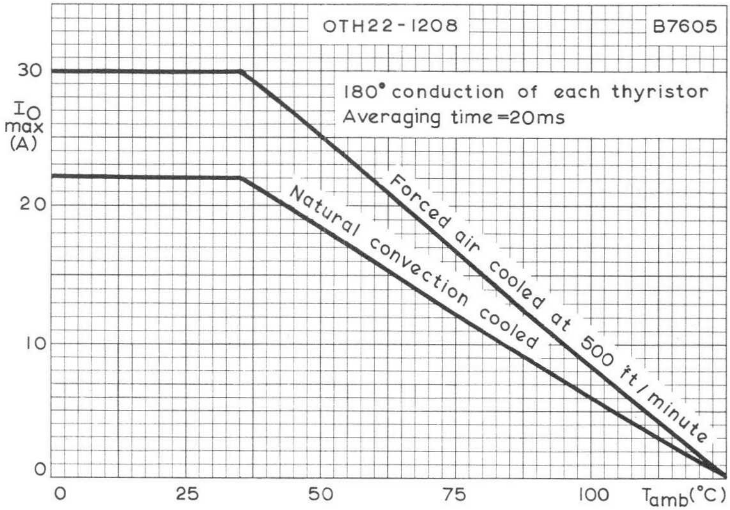
OTH22-1208

OUTLINE AND DIMENSIONS

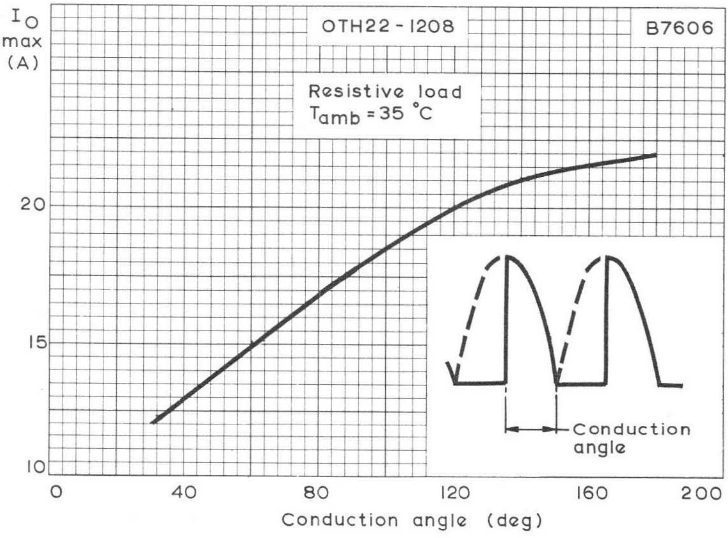


Note : Terminations lie within side plate area but clearance must be provided externally. +, −, and A.C. terminations are 1/4" UNF.

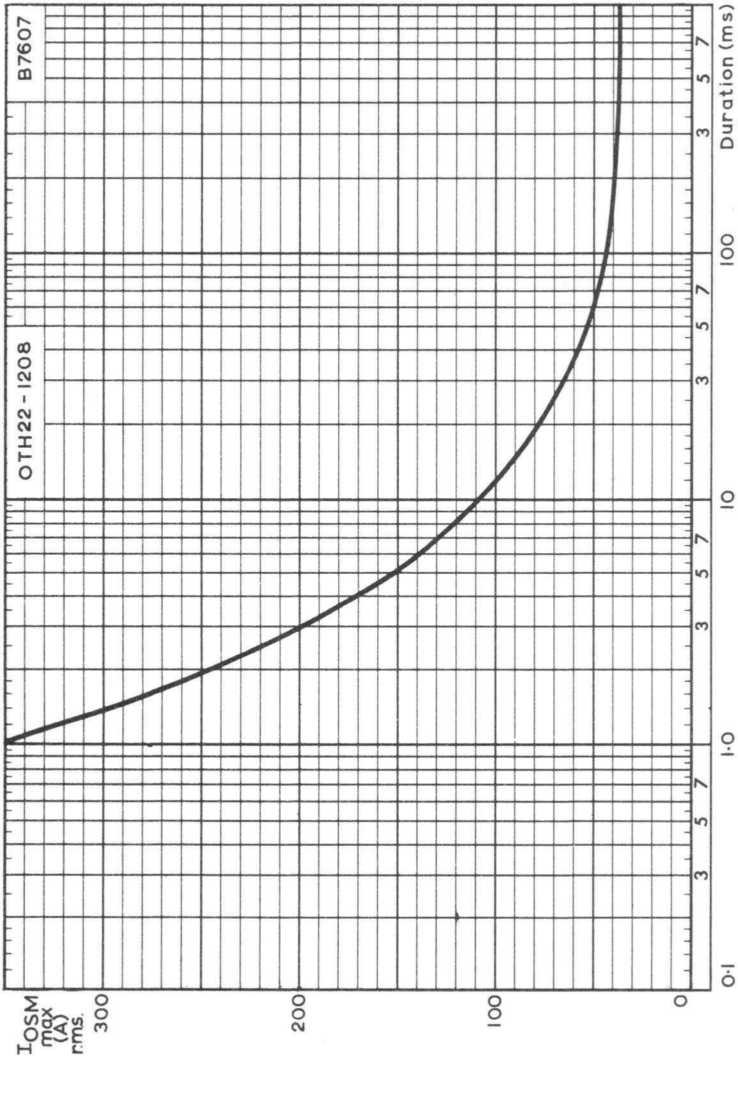
All dimensions in mm.



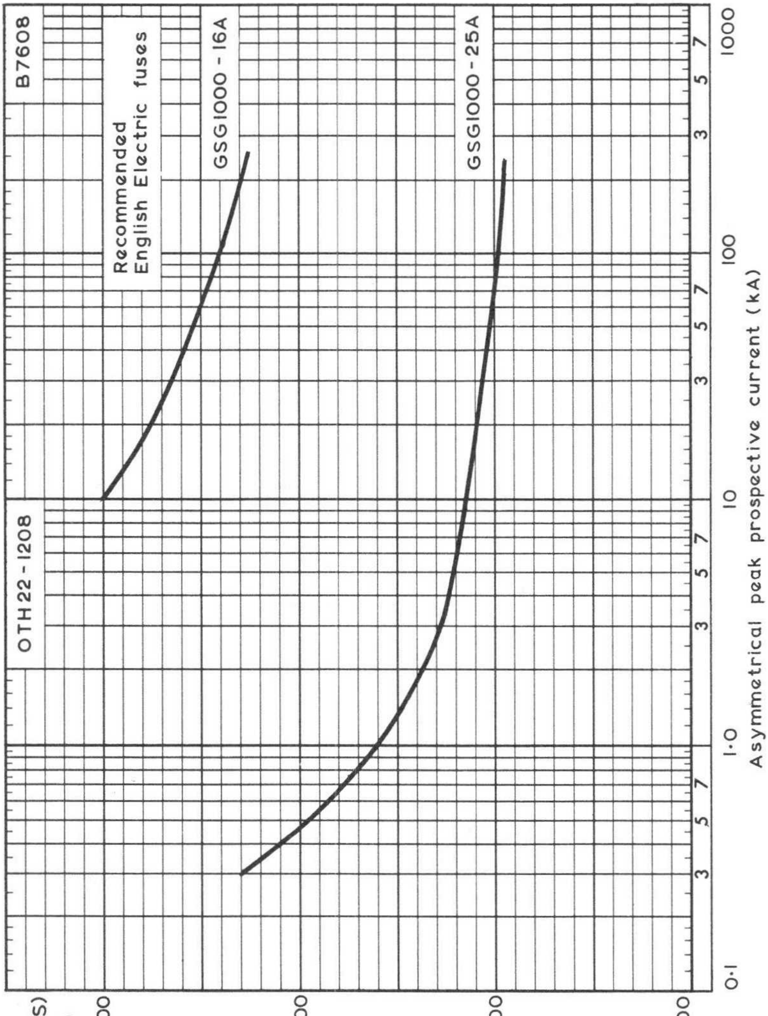
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



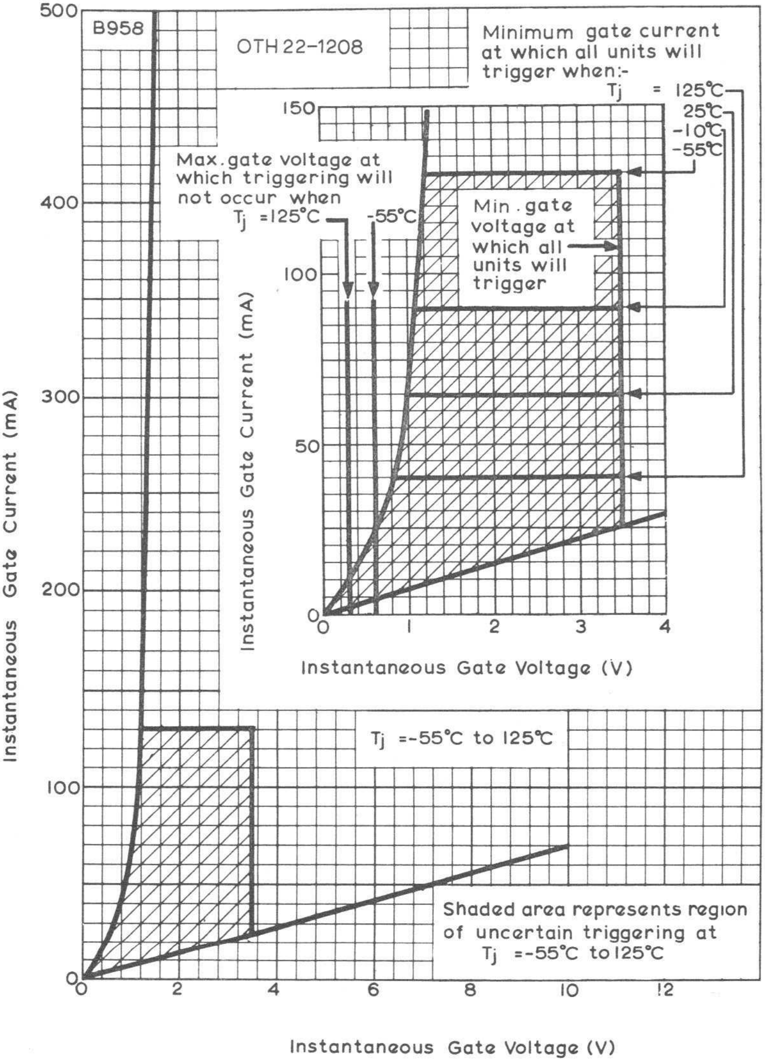
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE CURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF
THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH22-1209

TENTATIVE DATA

The OTH22-1209 is a single-phase a.c. controller consisting of two thyristors mounted on two 30D heatsinks. It is capable of supplying an r.m.s. current of 22A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of 440Vr.m.s.

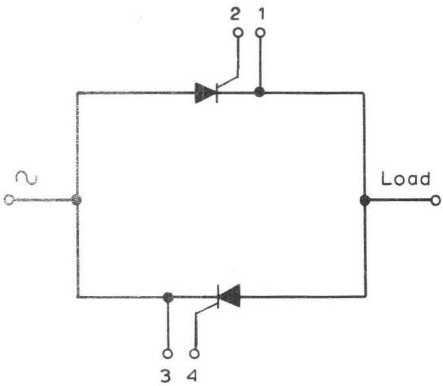
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^oC$	22	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t< 10ms, see note 5)	1100	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling		
	$T_{amb} \leq 35^oC$	22	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	26	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	160	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	°C
T_{amb} max.	(see also curves on page C1)	125	°C

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	1.5	kg
	3.4	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices**

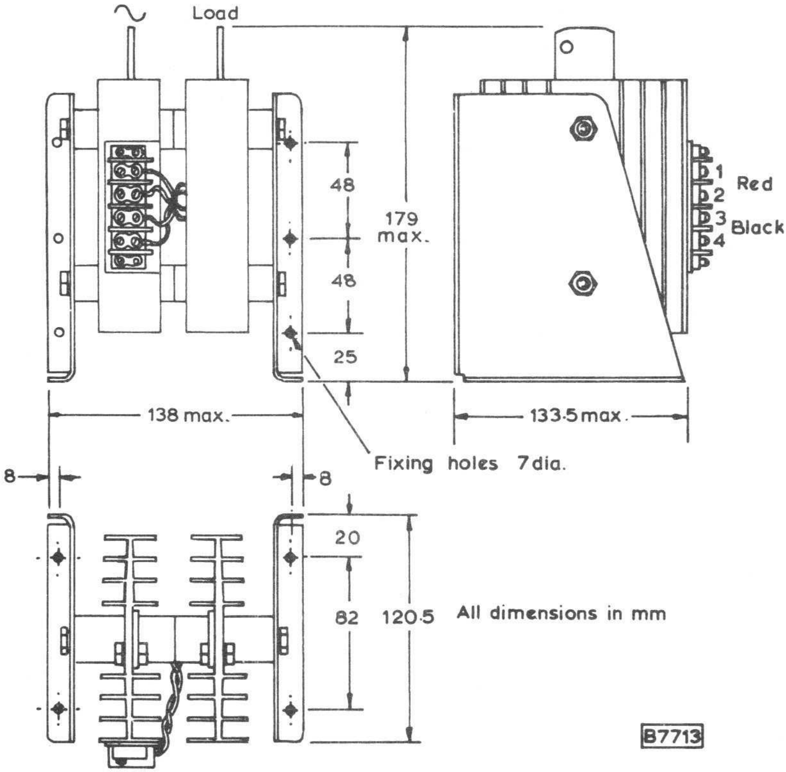
   Thyristors BTX47-1200R

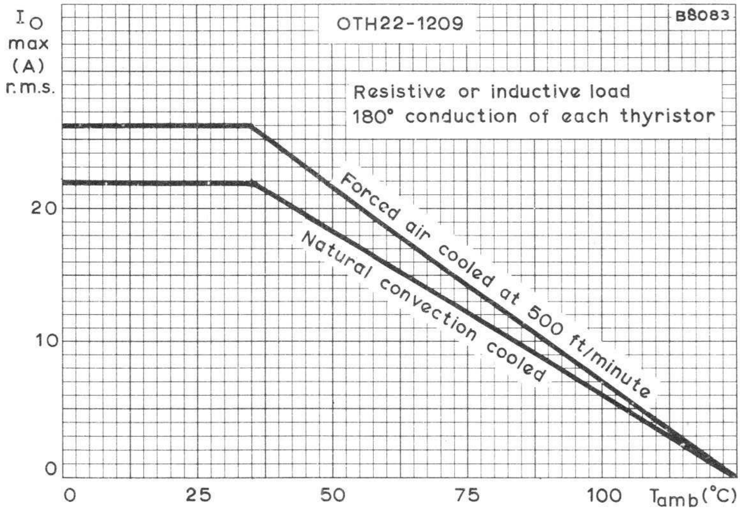
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

SINGLE-PHASE THYRISTOR STACK

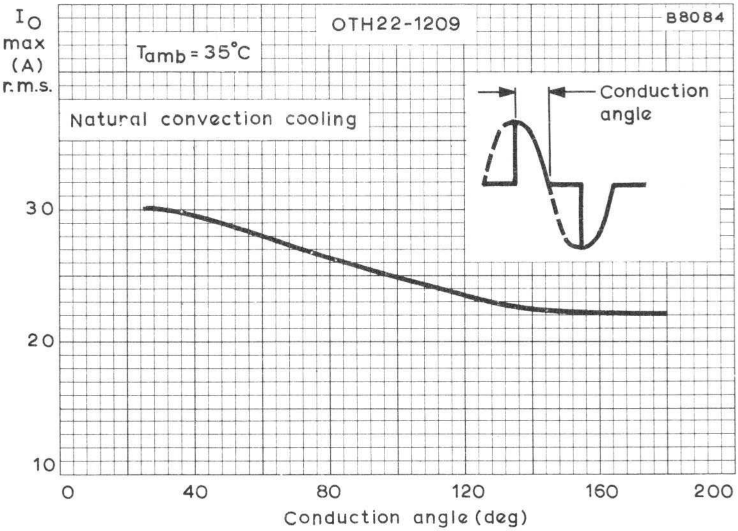
OTH22-1209

OUTLINE AND DIMENSIONS

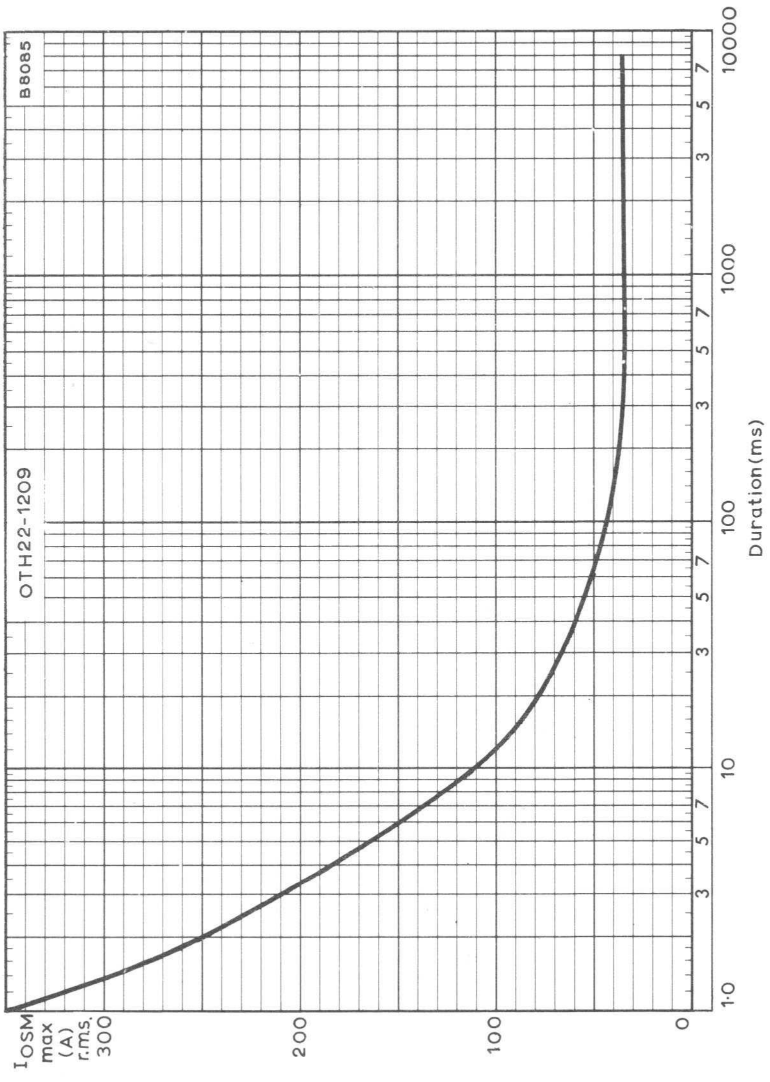




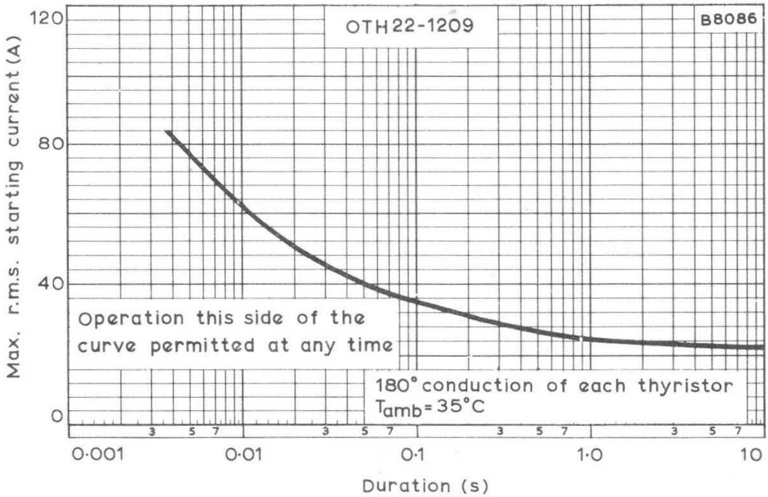
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



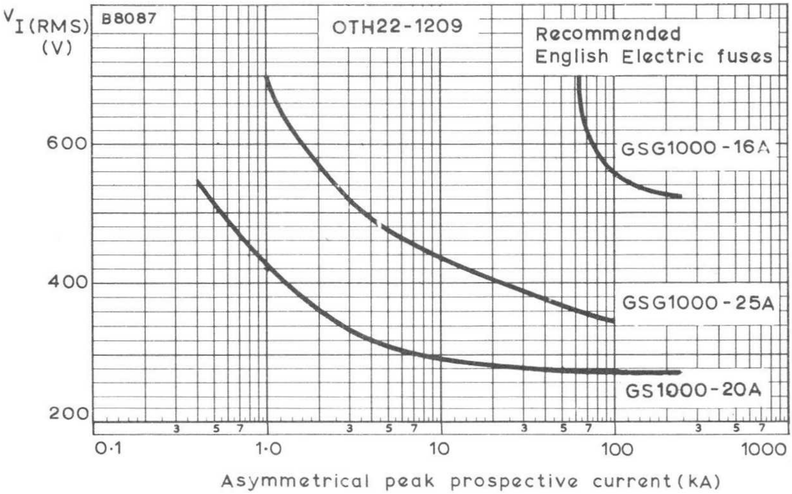
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



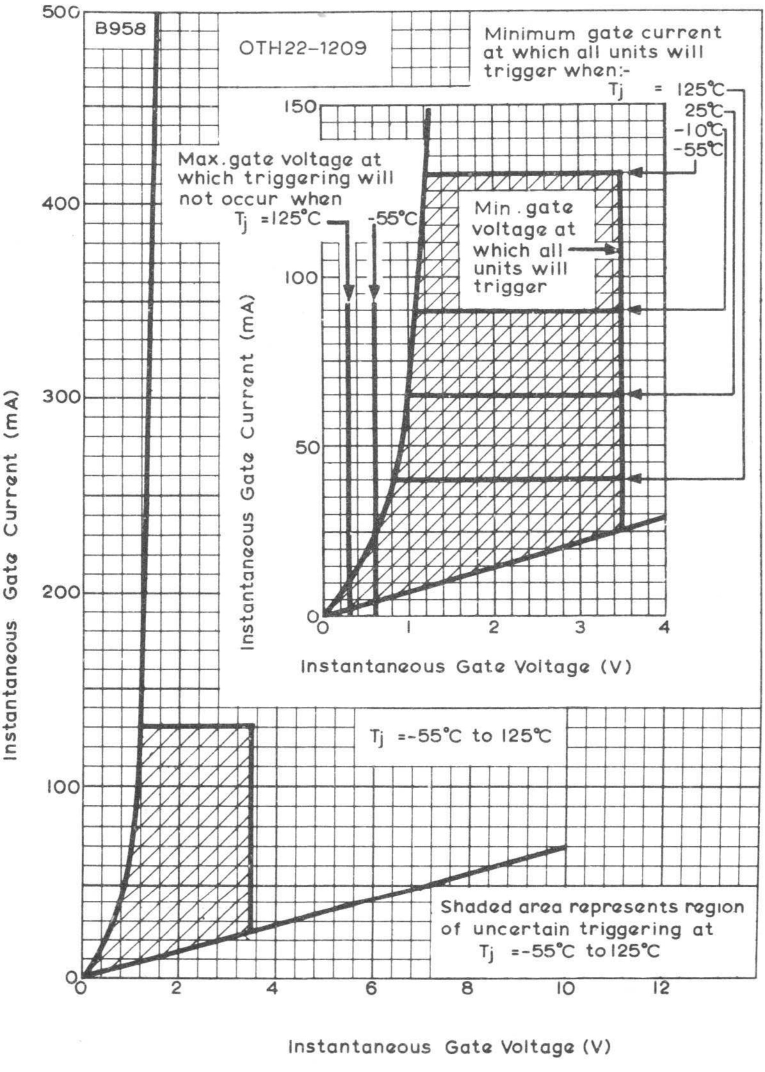
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT-BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH23-608

Half-controlled bridge-connected thyristor stack, suitable for 250V single-phase mains. It is suitable for natural convection or forced air cooling, and is capable of supplying an output current of 23A, at $T_{amb} = 35^{o}C$, with natural convection cooling and 180^{o} conduction of each thyristor.

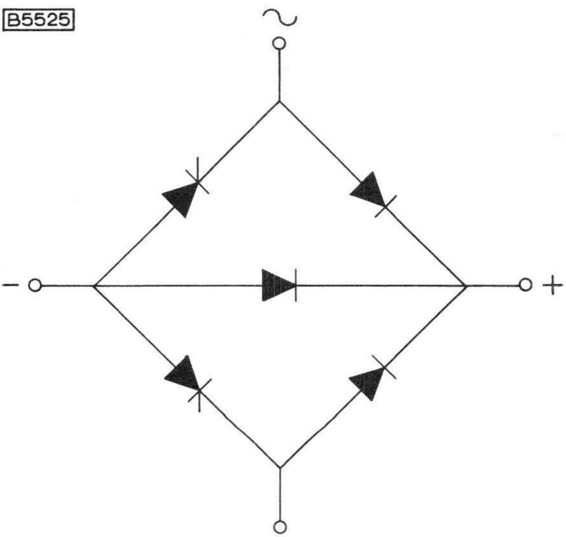
QUICK REFERENCE DATA

Input		
Max. r.m.s. input voltage	420	V
Max. non-repetitive peak input voltage	720	V
Output		
Max. mean output current ($T_{amb}=35^{o}C$) (natural convection cooling)	23	A
Max. repetitive peak output current	100	A

OUTLINE AND DIMENSIONS

For details see page D4

CIRCUIT DIAGRAM



RATINGS OF THE STACK

Limiting values of operation according to the absolute maximum system.

Electrical

Max. r.m.s. input voltage	420	V
Max. non-repetitive peak input voltage (fault conditions only, max. duration = 5ms)	720	V
*Max. mean output current, resistive or inductive load, 180° conduction of each thyristor, with natural convection cooling		
$T_{amb} \leq 35^{o}C$	23	A
$T_{amb} > 35^{o}C$	See graph on page C1	
with an air flow of velocity 400ft/min.		
$T_{amb} \leq 35^{o}C$	32	A
$T_{amb} > 35^{o}C$	See graph on page C1	
For conduction angles other than 180°	See graph on page C5	
Max. repetitive peak output current	100	A
Max. r.m.s. surge current for selecting protective devices	See graph on page C3	

Temperature

T_{stg} max.	125	°C
T_{amb} max.	See graph on page C1	

ELECTRICAL RATINGS OF THYRISTOR GATES

Max. peak forward gate-to-cathode voltage, anode positive w.r.t. cathode	10	V
Max. peak reverse gate-to-cathode voltage	5.0	V
Max. peak forward gate current, anode positive w.r.t. cathode	2.0	A
Max. peak gate-to-cathode dissipation	5.0	W
*Max. average gate dissipation	500	mW

*Max. averaging time = 20ms.

TYPICAL CHARACTERISTICS OF THYRISTORS ($T_j = 125^oC$)

Thyristor gate characteristics	See graph on page C4	
Holding current	10	mA
Turn-on time		
forward voltage before triggering = 50V		
forward current = 1.0A	2.5	μs
= 10A	3.0	μs
= 50A	4.4	μs
forward voltage before triggering = 400V		
forward current = 1.0A	1.0	μs
= 10A	1.5	μs
= 50A	2.0	μs
Turn-off time		
rate of rise of applied forward voltage = 20V/μs		
forward current before recovery = 10A		
reverse current = 5 to 20A	20	μs

INSULATION

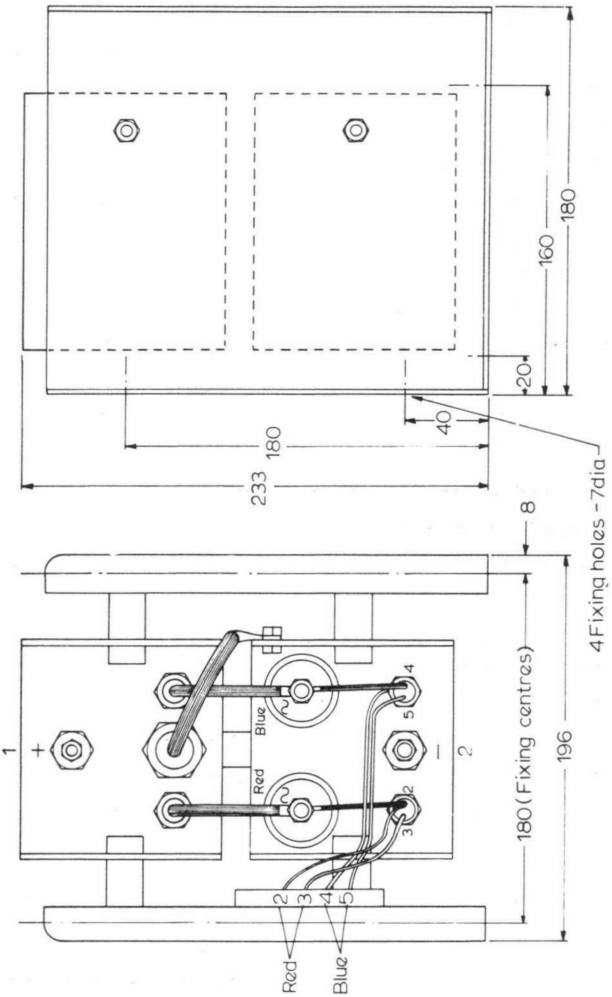
Designed to withstand 5kV (r.m.s.) between all electrical terminations joined together and the frame.

RECOMMENDED FUSES (For short circuit protection)

Fuses	Location
GSG1000/25A (English Electric)	A.C. input line
GSG1000/16A (English Electric)	See graph on page C2

MECHANICAL DATA

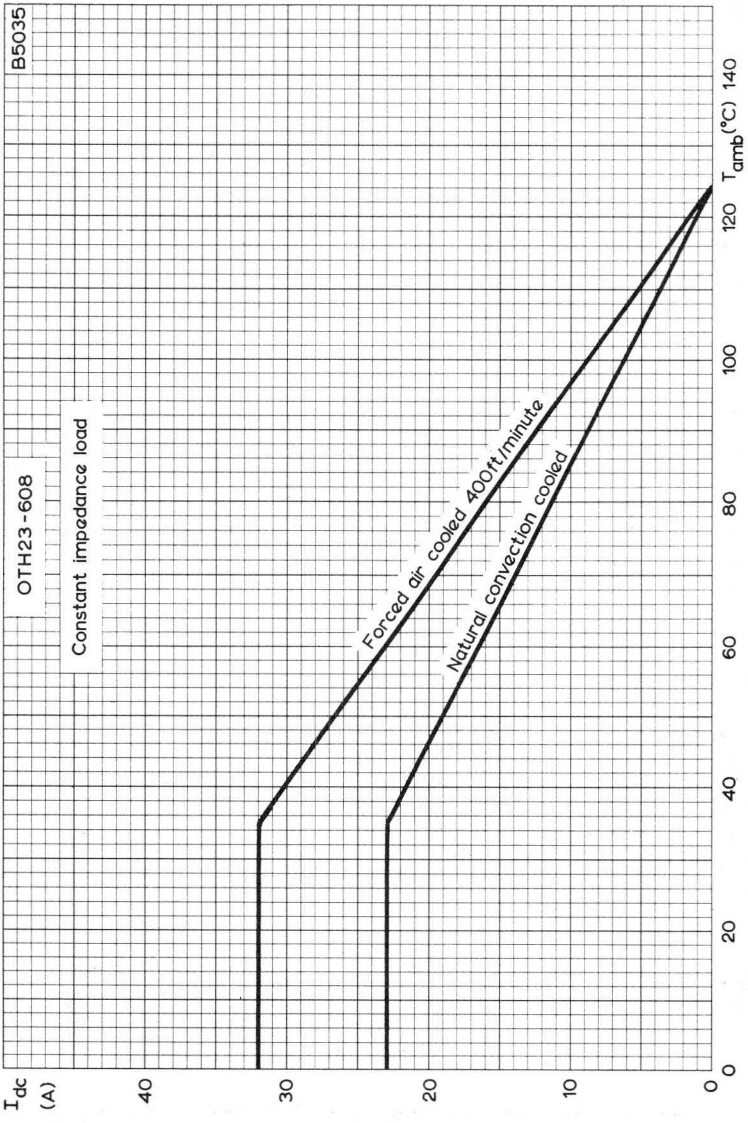
Weight (approximately)	3.3	kg
	7.3	lb
Dimensions	See outline drawing on page D4	



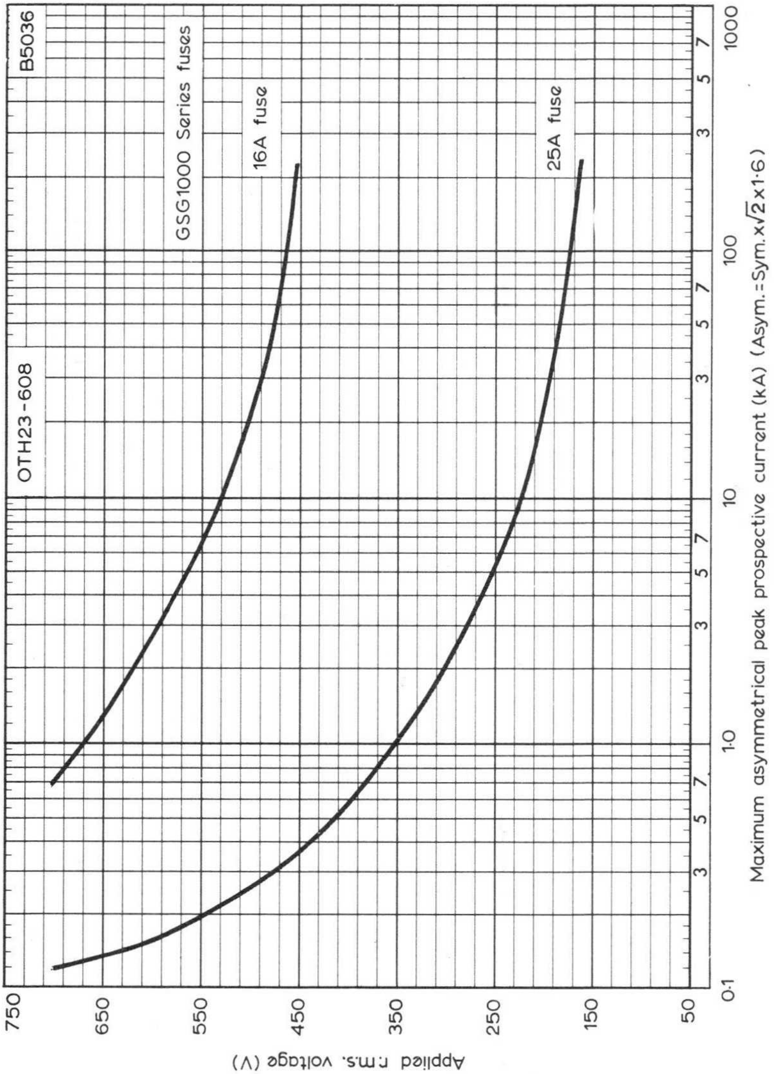
B4933

Note: Terminations lie within side-plate area, but clearance must be provided externally.
+,− and ∼ terminations are $\frac{1}{4}$" U.N.F.

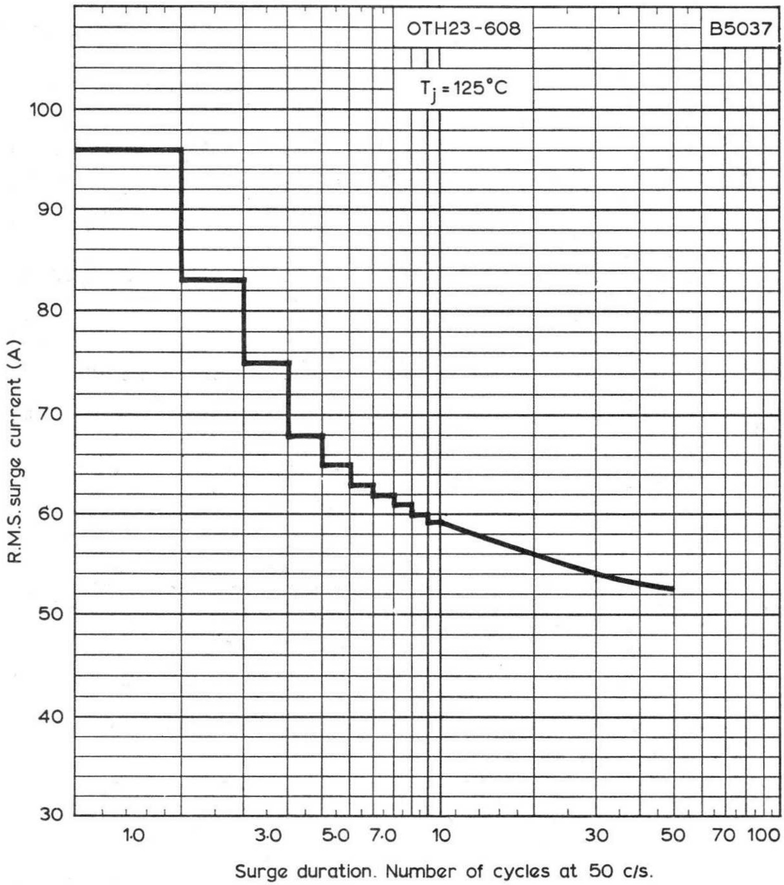
All dimensions in mm



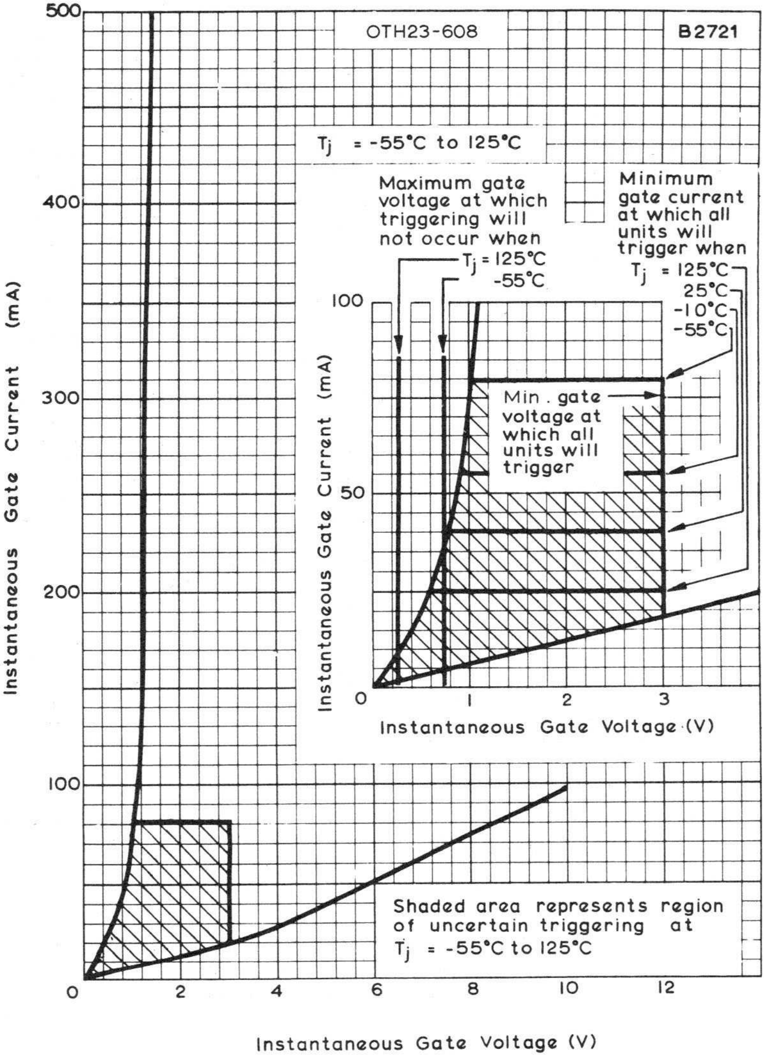
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE. 180° CONDUCTION OF EACH THYRISTOR, MAXIMUM AVERAGING TIME = 20ms



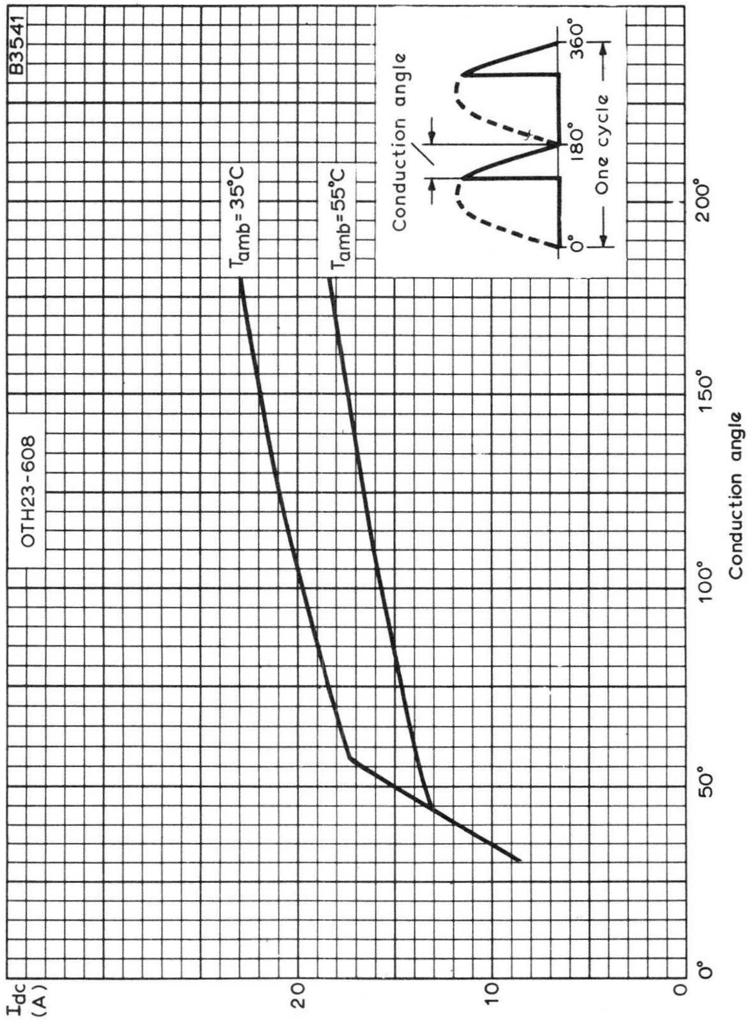
APPLIED VOLTAGE PLOTTED AGAINST PROSPECTIVE CURRENT, FOR SHORT CIRCUIT PROTECTION



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION.
FOR SELECTING PROTECTIVE DEVICES
(FUSES, CIRCUIT BREAKERS ETC.)



THYRISTOR GATE CHARACTERISTICS
THE TOP RIGHT-HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN



MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE, AT TWO AMBIENT TEMPERATURES

SINGLE-PHASE THYRISTOR STACK

OTH23-609

The OTH23-609 is a single-phase a.c. controller consisting of two thyristors mounted on two 30D heatsinks. It is capable of supplying an r.m.s. current of 26A at an ambient temperature of 35 °C, and is intended for operation from a nominal a.c. mains supply of up to 250Vr.m.s.

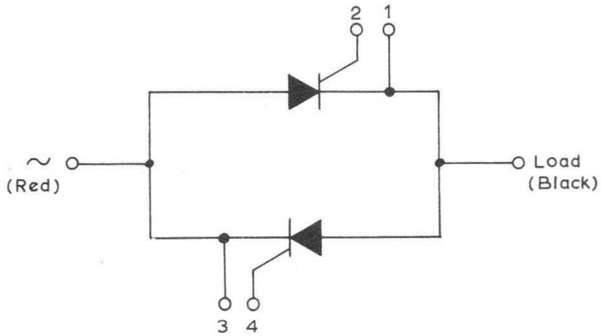
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5.0ms)	720	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^{\circ}C$	26	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage

$V_{I\ (RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5ms)	720	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^{o}C$	26	A
	$T_{amb} > 35^{o}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	140	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	°C
T_{amb} max. (see also curves on page C1)		125	°C

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$	40	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	1.5	kg
	3.4	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R×C (μs)	R-C in secondary of transformer C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A)

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:-

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

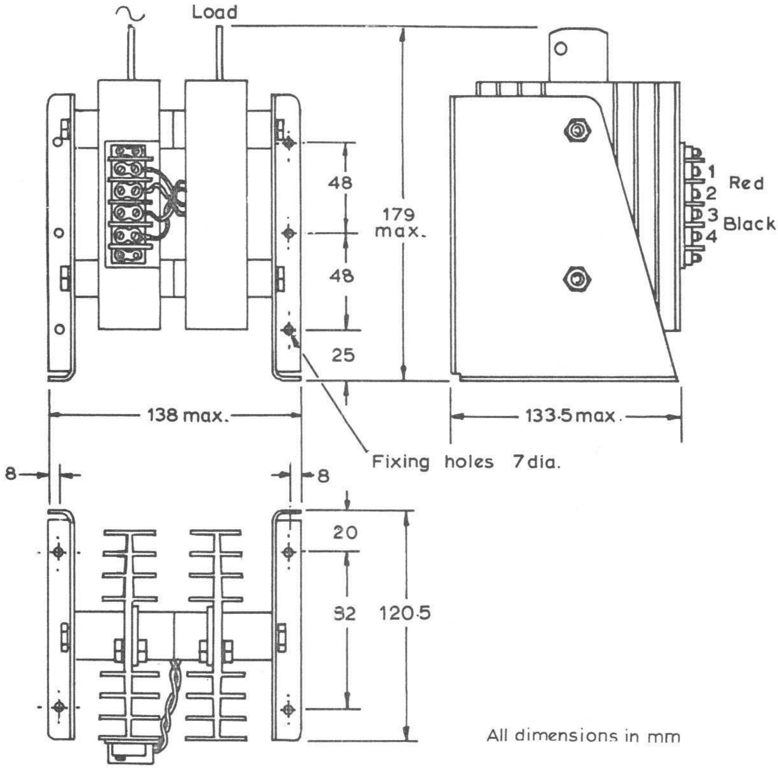
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

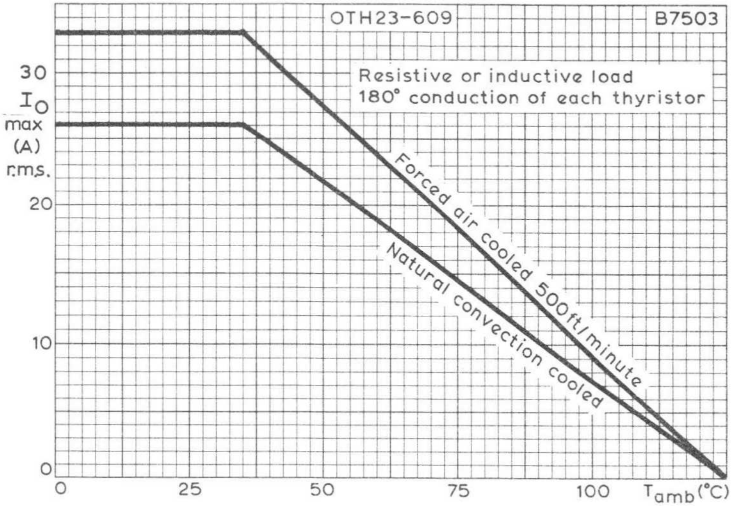
4. Suitable Replacement Devices

   Thyristors BTY91-600R

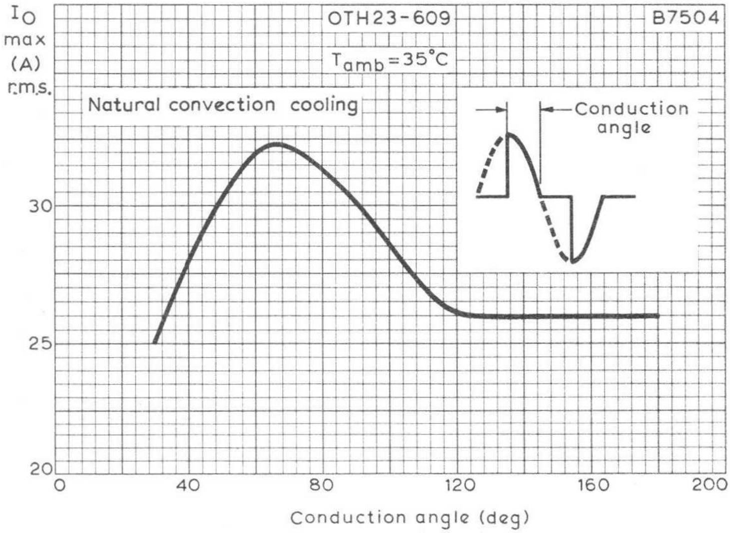
OUTLINE AND DIMENSIONS



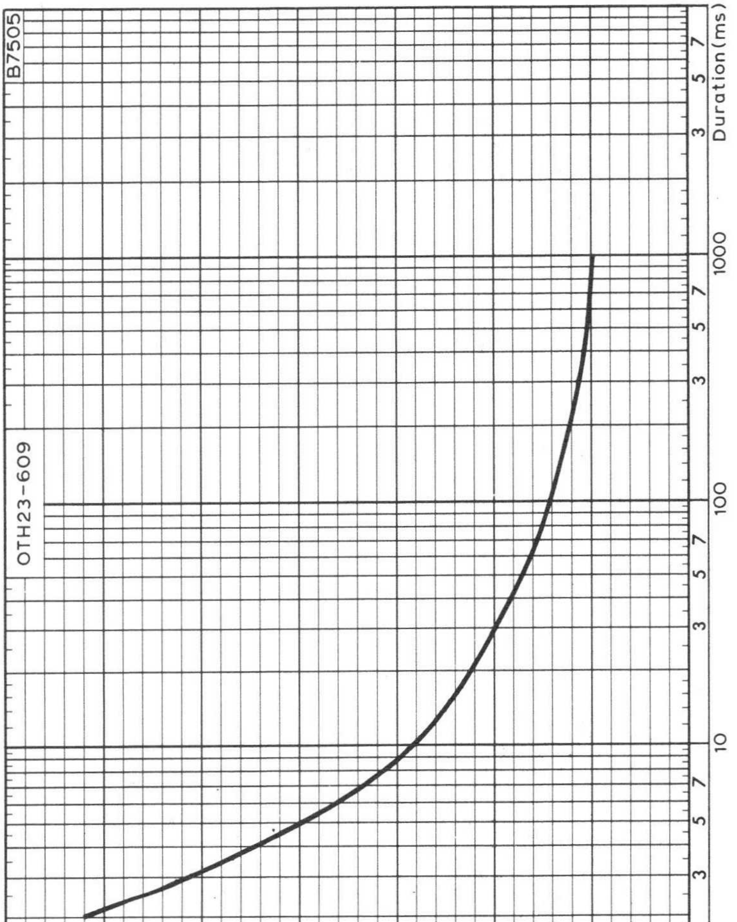
All dimensions in mm



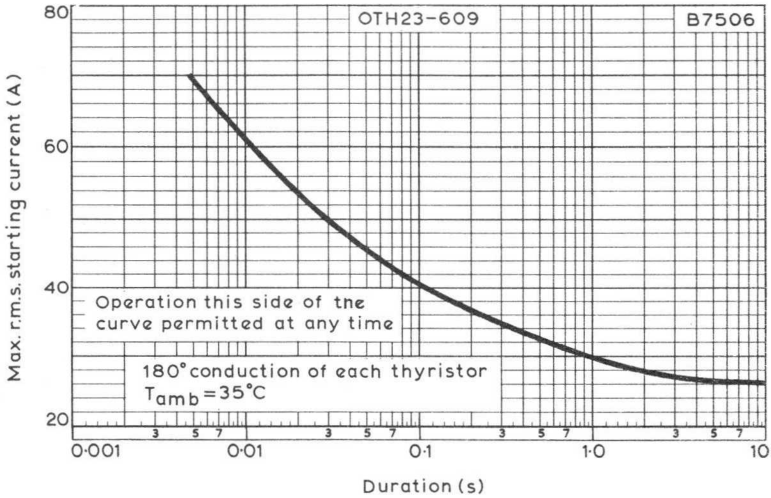
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



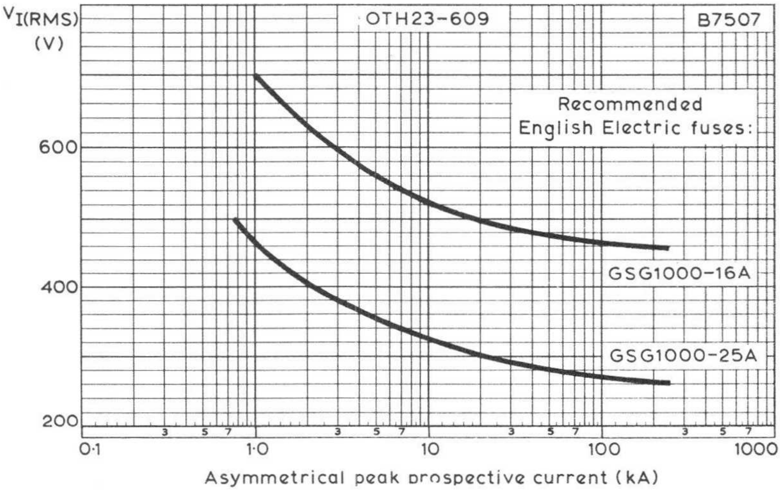
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



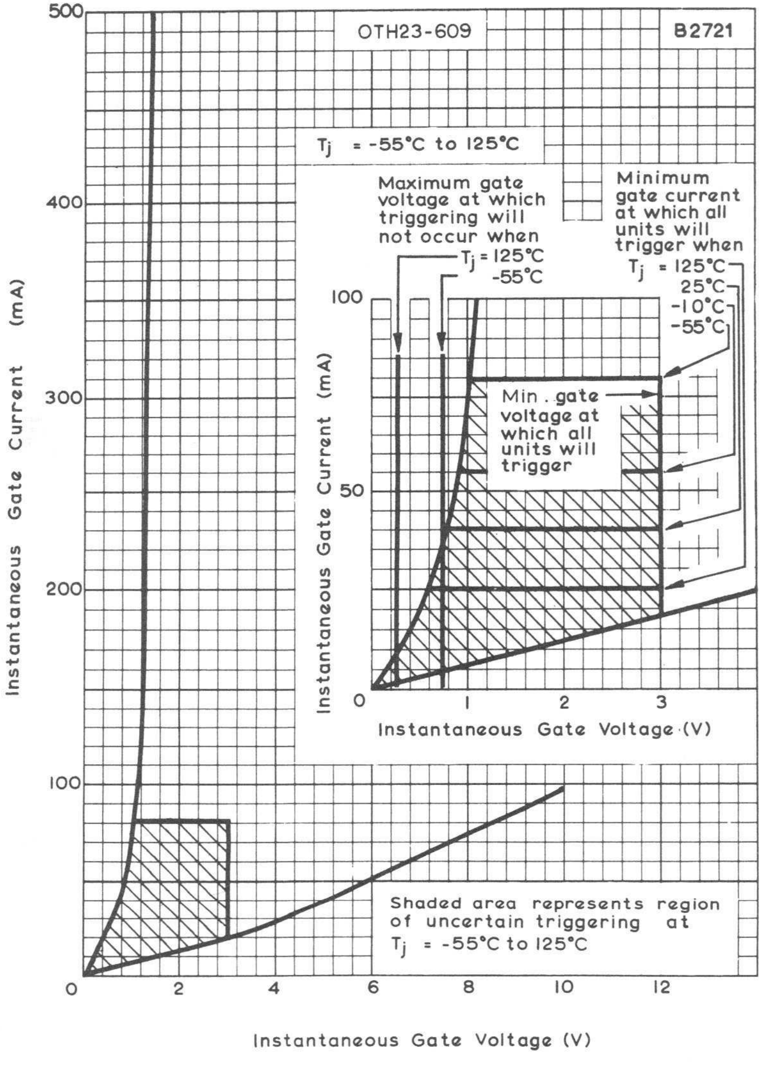
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH28-1209

TENTATIVE DATA

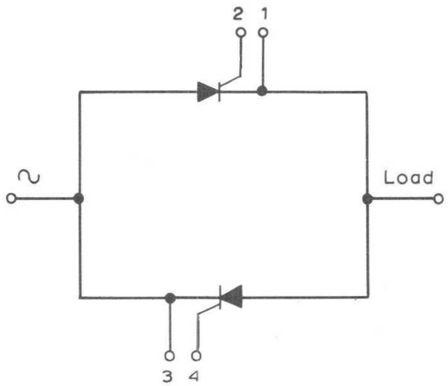
The OTH28-1209 is a single-phase a.c. controller consisting of two thyristors mounted on two 30D heatsinks. It is capable of supplying an r.m.s. current of 28A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of 440Vr.m.s.

QUICK REFERENCE DATA			
Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^oC$	28	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t< 10ms, see note 5)	1100	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^{o}C$	28	A
	$T_{amb} > 35^{o}C$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^{o}C$	35	A
	$T_{amb} > 35^{o}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	200	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.	125	^{o}C
T_{amb} max. (see also curves on page C1)	125	^{o}C

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	1.5	kg
	3.4	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

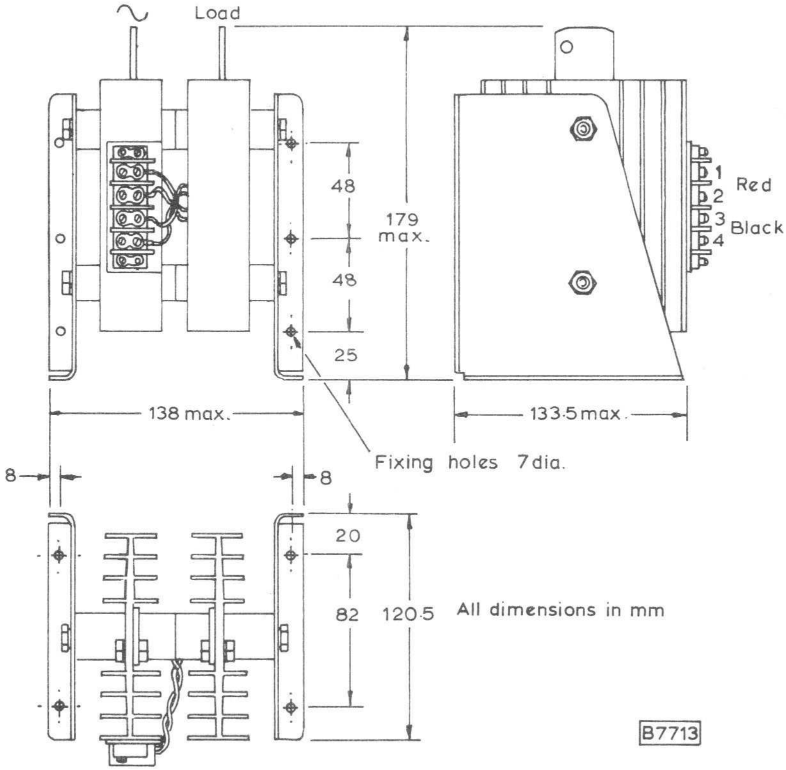
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

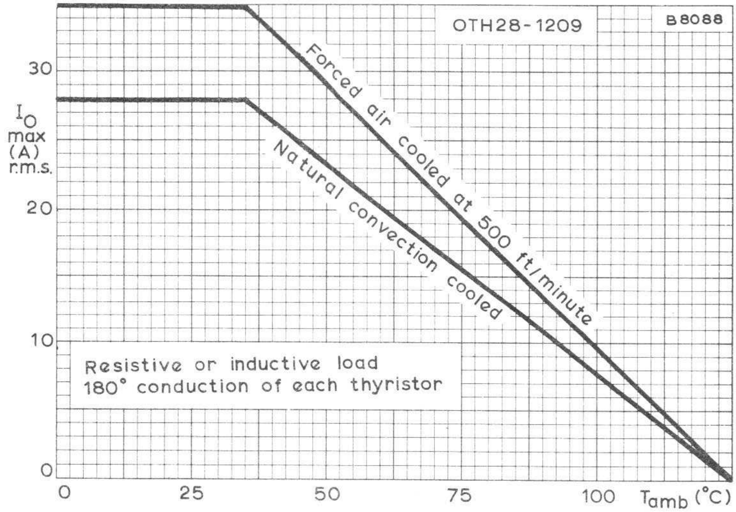
4. **Suitable Replacement Devices**

   Thyristors BTX48-1200R

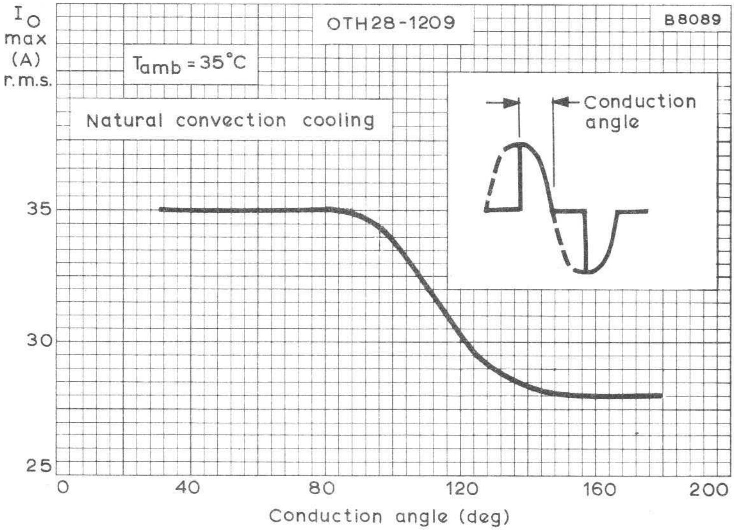
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

OUTLINE AND DIMENSIONS

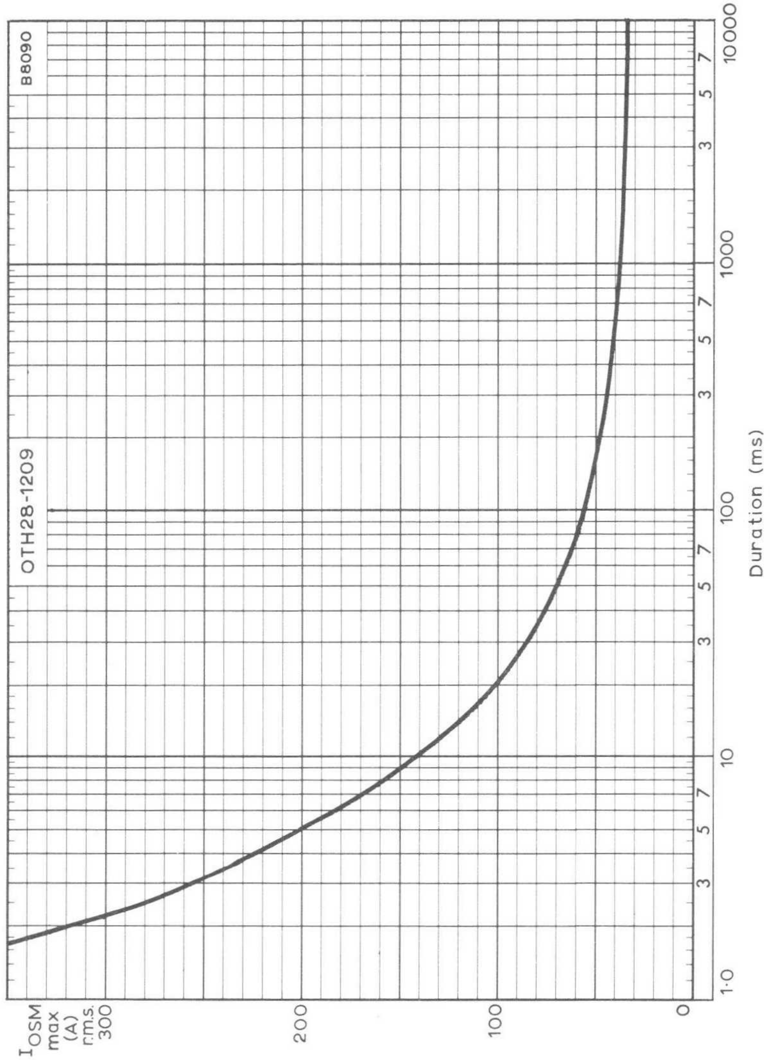




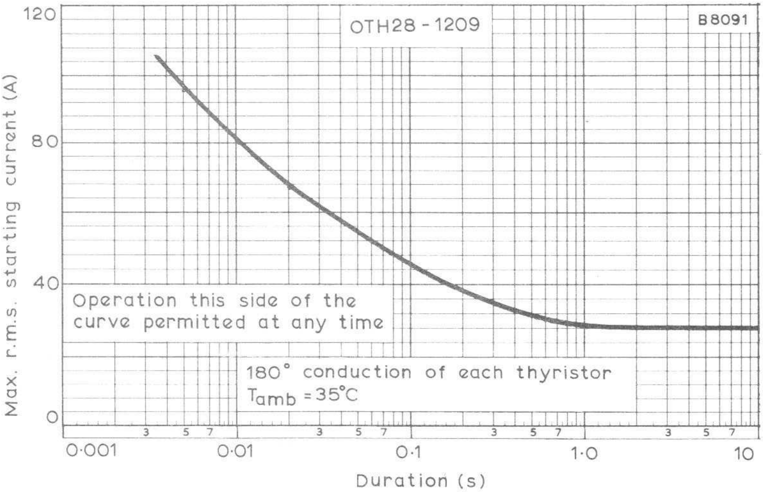
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



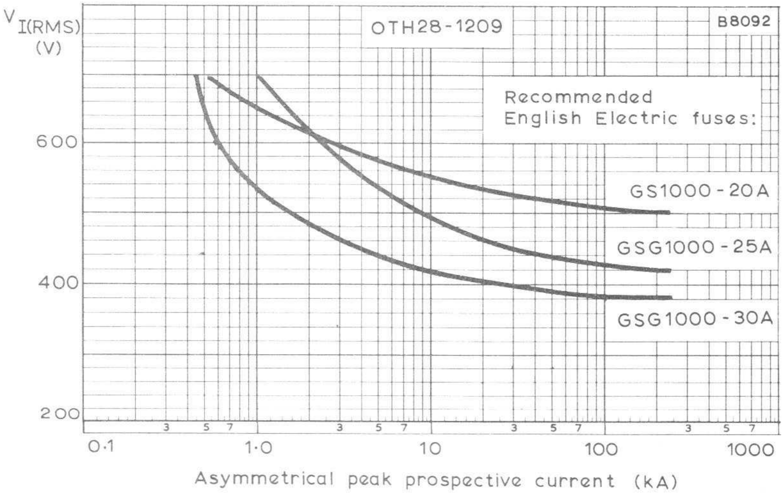
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



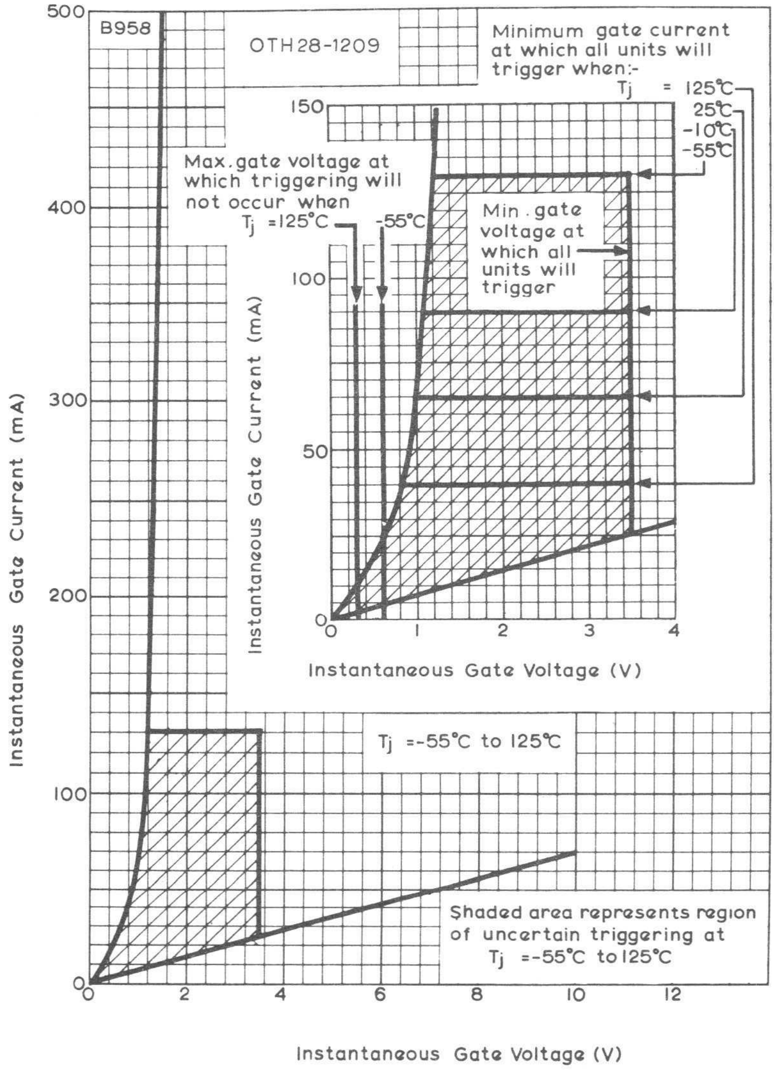
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH29-1208

The OTH29-1208 is a half-controlled bridge connected thyristor stack with flywheel diode, intended for 440V single-phase mains. It is capable of supplying an output current of 29A at T_{amb} = 35°C with natural convection cooling and 180° conduction of each thyristor.

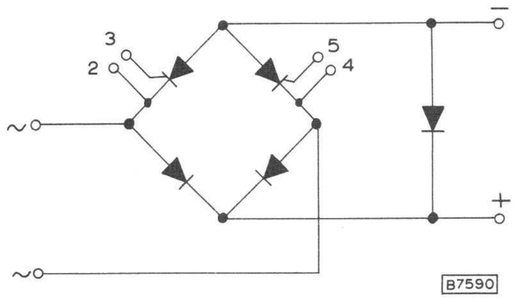
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak voltage	1100	V
Output			
V_O	Max. average voltage	505	V
I_O	Max. average current (T_{amb} = 35°C, natural convection cooling)	29	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak voltage	1100	V
V_{ISM}	Max. non-repetitive peak voltage, $t < 10ms$, see note 5	1100	V

Output voltage

V_O	Max. average voltage	505	V

Output current

I_O	Max. average current, resistive or inductive load, 180^o conduction of thyristors, natural convection cooled		
	$T_{amb} \leq 35^oC$	29	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	32	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	200	A

Temperature

T_{stg} max.		125	^oC
T_{amb} operating		See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	3.5	kg
	8.0	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows: -

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R × C (μs)	C (μF)	R × C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

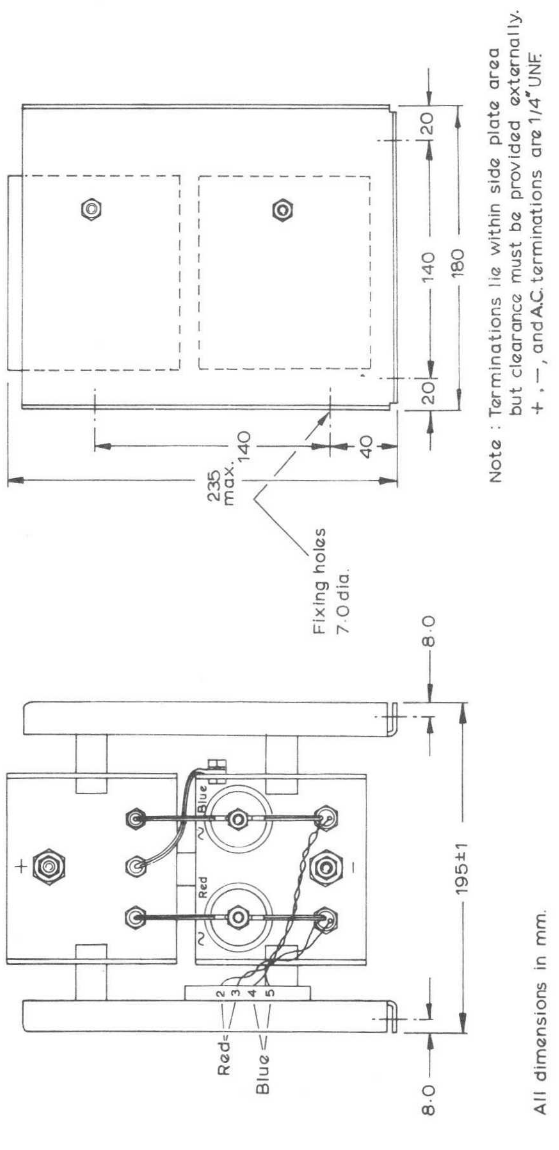
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

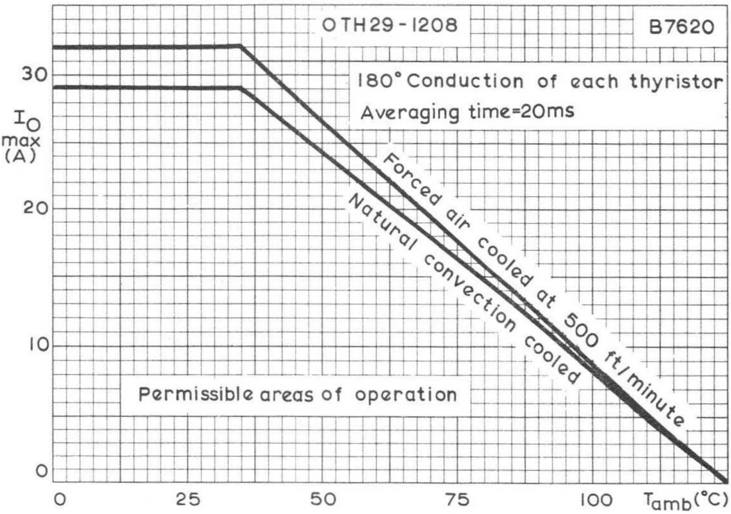
4. Suitable Replacement Devices

Bridge Diodes	BYX25 - 1000
Bridge Thyristors	BTX48 - 1200R
Flywheel Diode	BYX25 - 1000

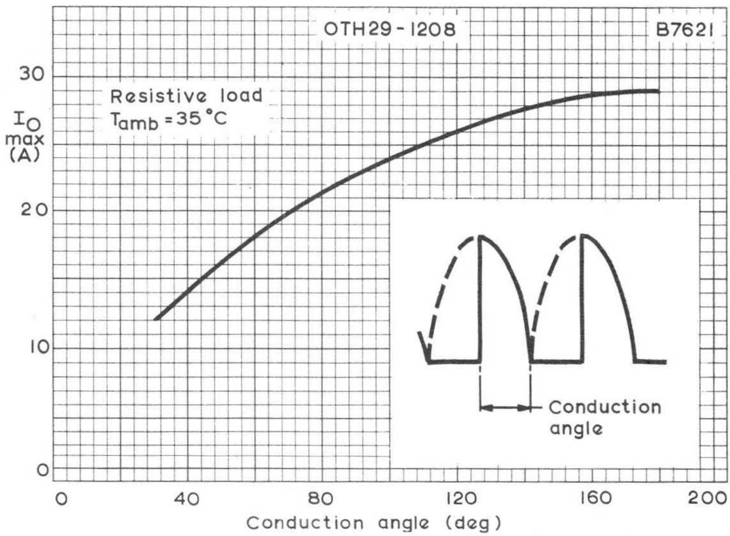
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

OUTLINE AND DIMENSIONS

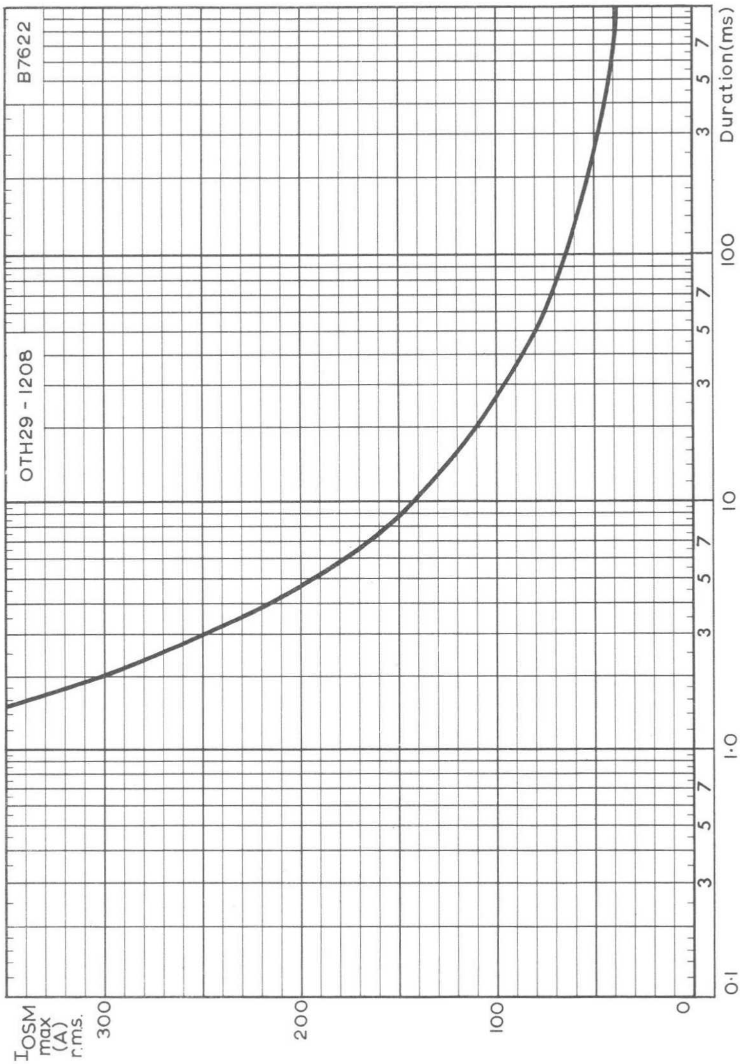




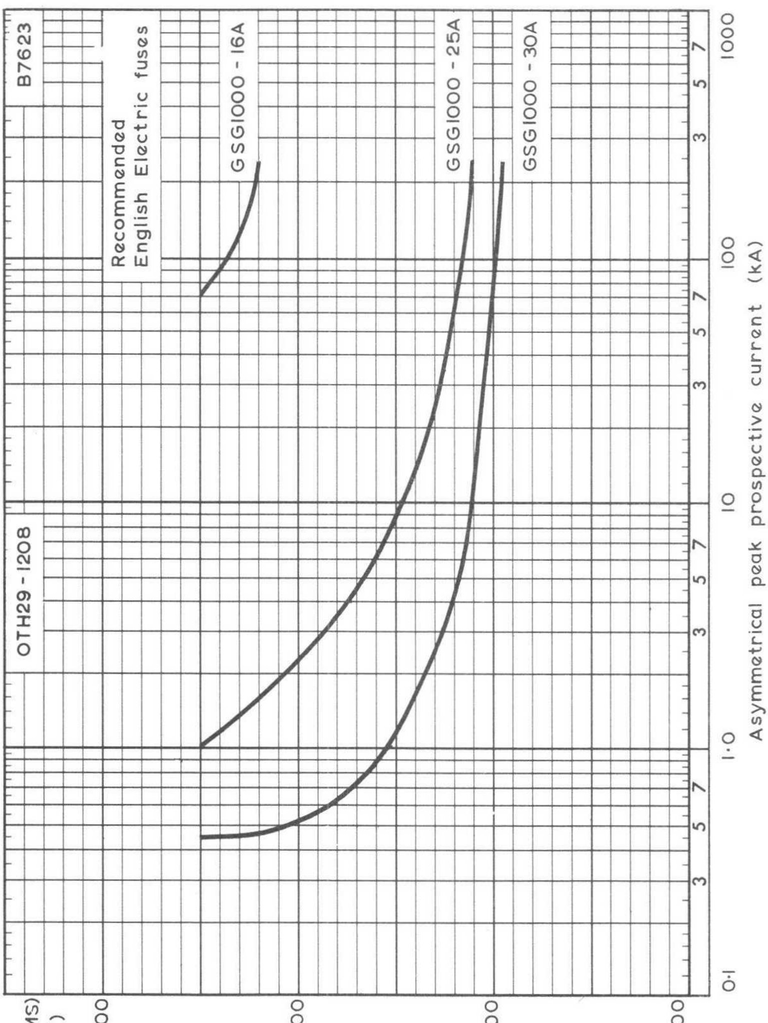
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



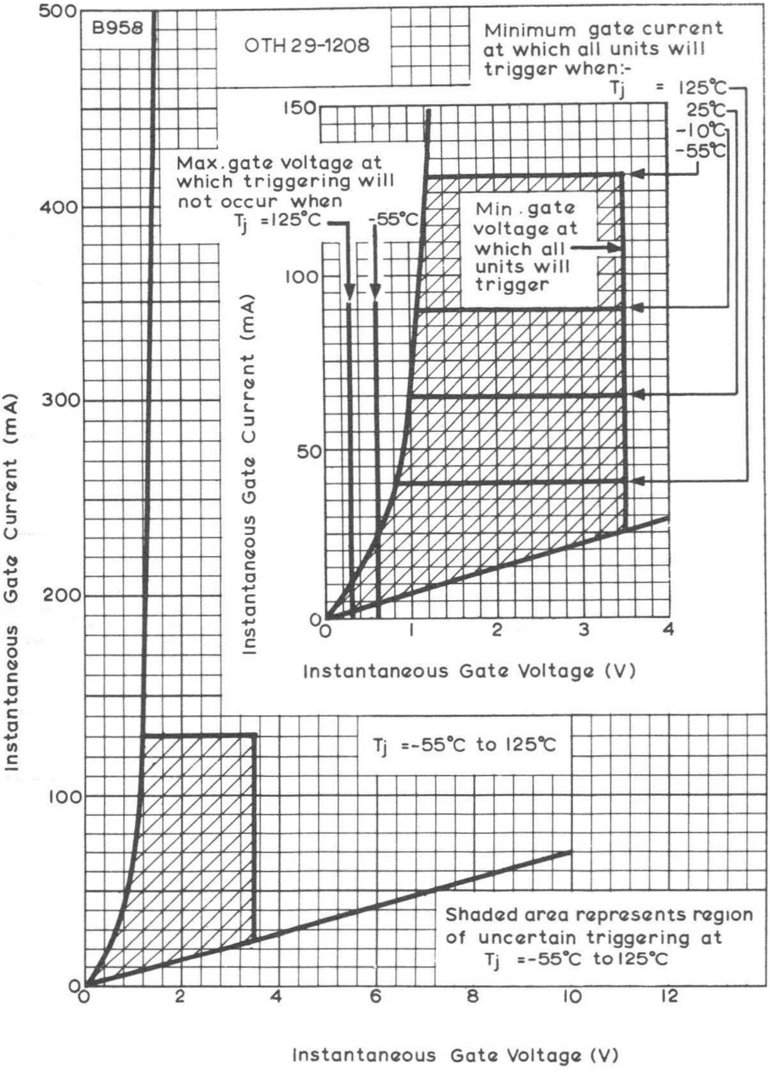
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF
THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH36-1209

TENTATIVE DATA

The OTH36-1209 is a single-phase a.c. controller consisting of two thyristors mounted on two 40D heatsinks. It is capable of supplying an r.m.s. current of 36A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of 440Vr.m.s.

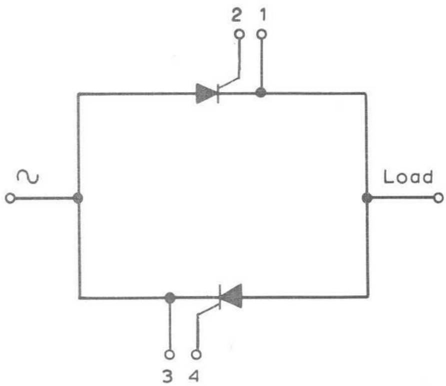
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^{\circ}C$	36	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage ($t < 10ms$, see note 5)	1100	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180^o conduction of each thyristor, natural convection cooling		
	$T_{amb} \leq 35^oC$	36	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 55^oC$	36	A
	$T_{amb} > 55^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	200	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curves on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	2.6	kg
	5.8	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

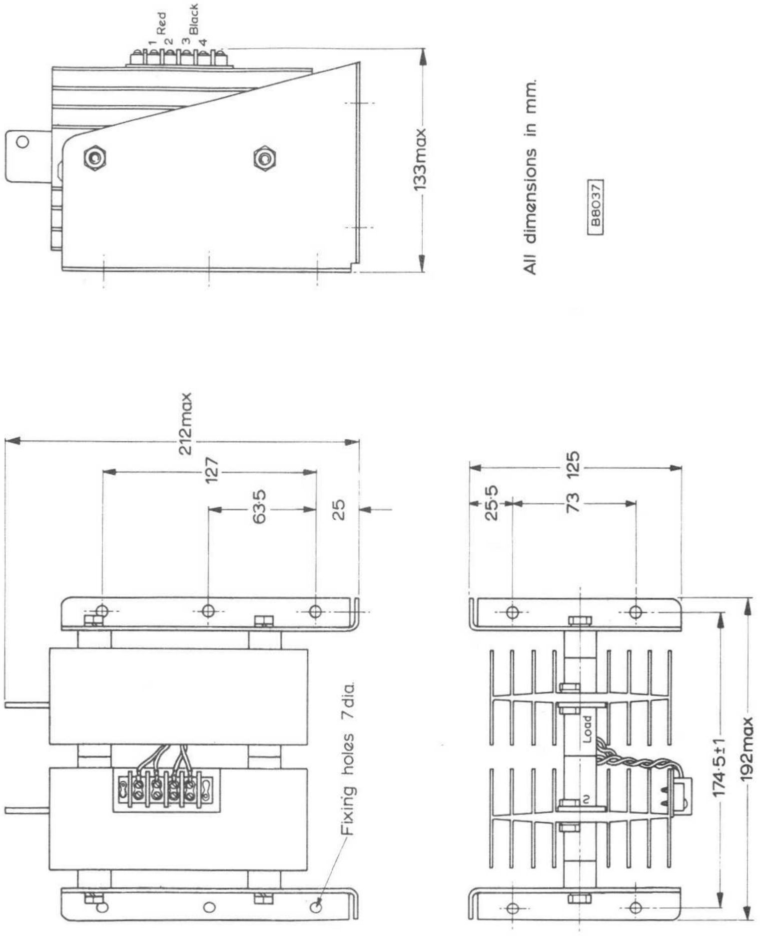
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

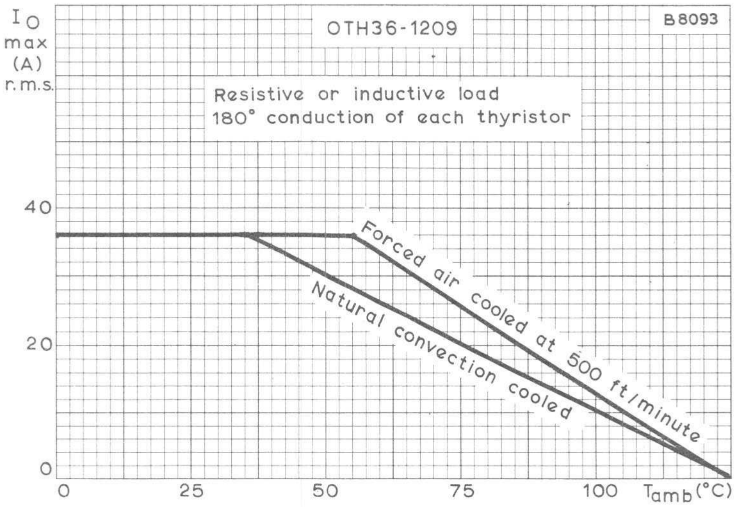
4. **Suitable Replacement Devices**

   Thyristors BTX48-1200R

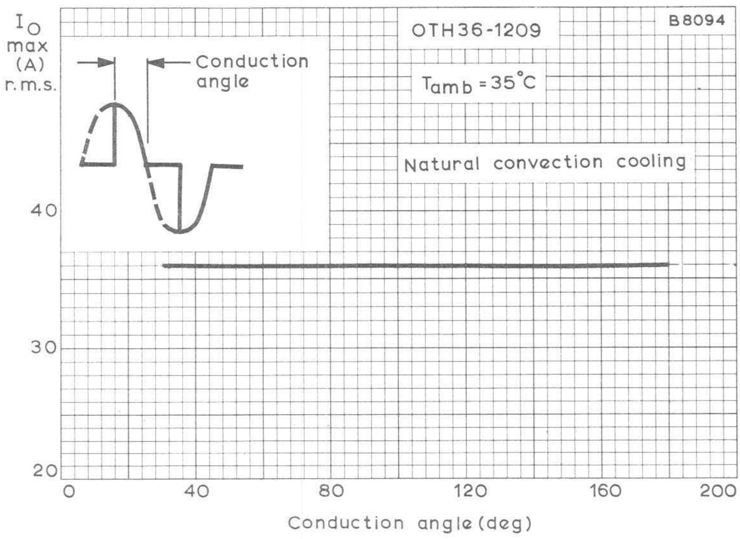
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

OUTLINE AND DIMENSIONS

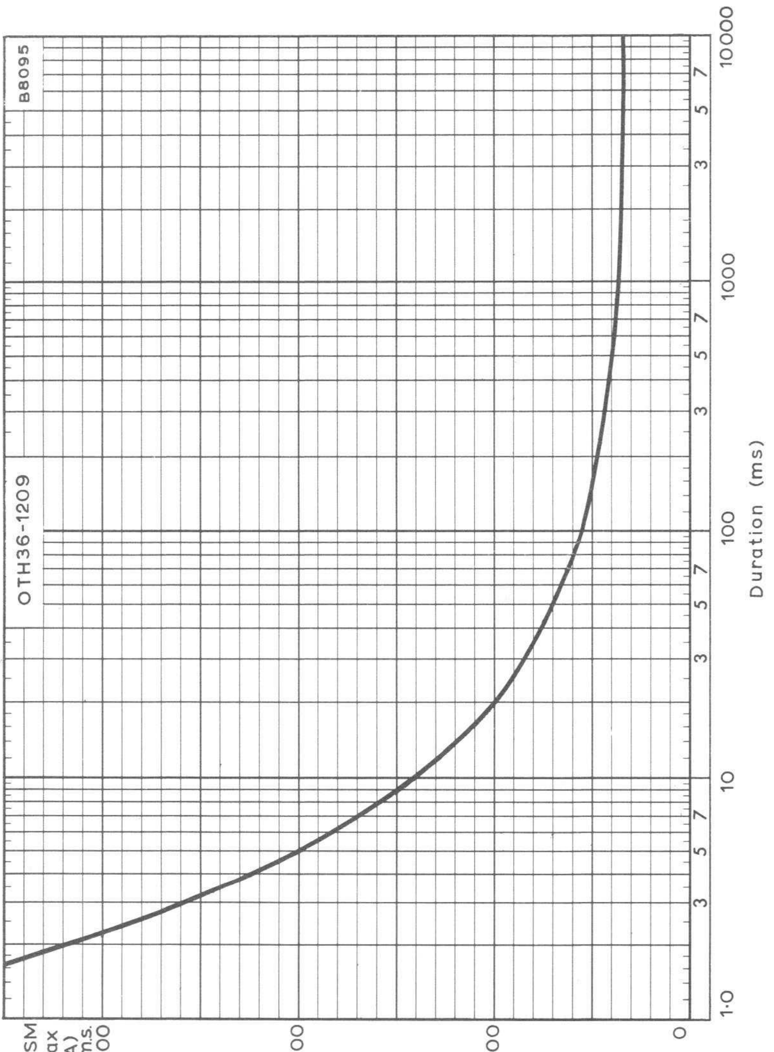




MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



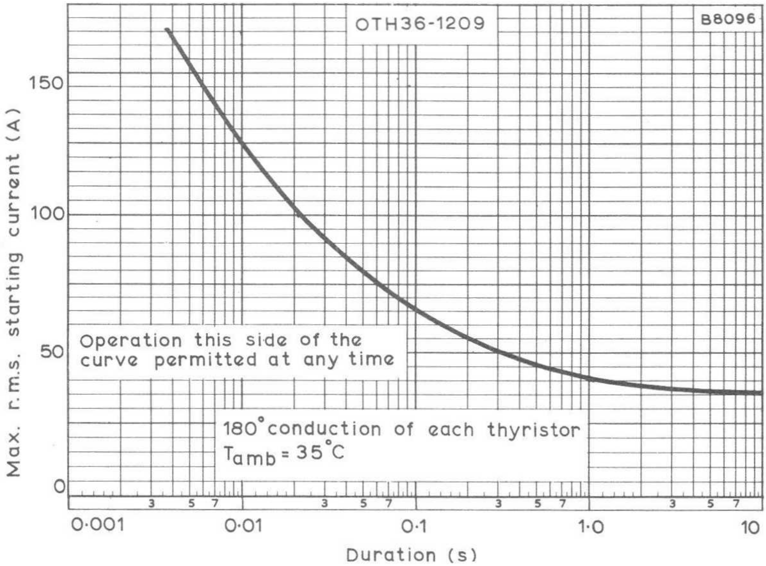
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



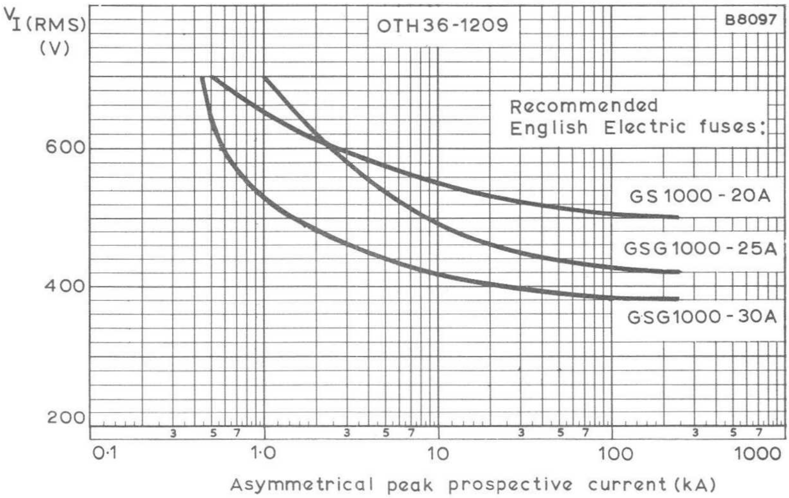
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)

SINGLE-PHASE THYRISTOR STACK

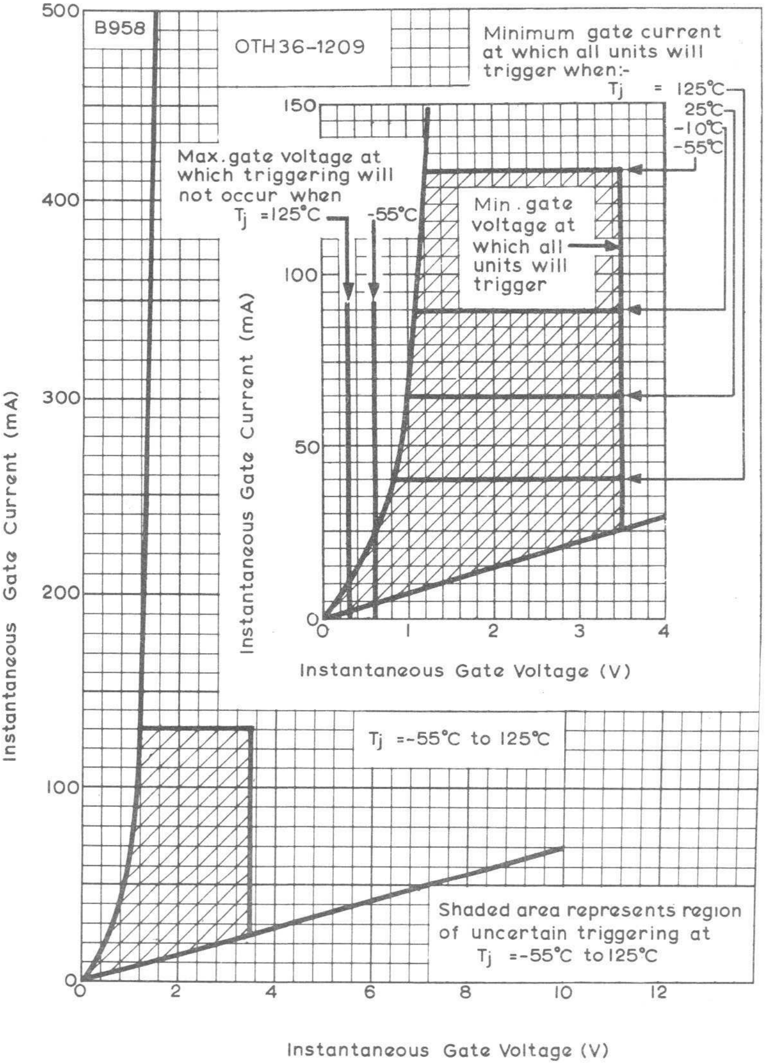
OTH36-1209



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH40-608A

TENTATIVE DATA

The OTH40-608A is a half-controlled, bridge connected, single-phase thyristor stack with flywheel diode, intended for 250V mains. It is suitable for natural convection or forced air cooling and is capable of supplying up to 40A at $T_{amb} = 60^{o}C$.

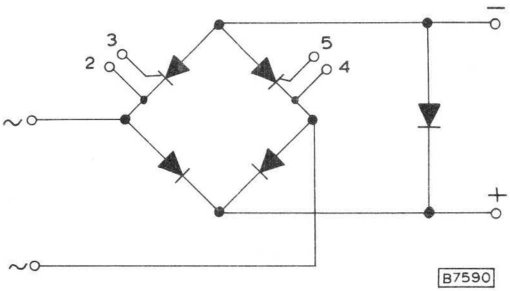
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{ISM}	Max. non-repetitive peak voltage	700	V
Output			
I_O	Max. mean output current ($T_{amb} = 35^{o}C$, natural convection cooling)	40	A
I_{ORM}	Max. repetitive peak current	200	A

OUTLINE AND DIMENSIONS

For details see page 5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IWM}	Max. crest working voltage	600	V
V_{IRM}	Max. repetitive peak voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (t< 10ms)	700	V

Output voltage

V_O	Max. average voltage	375	V

Output current

I_O	Max. average current, resistive or inductive load, 180^o conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^oC$	40	A
	$T_{amb} > 35^oC$	See curve on page 6	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 60^oC$	40	A
	$T_{amb} > 60^oC$	See curve on page 6	
I_{ORM}	Max. repetitive peak current	200	A

Temperature

T_{stg} max.	125	^oC
T_{amb} (operating)	See curve on page 6	

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page 8)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	4.0	kg
	8.8	lb
Dimensions	See outline drawing on page 5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R×C (μs)	R-C in secondary of transformer C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$

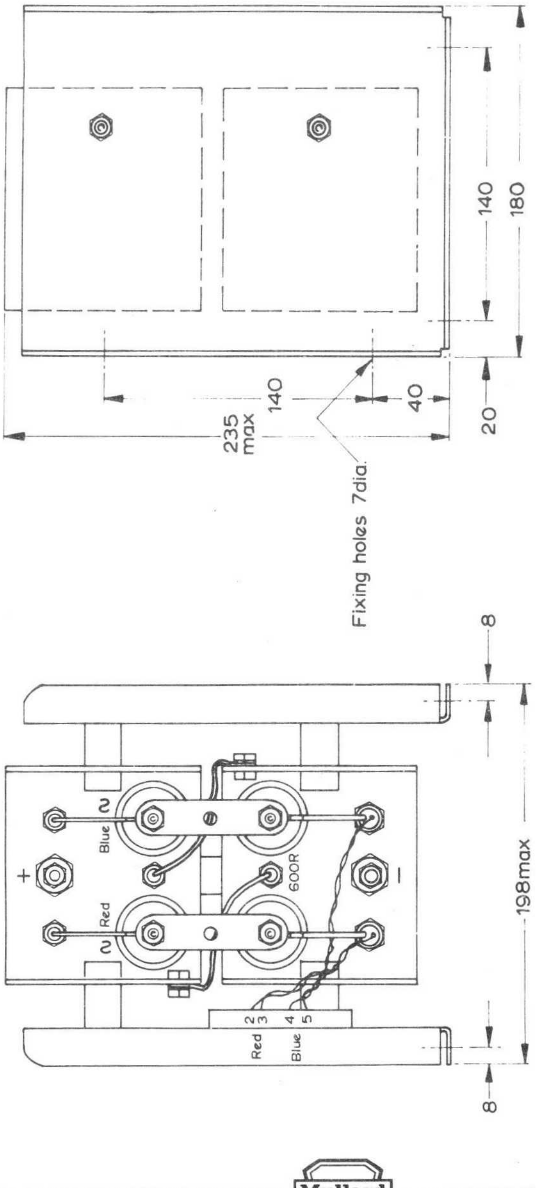
4. **Suitable Replacement Devices**

Bridge diodes	BYX25-600
Thyristors	BTX81-600R
Flywheel diodes	BYX25-600 and BYX25-600R

SINGLE-PHASE THYRISTOR STACK

OTH40-608A

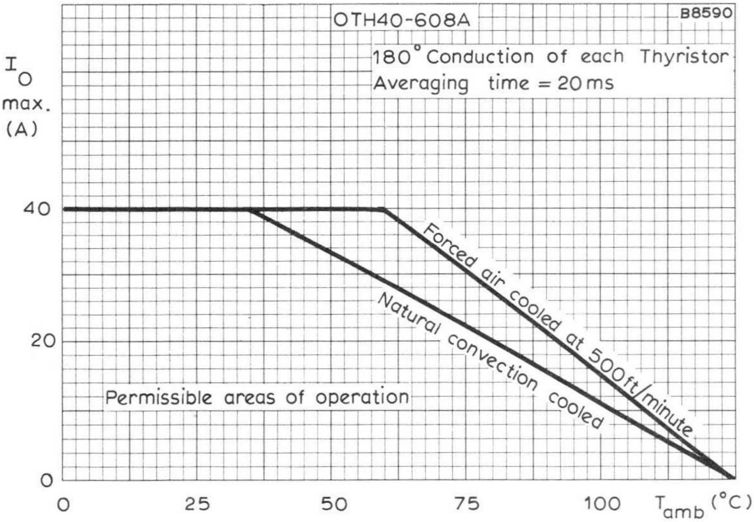
OUTLINE AND DIMENSIONS



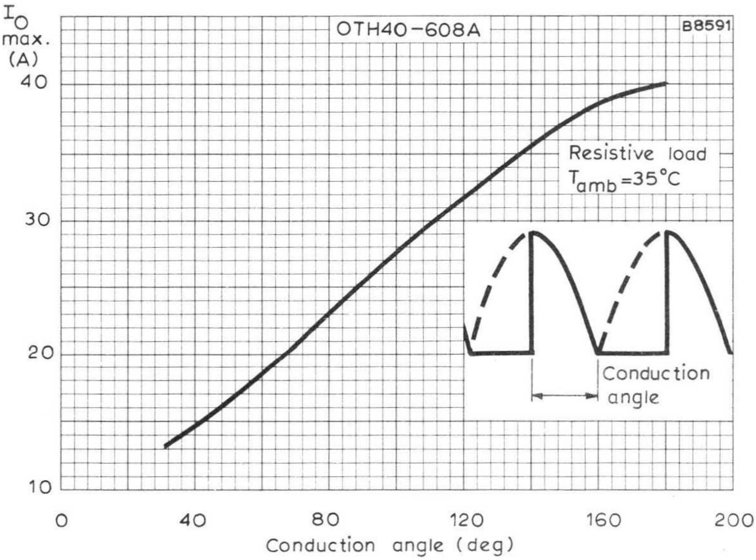
Note: Terminations lie within side plate area but clearance must be provided externally
+,− and A.C. terminations are 1/4" U.N.F.
Thyristors may be fused by removing bus bars and replacing with fuses having 63mm fixing centres.

All dimensions in mm.

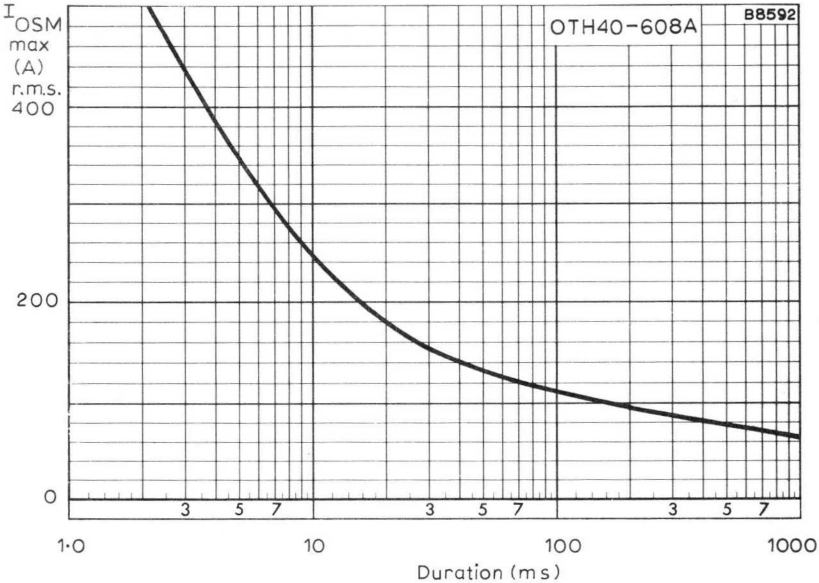
B8584



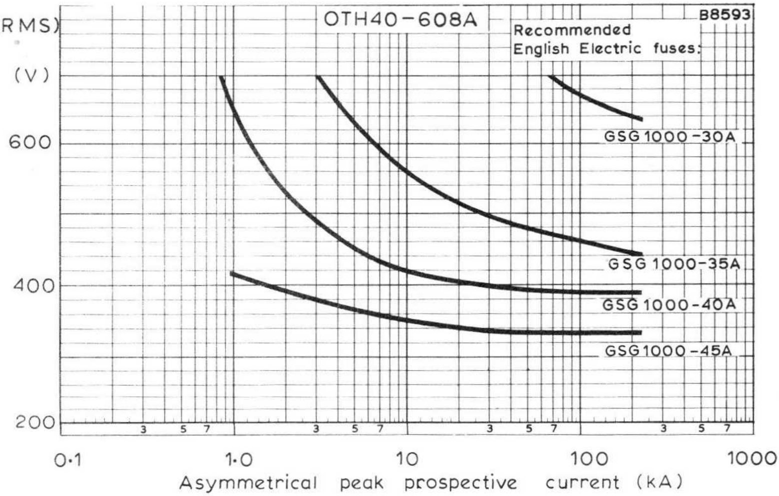
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



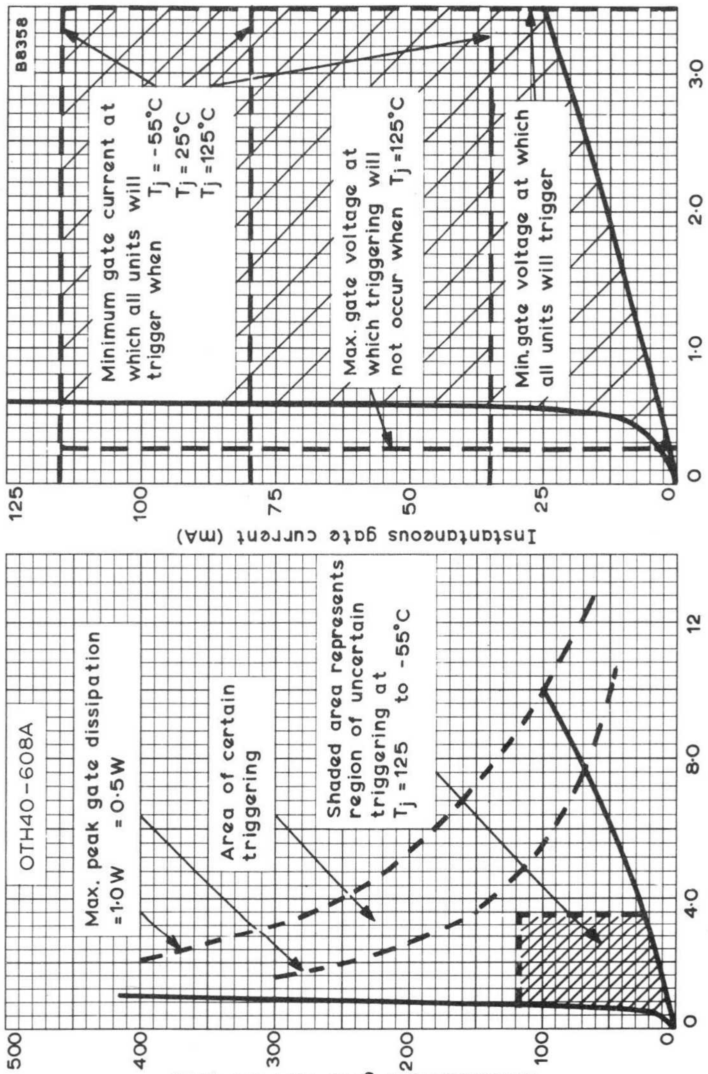
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times\sqrt{2}\times 1.6$)



THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH44-609

TENTATIVE DATA

The OTH44-609 is a single-phase a.c. controller consisting of two thyristors mounted on two 40D heatsinks. It is capable of supplying an r.m.s. current of 44A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of up to 250Vr.m.s. It is capable of controlling a tungsten filament lamp of up to 5kW.

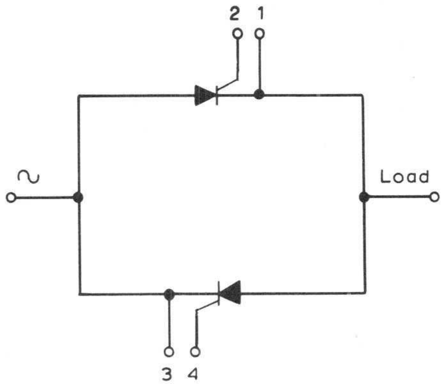
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage ($t < 10ms$)	700	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35^{o}C$	44	A

OUTLINE AND DIMENSIONS

For details see page 5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t< 10ms)	700	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling		
	$T_{amb} \leq 35^{o}C$	44	A
	$T_{amb} > 35^{o}C$	See curve on page 6	
I_{ORM}	Max. repetitive peak forward current	200	A
I_{OSM}	Max. surge current	See curve on page 6	

Temperature

T_{stg} max.		125	^{o}C
T_{amb} max.	(see also curve on page 6)	125	^{o}C

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page 8)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	2.6	kg
	5.8	lb
Dimensions	See outline drawing on page 5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$

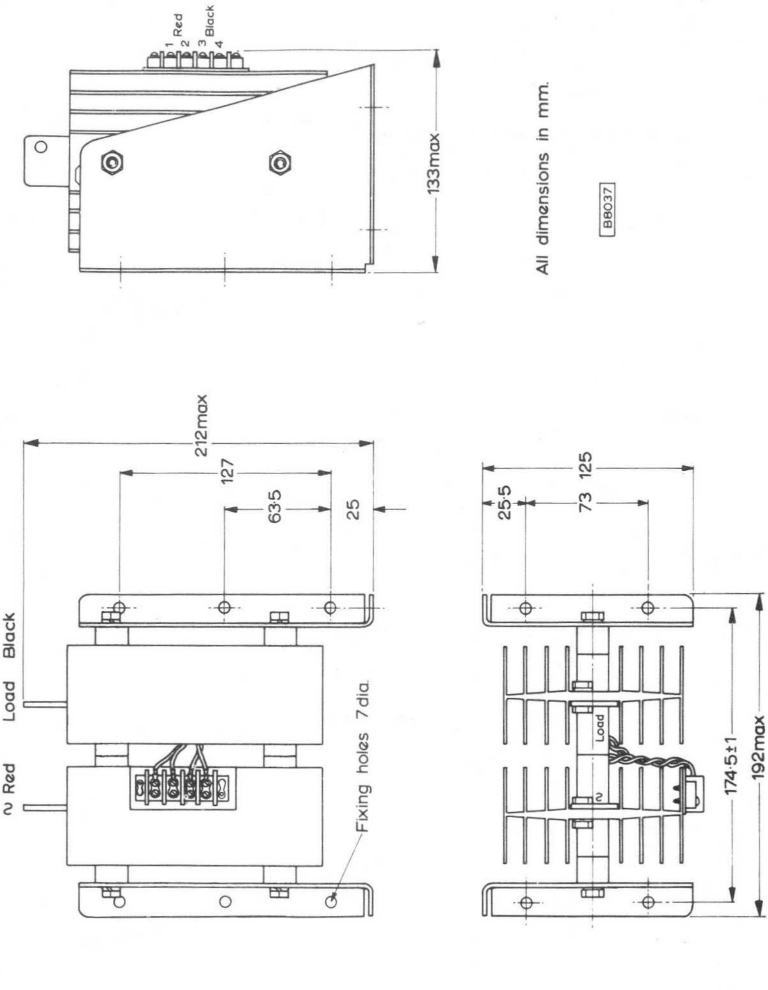
4. **Suitable Replacement Devices**

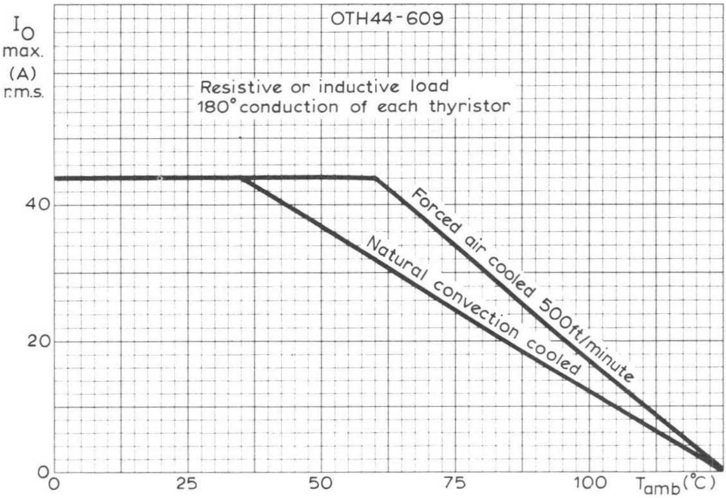
   Thyristors BTX81-600R

SINGLE-PHASE THYRISTOR STACK

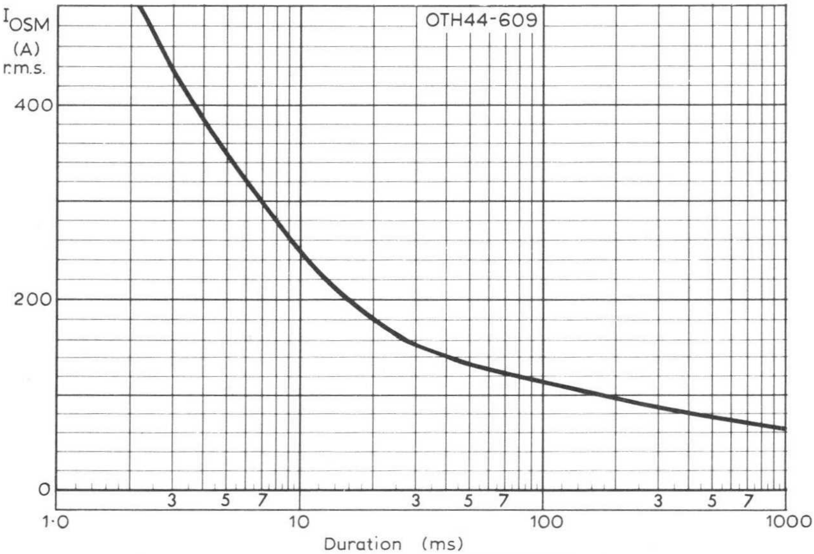
OTH44-609

OUTLINE AND DIMENSIONS

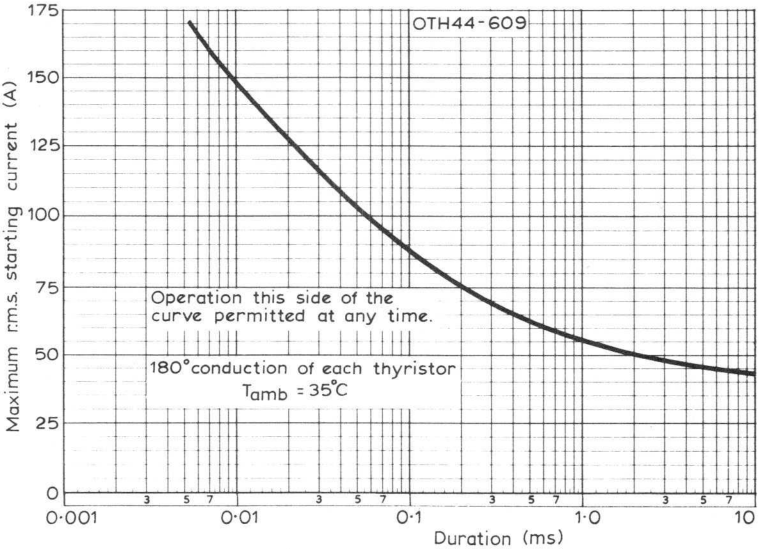




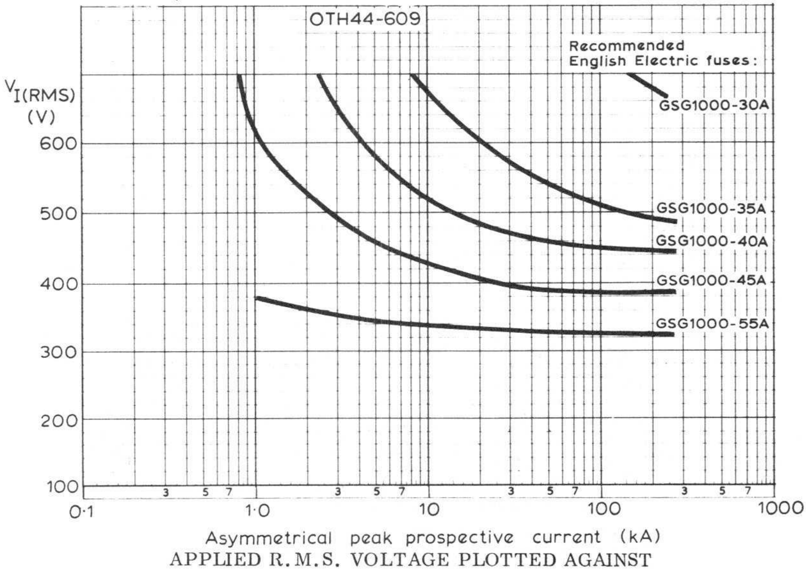
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



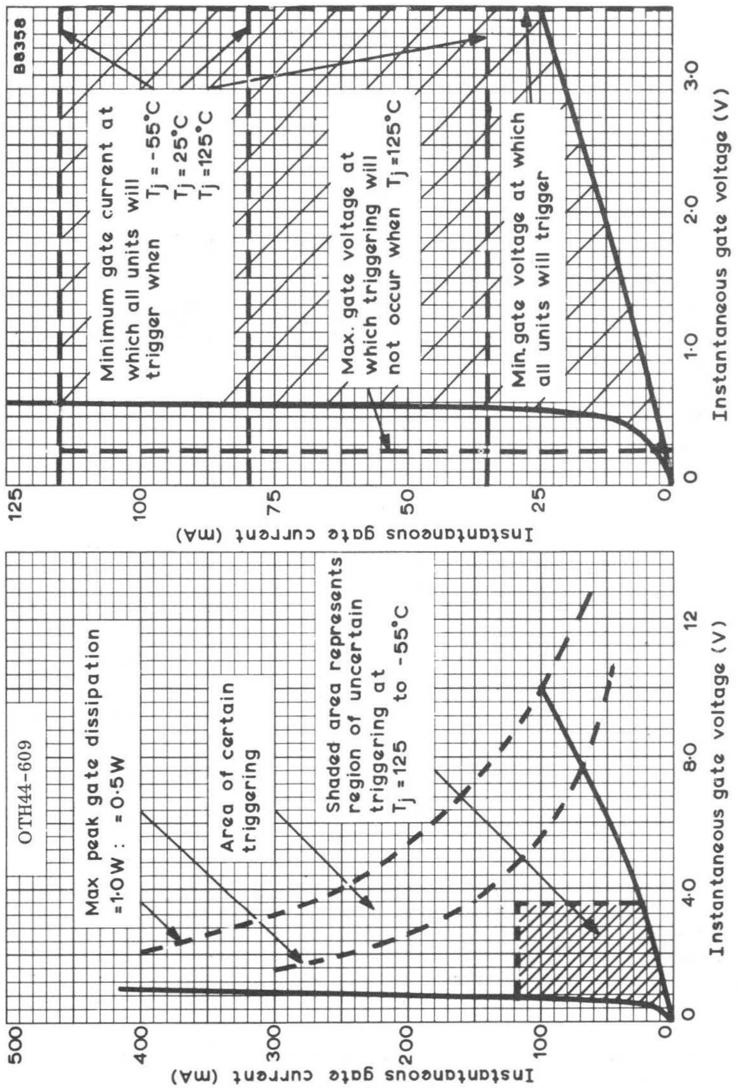
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH50-608

TENTATIVE DATA

The OTH50-608 is a half-controlled, bridge connected, single-phase thyristor stack with flywheel diode, intended for 250V mains. It is suitable for natural convection or forced air cooling and is capable of supplying up to 52A at $T_{amb} = 55^{\circ}C$.

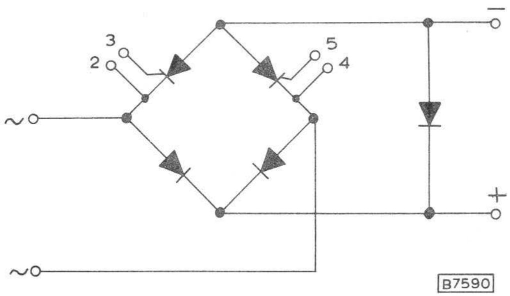
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{ISM}	Max. non-repetitive peak voltage	700	V
Output			
I_O	Max. mean output current ($T_{amb} = 35^{\circ}C$, natural convection cooling)	50	A
I_{ORM}	Max. repetitive peak current	200	A

OUTLINE AND DIMENSIONS

For details see page 5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IWM}	Max. crest working voltage	600	V
V_{IRM}	Max. repetitive peak voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (t< 10ms)	700	V

Output voltage

V_O	Max. average voltage	375	V

Output current

I_O	Max. average current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^{\circ}C$	50	A
	$T_{amb} > 35^{\circ}C$	See curve on page 6	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 55^{\circ}C$	52	A
	$T_{amb} > 55^{\circ}C$	See curve on page 6	
I_{ORM}	Max. repetitive peak current	200	A

Temperature

T_{stg} max.	125	°C
T_{amb} (operating)	See curve on page 6	

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page 8)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	4.0	kg
	8.8	lb
Dimensions	See outline drawing on page 5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

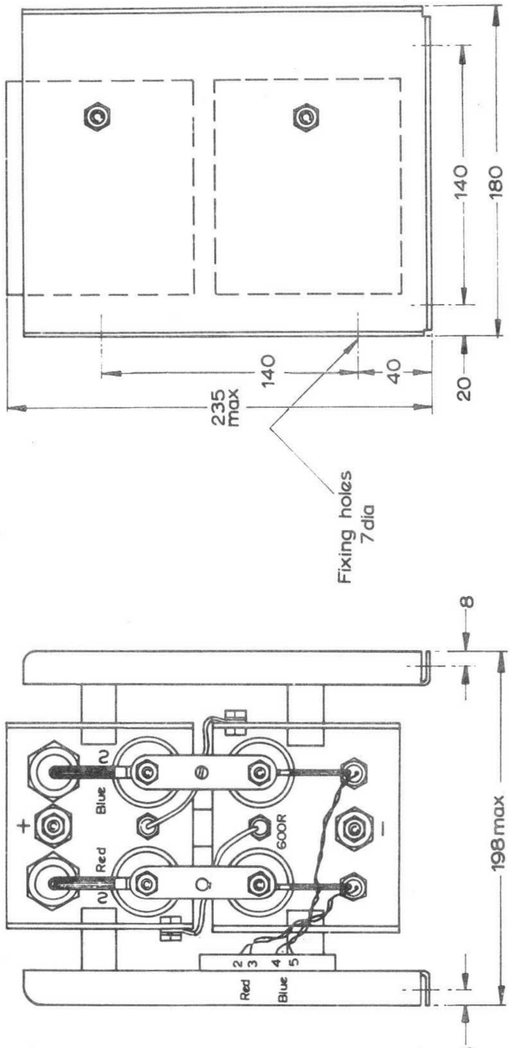
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$

4. **Suitable Replacement Devices**

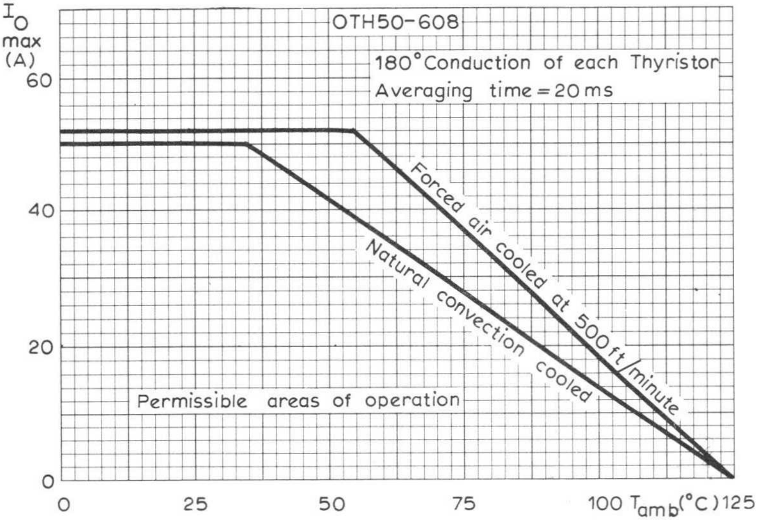
Bridge diodes	BYY77
Thyristors	BTX82-600R
Flywheel diodes	BYX25-600 and BYX25-600R

OUTLINE AND DIMENSIONS

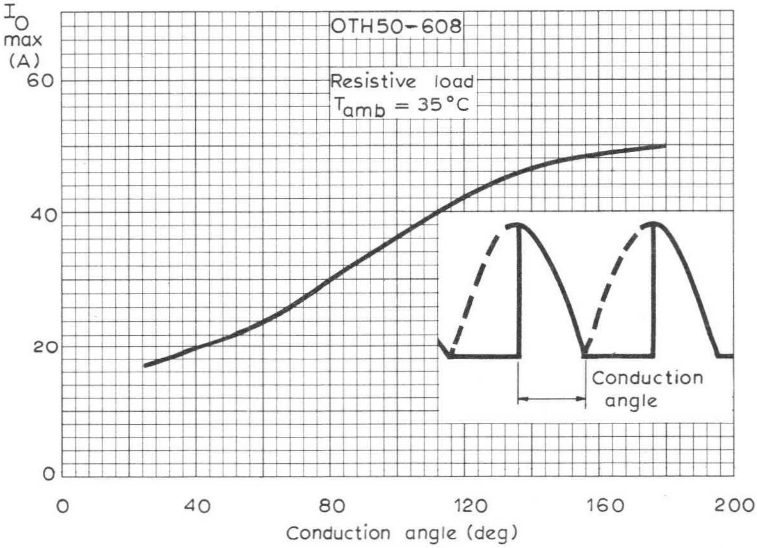


Note: Terminations lie within side plate area but clearance must be provided externally +,− and A.C. terminations are 1/4" UNF. Thyristors may be fused by removing bus bars and replacing with fuses having 63mm fixing centres.

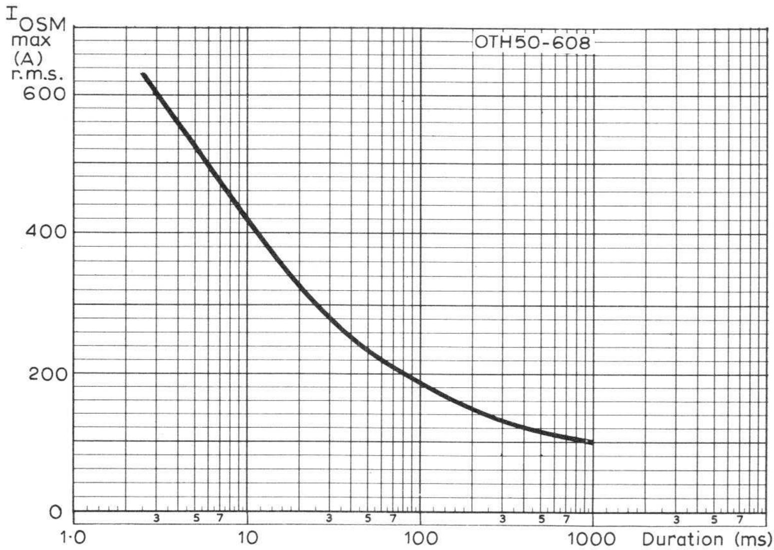
All dimensions in mm.



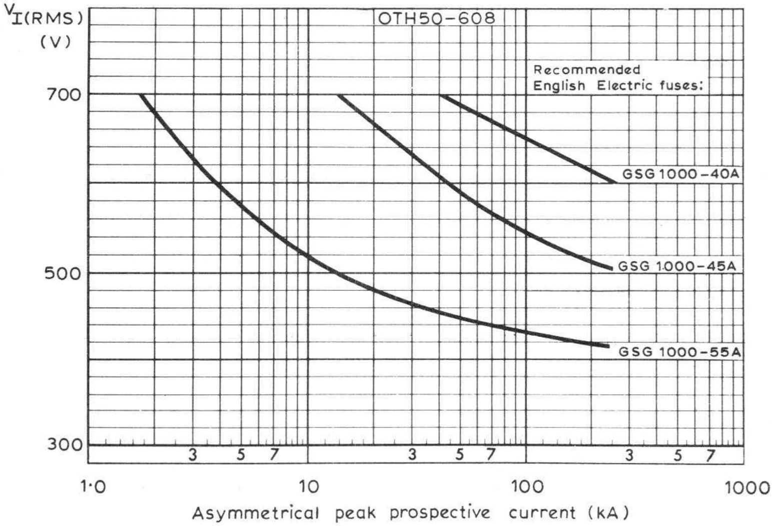
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



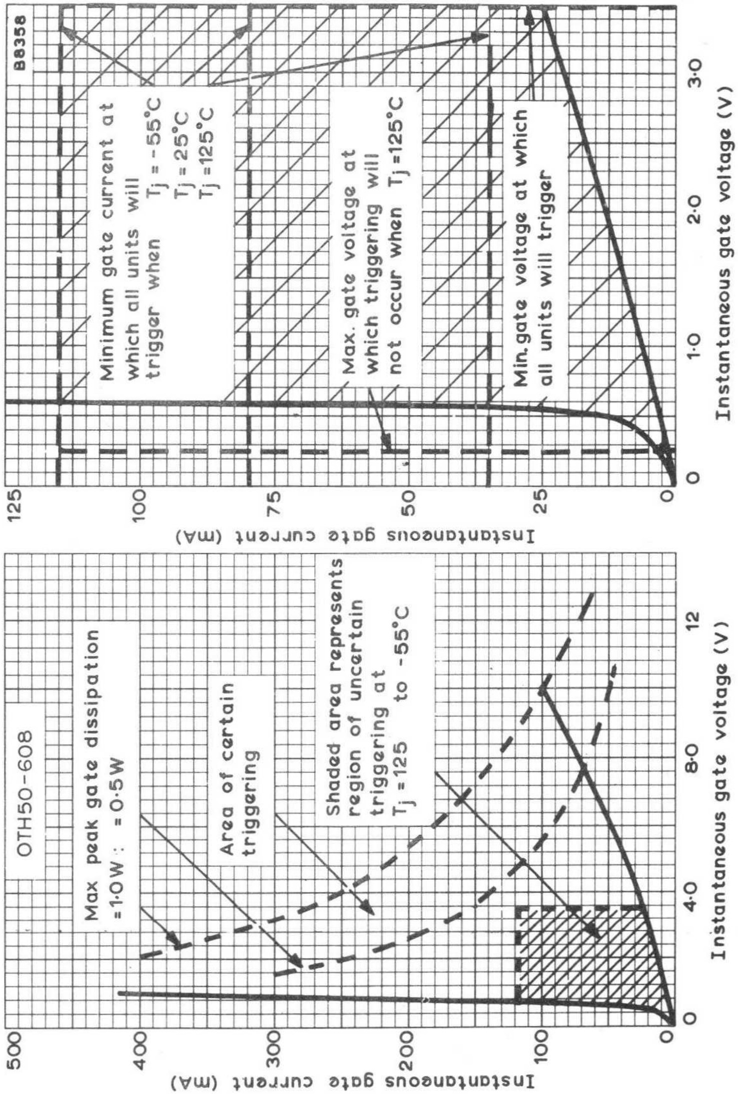
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE CHARACTERISTIC
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH57-609

TENTATIVE DATA

The OTH57-609 is a single-phase a.c. controller consisting of two thyristors mounted on two 40D heatsinks. It is capable of supplying an r.m.s. current of 57A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of up to 250Vr.m.s. It is capable of controlling a tungsten filament lamp of up to 6kW.

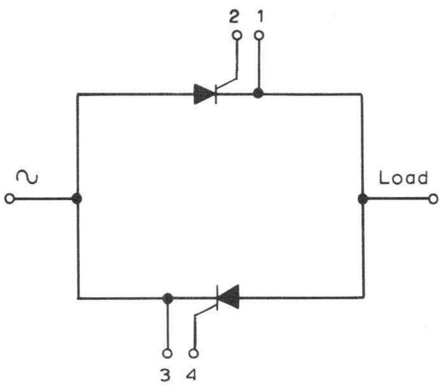
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage ($t < 10ms$)	700	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35°C$	57	A

OUTLINE AND DIMENSIONS

For details see page 5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak a.c. voltage ($t < 10ms$)	700	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180^o conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^oC$	57	A
	$T_{amb} > 35^oC$	See curve on page 6	
I_{ORM}	Max. repetitive peak forward current	350	A
I_{OSM}	Max. surge current	See curve on page 6	

Temperature

T_{stg} max.		125	^oC
T_{amb} max. (see also curve on page 6)		125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page 8)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	2.6	kg
	5.8	lb
Dimensions	See outline drawing on page 5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\,\frac{I_{mag}}{V_1}$	150	$225\,\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\,\frac{I_{mag}}{V_1}$	225	$400\,\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\,\frac{I_{mag}}{V_1}$	300	$900\,\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$

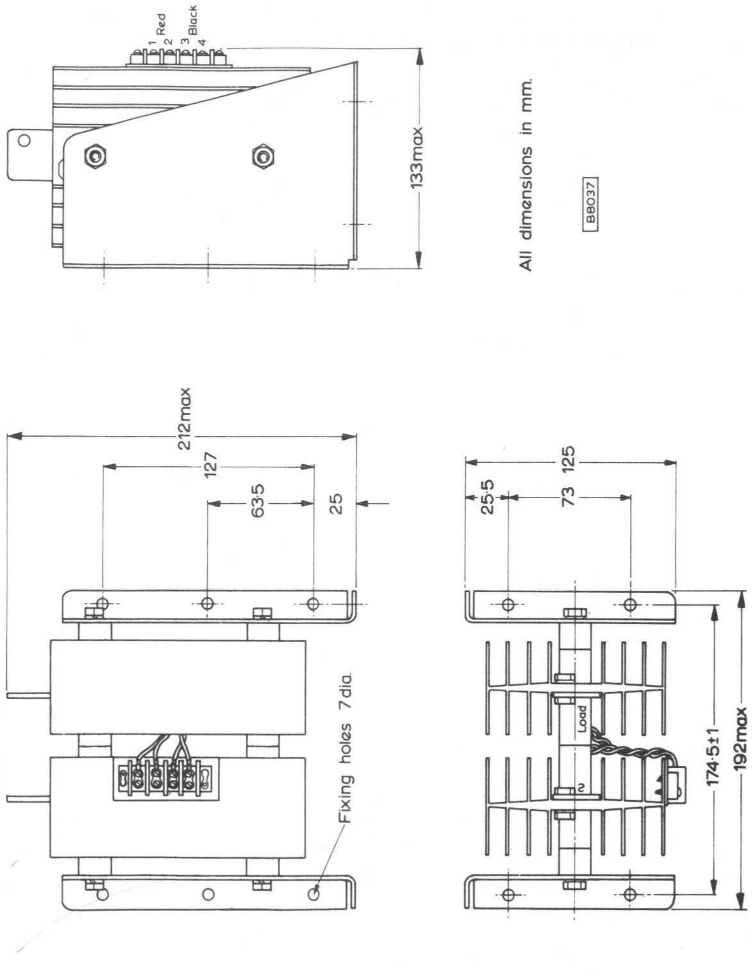
4. **Suitable Replacement Devices**

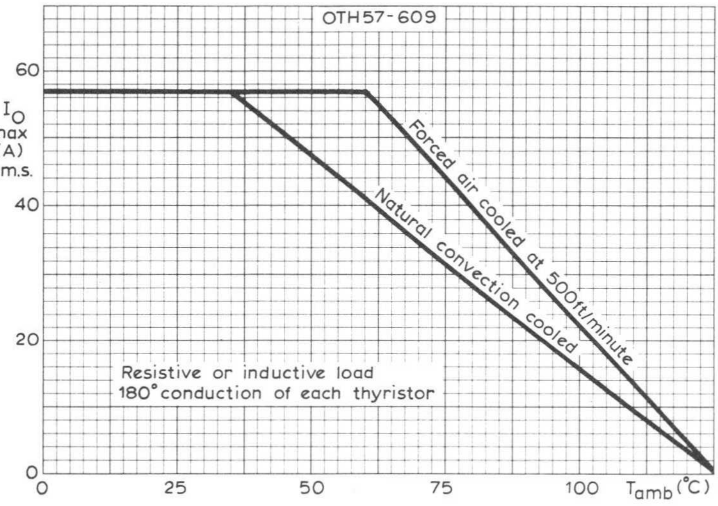
Thyristors	BTX82-600R

SINGLE-PHASE THYRISTOR STACK

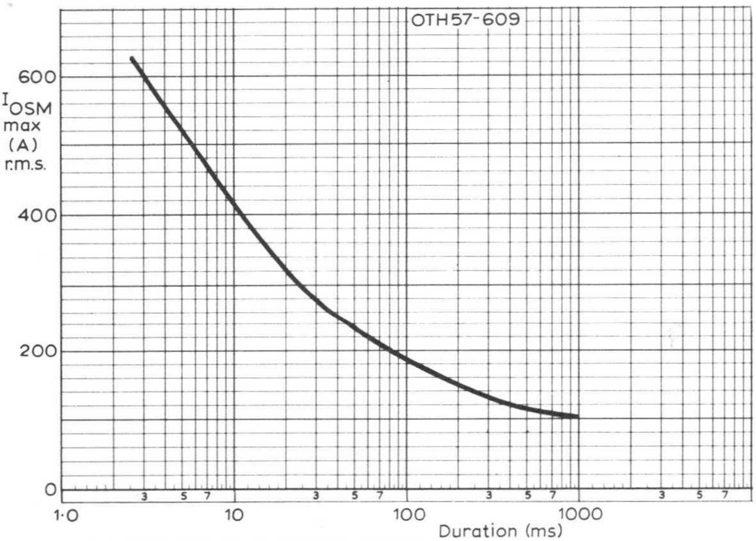
OTH57-609

OUTLINE AND DIMENSIONS

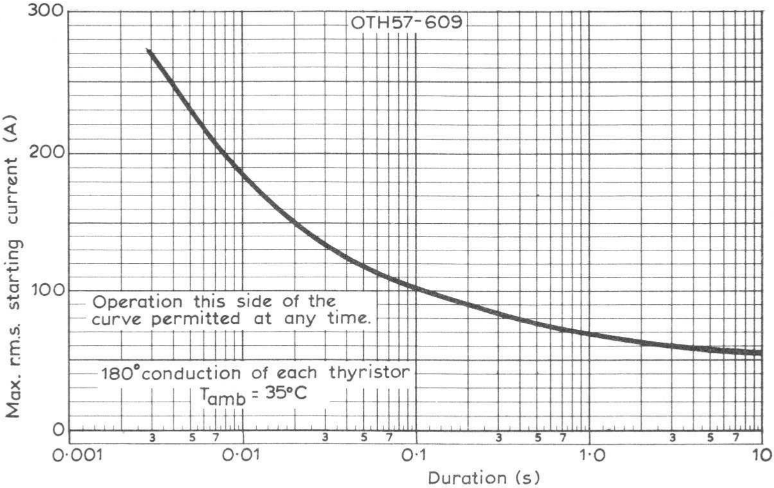




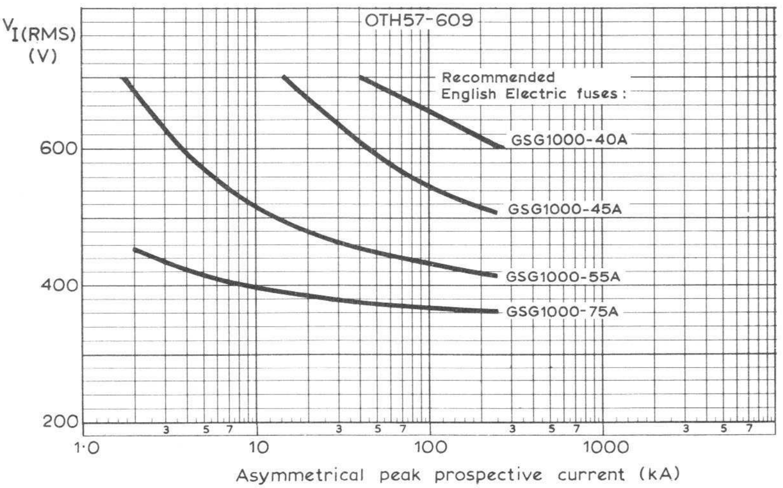
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



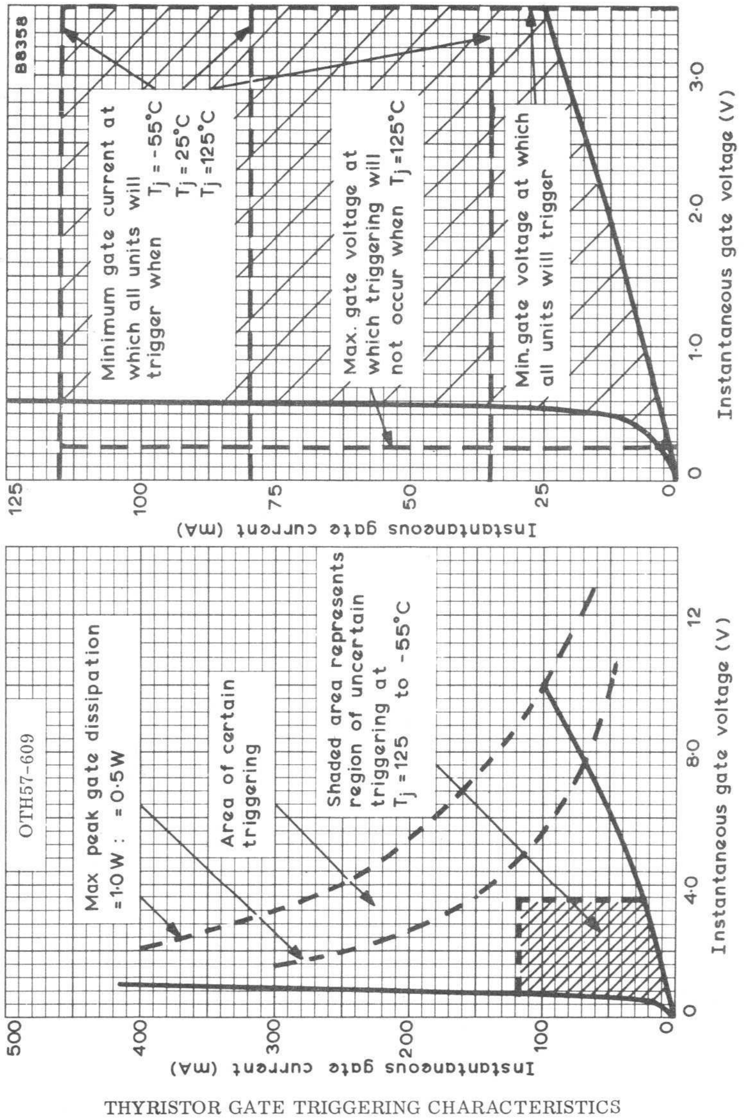
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH68-608

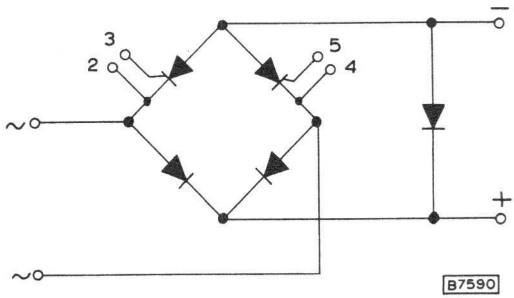
The OTH68-608 is a half-controlled bridge connected thyristor stack with flywheel diode, intended for 250V single-phase mains. It is capable of supplying an output current of 68A at $T_{amb} = 35^{o}C$ with natural convection cooling and 180^{o} conduction of each thyristor.

QUICK REFERENCE DATA			
Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak voltage	600	V
Output			
V_O	Max. average voltage	375	V
I_O	Max. average current ($T_{amb} = 35^{o}C$, natural convection cooling)	68	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IWM}	Max. crest working voltage	600	V
V_{IRM}	Max. repetitive peak voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5ms)	720	V

Output voltage

V_O	Max. average voltage	375	V

Output current

I_O	Max. average current, resistive or inductive load, 180^o conduction of thyristors, natural convection cooled		
	T_{amb} $\leq 35^oC$	68	A
	T_{amb} $> 35^oC$	See curve on page C1	
	Forced air cooled at 500 ft/minute		
	T_{amb} $\leq 35^oC$	80	A
	T_{amb} $> 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	200	A

Temperature

T_{stg} max.	125	^oC
T_{amb} operating	See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	8.5	kg
	19	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

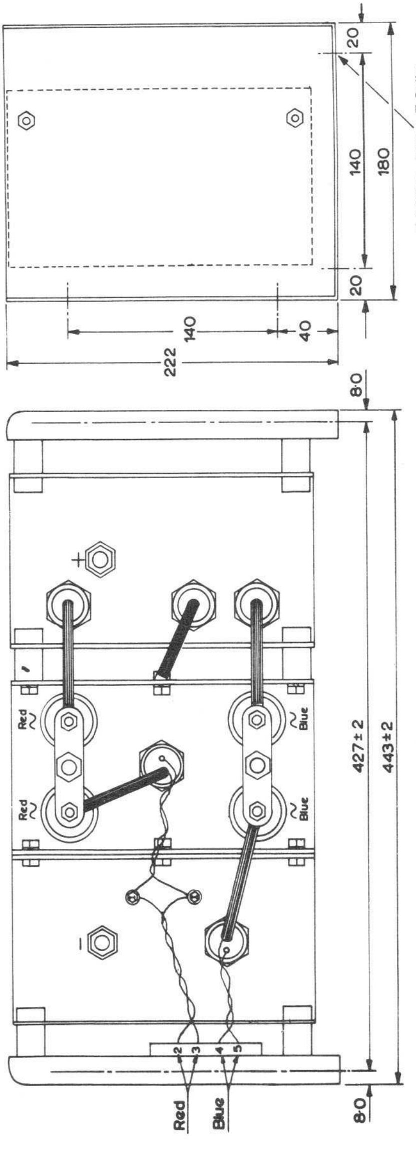
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
See also English Electric G.S.G. Fuse Data.

4. Suitable Replacement Devices

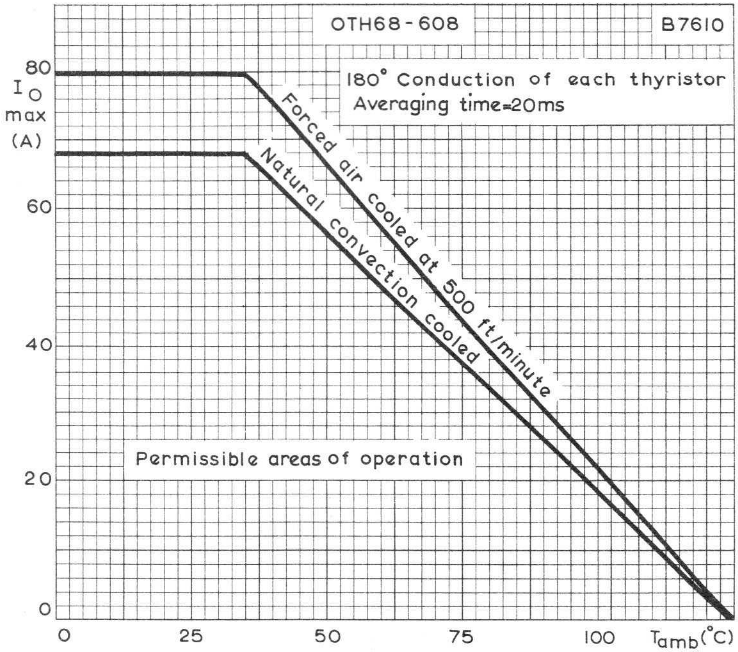
Bridge Diodes	BYY77
Bridge Thyristors	BTY95-600R
Flywheel Diode	BYY77

OUTLINE AND DIMENSIONS

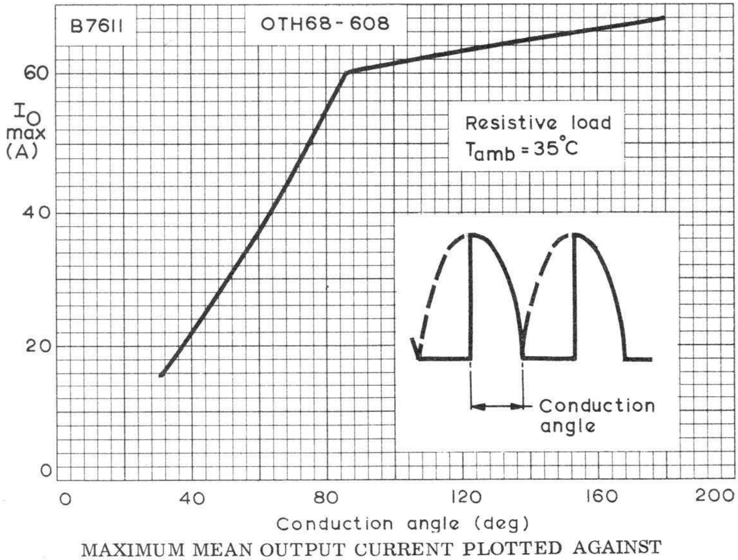


Note: Terminations lie within side plate area but clearance must be provided externally
+, − and ~ terminations are 3/8" UNF
A.C. terminations are split to permit fusing if required.

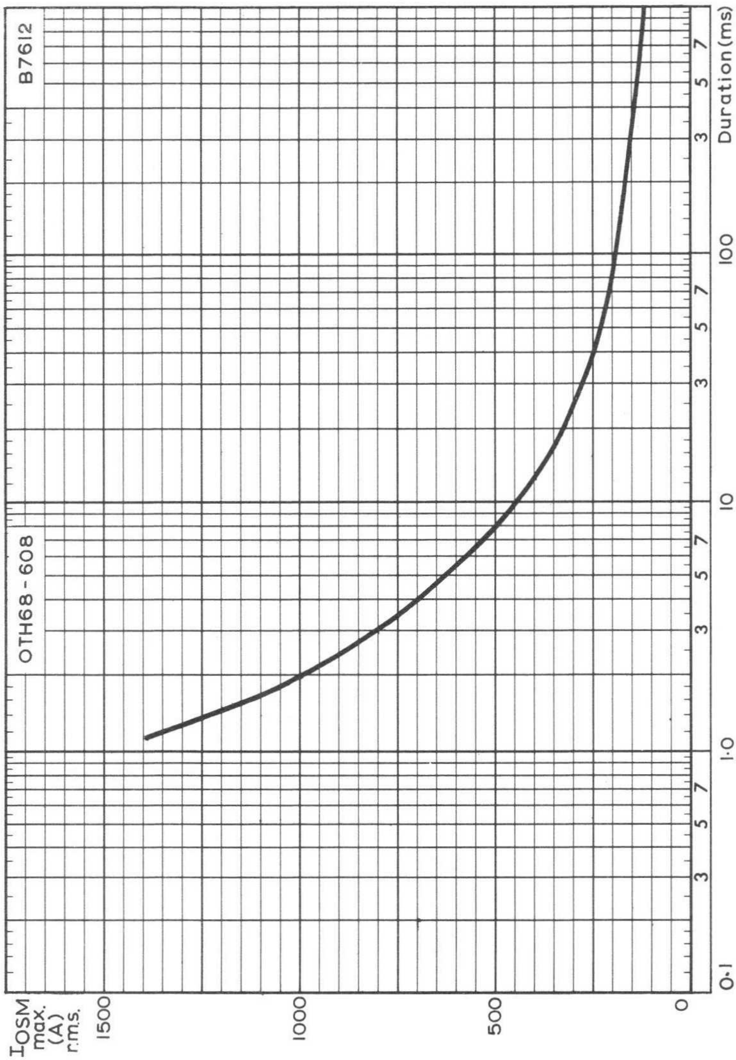
All dimensions in mm



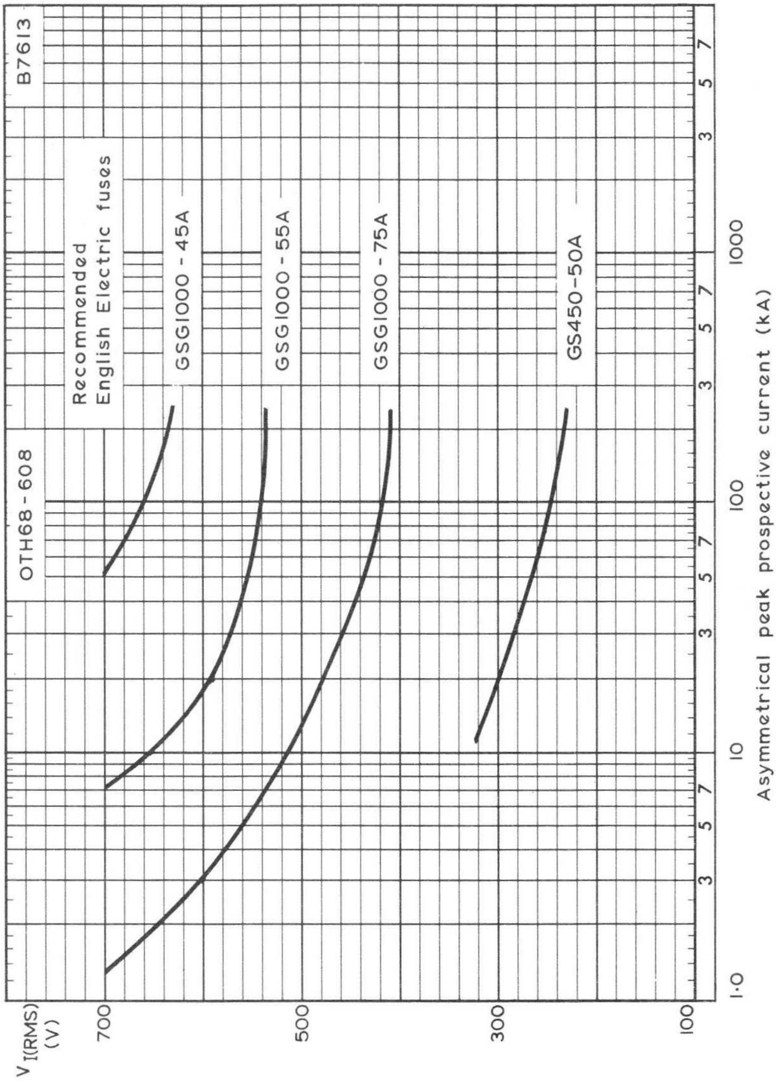
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



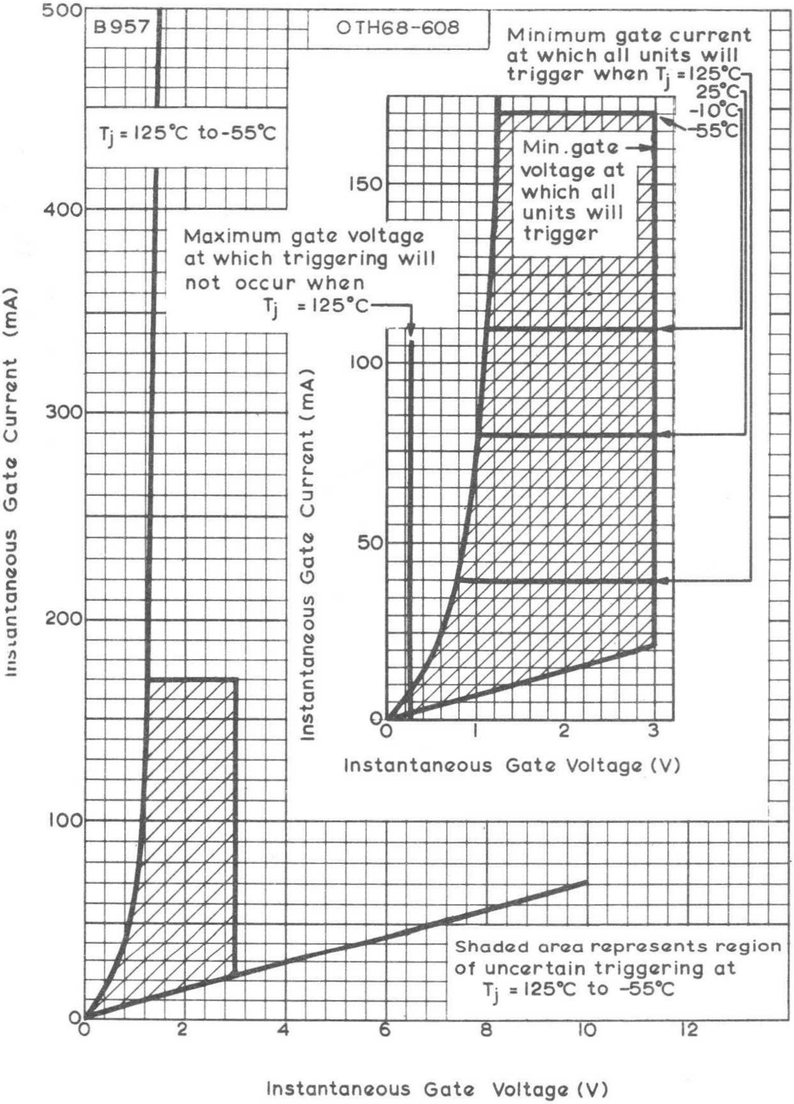
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$×1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF
THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH68-609

The OTH68-609 is a single-phase a.c. controller consisting of two thyristors mounted on two 60D heatsinks. It is capable of supplying an r.m.s. current of 75A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of up to 250Vr.m.s.

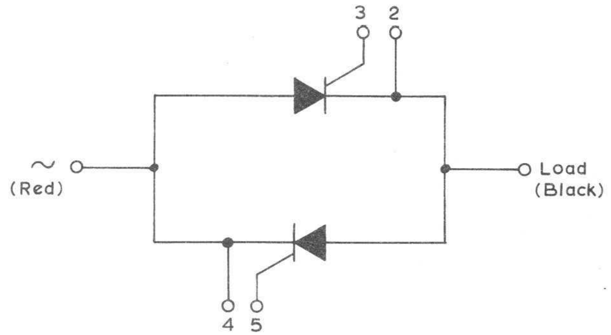
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5.0ms)	720	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35°C$	75	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5ms)	720	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180°conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^oC$	75	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	700	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max. (see also curves on page C1)		125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	5.7	kg
	12.7	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

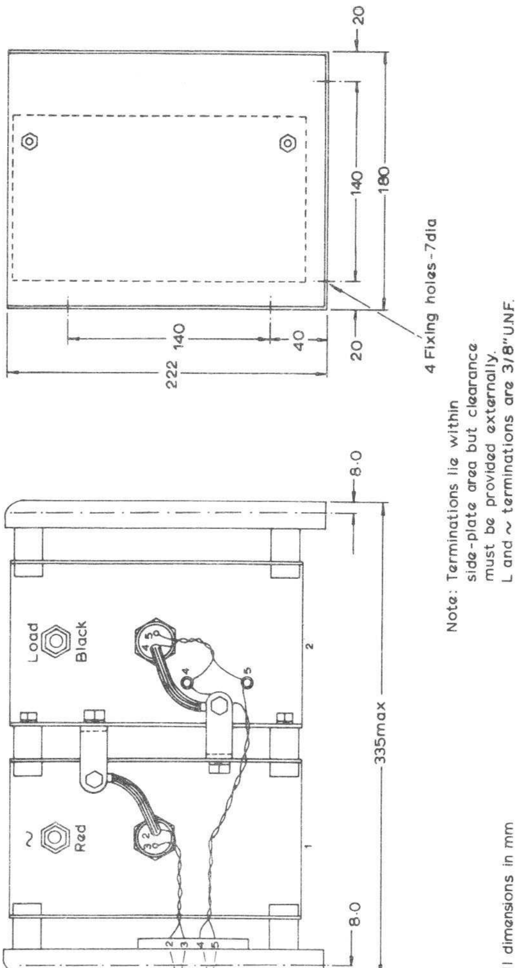
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

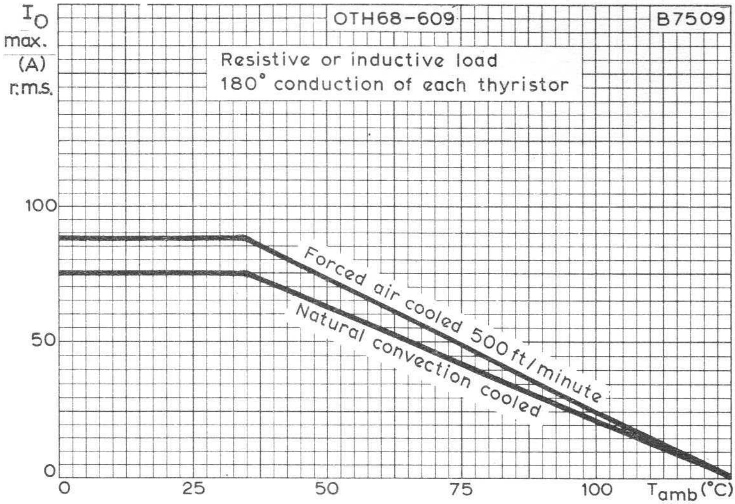
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices.**

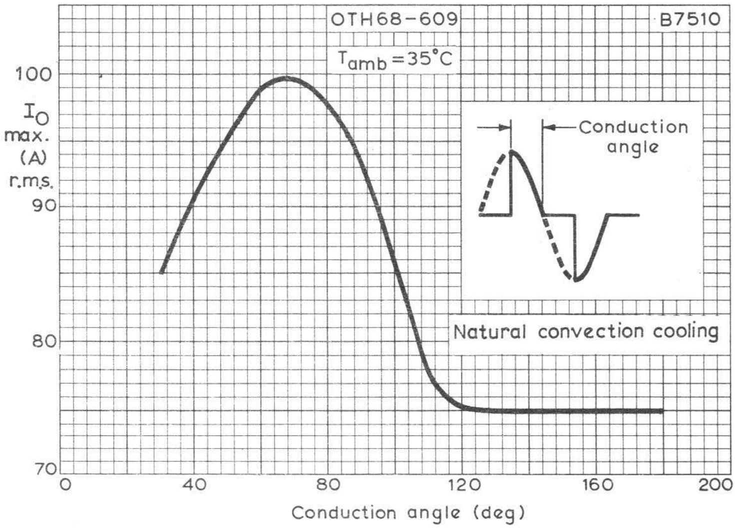
Thyristors BTY95-600R

OUTLINE AND DIMENSIONS

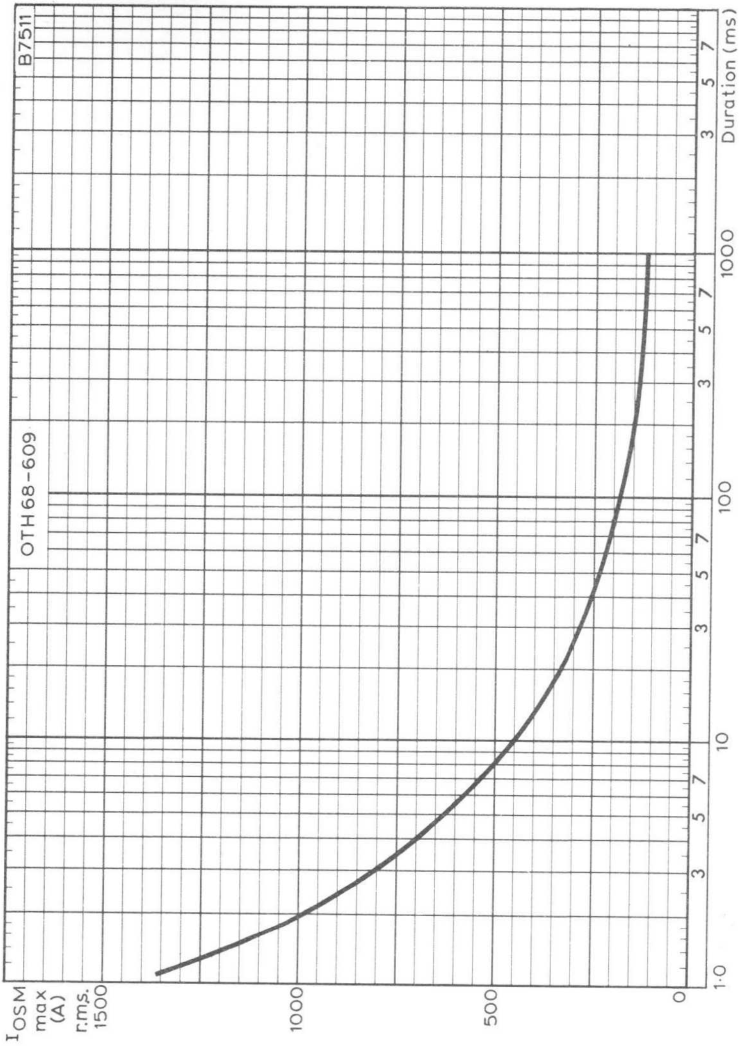




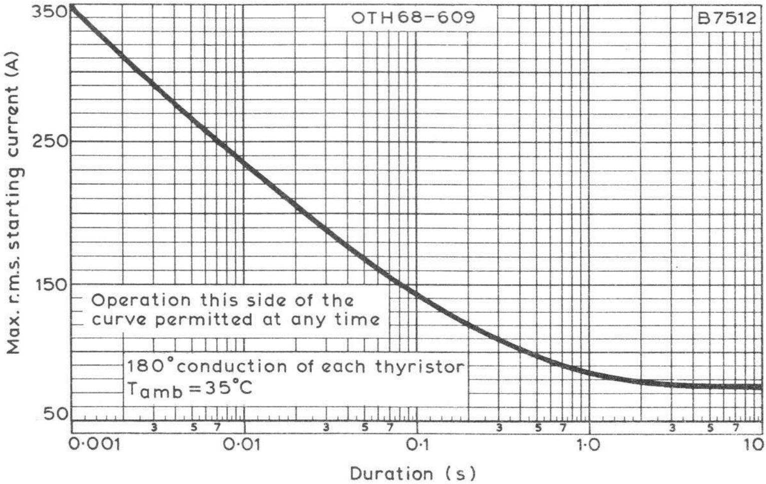
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



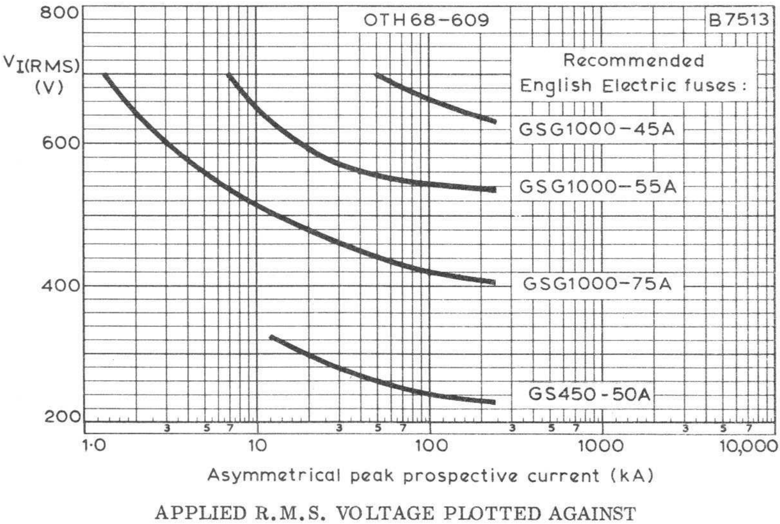
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



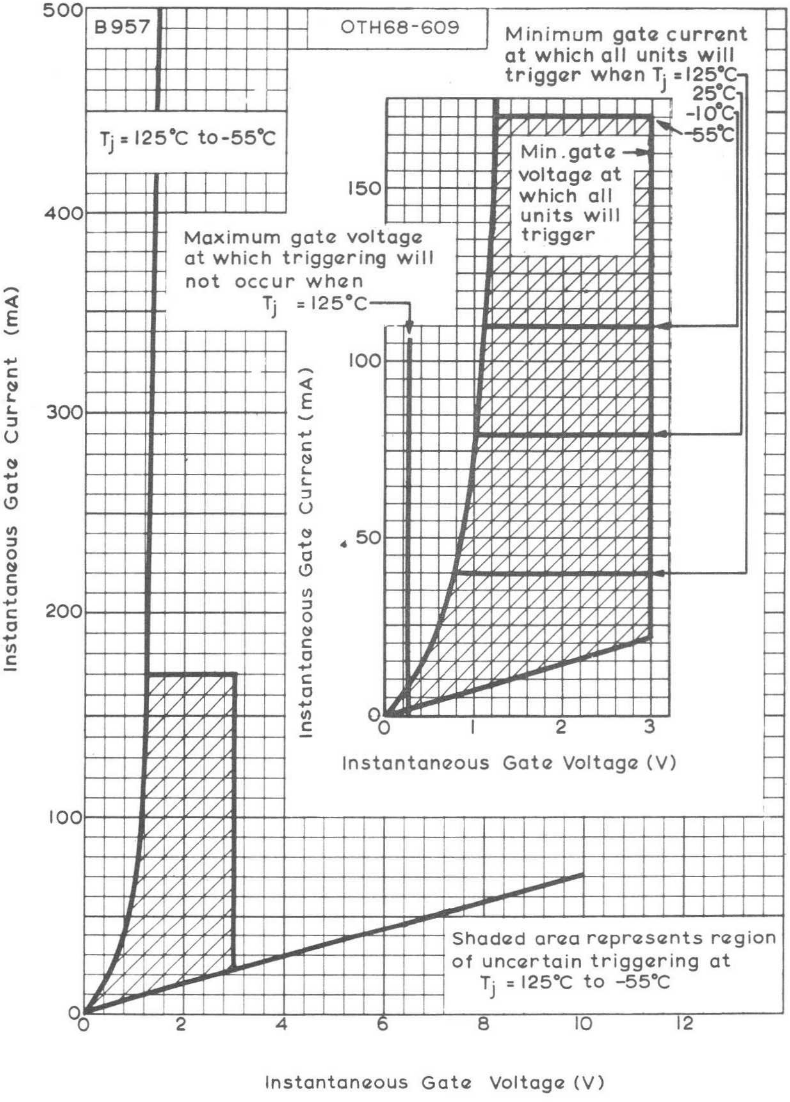
MAXIMUM R. M. S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH68-1208A

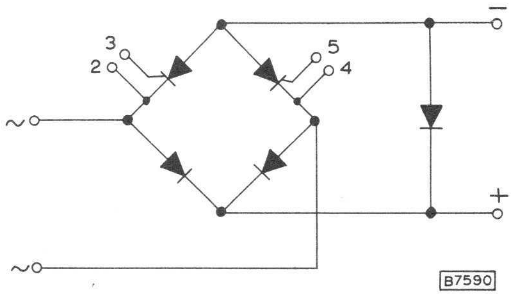
The OTH68-1208A is a half-controlled bridge connected thyristor stack with flywheel diode, intended for 440V single-phase mains. It is capable of supplying an output current of 68A at T_{amb} = 35°C with natural convection cooling and 180° conduction of each thyristor.

QUICK REFERENCE DATA			
Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak voltage	1100	V
Output			
V_O	Max. average voltage	505	V
I_O	Max. average current (T_{amb} = 35°C, natural convection cooling)	68	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak voltage	1100	V
V_{ISM}	Max. non-repetitive peak voltage, $t < 10ms$, see note 5	1100	V

Output voltage

V_O	Max. average voltage	505	V

Output current

I_O	Max. average current, resistive or inductive load, 180° conduction of thyristors, natural convection cooled		
	$T_{amb} \leq 35^{\circ}C$	68	A
	$T_{amb} > 35^{\circ}C$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^{\circ}C$	80	A
	$T_{amb} > 35^{\circ}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	200	A

Temperature

T_{stg} max.	125	$^{\circ}C$
T_{amb} operating	See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	5.5	kg
	12	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current x $\sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices**

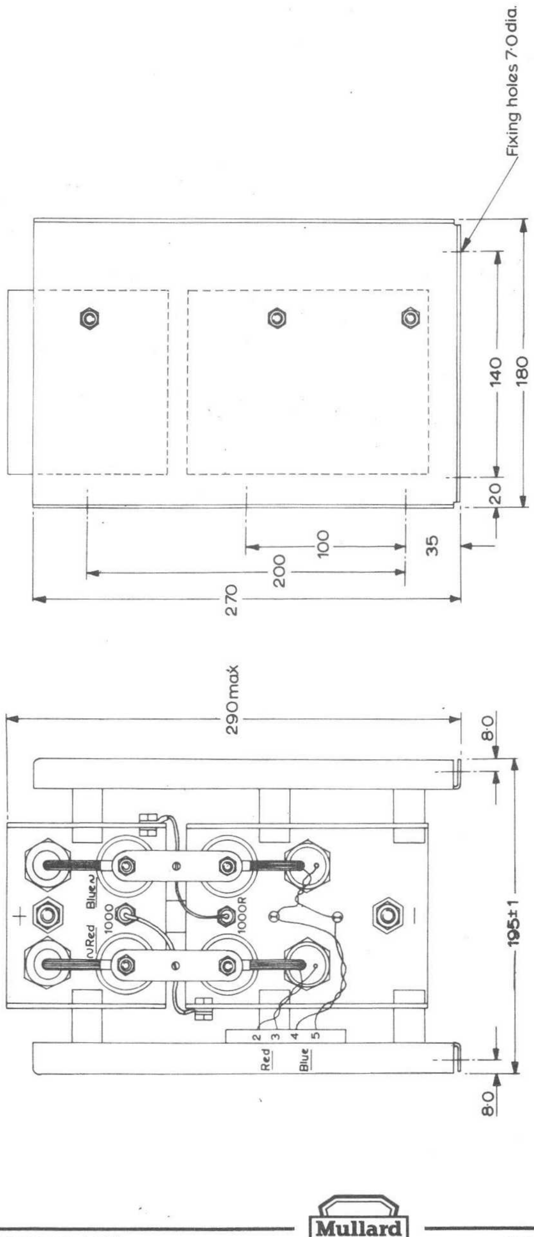
Bridge Diodes	BYX15
Bridge Thyristors	BTX49 - 1200R
Flywheel Diodes	BYX25 - 1000 and BYX25 - 1000R

5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

SINGLE-PHASE THYRISTOR STACK

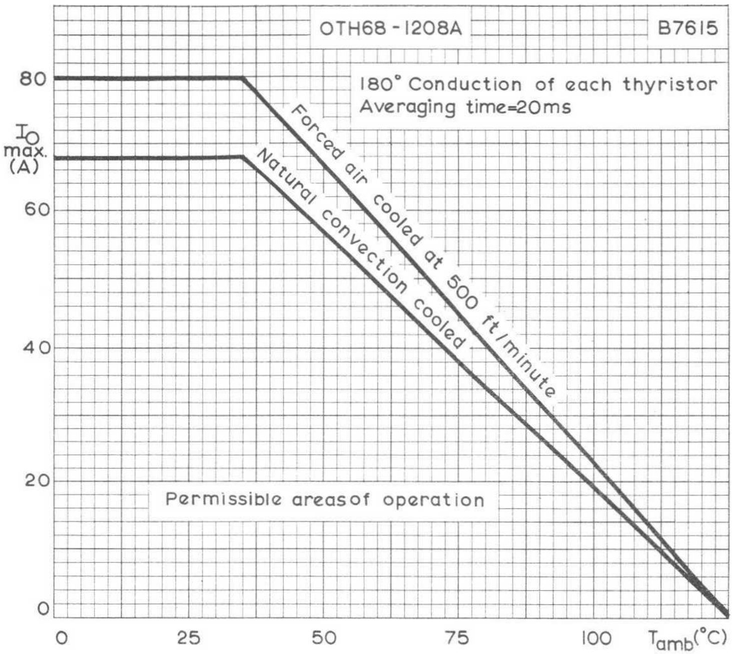
OTH68-1208A

OUTLINE AND DIMENSIONS

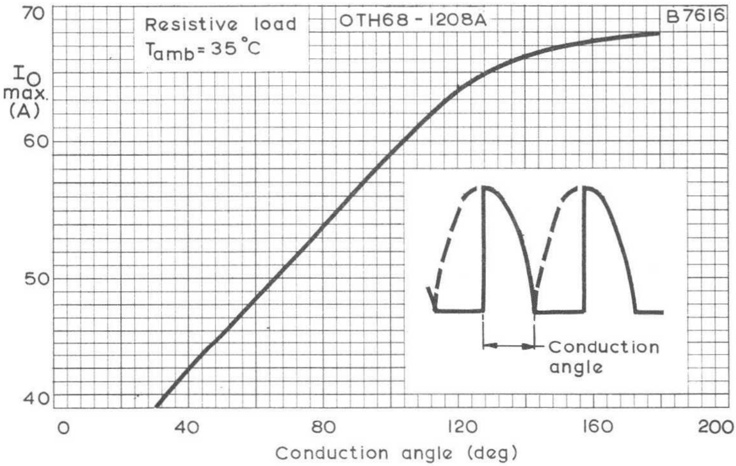


Note: Terminations lie within side plate area but clearance must be provided externally.
+ and − Terminations are 3/8" UNF.
A.C. terminations are 1/4" UNF.
Thyristors may be fused by removing bus bars and replacing with fuses having 63mm fixing centres.

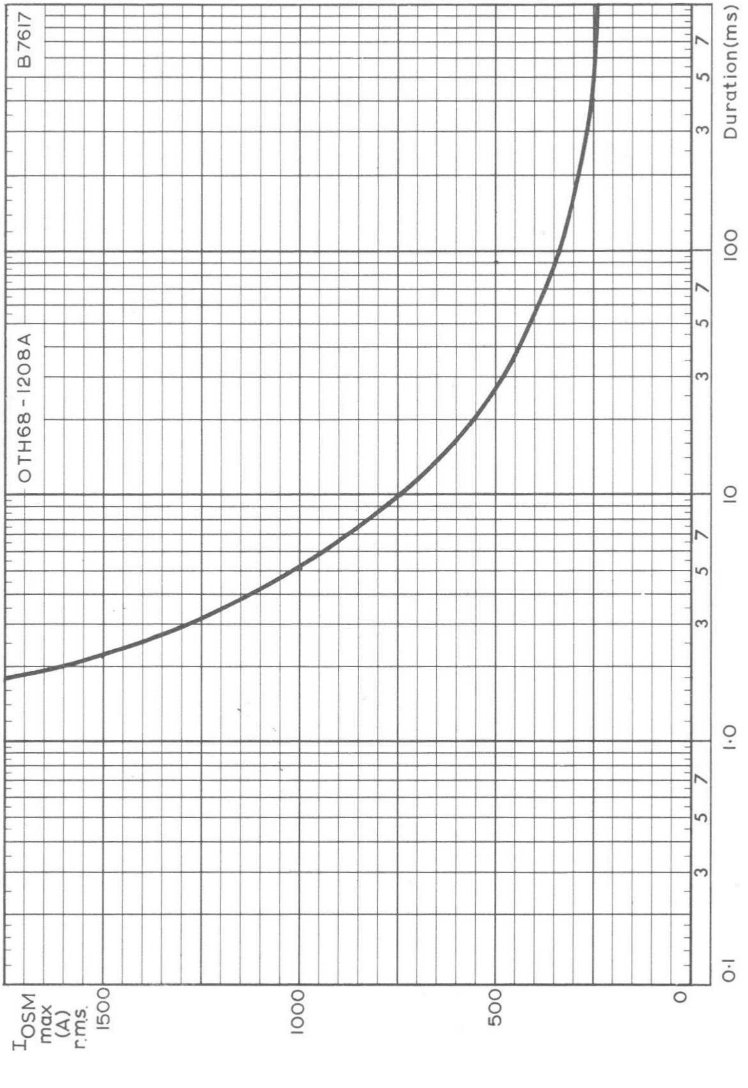
All dimensions in mm.



MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



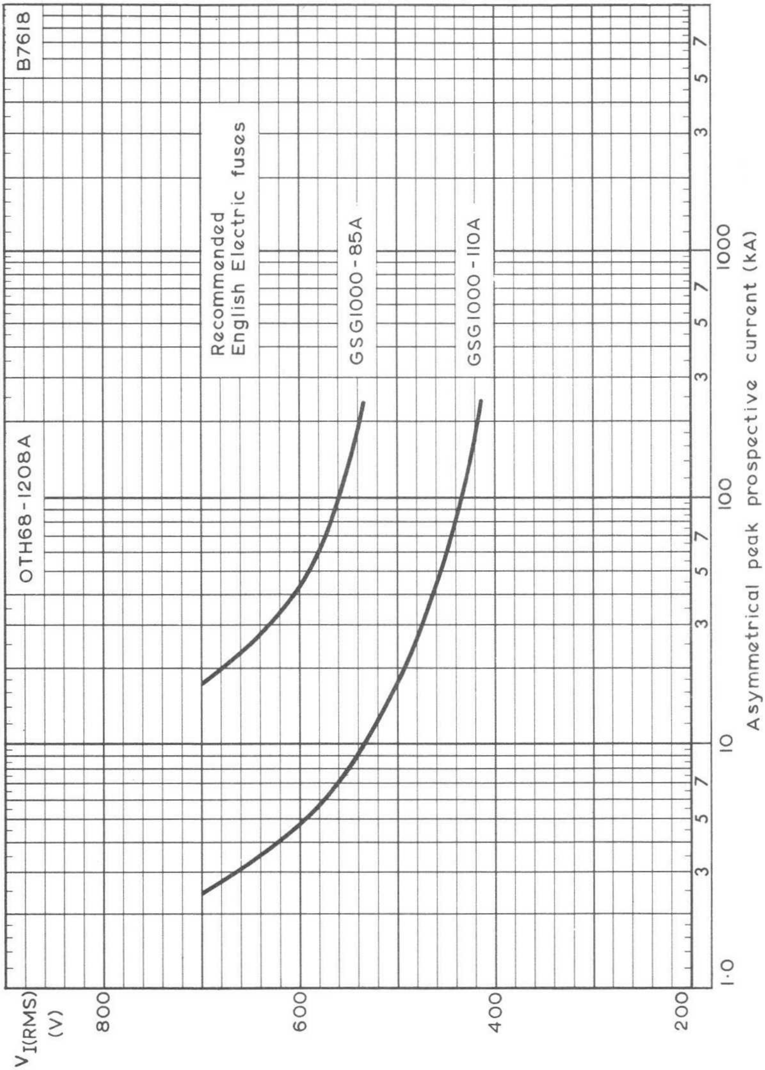
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



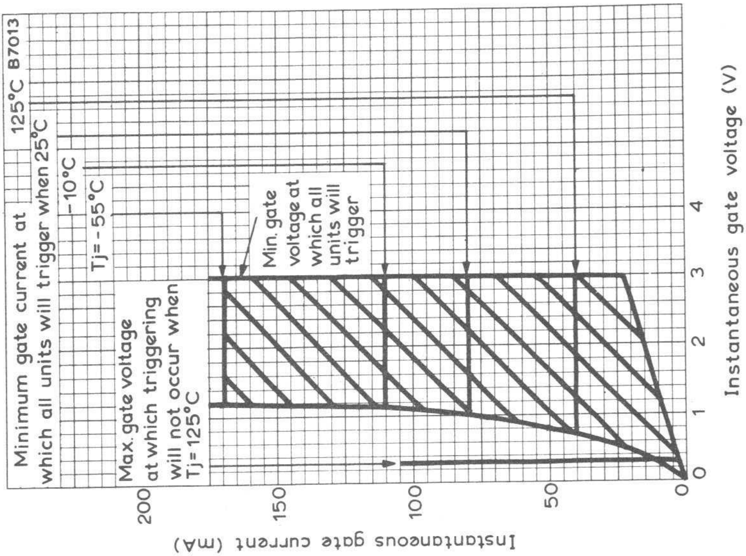
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)

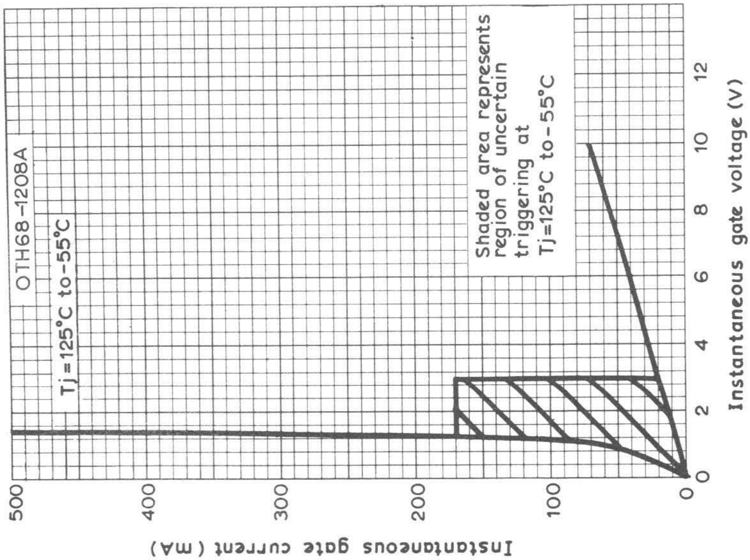
SINGLE-PHASE THYRISTOR STACK

OTH68-1208A



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)





THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF
THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH105-1209

TENTATIVE DATA

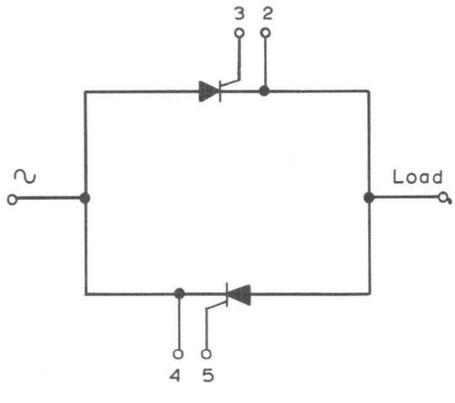
The OTH105-1209 is a single-phase a.c. controller consisting of two thyristors mounted on two 60D heatsinks. It is capable of supplying an r.m.s. current of 105A at an ambient temperature of $35^{\circ}C$, and is intended for operation from a nominal a.c. mains supply of 440Vr.m.s.

QUICK REFERENCE DATA			
Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^{\circ}C$	105	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t< 10ms, see note 5)	1100	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180^o conduction of each thyristor, natural convection cooling		
	$T_{amb} \leq 35^oC$	105	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	140	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	1000	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curves on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	5.7	kg
	12.7	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

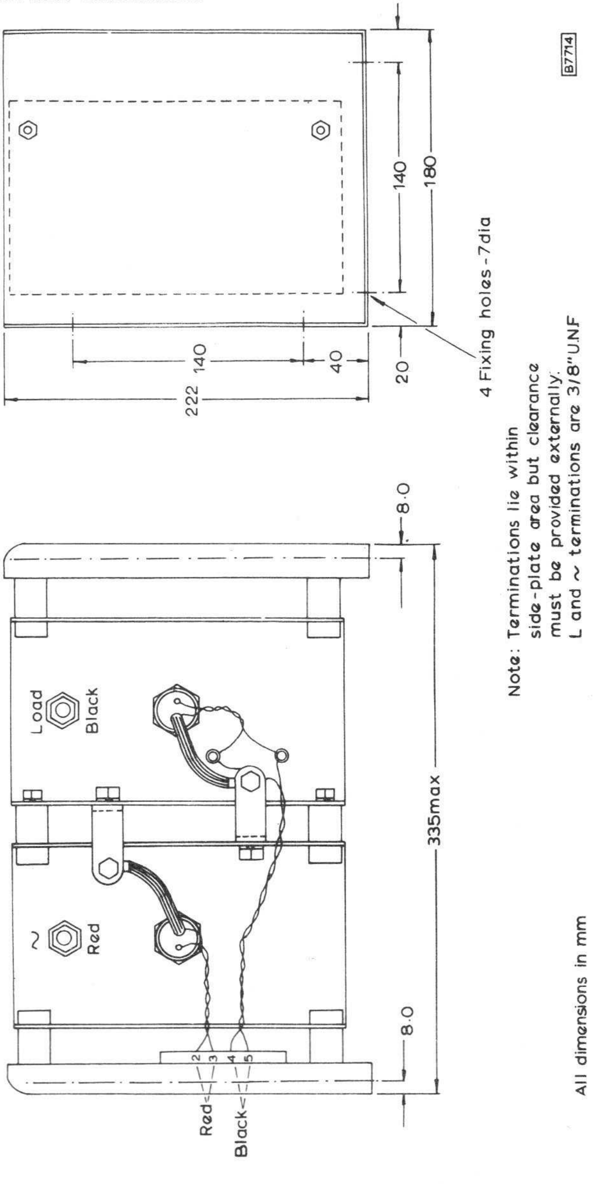
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices**

   Thyristors BTX49-1200R

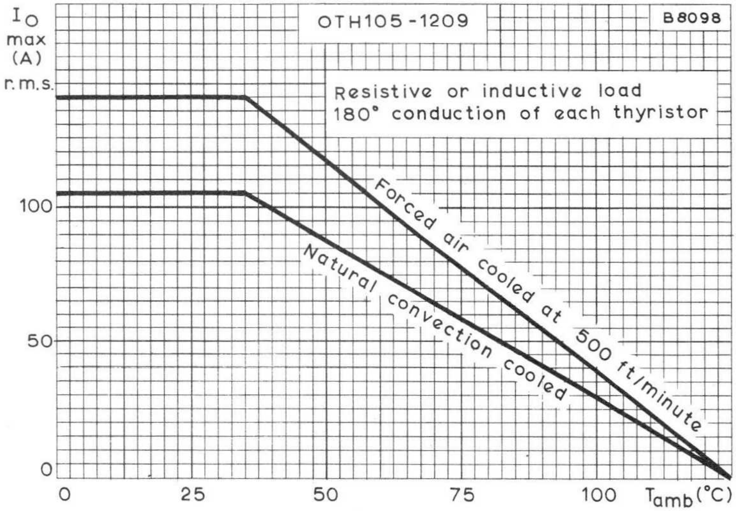
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

OUTLINE AND DIMENSIONS

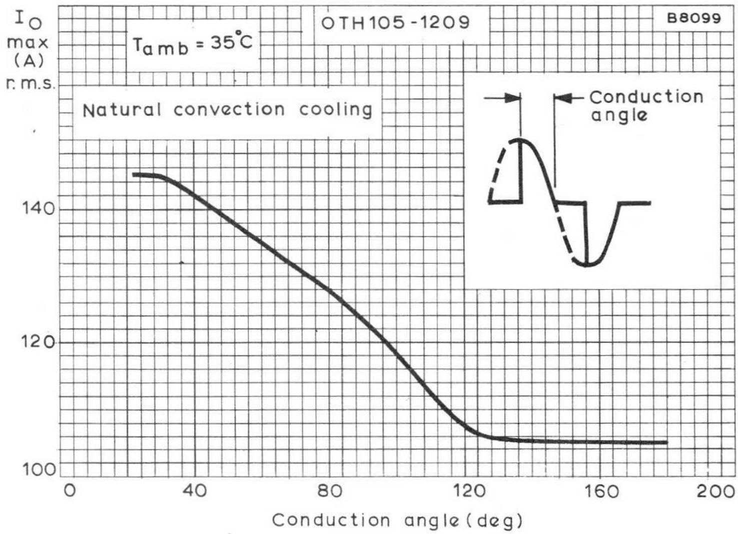


SINGLE-PHASE THYRISTOR STACK

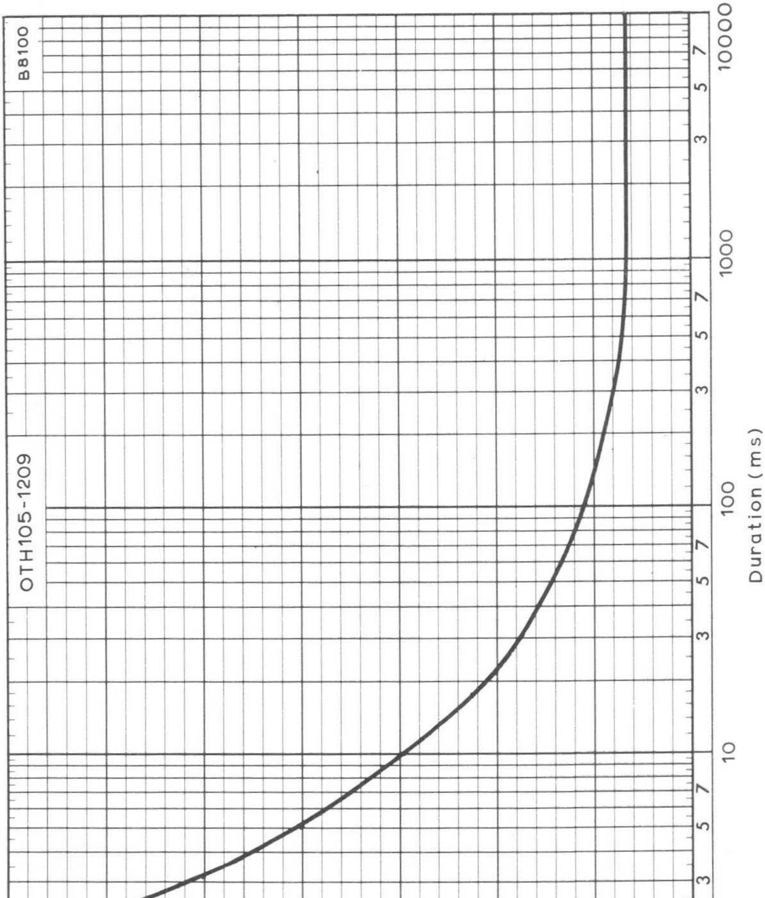
OTH105-1209



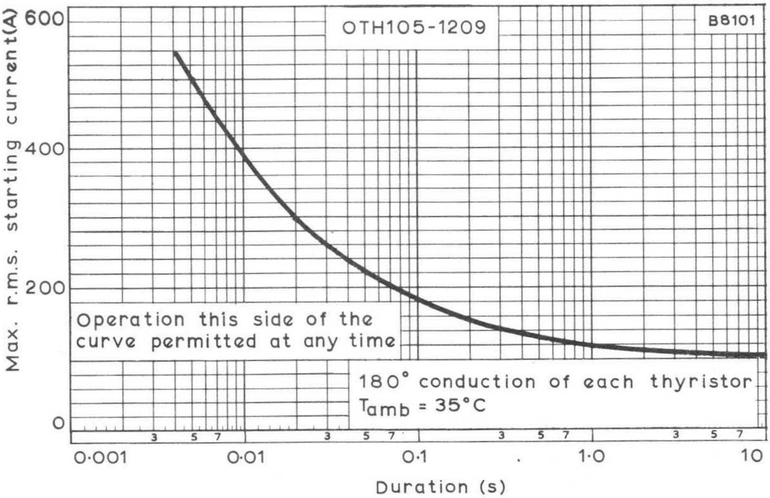
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



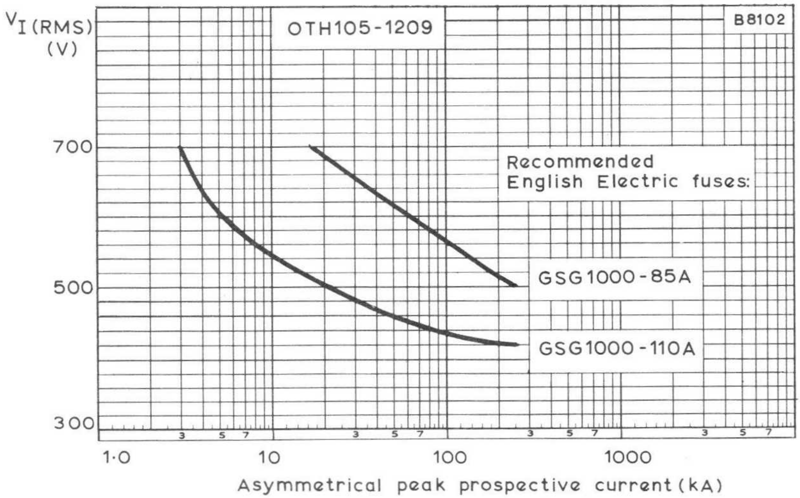
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



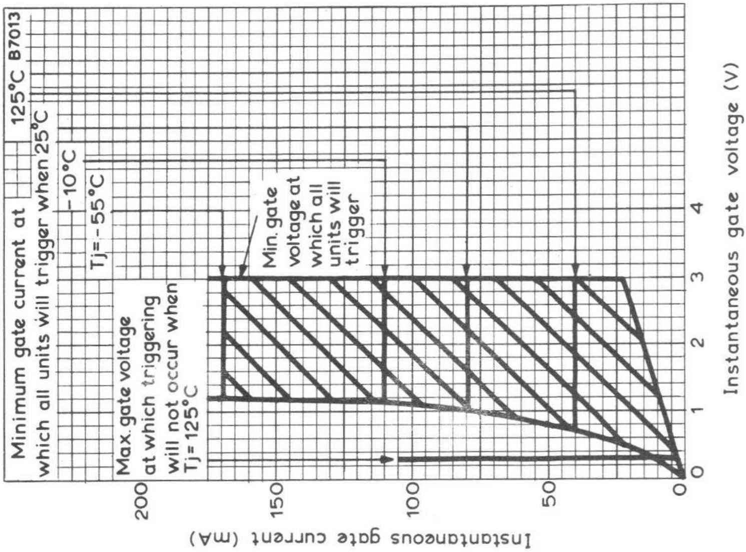
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)

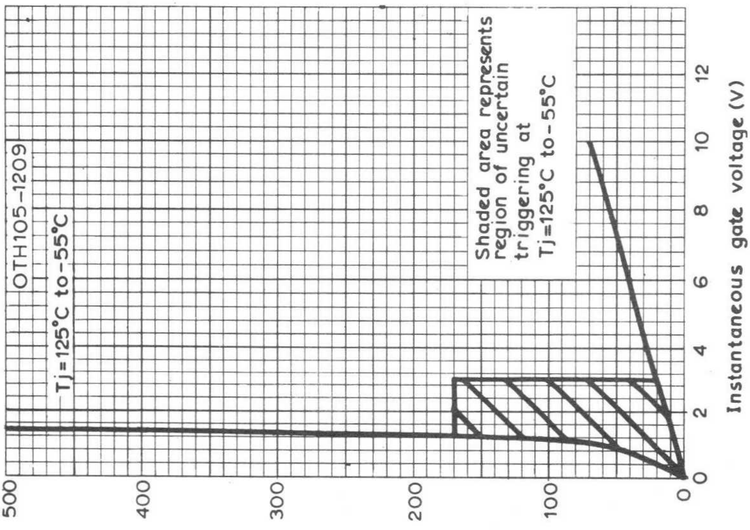


MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)





THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH110-608

The OTH110-608 is a half-controlled bridge connected thyristor stack with flywheel diode, intended for 250V single-phase mains. It is capable of supplying an output current of 110A at T_{amb} = 35°C with natural convection cooling and 180° conduction of each thyristor.

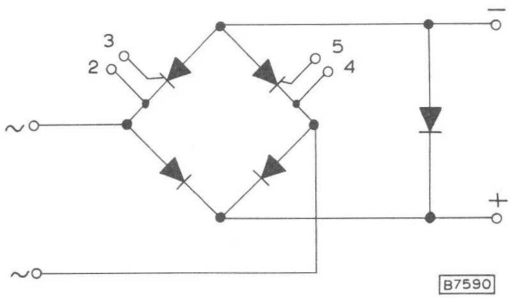
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak voltage	600	V
Output			
V_O	Max. average voltage	375	V
I_O	Max. average current (T_{amb} = 35°C, natural convection cooling)	110	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IWM}	Max. crest working voltage	600	V
V_{IRM}	Max. repetitive peak voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5ms)	720	V

Output voltage

V_O	Max. average voltage	375	V

Output current

I_O	Max. average current, resistive or inductive load, 180° conduction of thyristors, natural convection cooled		
	$T_{amb} \leq 35^{\circ}C$	110	A
	$T_{amb} > 35^{\circ}C$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^{\circ}C$	140	A
	$T_{amb} > 35^{\circ}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	380	A

Temperature

T_{stg} max.		125	$^{\circ}C$
T_{amb} operating		See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$	70	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame

MECHANICAL DATA

Weight (approx.)	9.1	kg
	20	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current x $\sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

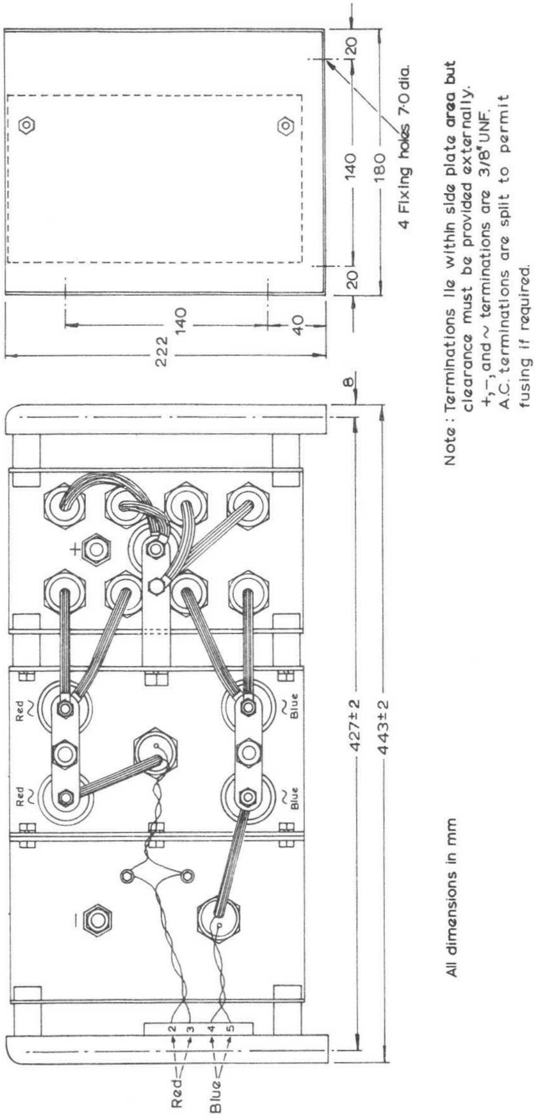
4. **Suitable Replacement Devices**

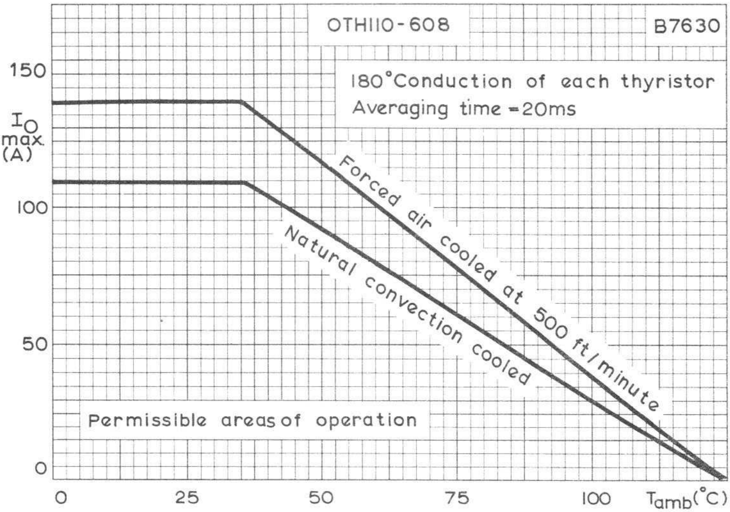
Bridge Diodes	BYY77
Bridge Thyristors	BTY99 - 600R
Flywheel Diodes	BYY77

SINGLE-PHASE THYRISTOR STACK

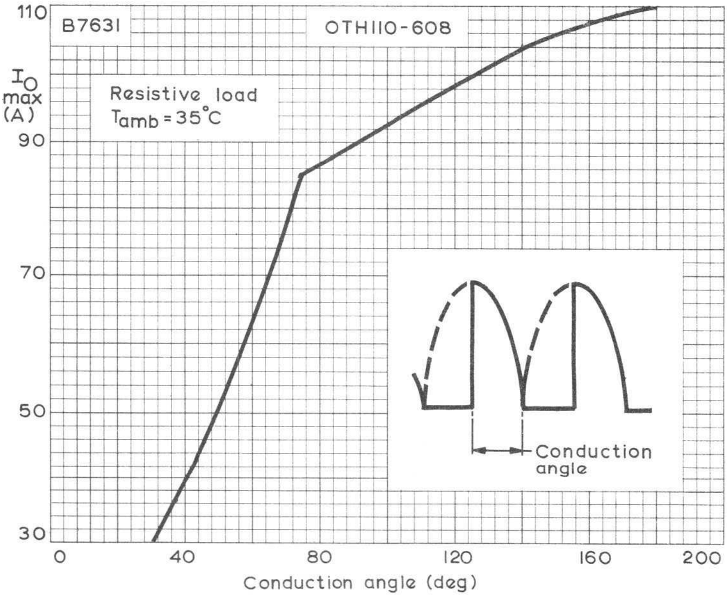
OTH110-608

OUTLINE AND DIMENSIONS

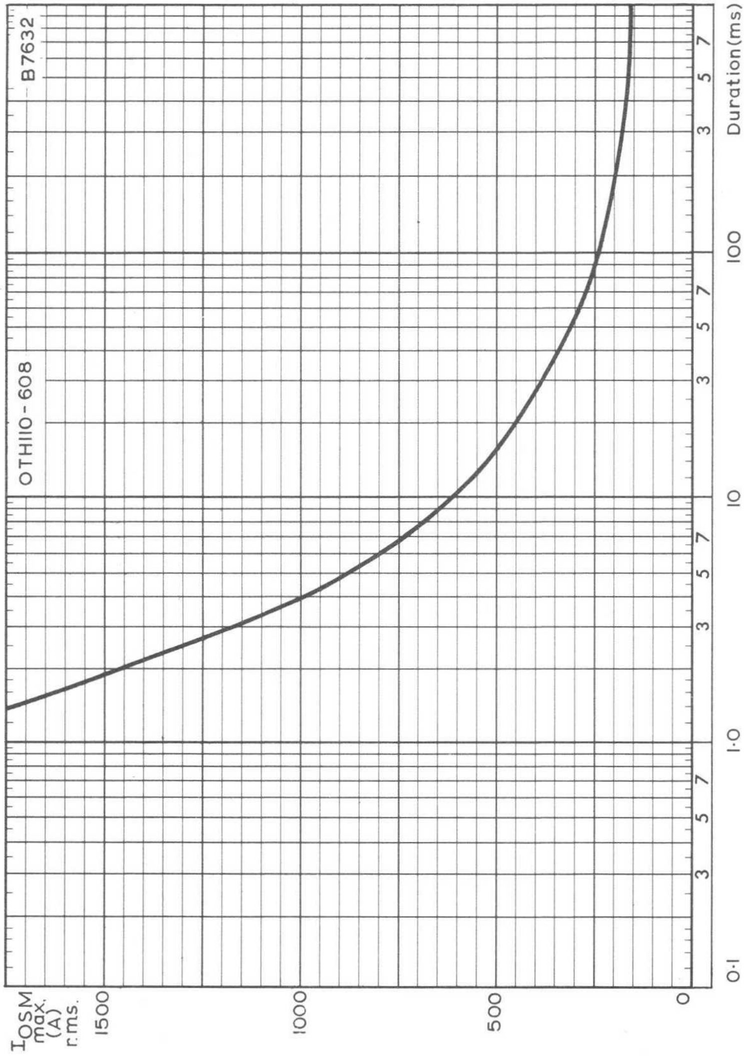




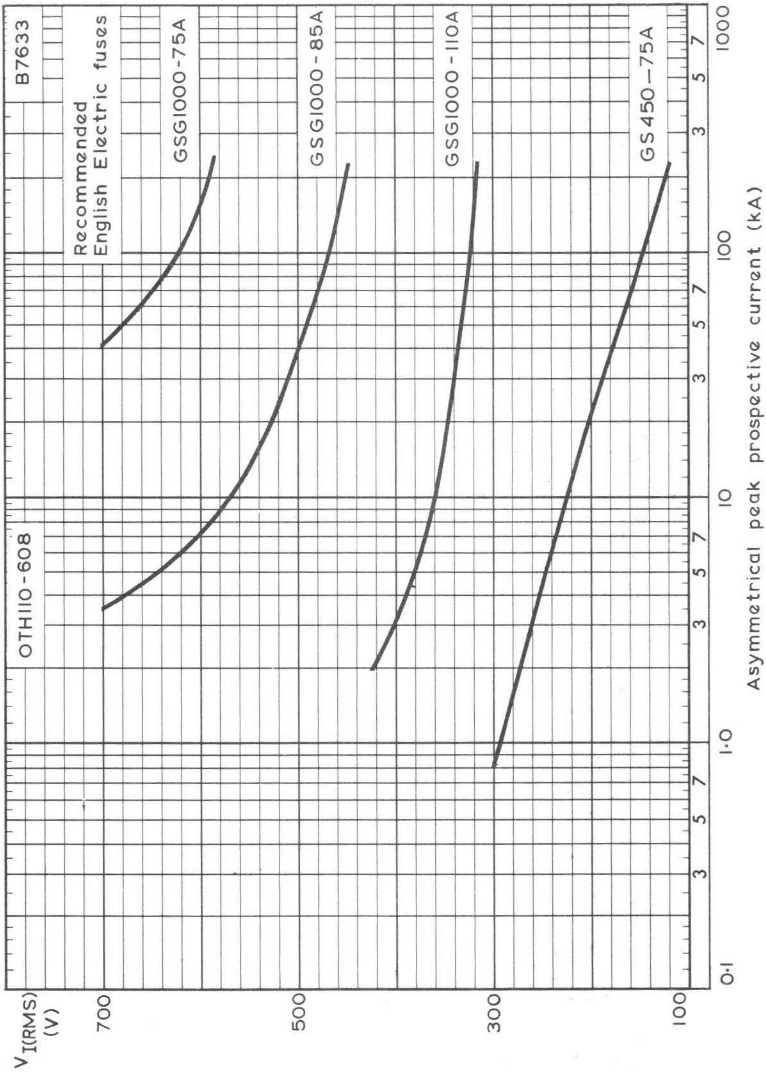
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



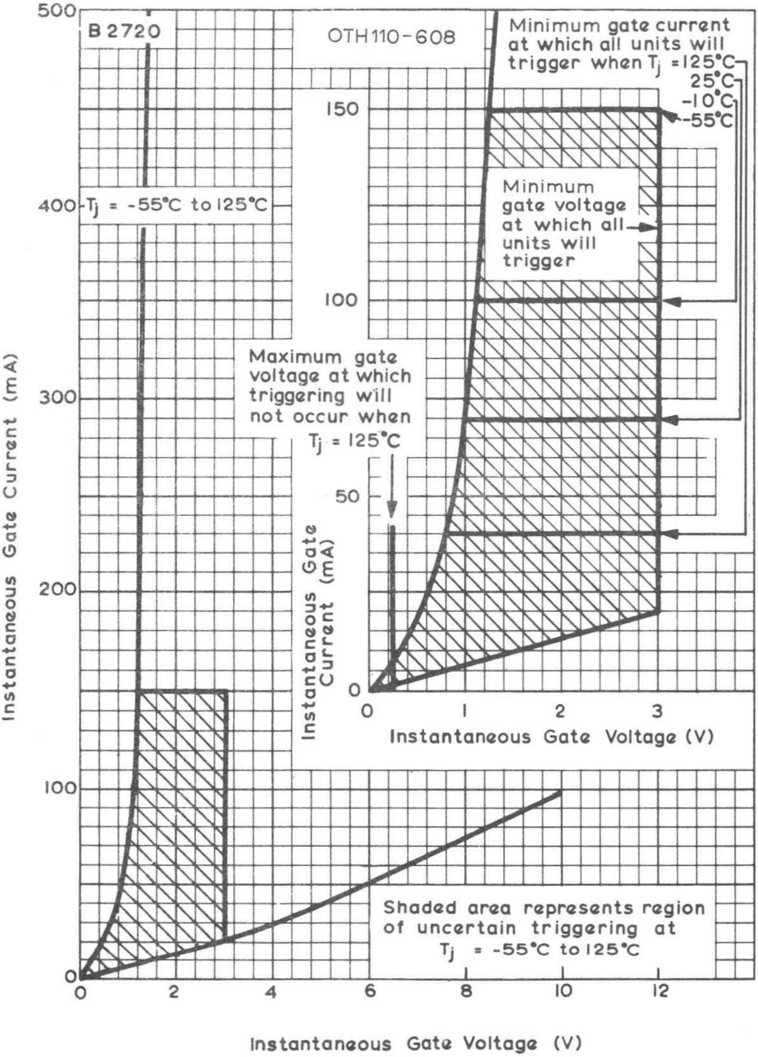
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$×1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT OF
THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH110-609

The OTH110-609 is a single-phase a.c. controller consisting of two thyristors mounted on two 60D heatsinks. It is capable of supplying an r.m.s. current of 122A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of up to 250Vr.m.s.

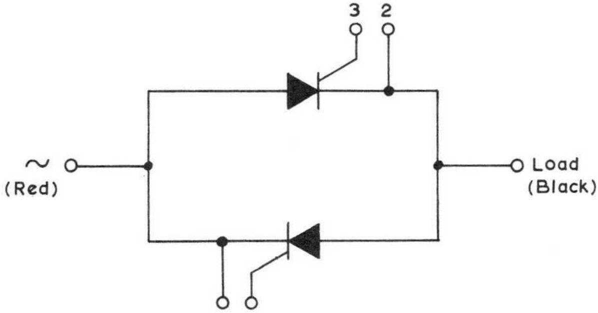
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5.0ms)	720	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^{\circ}C$	122	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	420	V
V_{IRM}	Max. repetitive peak a.c. voltage	600	V
V_{ISM}	Max. non-repetitive peak voltage (fault conditions only, max. duration = 5ms)	720	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180^o conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^oC$	122	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	1000	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max. (see also curves on page C1)		125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	70	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	5.7	kg
	12.7	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
See also English Electric G.S.G. Fuse Data.

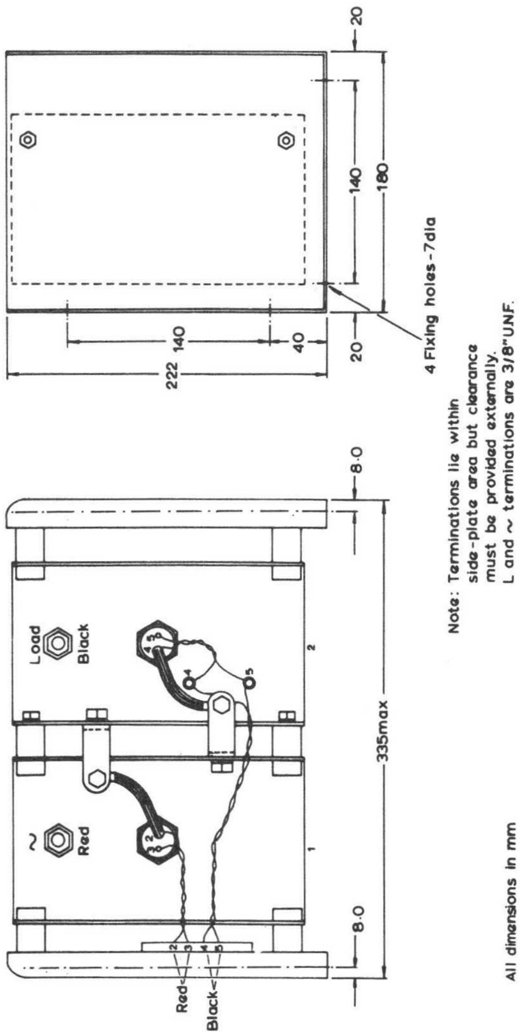
4. Suitable Replacement Devices

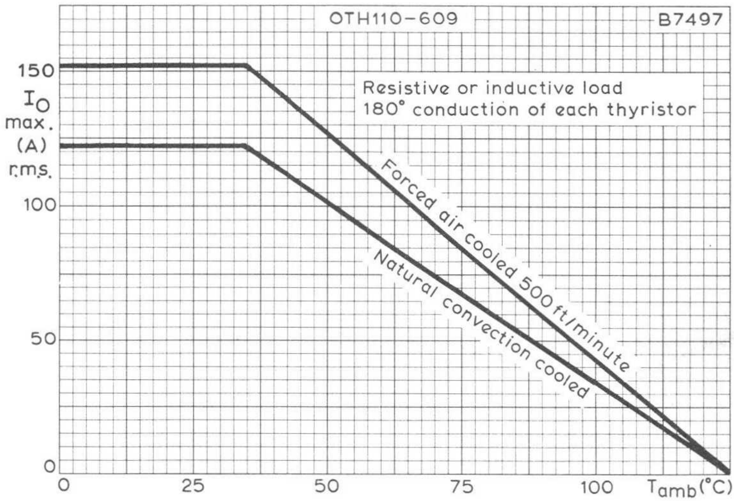
Thyristors BTY99-600R

SINGLE-PHASE THYRISTOR STACK

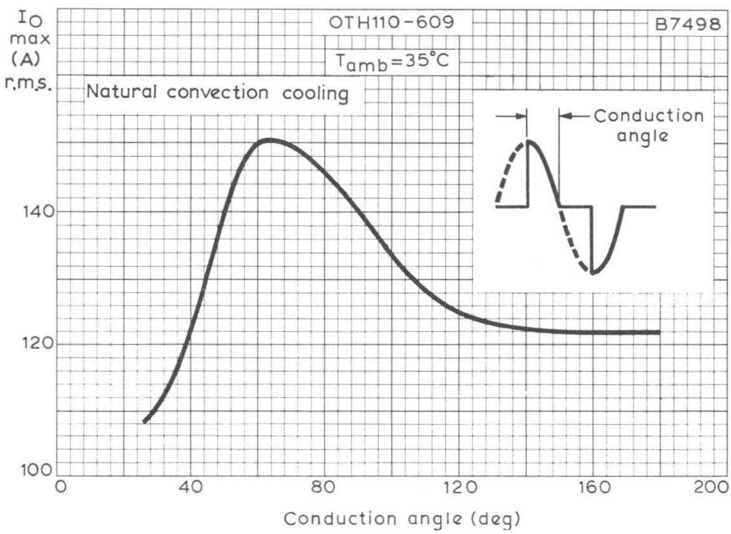
OTH110-609

OUTLINE AND DIMENSIONS

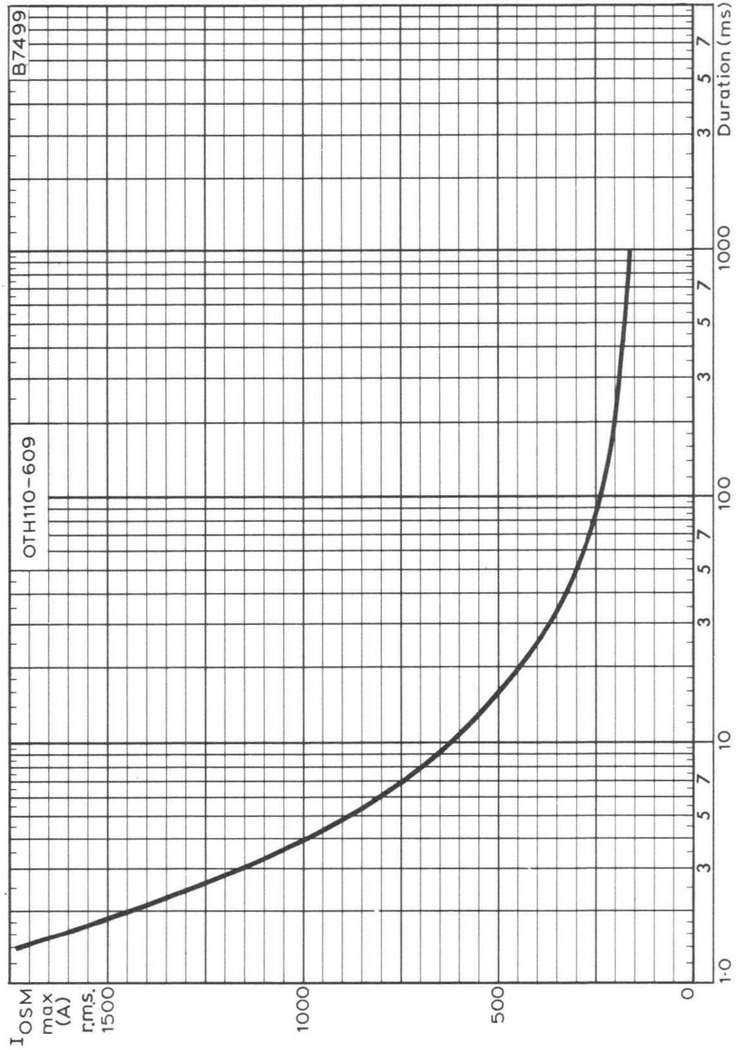




MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



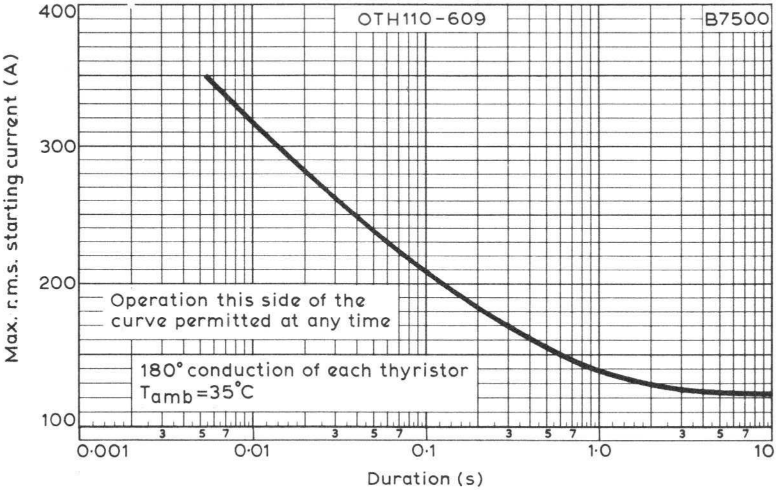
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



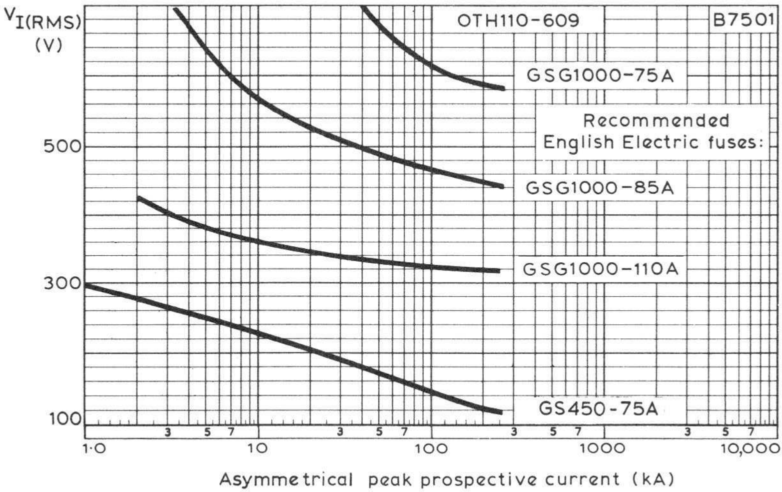
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)

SINGLE-PHASE THYRISTOR STACK

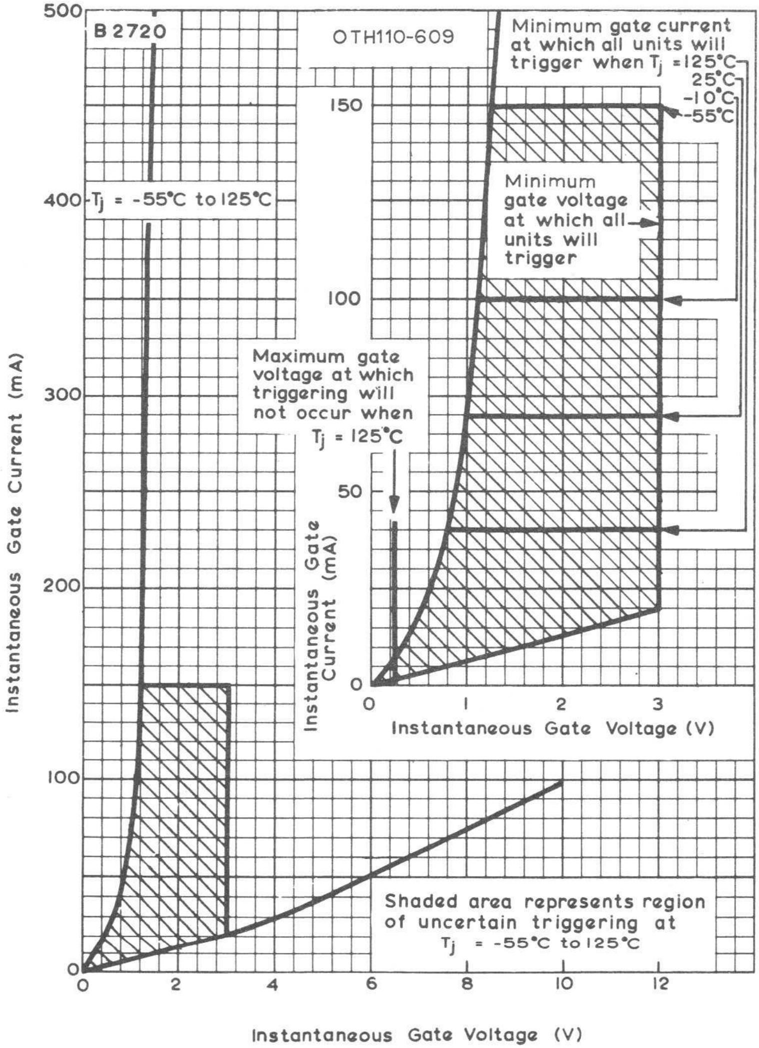
OTH110-609



MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$×1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH110-1208A

The OTH110-1208A is a half-controlled bridge connected thyristor stack with flywheel diode, intended for 250V single-phase mains. It is capable of supplying an output current of 110A at T_{amb} = 35°C with natural convection cooling and 180° conduction of each thyristor.

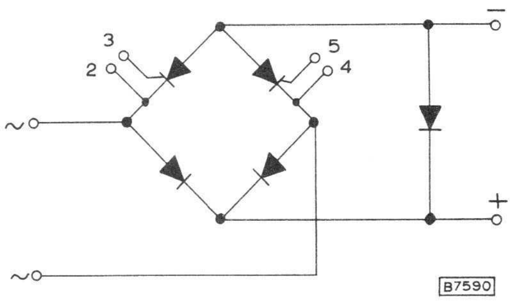
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak voltage	1100	V
Output			
V_O	Max. average voltage	505	V
I_O	Max. average current (T_{amb} = 35°C, natural convection cooling)	110	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak voltage	1100	V
V_{ISM}	Max. non-repetitive peak voltage, $t<10ms$, see note 5	1100	V

Output voltage

V_O	Max. average voltage	505	V

Output current

I_O	Max. average current, resistive or inductive load, 180^o conduction of thyristors, natural convection cooled		
	$T_{amb} \leq 35^oC$	110	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	140	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	500	A

Temperature

T_{stg} max.		125	^oC
T_{amb} operating		See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	9.1	kg
	20	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

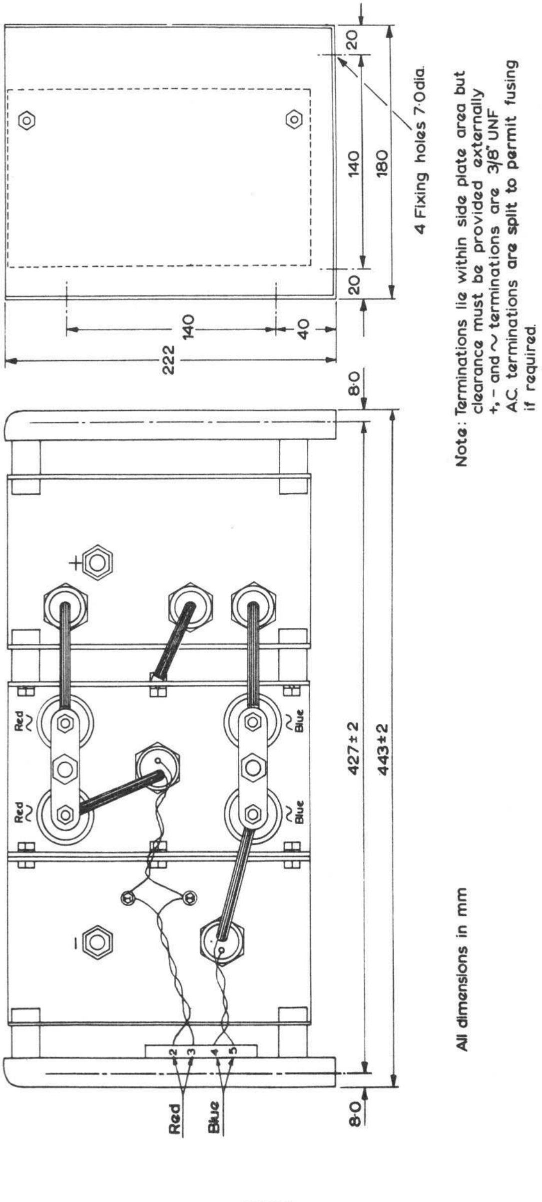
   Peak asymmetrical current = r.m.s. symmetrical current x $\sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data

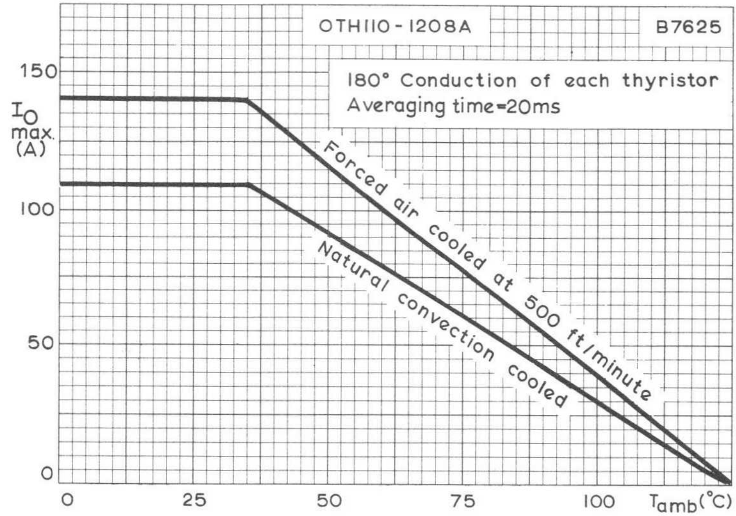
4. Suitable Replacement Devices

Bridge Diodes	BYX32 - 1200
Bridge Thyristors	BTX50 - 1200R
Flywheel Diode	BYX32 - 1200

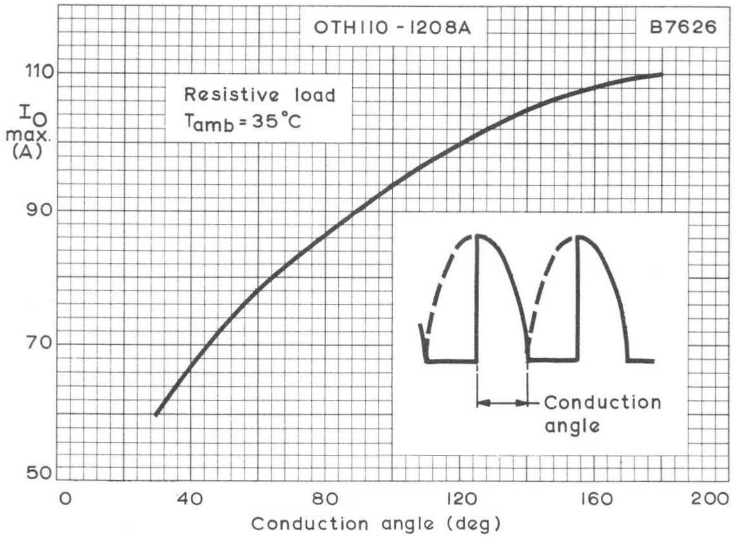
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

OUTLINE AND DIMENSIONS

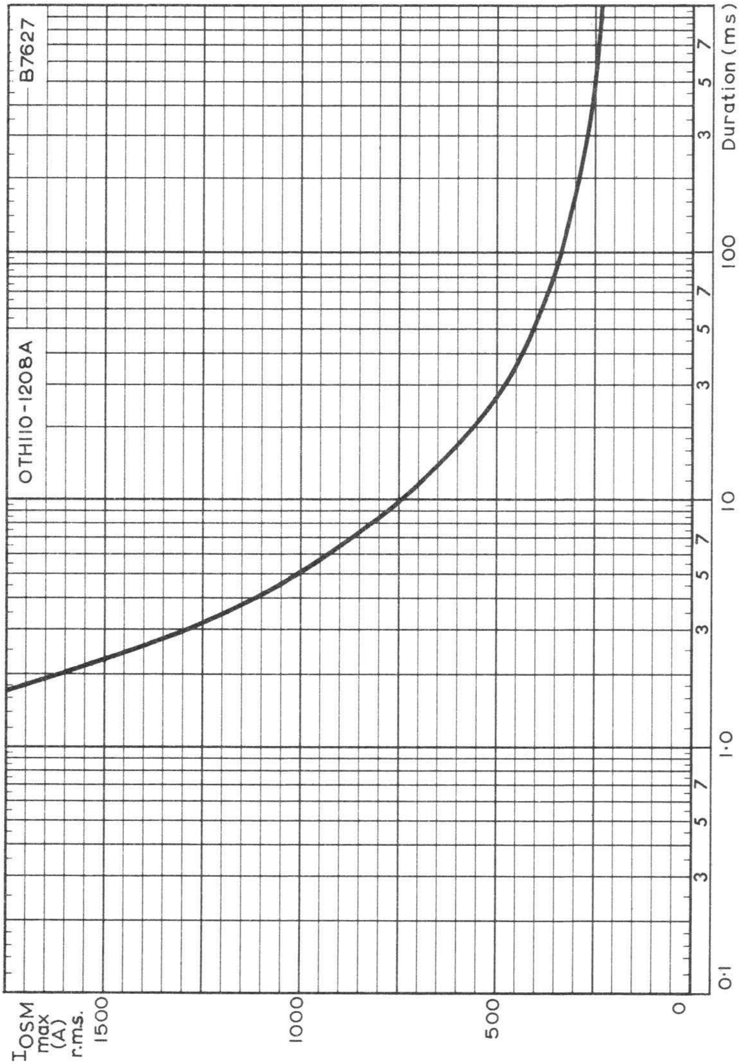




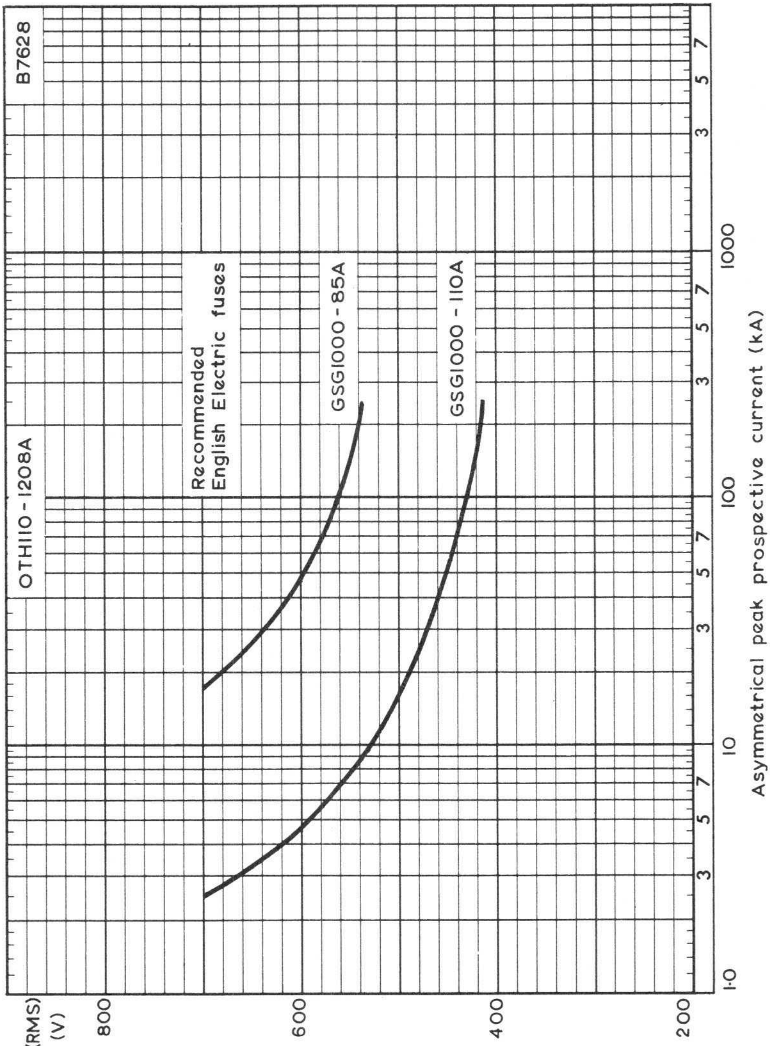
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



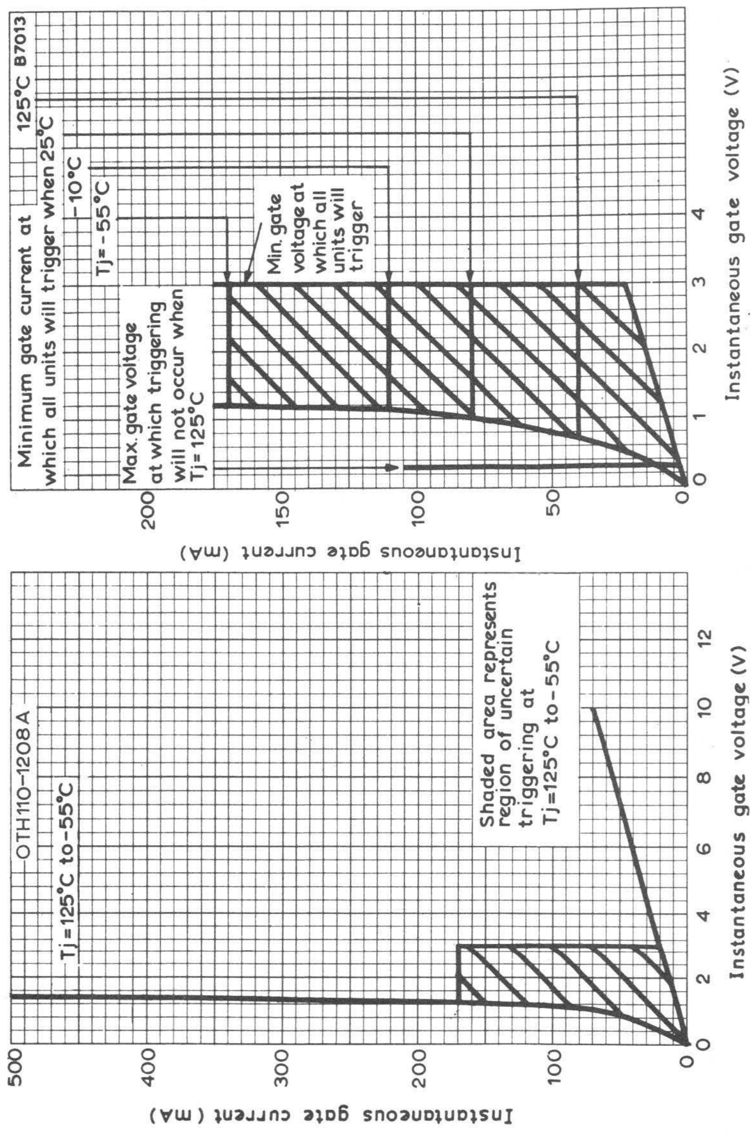
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE; NATURAL CONVECTION COOLING



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT OF
THE PORTION OF THE GRAPH NEAR THE ORIGIN

SINGLE-PHASE THYRISTOR STACK

OTH127-1209

TENTATIVE DATA

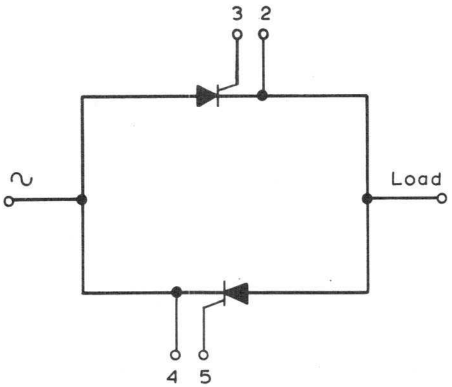
The OTH127-1209 is a single-phase a.c. controller consisting of two thyristors mounted on two 60D heatsinks. It is capable of supplying an r.m.s. current of 127A at an ambient temperature of 35°C, and is intended for operation from a nominal a.c. mains supply of 440Vr.m.s.

QUICK REFERENCE DATA			
Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor. Natural convection cooling, $T_{amb} \leq 35^{o}C$	127	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t< 10ms, see note 5)	1100	V

Output current

I_O	Max. r.m.s. current, resistive or inductive load, 180^{o} conduction of each thyristor, natural convection cooling		
	$T_{amb} \leq 35^{o}C$	127	A
	$T_{amb} > 35^{o}C$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^{o}C$	155	A
	$T_{amb} > 35^{o}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	1000	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^{o}C
T_{amb} max.	(see also curves on page C1)	125	^{o}C

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	5.7	kg
	12.7	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

   The modules may also be supplied assembled to the stack. When this is required suffix F1 for MY5001 or F3 for MY5011 should be added to the stack type number.

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices**

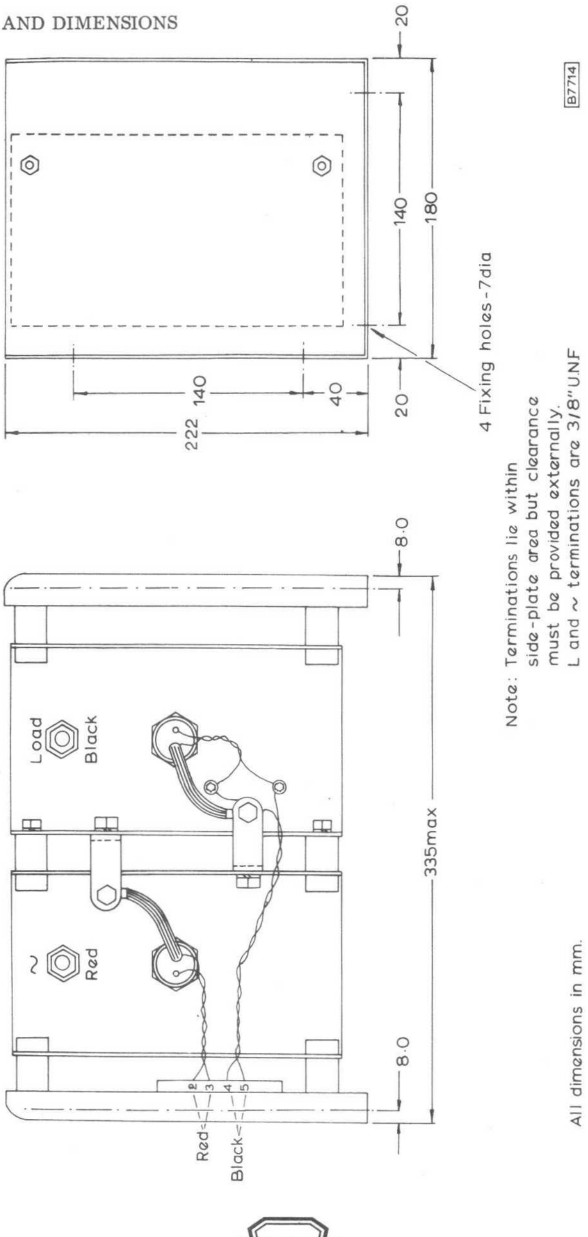
   Thyristors BTX50-1200R

5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

SINGLE-PHASE THYRISTOR STACK

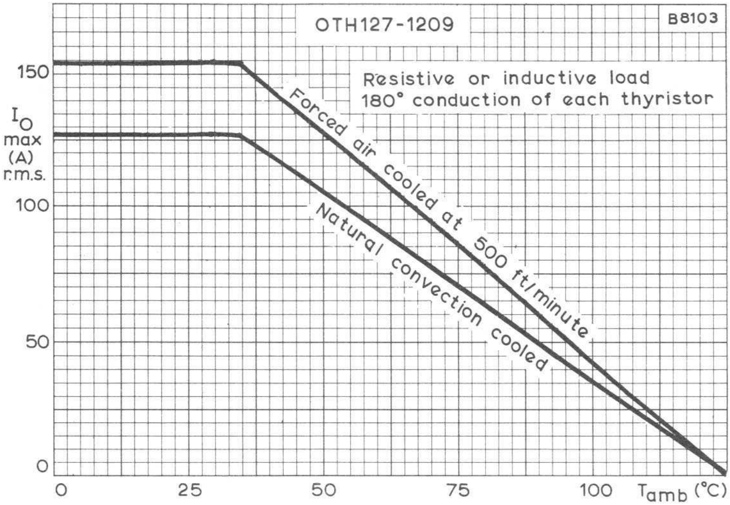
OTH127-1209

OUTLINE AND DIMENSIONS

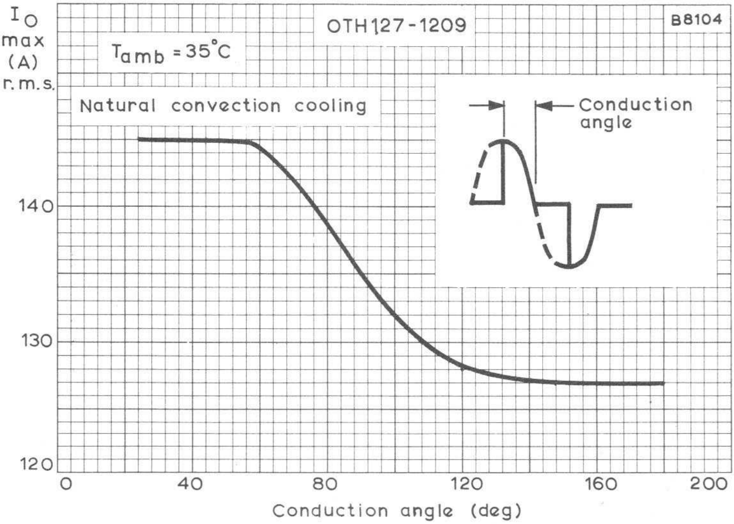


SINGLE-PHASE THYRISTOR STACK

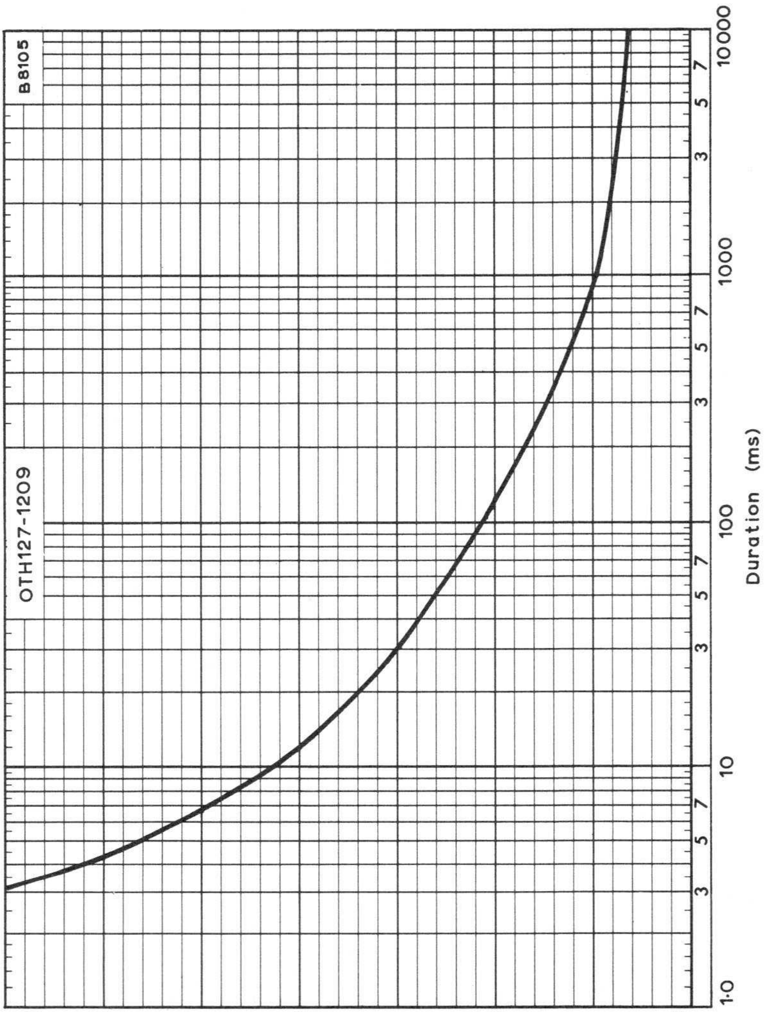
OTH127-1209



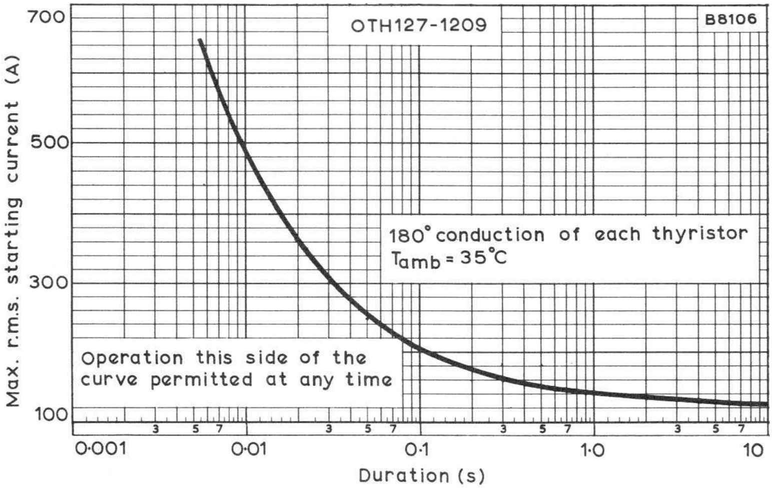
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE



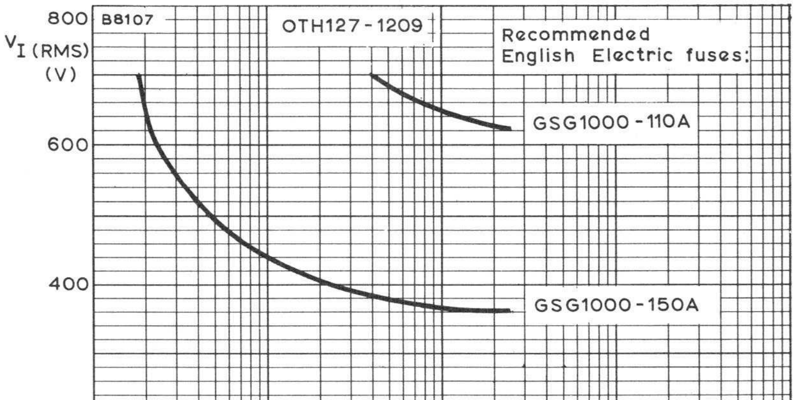
MAXIMUM R.M.S. OUTPUT CURRENT PLOTTED AGAINST CONDUCTION ANGLE



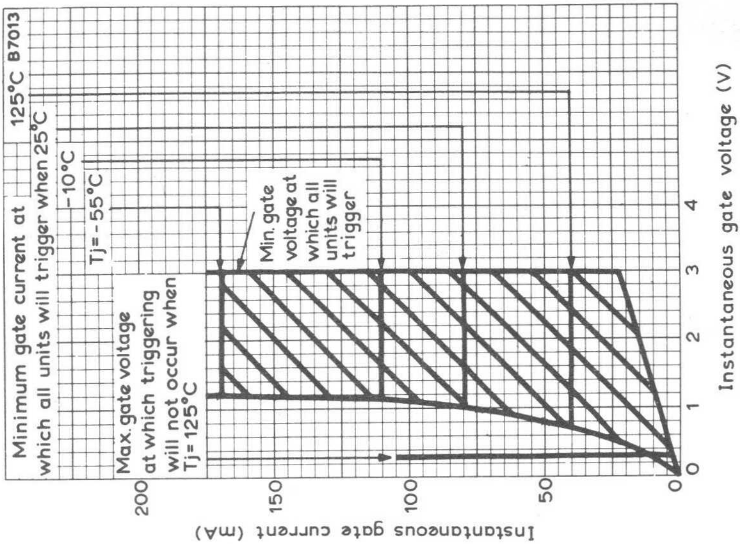
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)

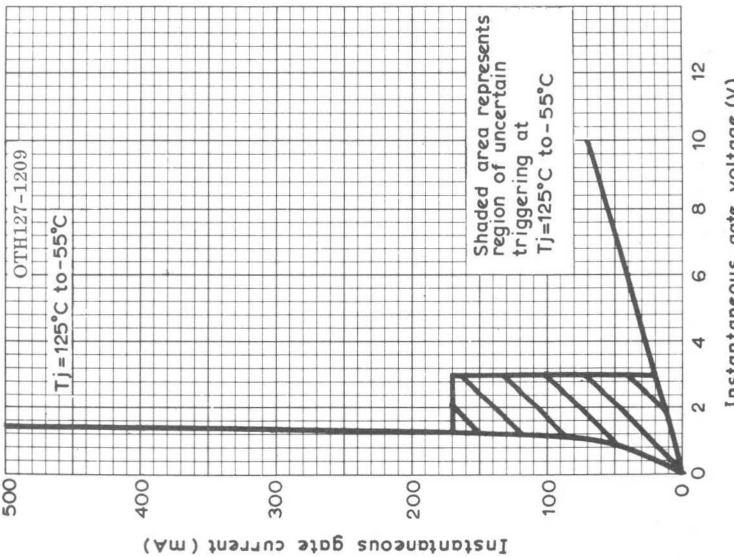


MAXIMUM R.M.S. STARTING CURRENT PLOTTED AGAINST DURATION OF START



APPLIED R.M.S. VOLTAGE PLOTTED AGAINST ASYMMETRICAL PEAK PROSPECTIVE CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$ × 1.6)





THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACK

OTK11-1009L

TENTATIVE DATA

The OTK11 - 1009L is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 11A per phase at 35°C with 180° conduction of each thyristor, and controlling a total power of up to 8.3kW.

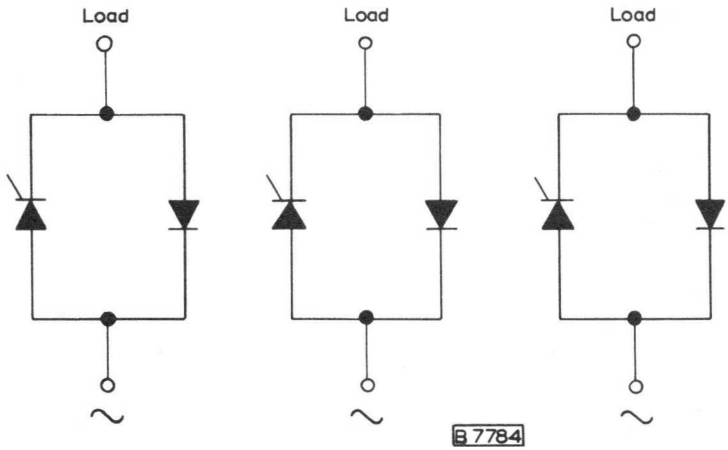
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1000	V
Output			
I_O	Max. r.m.s. current per phase resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35^{\circ}C$	11	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 - 400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	707	V
V_{IRM}	Max. repetitive peak a.c. voltage	1000	V
V_{ISM}	Max. non-repetitive peak a.c. voltage ($t < 10ms$)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor and natural convection cooled		
	$T_{amb} \leq 35^{o}C$	11	A
	$T_{amb} > 35^{o}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	40	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.	100	°C
T_{amb} max. (see also curve on page C1)	100	°C

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{o}C$	2.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{o}C$	25	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	360	g
	12.6	oz
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

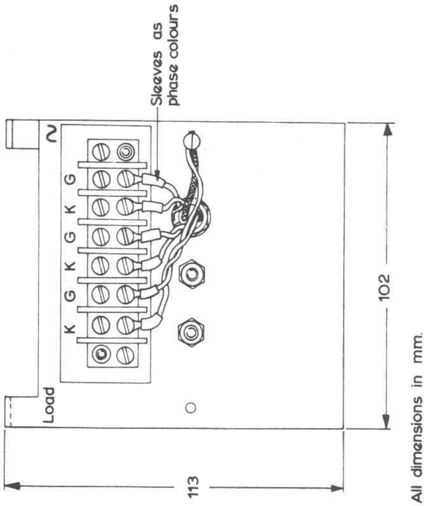
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$

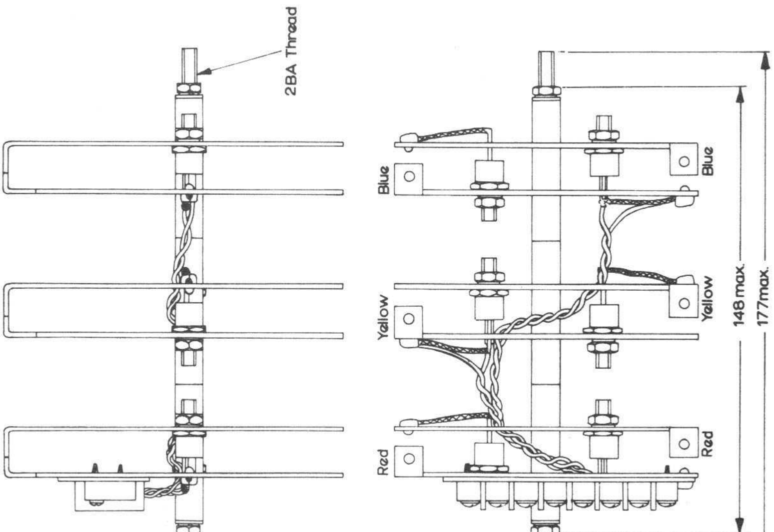
   See also English Electric G.S. Fuse Data

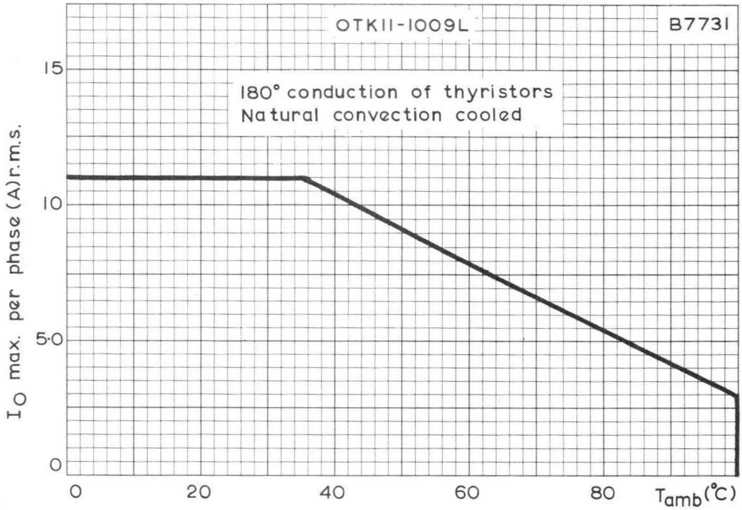
4. Suitable Replacement Devices

Thyristors	BTY79 - 1000R
Diodes	BYX39 - 1000R

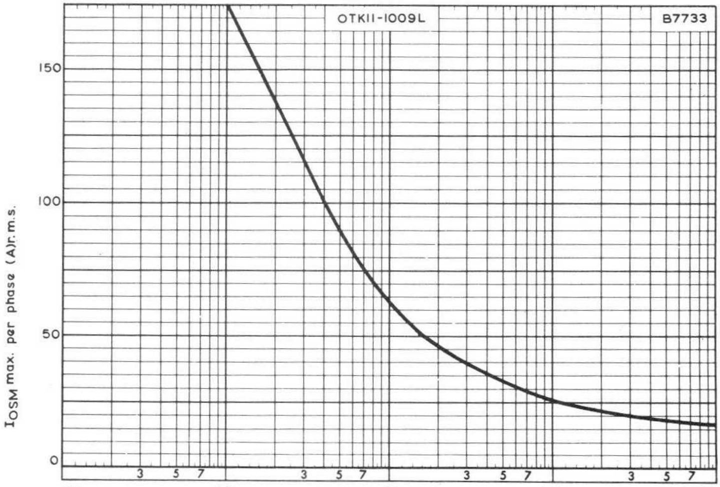
OUTLINE AND DIMENSIONS



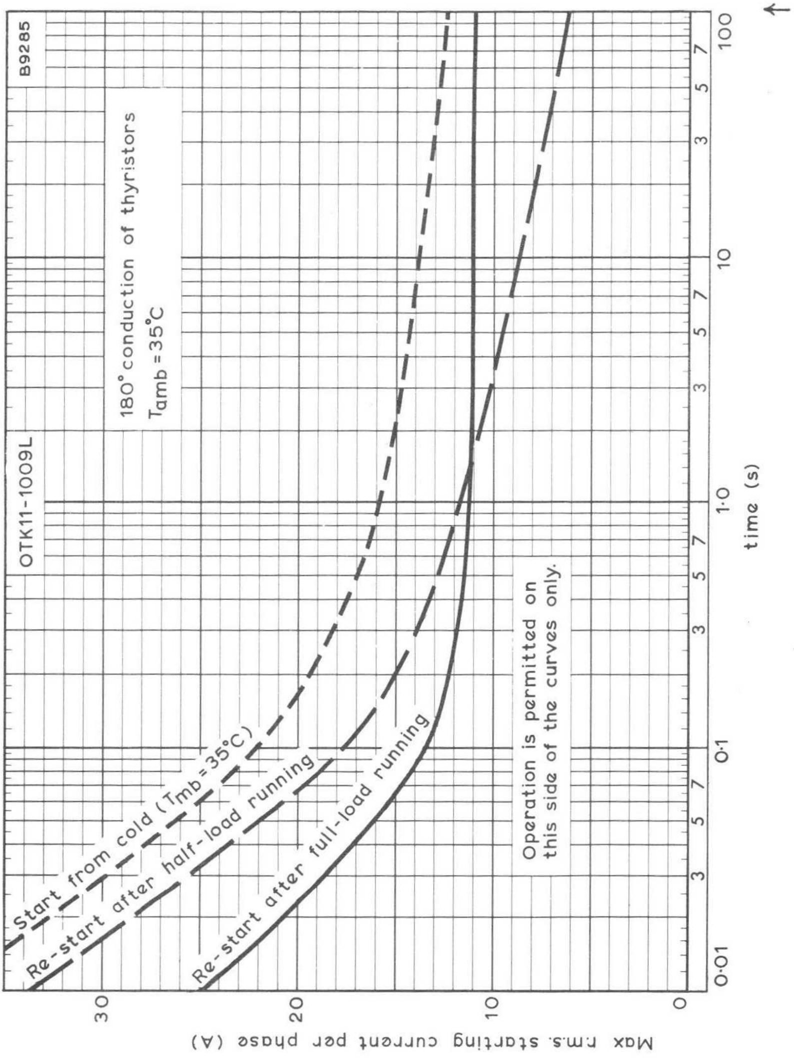




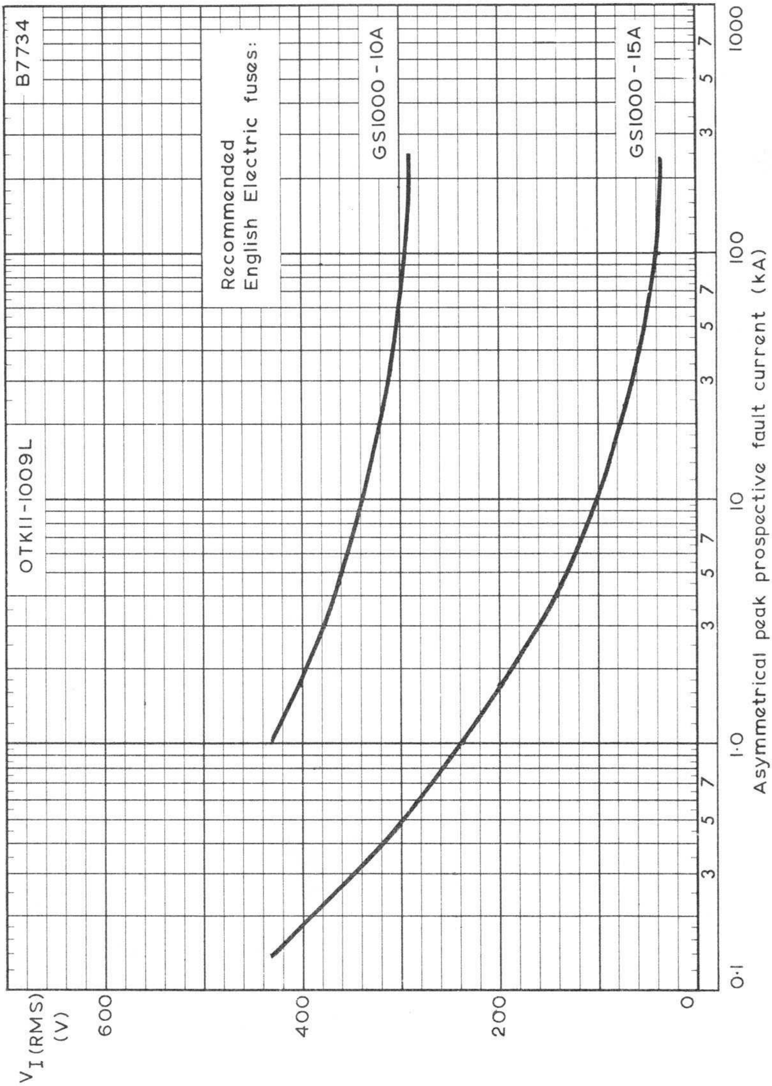
MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE PLOTTED AGAINST AMBIENT TEMPERATURE



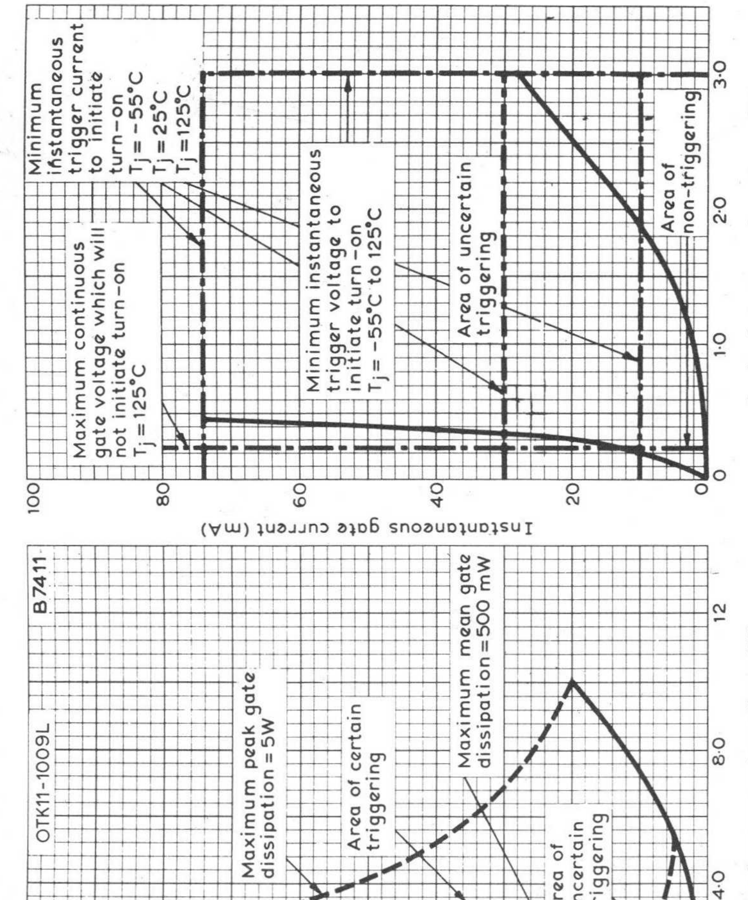
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times\sqrt{2}\times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACK

OTK21-1209

The OTK21-1209 is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 28A per phase at 35°C under forced air cooling conditions, with 180° conduction of each thyristor, and controlling a total power of up to 21kW.

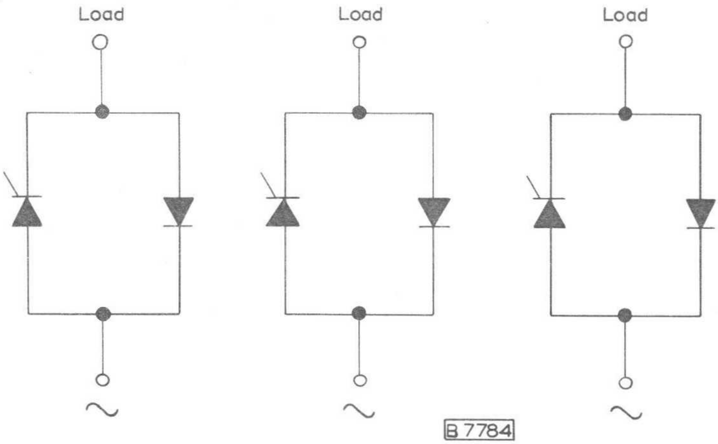
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current per phase, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35°C$	21	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t < 10ms, see note 5)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current resistive or inductive load, 180° conduction of each thyristor and natural convection cooled		
	$T_{amb} \leq 35^oC$	21	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	28	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	160	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curves on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	3.8	kg
	8.5	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

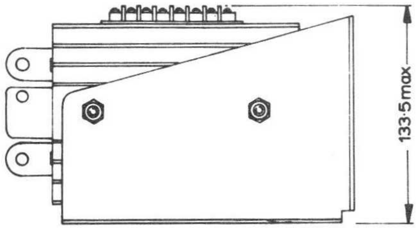
   Peak asymmetrical current = r.m.s. symmetrical current $\times\sqrt{2}\times 1.6$
   See also English Electric G.S.G. Fuse Data.

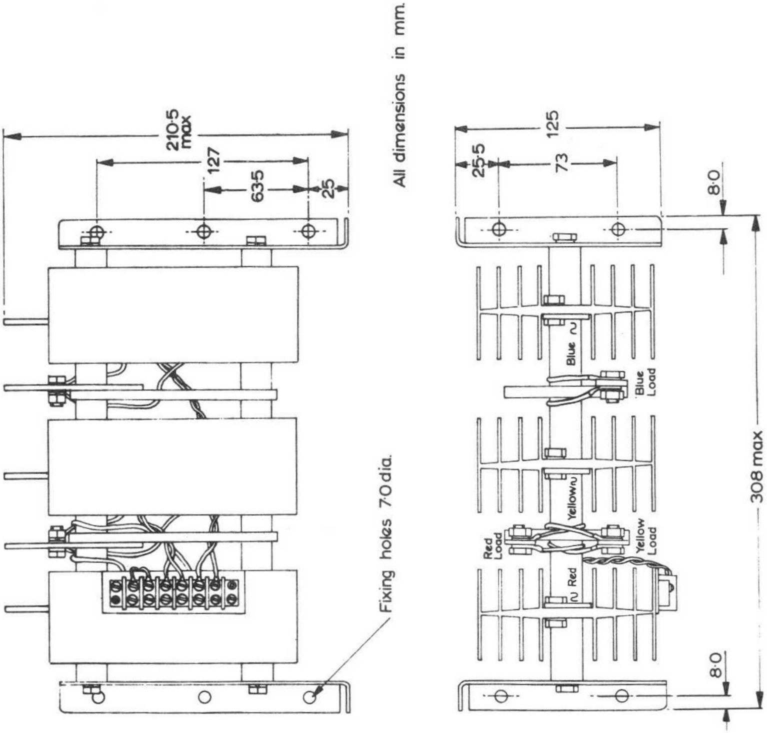
4. Suitable Replacement Devices

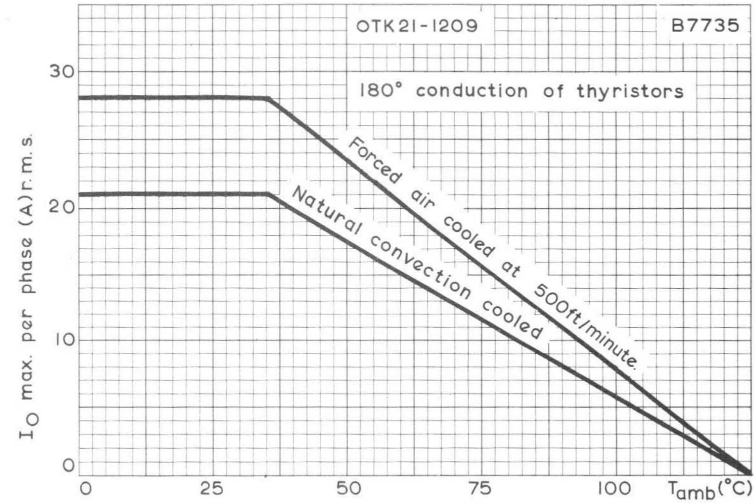
Thyristors	BTX47-1200R
Diodes	BYX25-1000

5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward breakover. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

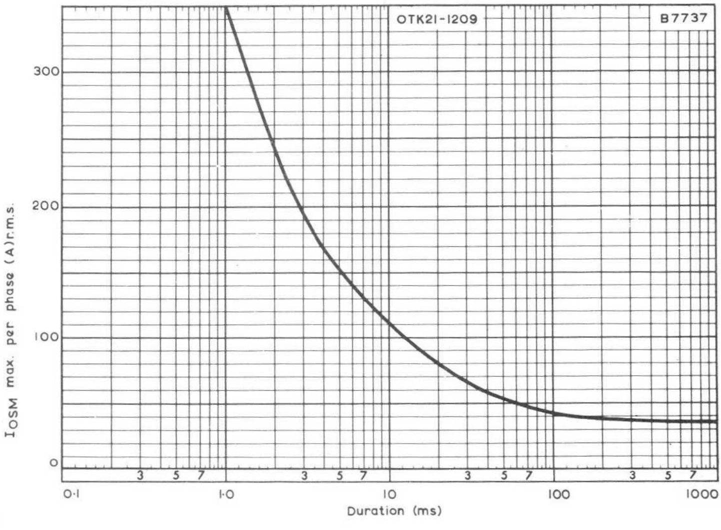
OUTLINE AND DIMENSIONS



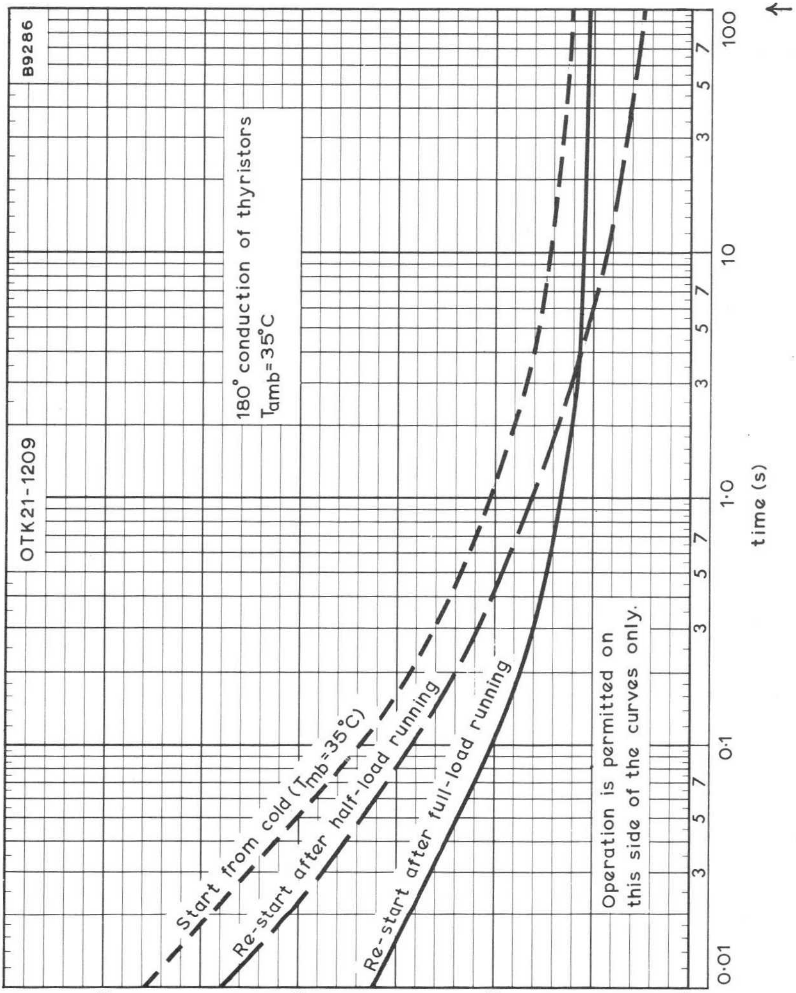




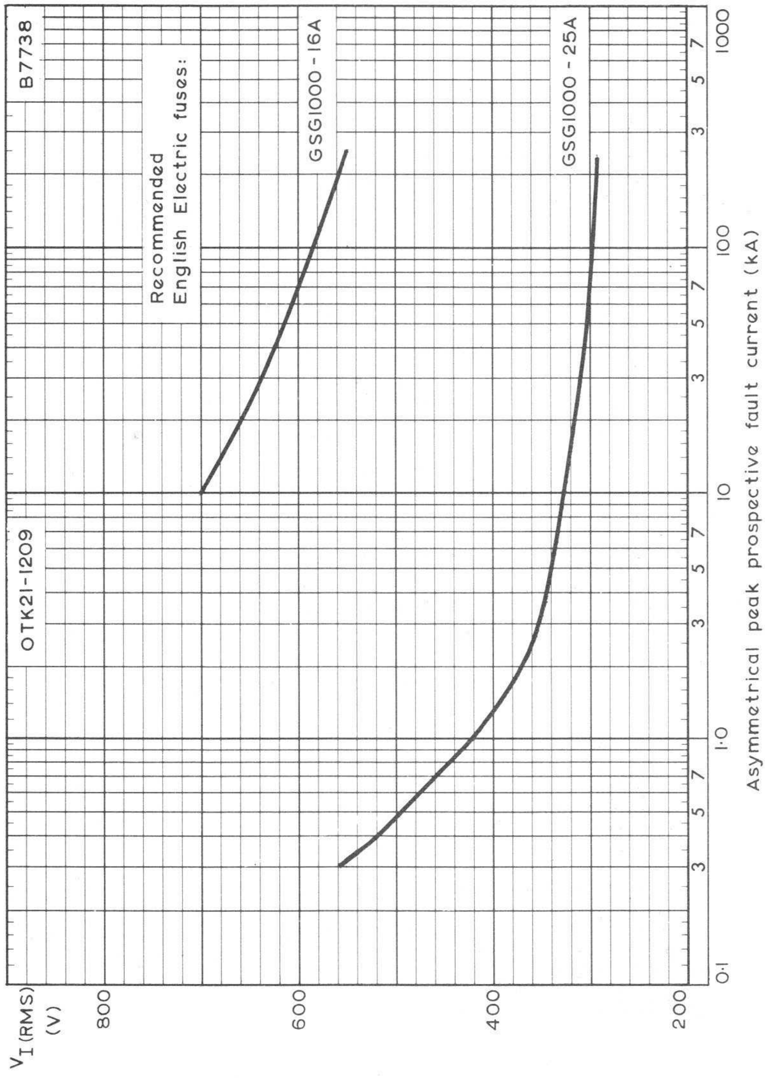
MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE
PLOTTED AGAINST AMBIENT TEMPERATURE



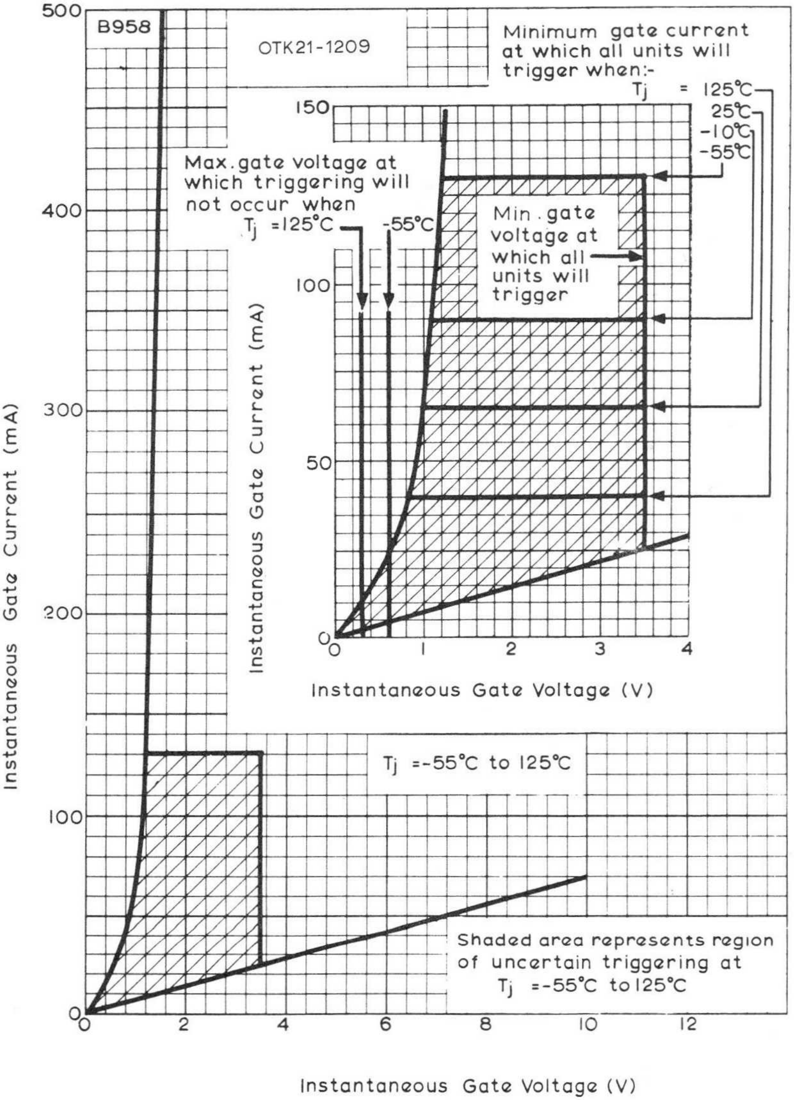
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times\sqrt{2}\times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACK

OTK23-1208

TENTATIVE DATA

The OTK23-1208 is a half-controlled three-phase thyristor stack with a flywheel diode, intended for 440V mains. It is suitable for natural convection or forced air cooling and is capable of supplying up to 30A at $T_{amb} = 35^{o}C$.

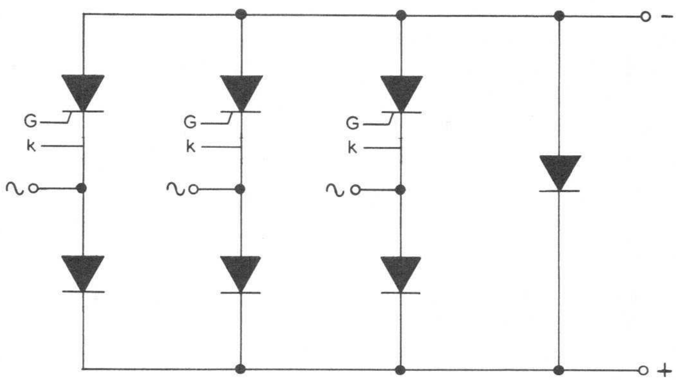
QUICK REFERENCE DATA

Input			
$V_{I(rms)}$	Max. r.m.s. voltage	570	V
Output			
V_O	Max. average voltage	770	V
I_O	Max. average current ($T_{amb} = 35^{o}C$, natural convection cooling)	23	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for frequency range 50 to 400Hz.

Electrical

$V_{I(rms)}$	Max. r.m.s. input voltage	570	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak input voltage	1100	V
V_{ISM}	Max. non-repetitive peak input voltage ($t < 10ms$, see note 4)	1100	V
V_O	Max. average output voltage	770	V
I_O	Max. average output current, resistive or inductive load, 120^o conduction of thyristors, natural convection cooling		
	$T_{amb} \leq 35^oC$	23	A
	$T_{amb} > 35^oC$	See curve on page C1	
	forced air cooling at 500ft/minute		
	$T_{amb} \leq 35^oC$	30	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak output current	160	A

Temperature

T_{stg} max.	125	^oC
T_{amb} (operating)	See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	3.8	kg
	8.5	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger modules are available for this stack. (Type No. MY5001, MY5011, one per phase)

3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:-

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack, it is protecting, must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

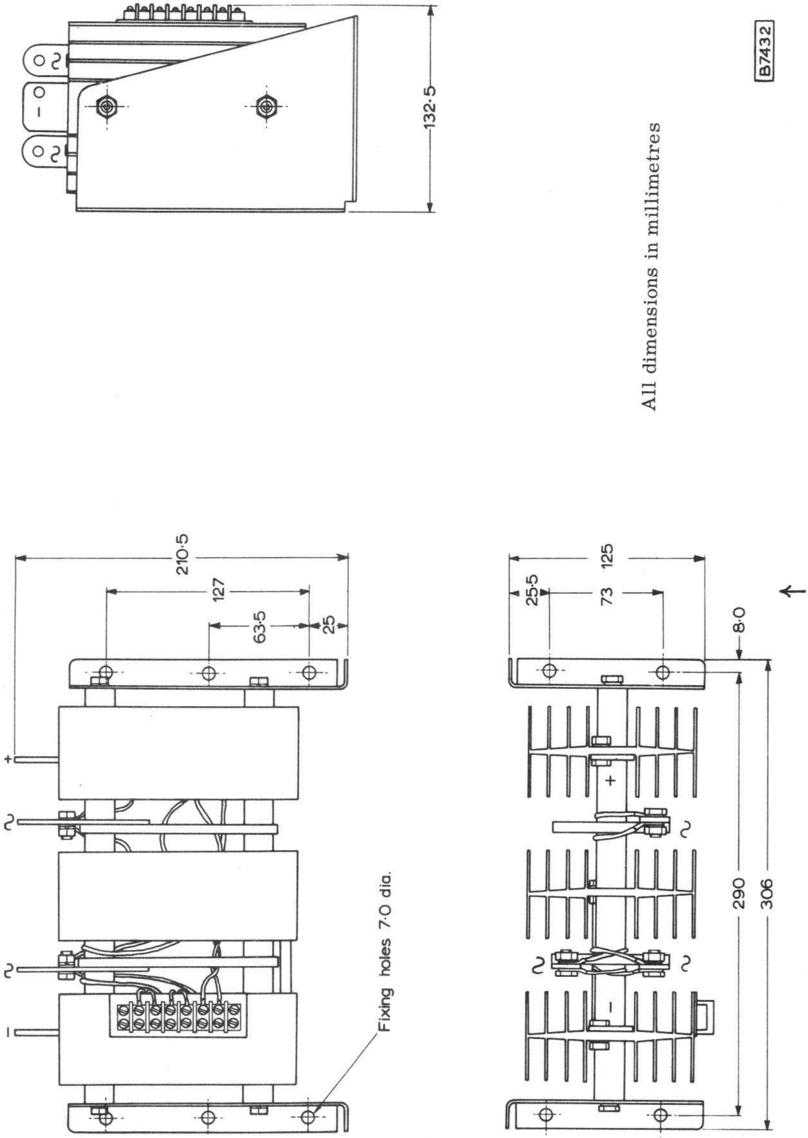
Peak asymmetrical current = r.m.s. symmetrical current $\times\sqrt{2}\times 1.6$

See also English Electric GSG fuse data.

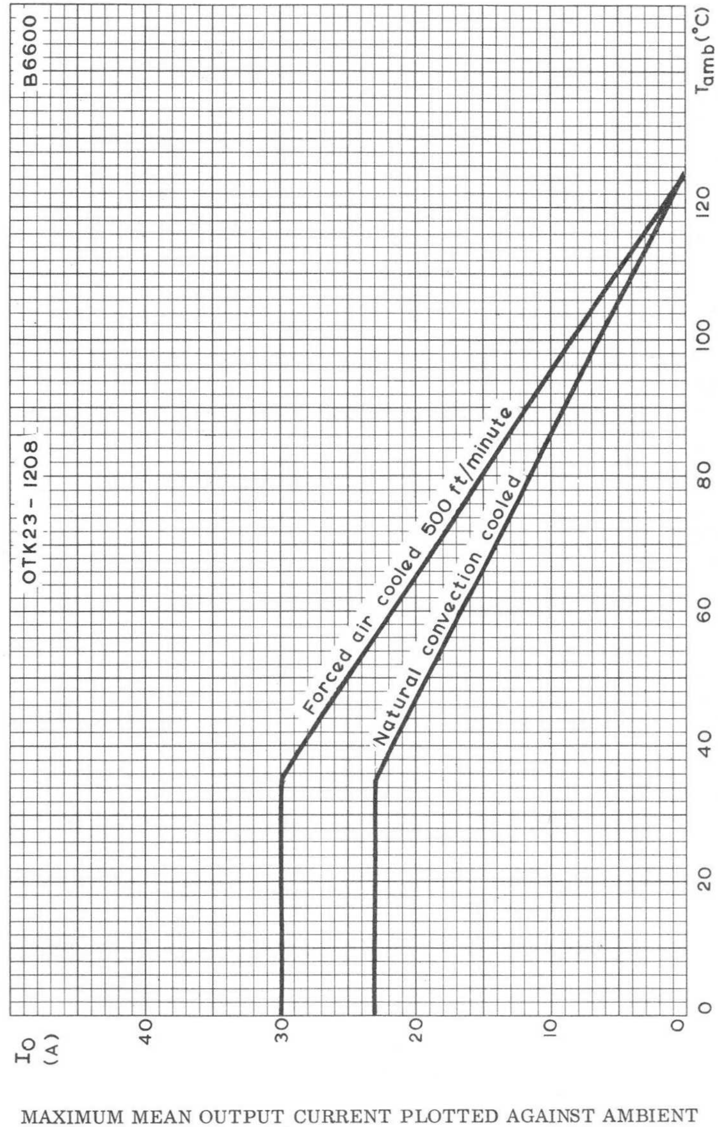
4. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

5. Suitable replacement devices

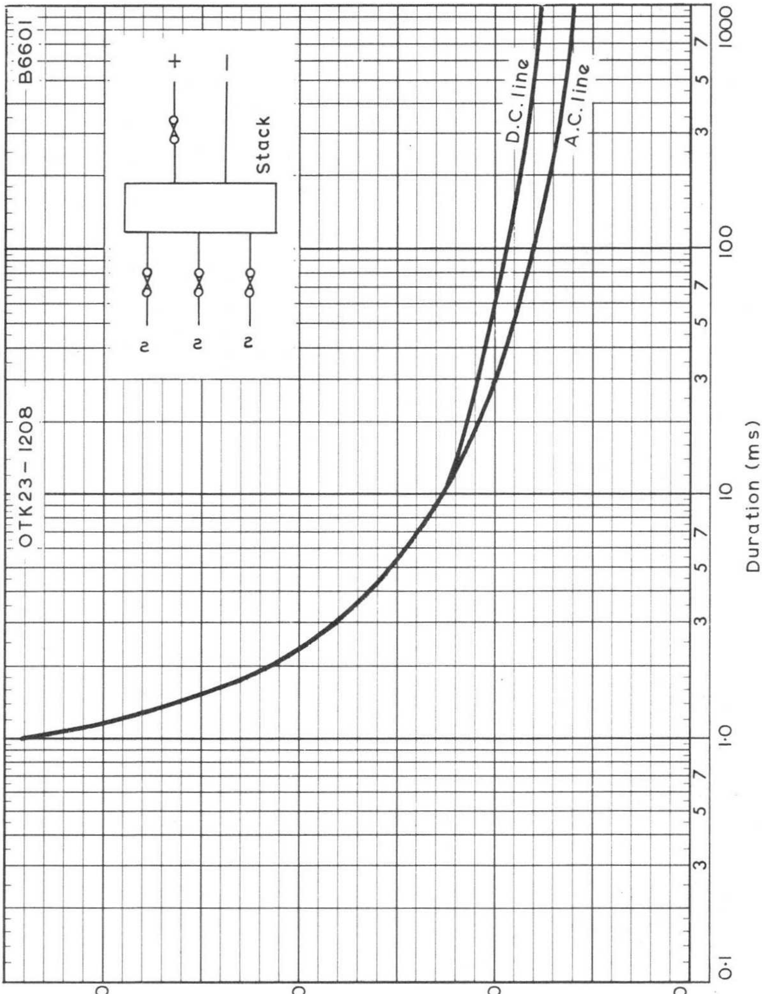
Thyristors	BTX47-1200R
Diodes in bridge circuit	BYX25-1000
Flywheel diode	BYX25-1000R



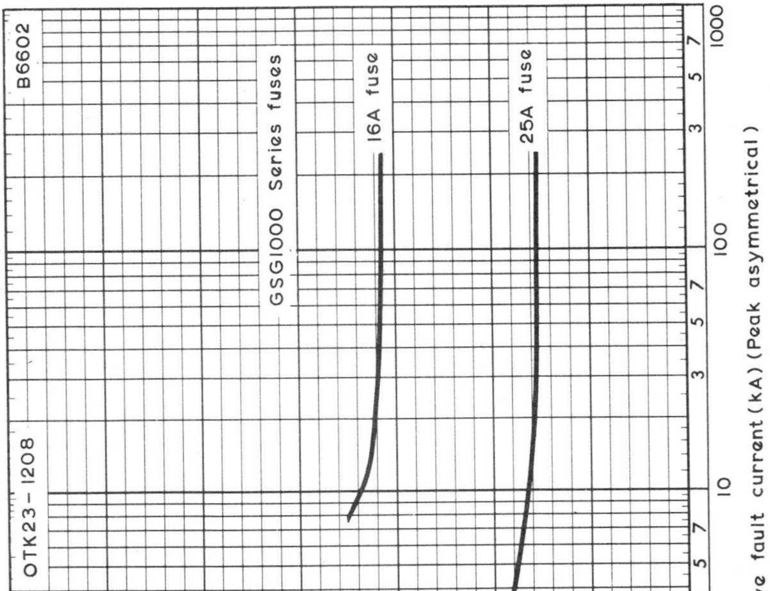
132·5
210·5
127
63·5
25
125
25·5
73
8·0
290
306
Fixing holes 7·0 dia.
All dimensions in millimetres
B7432



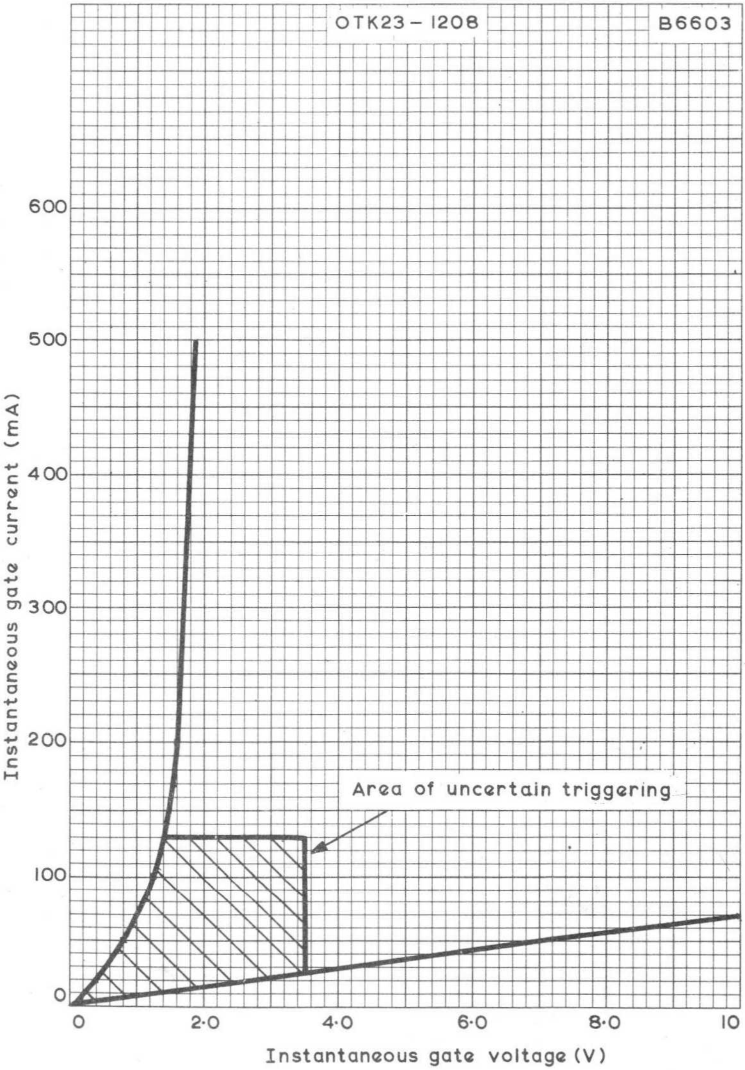
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE. 120° CONDUCTION OF EACH THYRISTOR. MAXIMUM AVERAGING TIME 20ms.



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



R.M.S. INPUT VOLTAGE PLOTTED AGAINST MAXIMUM PEAK ASYMMETRICAL PROSPECTIVE FAULT CURRENT



THYRISTOR GATE CHARACTERISTIC

THREE-PHASE THYRISTOR STACK

OTK27-1209

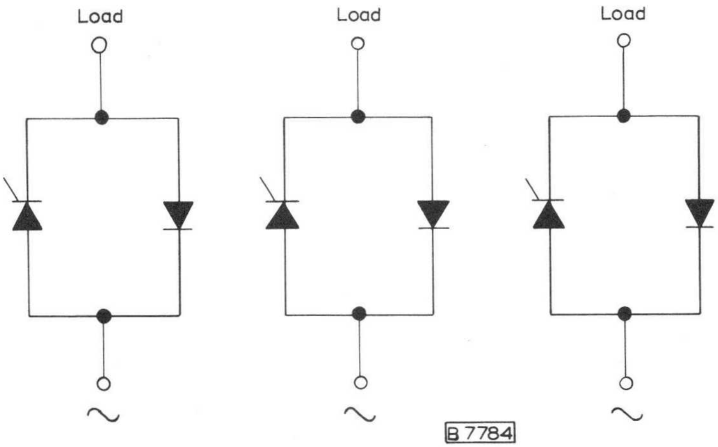
The OTK27-1209 is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 32A per phase at 35°C under forced air cooling conditions with 180° conduction of each thyristor and controlling a total power of up to 24kW.

QUICK REFERENCE DATA			
Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current per phase, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35^{\circ}C$	27	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t <10ms, see note 5)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current, resistive or inductive load, 180^o conduction of each thyristor and natural convection cooled		
	$T_{amb} \leq 35^oC$	27	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	32	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	160	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curve on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	6.0	kg
	13.2	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices**

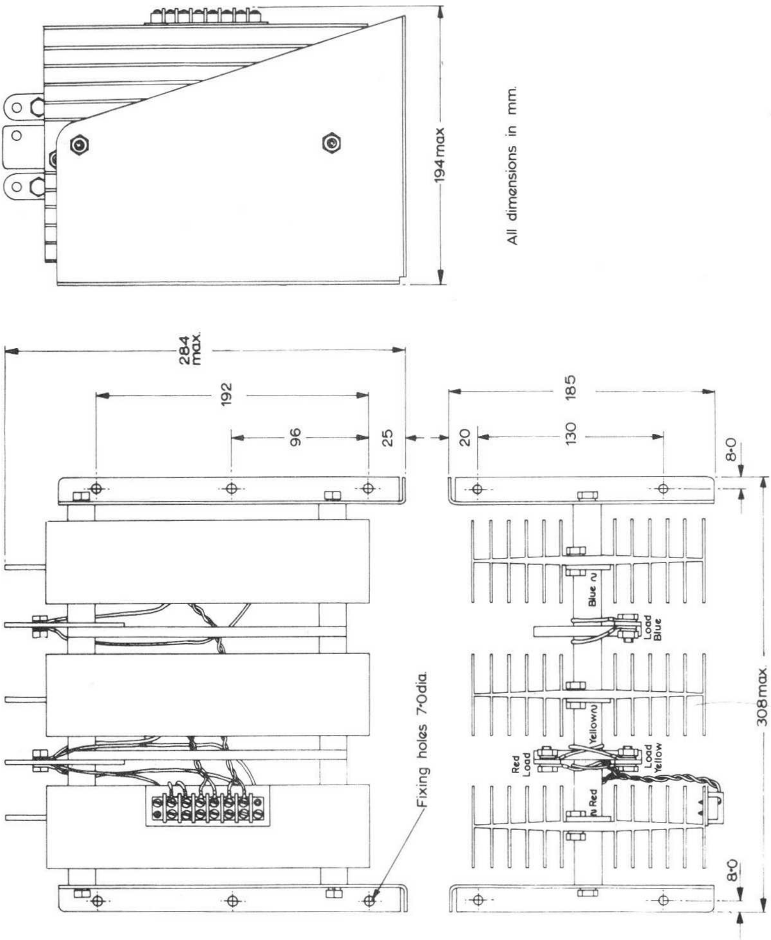
Thyristors	BTX47-1200R
Diodes	BYX25-1000

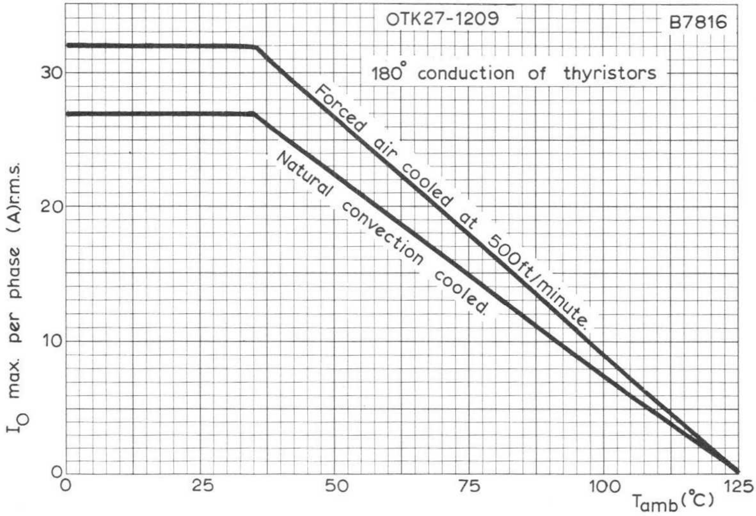
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

THREE-PHASE THYRISTOR STACK

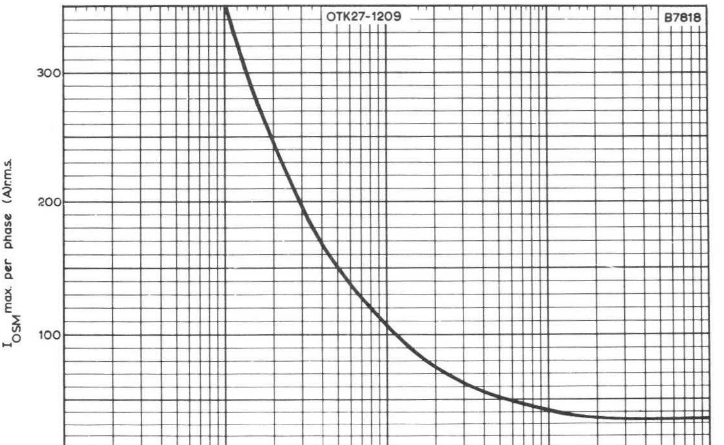
OTK27-1209

OUTLINE AND DIMENSIONS

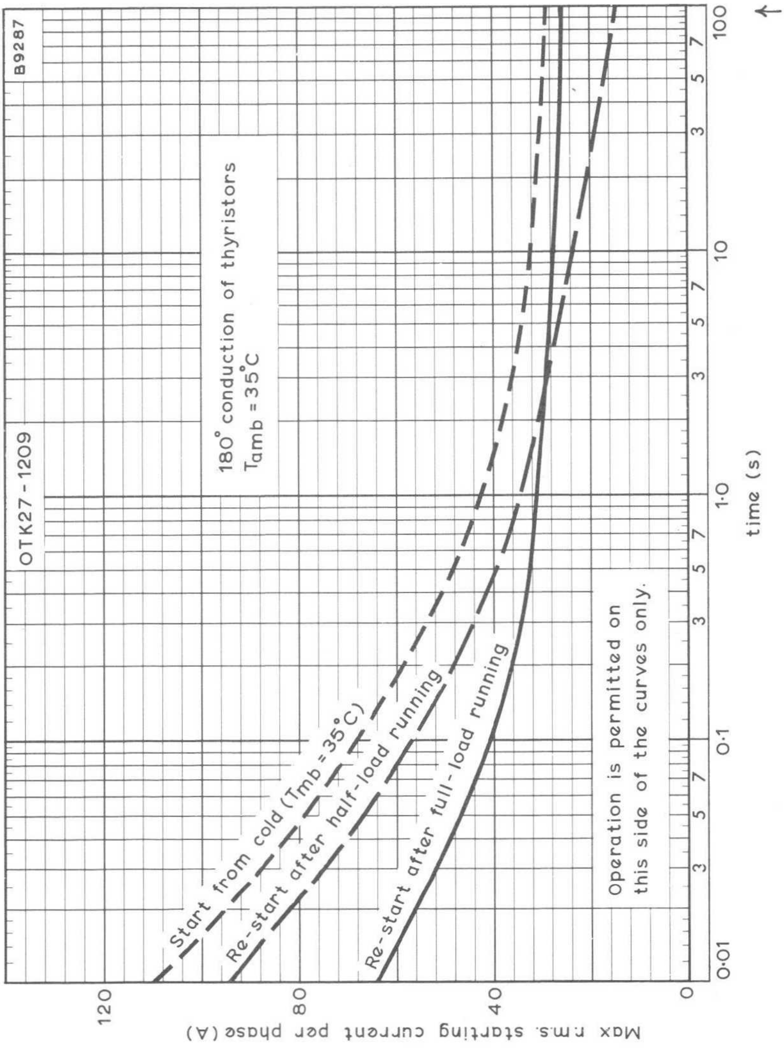




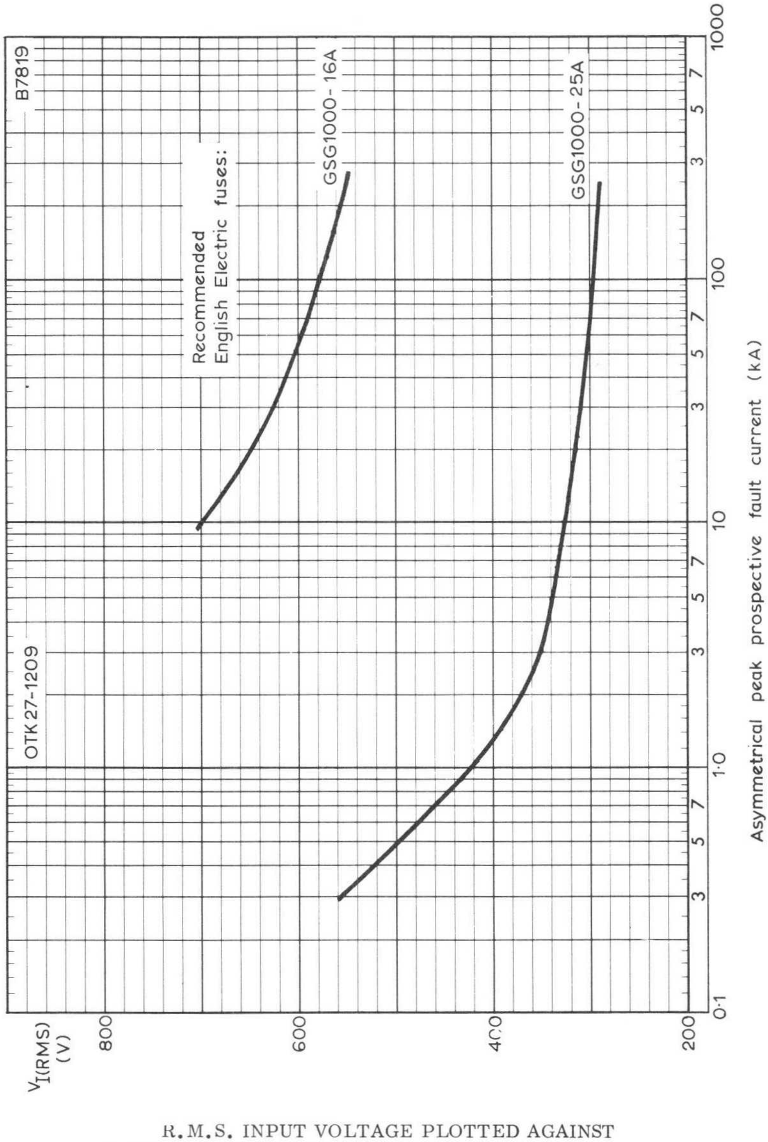
MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE
PLOTTED AGAINST AMBIENT TEMPERATURE



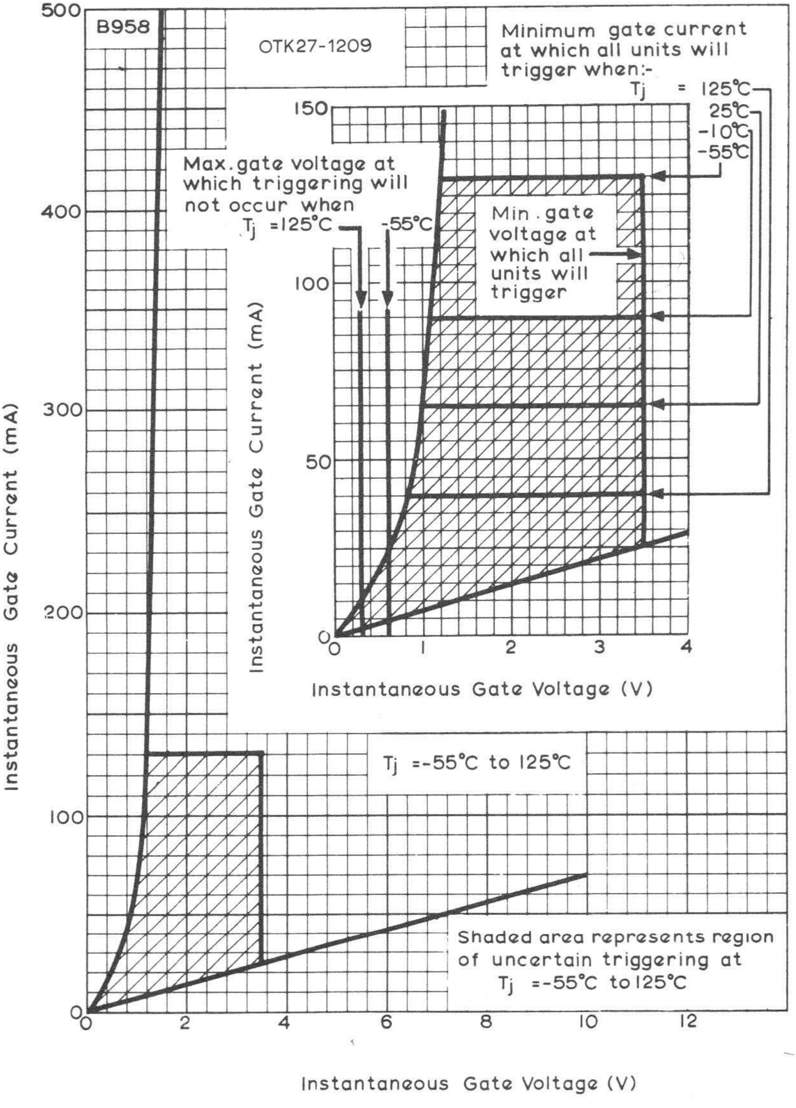
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times\sqrt{2} \times 1.6$)



Instantaneous Gate Voltage (V)

THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

TENTATIVE DATA

The OTK30-1208 is a half-controlled three-phase thyristor stack with fly-wheel diode, intended for 440V mains. It is suitable for natural convection or forced air cooling and is capable of supplying up to 37A at $T_{amb} = 35^{o}C$.

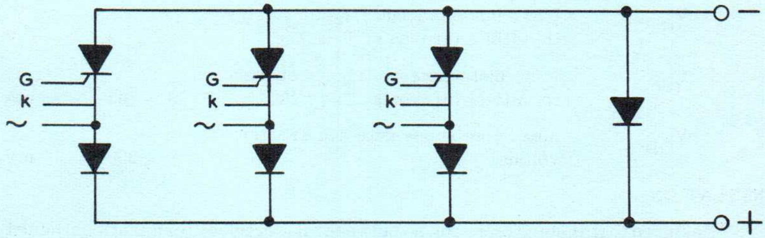
QUICK REFERENCE DATA

Input			
$V_{I(rms)}$	Max. r.m.s. voltage	570	V
Output			
V_O	Max. average voltage	770	V
I_O	Max. average current ($T_{amb} = 35^{o}C$) (natural convection cooling)	30	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400c/s.

Electrical

$V_{I(rms)}$	Max. r.m.s. input voltage	570	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak input voltage	1100	V
V_{ISM}	Max. non-repetitive peak input voltage, $t < 10ms$ (see note 4)	1100	V
V_O	Max. average output voltage	770	V
I_O	Max. average output current, resistive or inductive load, 180^o conduction of thyristors, natural convection cooling		
	$T_{amb} \leq 35^oC$	30	A
	$T_{amb} > 35^oC$	See curve on page C1	
	forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	37	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak output current	160	A

Temperature

T_{stg} max.	125	^oC
T_{amb} max.	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Max. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	5.0	kg
	11	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (µF)	R-C in primary of transformer R×C (µs)	R-C in secondary of transformer C (µF)	R-C in secondary of transformer R×C (µs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type No. MY5001, MY5011, one per phase.

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:-

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack, it is protecting, must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

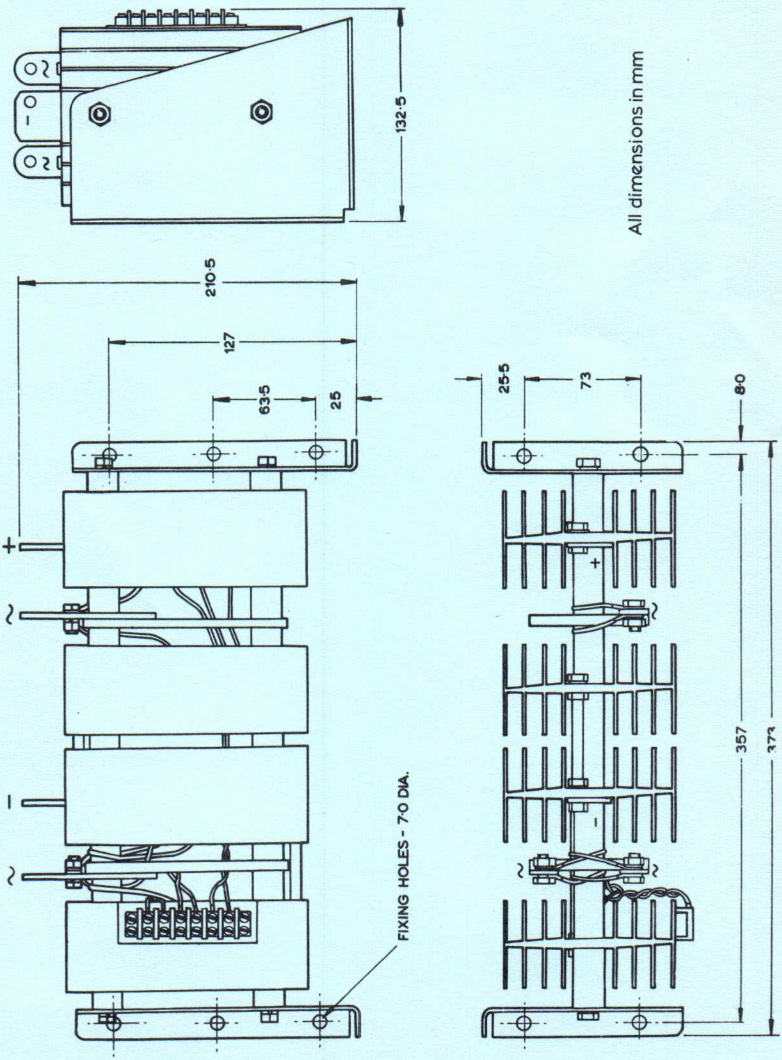
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

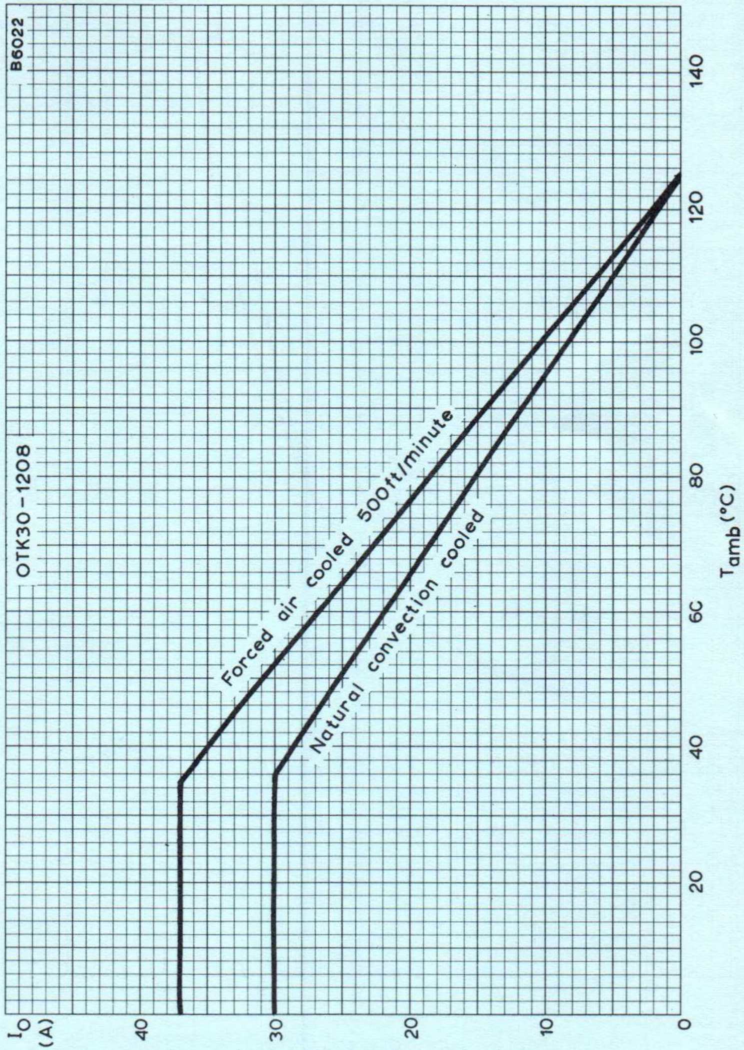
   Peak asymmetrical current = r.m.s. symmetrical current × $\sqrt{2}$ × 1.6.
   See also English Electric GSG fuse data.

4. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward breakover. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

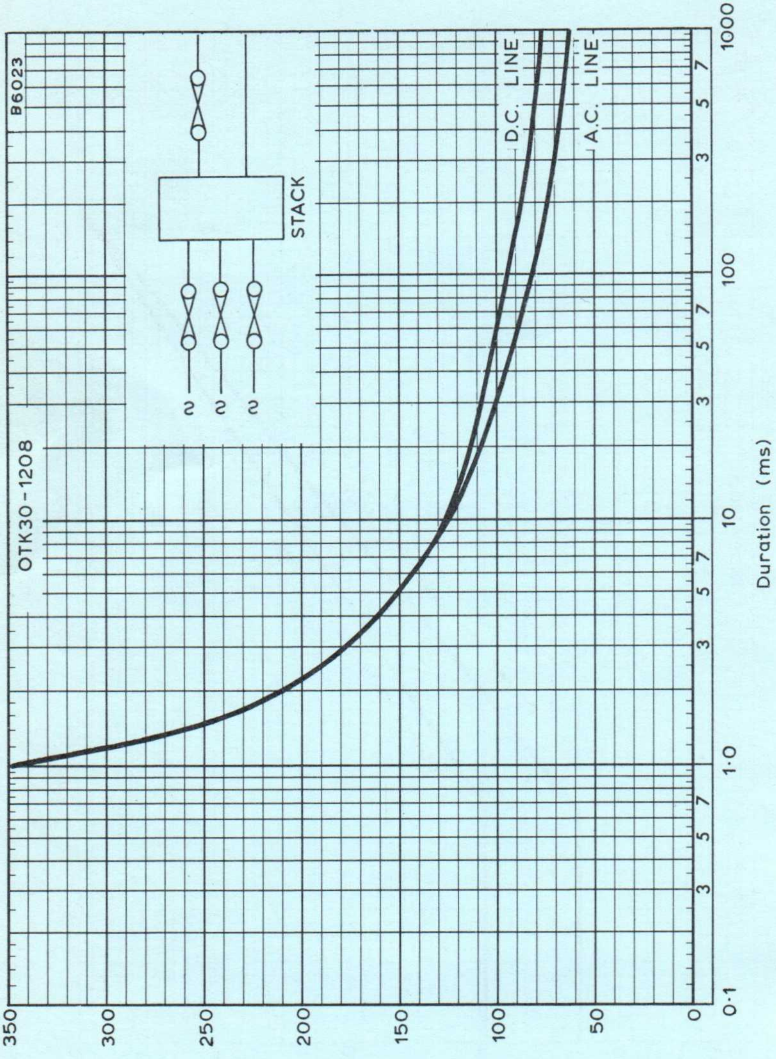
THREE-PHASE THYRISTOR STACK

OTK30-1208

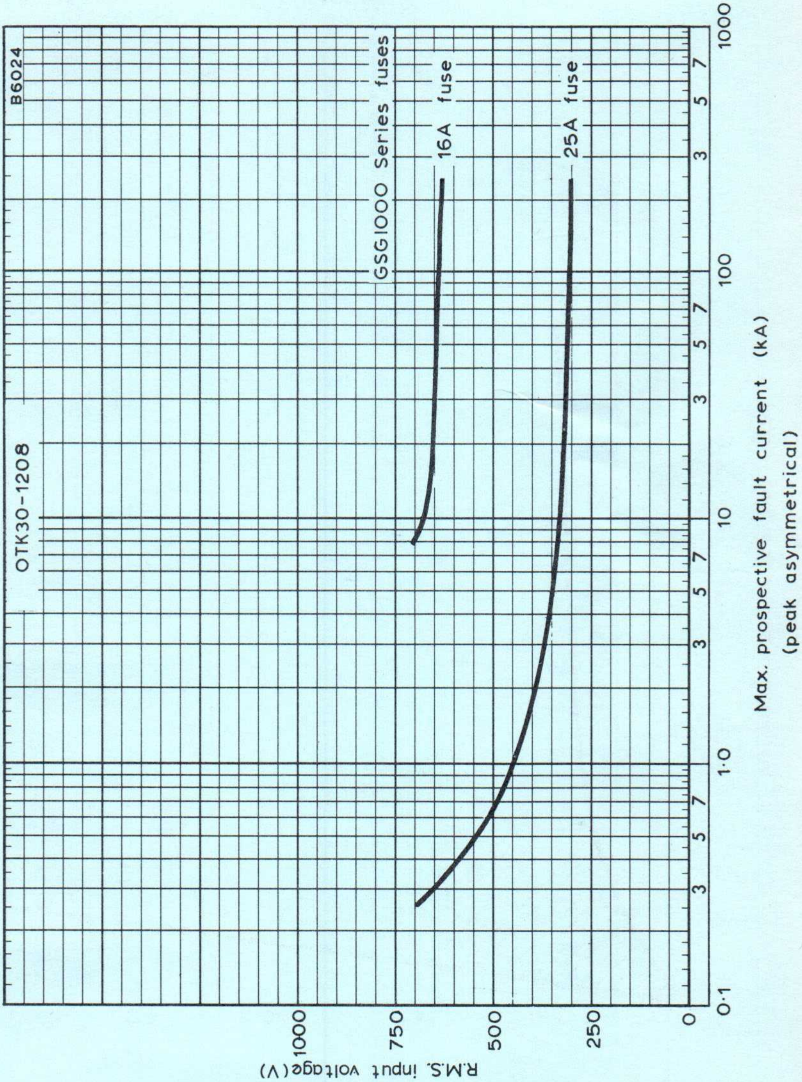




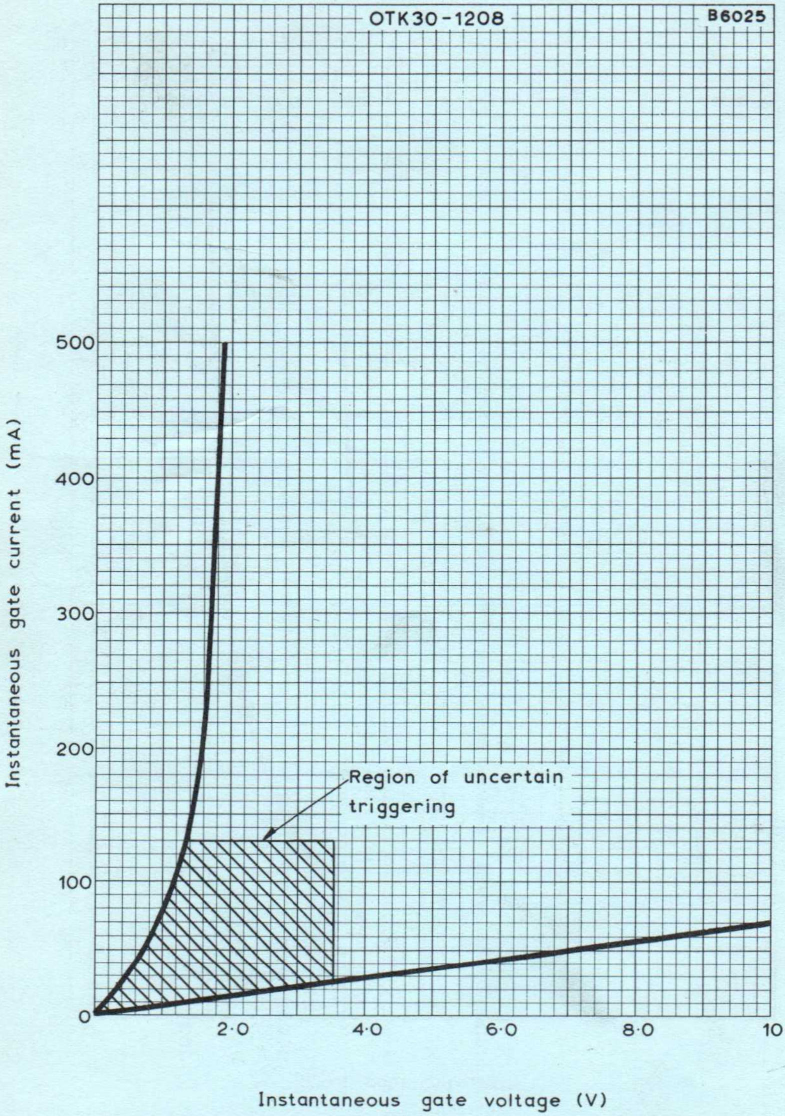
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE. 180° CONDUCTION OF EACH THYRISTOR. MAXIMUM AVERAGING TIME 20ms.



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION.
FOR FUSE AND CIRCUIT-BREAKER SELECTION



R.M.S. INPUT VOLTAGE PLOTTED AGAINST MAXIMUM PEAK ASYMMETRICAL PROSPECTIVE FAULT CURRENT



THYRISTOR GATE CHARACTERISTIC

THREE-PHASE THYRISTOR STACK

OTK35-1209

The OTK35-1209 is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 35A per phase at 55°C under forced air cooling conditions with 180° conduction of each thyristor and controlling a total power of up to 26kW.

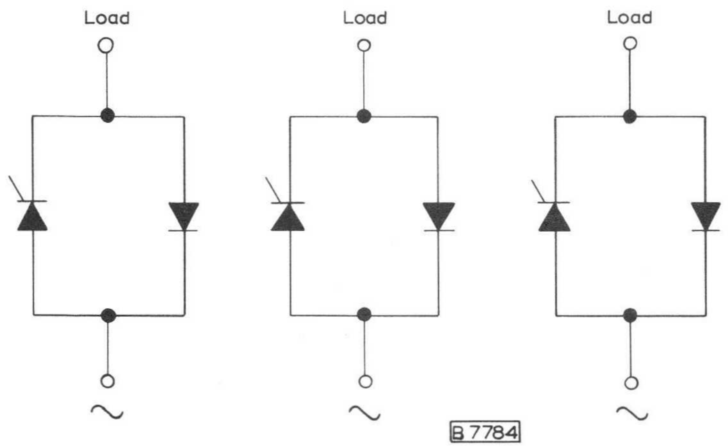
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current per phase, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35^oC$	35	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t <10ms, see note 5)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current resistive or inductive load, 180^o conduction of each thyristor and natural convection cooled		
	$T_{amb} \leq 35^oC$	35	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 55^oC$	35	A
	$T_{amb} > 55^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	200	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curves on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.5	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	65	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	6.0	kg
	13.2	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. Suitable Replacement Devices

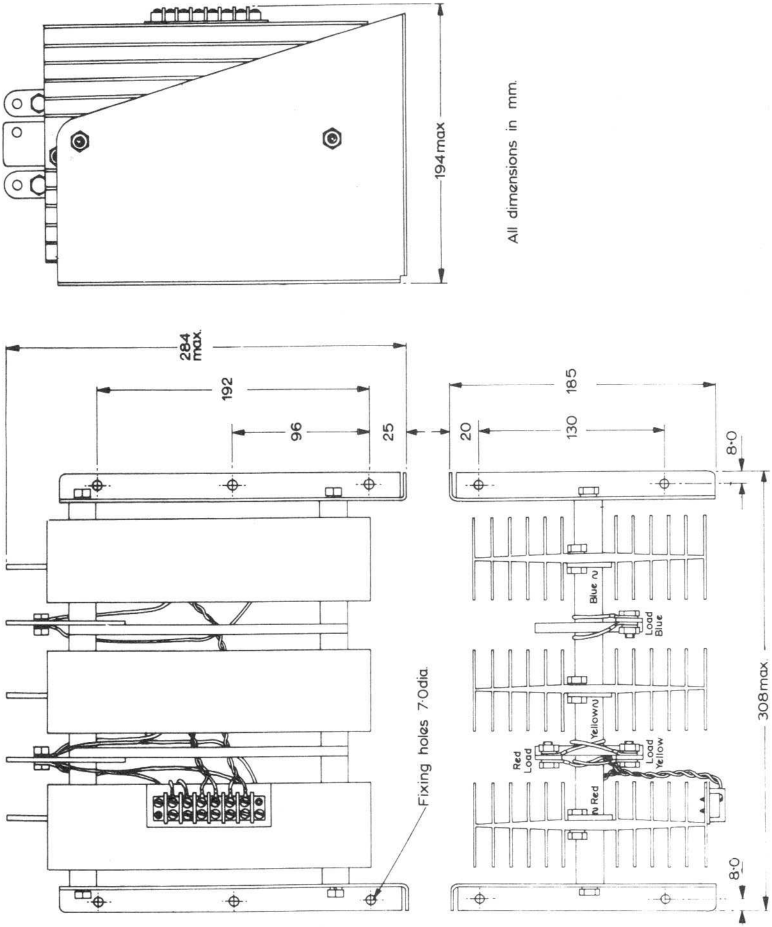
Thyristors	BTX48-1200R
Diodes	BYX25-1000

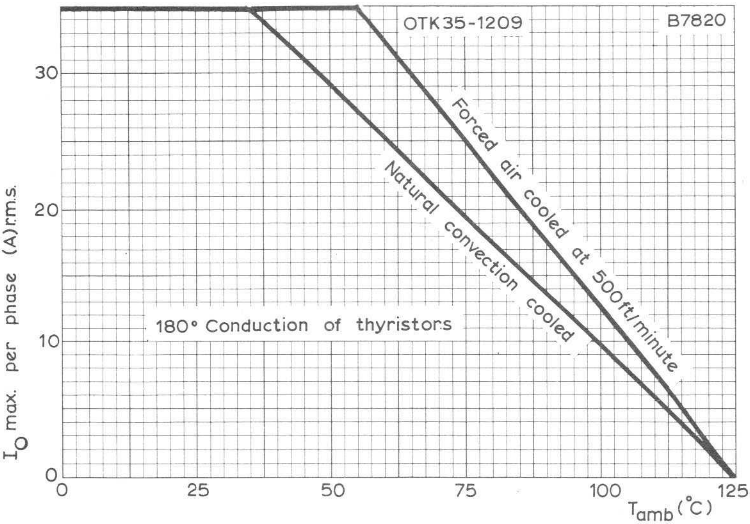
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

THREE-PHASE THYRISTOR STACK

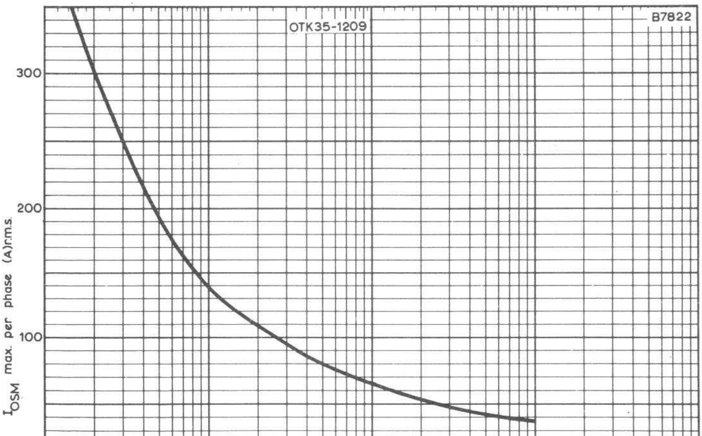
OTK35-1209

OUTLINE AND DIMENSIONS

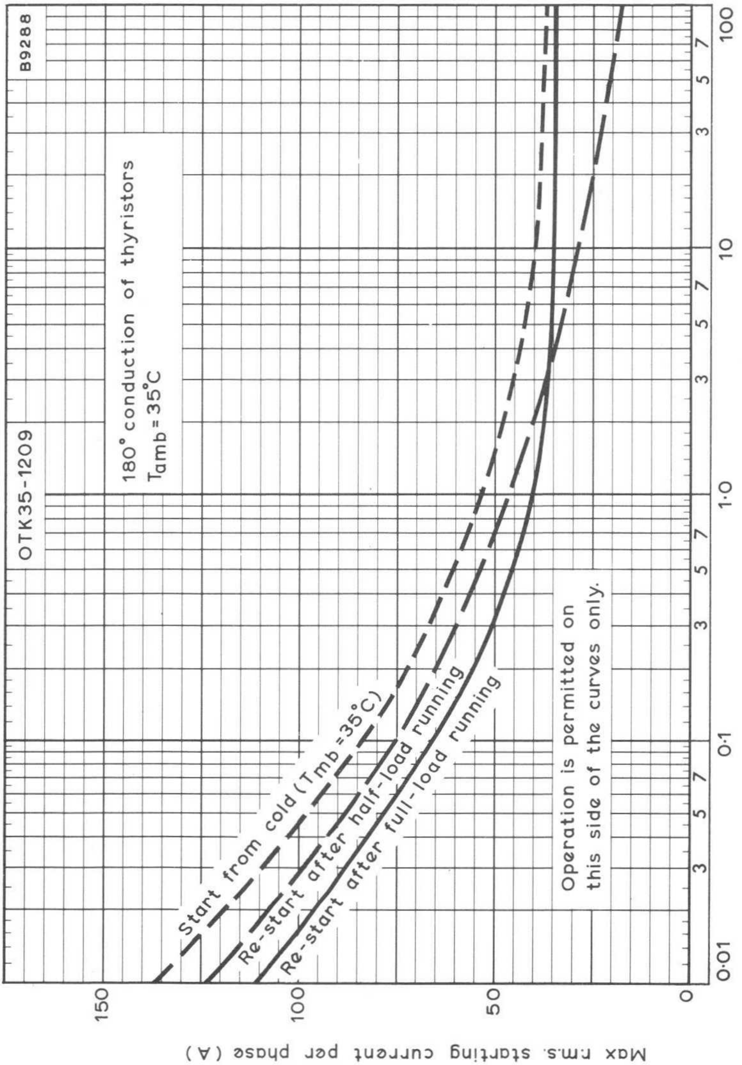




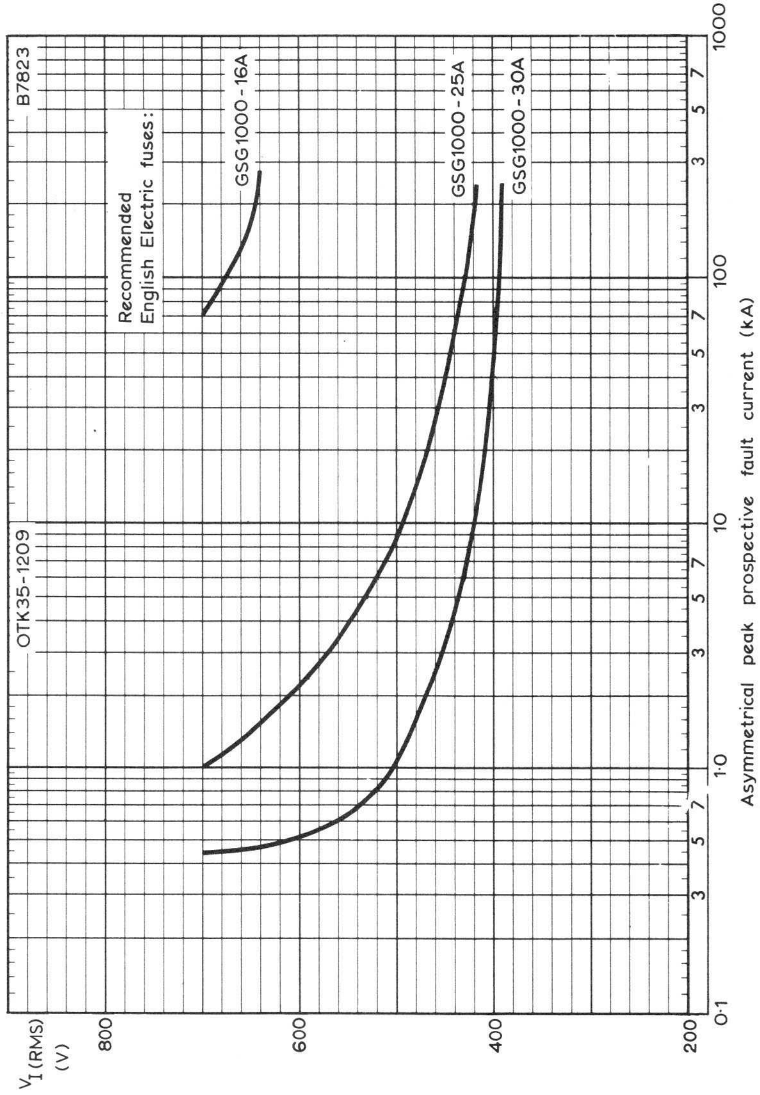
MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE
PLOTTED AGAINST AMBIENT TEMPERATURE



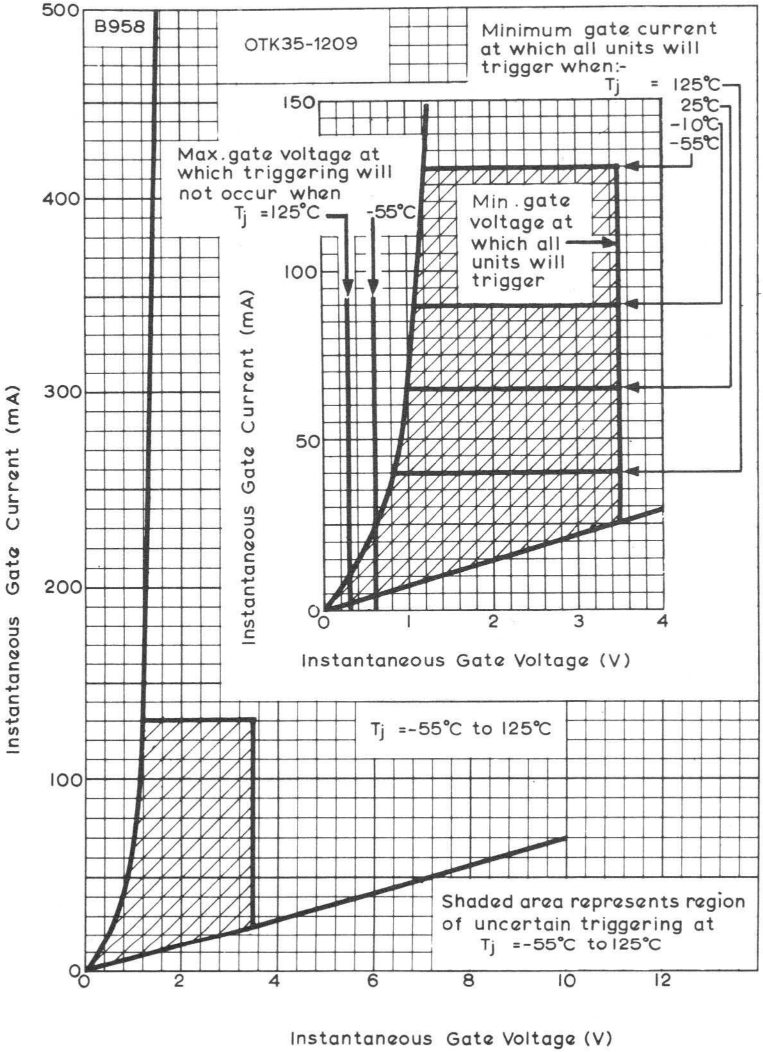
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times\sqrt{2}\times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACK

OTK87-1209

The OTK87-1209 is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 87A per phase at 60°C under forced air cooling conditions with 180° conduction of each thyristor and controlling a total power of up to 66kW.

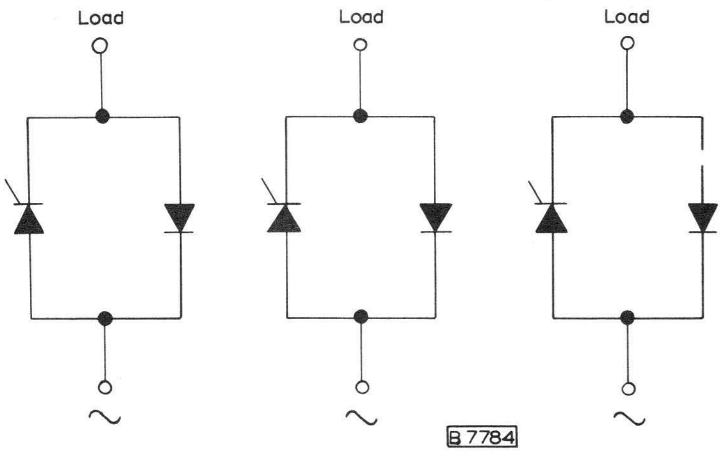
QUICK REFERENCE DATA

Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current per phase, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35°C$	87	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage ($t < 10$ms, see note 5)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current resistive or inductive load, 180^o conduction of each thyristor and natural convection cooled		
	$T_{amb} \leq 35^oC$	87	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 60^oC$	87	A
	$T_{amb} > 60^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	200	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curve on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	8.5	kg
	19	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. Fusing

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. Suitable Replacement Devices

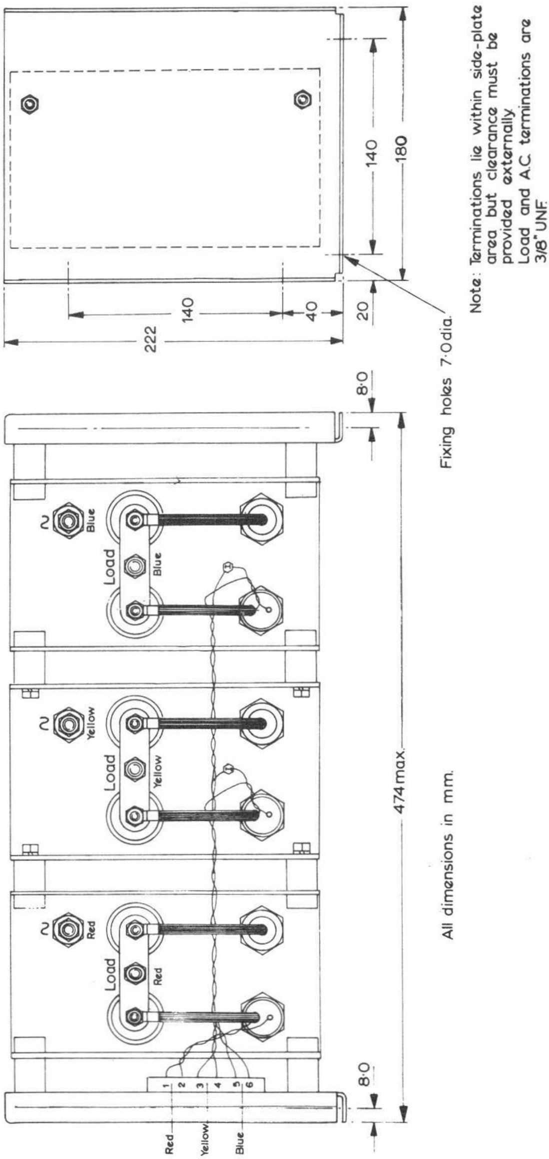
Thyristors	BTX49-1200R
Diodes	BYX15

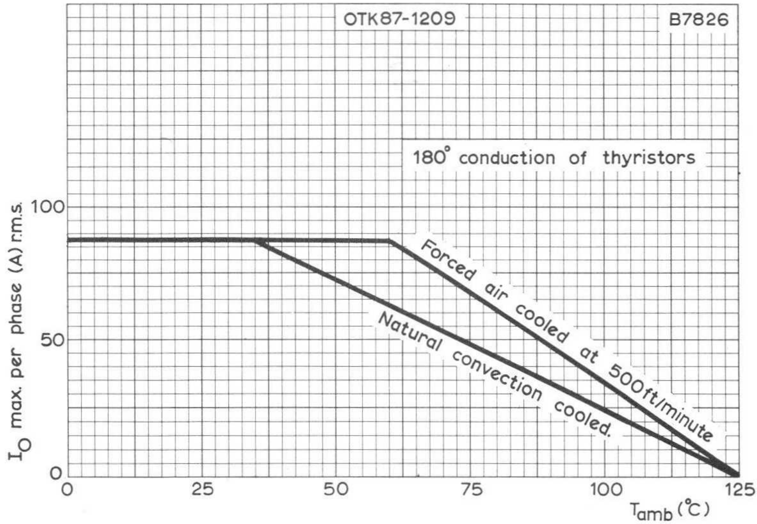
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

THREE-PHASE THYRISTOR STACK

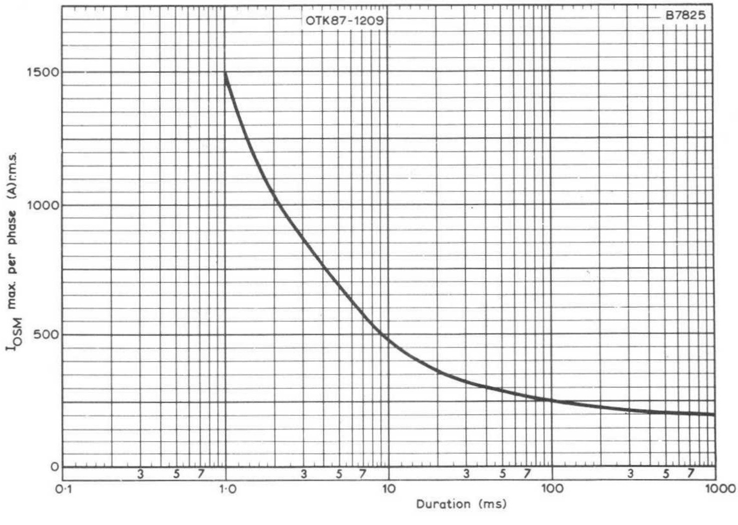
OTK87-1209

OUTLINE AND DIMENSIONS

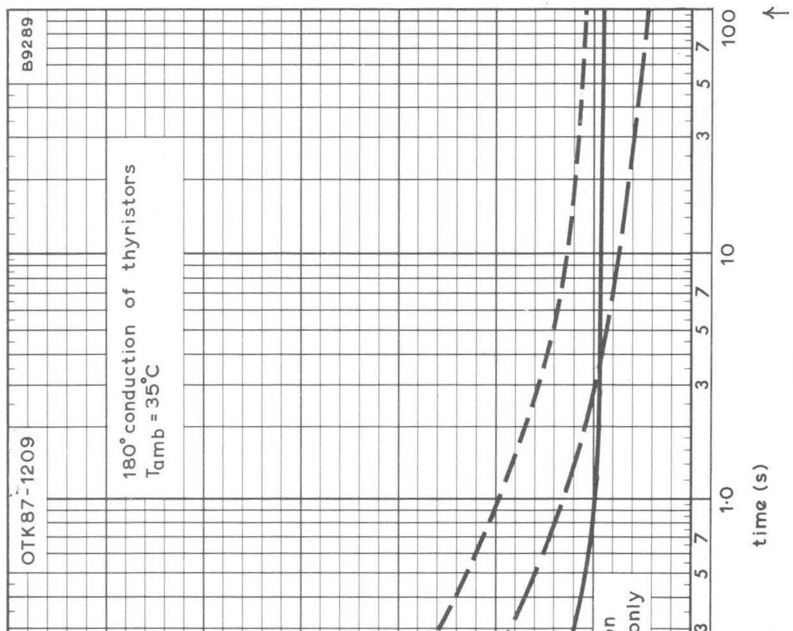




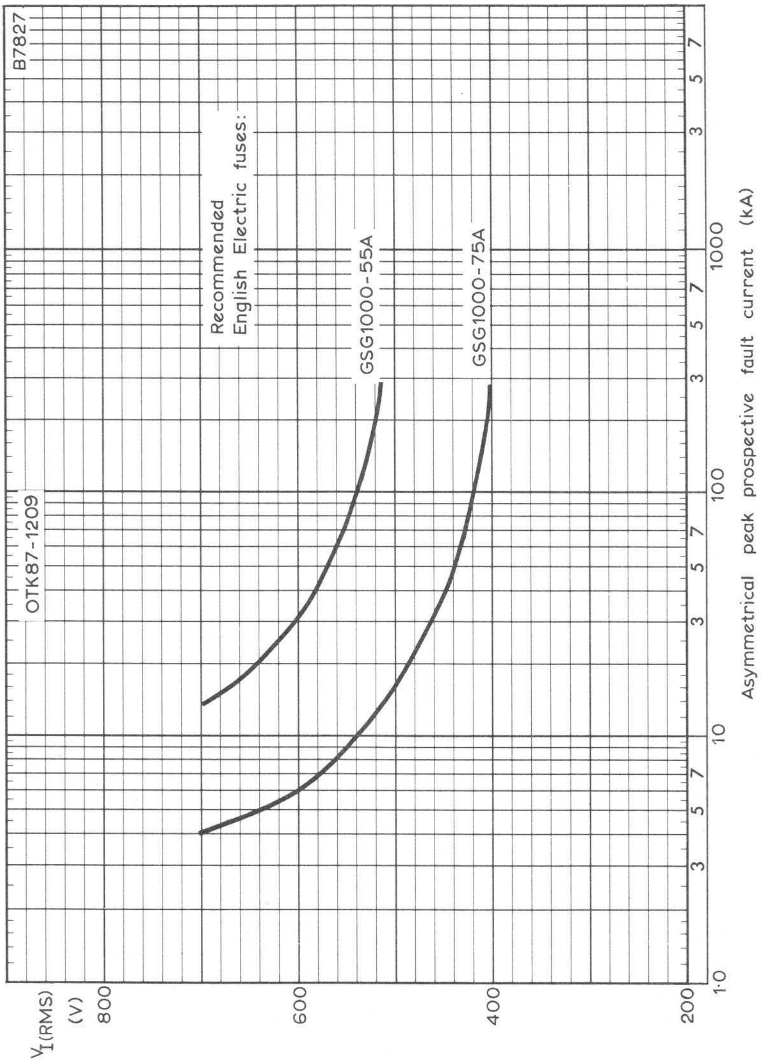
MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE PLOTTED AGAINST AMBIENT TEMPERATURE



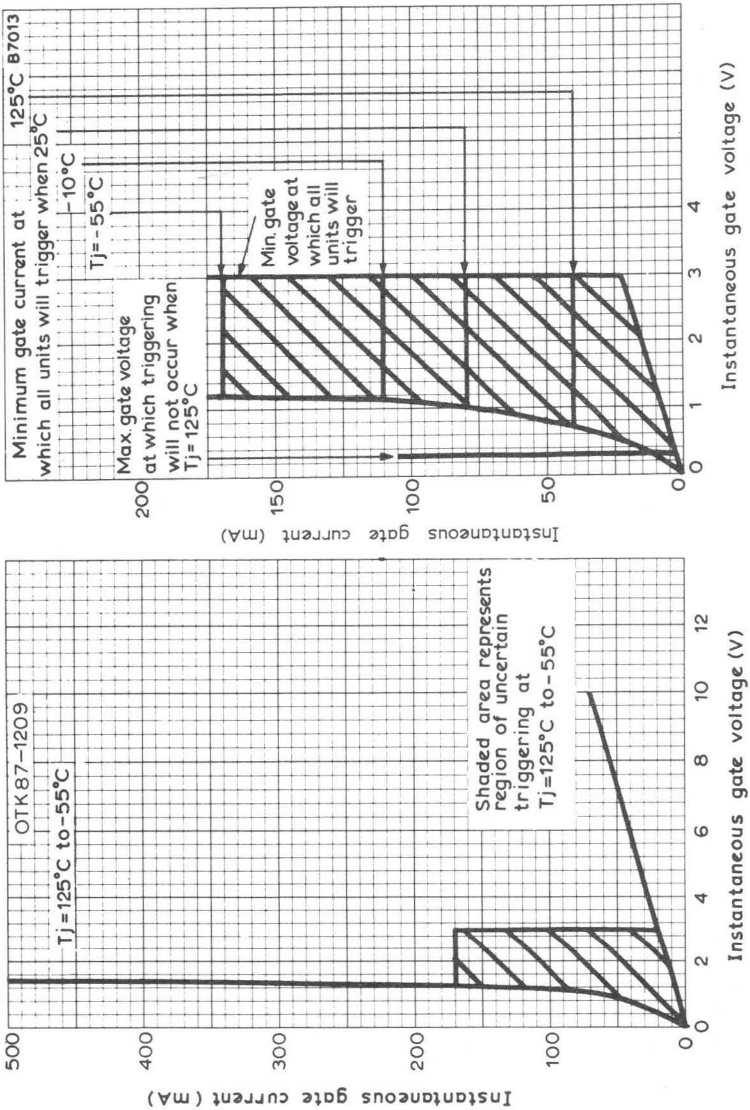
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times\sqrt{2}\times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACK

OTK110-1209A

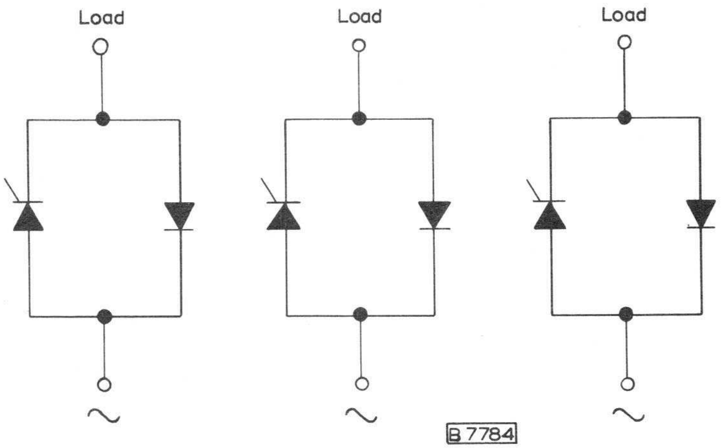
The OTK110-1209A is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 150A per phase at 35°C under forced air cooling conditions, with 180° conduction of each thyristor, and controlling a total power of up to 107kW.

QUICK REFERENCE DATA			
Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current per phase resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35°C$	110	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
The following ratings apply for the frequency range 50-400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage (t < 10ms, see note 5)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor and natural convection cooled		
	$T_{amb} \leq 35^oC$	110	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 35^oC$	150	A
	$T_{amb} > 35^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	380	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curves on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	9	kg
	20	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2 To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

Trigger Modules are available for this stack (Type Nos. MY5001,MY5011)

3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
See also English Electric G.S.G. Fuse Data.

4. Suitable Replacement Devices

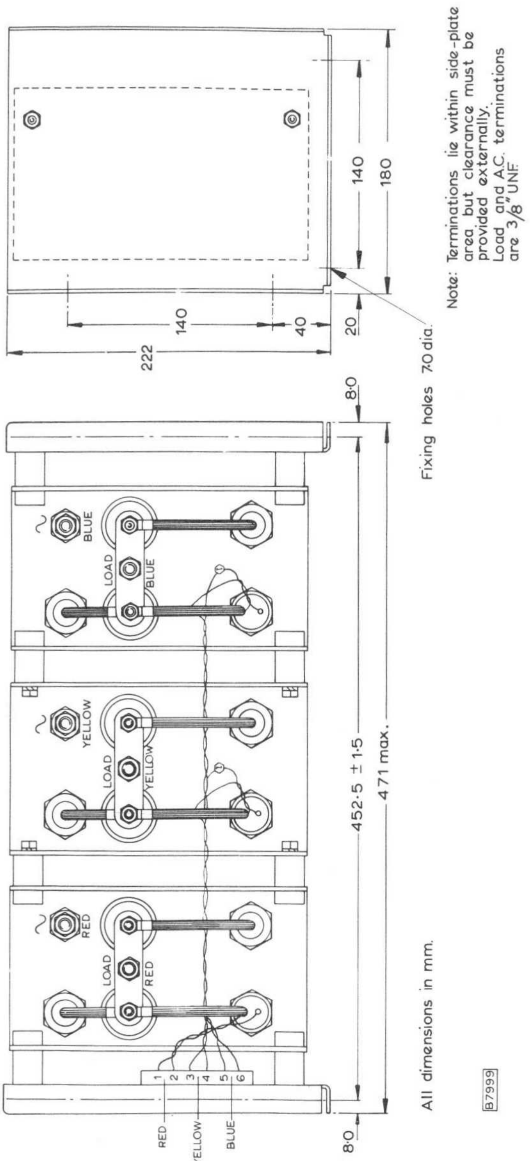
Thyristors	BTX50-1200R
Diodes	BYX15

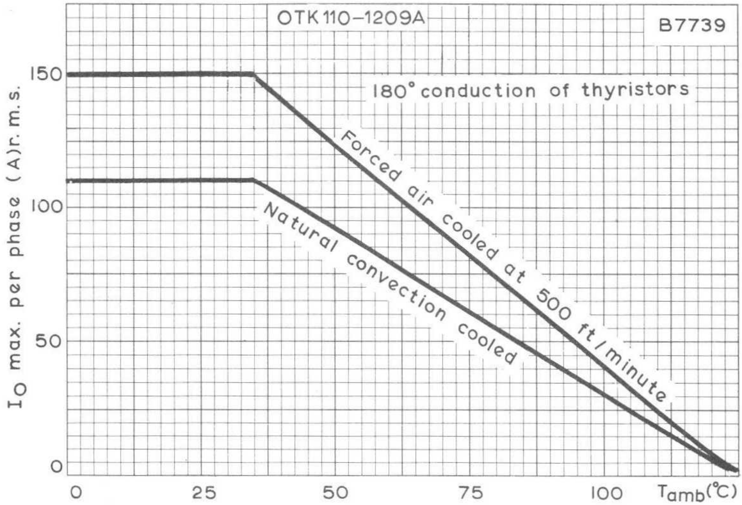
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward breakover. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

THREE-PHASE THYRISTOR STACK

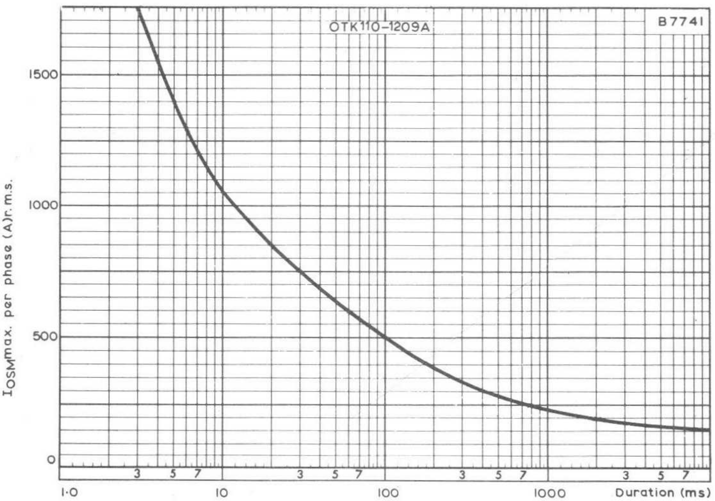
OTK110-1209A

OUTLINE AND DIMENSIONS

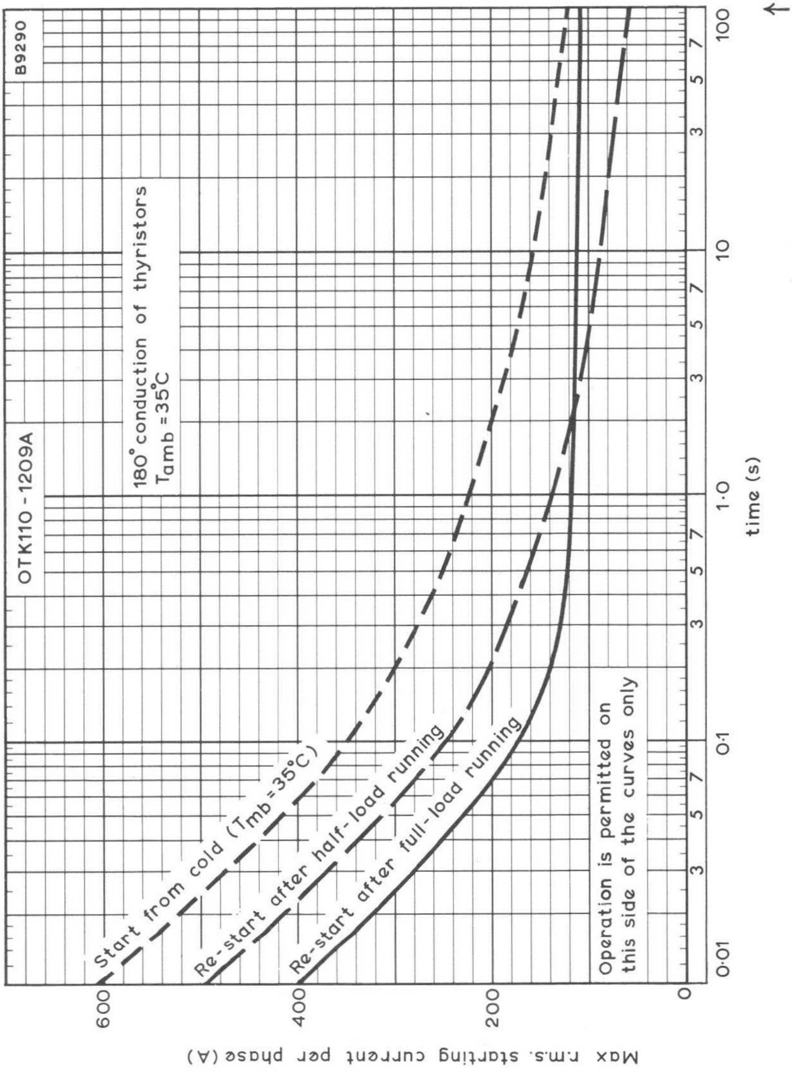




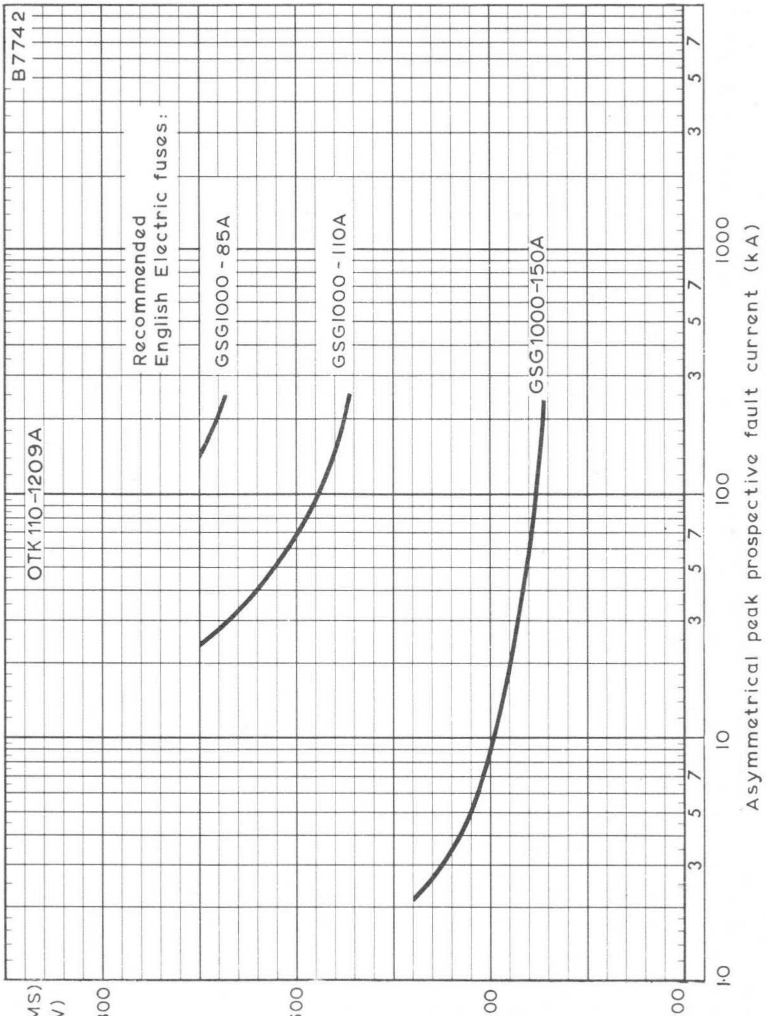
MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE
PLOTTED AGAINST AMBIENT TEMPERATURE



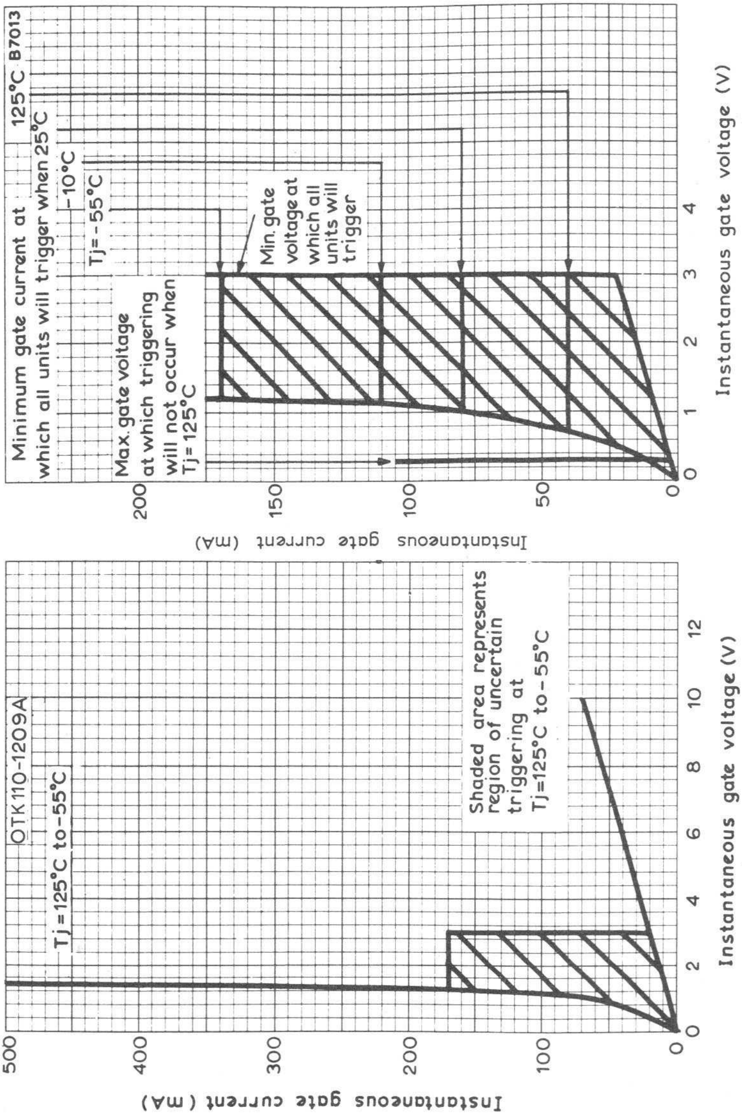
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACKS

OTK120-1208
OTK120-1208A

TENTATIVE DATA

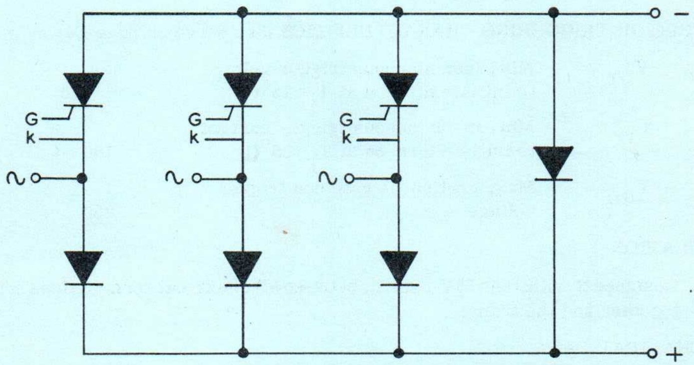
The OTK120-1208, 1208A are half-controlled three-phase thyristor stacks each having a flywheel diode, intended for 440V mains. They are suitable for natural convection or forced air cooling and are capable of supplying up to 120A at $T_{amb} = 70^{o}C$. The OTK120-1208A is electrically similar to the OTK120-1208, but has a different mechanical arrangement.

QUICK REFERENCE DATA

Input			
$V_{I(rms)}$	Max. r.m.s. voltage	570	V
Output			
V_O	Max. average voltage	770	V
I_O	Max. average current ($T_{amb} = 35^{o}C$, natural convection cooling)	120	A

OUTLINE AND DIMENSIONS

For details see pages D5 and D6



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for frequency range 50 to 400Hz.

Electrical

$V_{I(rms)}$	Max. r.m.s. input voltage	570	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak input voltage	1100	V
V_{ISM}	Max. non-repetitive peak input voltage ($t < 10ms$, see note 4)	1100	V
V_O	Max. average output voltage	770	V
I_O	Max. average output current, resistive or inductive load, 120° conduction of thyristors, natural convection cooled		
	$T_{amb} \leq 35^{\circ}C$	120	A
	$T_{amb} > 35^{\circ}C$	See curve on page C1	
	forced air cooled at 500ft/minute		
	$T_{amb} \leq 70^{\circ}C$	120	A
	$T_{amb} > 70^{\circ}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak output current	200	A

Temperature

T_{stg} max.	125	$^{\circ}C$
T_{amb} (operating)	See curve on page C1	

THYRISTOR TRIGGERING CHARACTERISTICS (See curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$	100	mA
V_{GD}	Max. continuous gate non trigger voltage	250	mV

INSULATION

Designed to withstand 5kV r.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	OTK120-1208	20	kg
		40.2	lb
	OTK120-1208A	14.5	kg
		32	lb

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows:-

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R × C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R × C (μs)
2.0	$200 \frac{I_{mag}}{V_1}$	150	$225 \frac{I_{mag} T^2}{V_1}$	200
1.5	$400 \frac{I_{mag}}{V_1}$	225	$400 \frac{I_{mag} T^2}{V_1}$	275
1.0	$800 \frac{I_{mag}}{V_1}$	300	$900 \frac{I_{mag} T^2}{V_1}$	350

   Where I_{mag} = magnetising primary r.m.s. current (A)

   $T = \frac{V_1}{V_2}$ where V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   The capacitance values calculated from the above table are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger modules are available for these stacks. (Type No. MY5001, MY5011, one per phase)

3. Fusing

When selecting a fuse to protect the stack against short circuit the following rules must be adhered to:

(a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

(b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

(c) The stack, it is protecting, must have a transient reverse voltage in excess of the arc voltage of the fuse.

The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

Peak asymmetrical current = r.m.s. symmetrical current $\times\sqrt{2}\times 1.6$

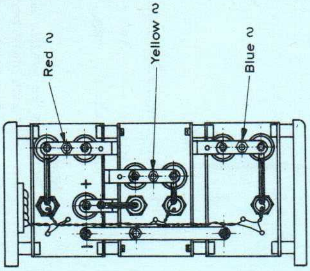
See also English Electric GSG fuse data.

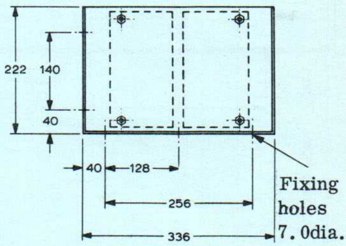
4. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

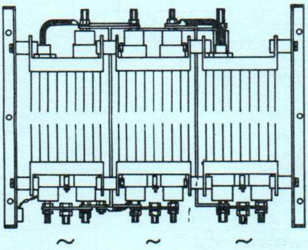
5. Suitable replacement devices

Thyristors	BTX49-1200R
Diodes in bridge arms	BYX15
Flywheel Diode	BYX16

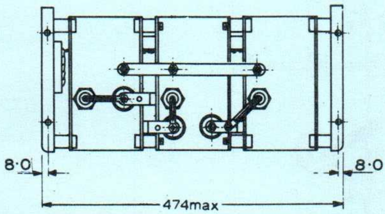
OUTLINE AND DIMENSIONS : OTK120-1208



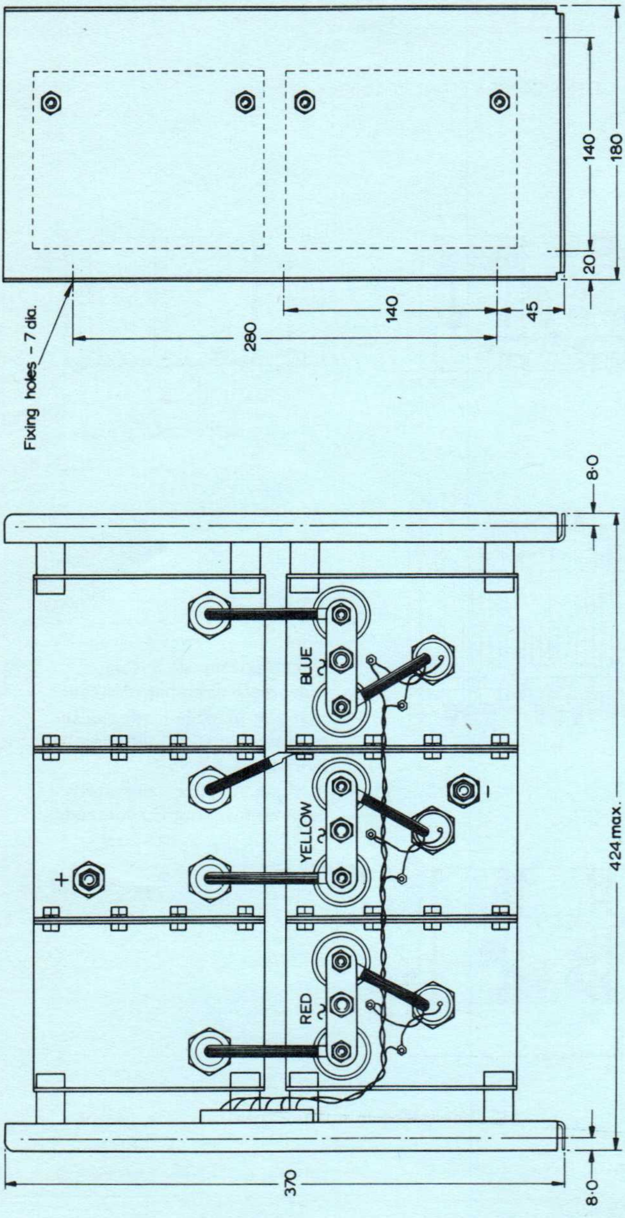




Note
Terminations lie within side-plate area but clearance must be provided externally.
+, - and ~ terminations are 3/8" UNF.
A.C. connections are split to permit fusing if required.



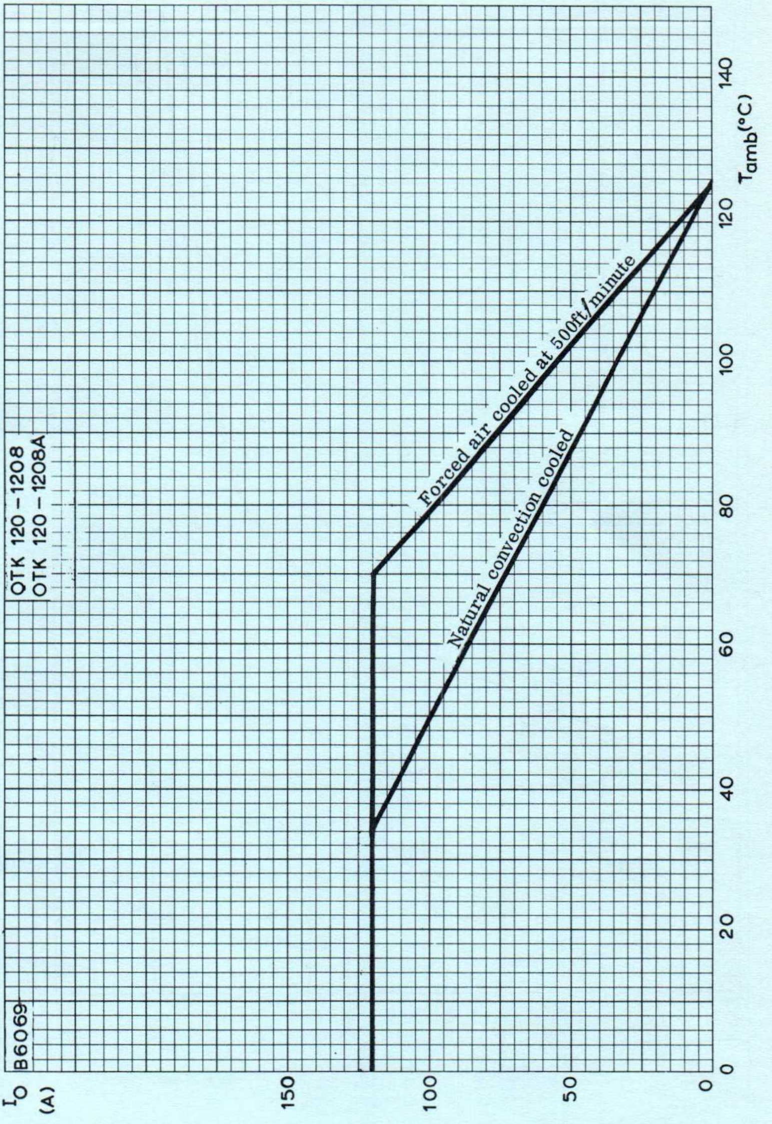
All dimensions in millimetres



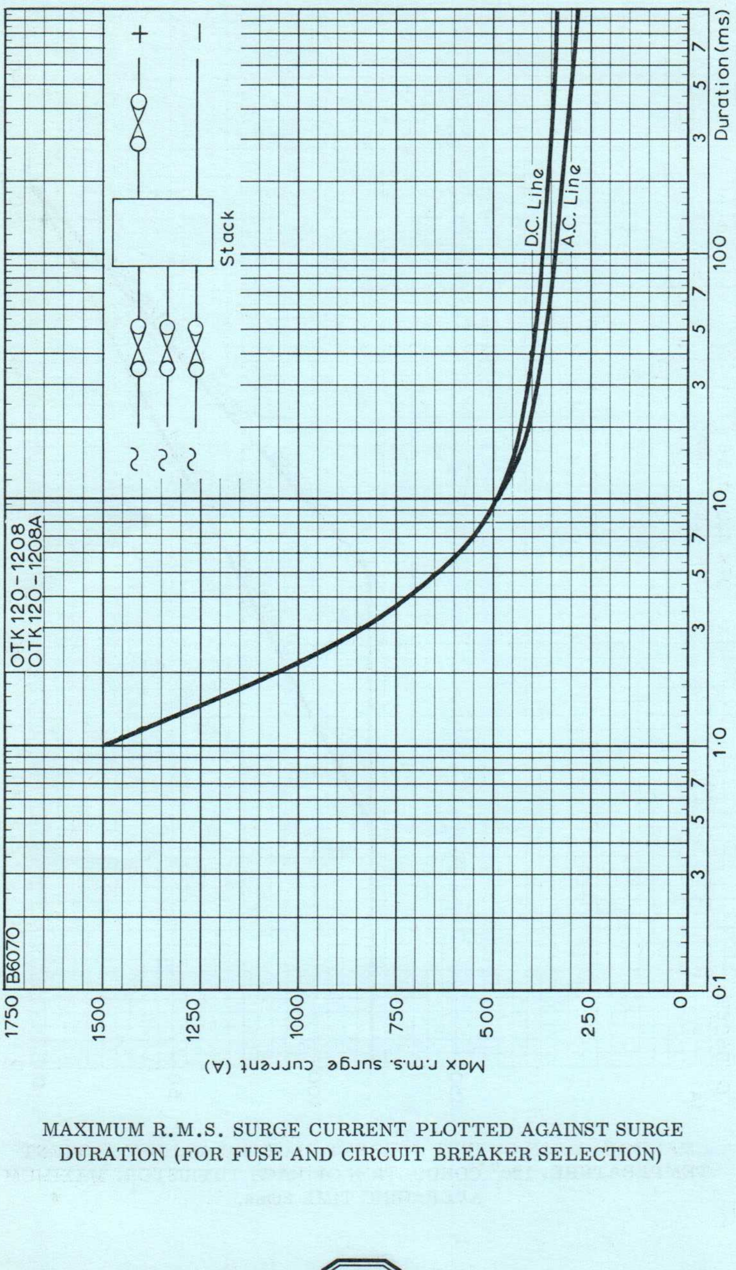
Note:-
Terminals lie within side-plate area but clearance must be provided externally.
+,−and ~ terminals are 3/8" U.N.F.
A.C. terminations are split to permit fusing if required.

All dimensions in millimetres.

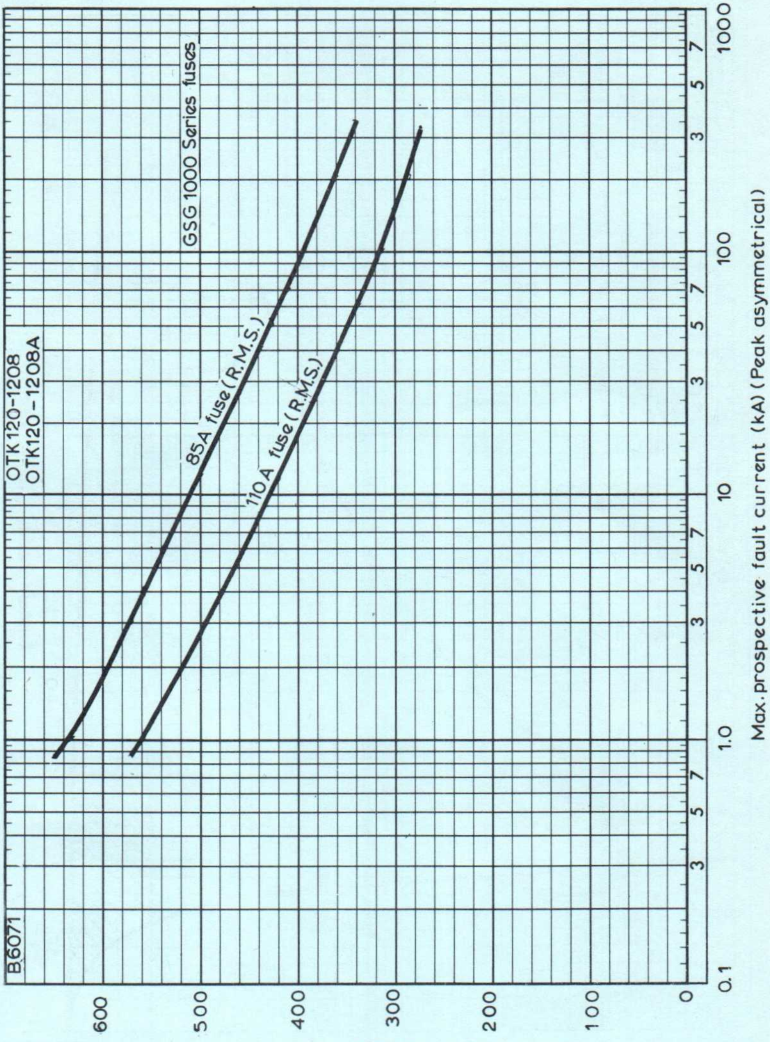
B6055



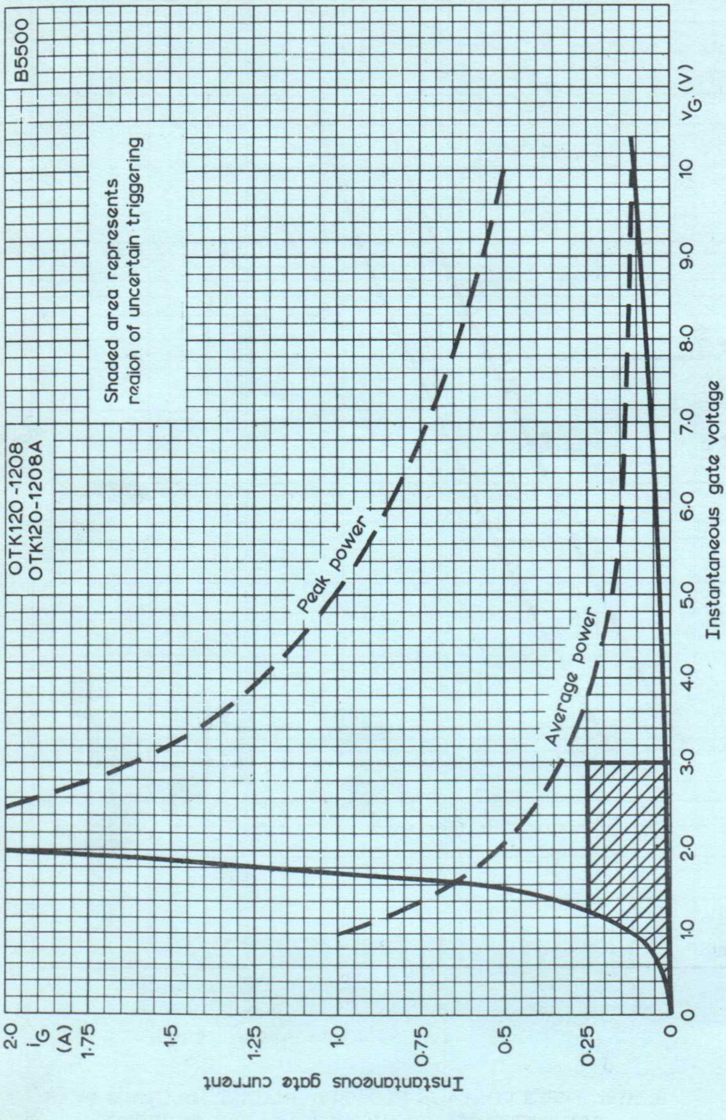
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST AMBIENT TEMPERATURE. 120° CONDUCTION OF EACH THYRISTOR. MAXIMUM AVERAGING TIME 20ms.



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION (FOR FUSE AND CIRCUIT BREAKER SELECTION)



R.M.S. INPUT VOLTAGE PLOTTED AGAINST MAXIMUM PEAK ASYMMETRICAL PROSPECTIVE FAULT CURRENT



THYRISTOR GATE CHARACTERISTIC

THREE-PHASE THYRISTOR STACK

OTK130-1209

TENTATIVE DATA

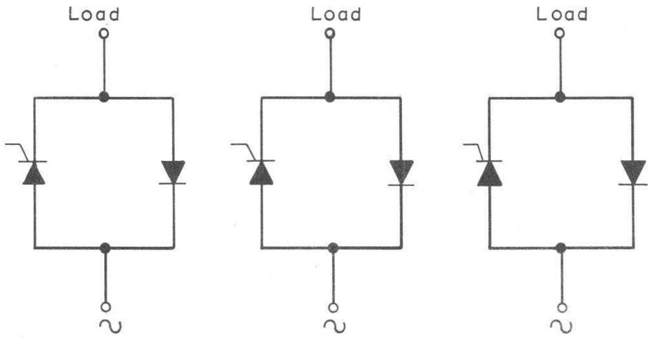
The OTK130-1209 is a three-phase a.c. controller suitable for operation from 440V mains. It is capable of supplying an r.m.s. current of up to 150A per phase at 45°C under forced air cooling conditions, with 180° conduction of each thyristor, and controlling a total power of up to 107kW.

QUICK REFERENCE DATA			
Input			
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
Output			
I_O	Max. r.m.s. current per phase, resistive or inductive load, 180° conduction of each thyristor, natural convection cooling, $T_{amb} \leq 35^{\circ}C$	130	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage (per phase)

$V_{I(RMS)}$	Max. r.m.s. voltage	565	V
V_{IRM}	Max. repetitive peak a.c. voltage	1100	V
V_{ISM}	Max. non-repetitive peak a.c. voltage ($t < 10ms$, see note 5)	1100	V

Output current (per phase)

I_O	Max. r.m.s. current, resistive or inductive load, 180° conduction of each thyristor, and natural convection cooled		
	$T_{amb} \leq 35^{\circ}C$	130	A
	$T_{amb} > 35^{\circ}C$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 45^{\circ}C$	150	A
	$T_{amb} > 45^{\circ}C$	See curve on page C1	
I_{ORM}	Max. repetitive peak forward current	380	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	°C
T_{amb} max.	(see also curves on page C1)	125	°C

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^{\circ}C$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^{\circ}C$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	14.9	kg
	33	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

   A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

   The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer C (μF)	R-C in primary of transformer R×C (μs)	R-C in secondary of transformer C (μF)	R-C in secondary of transformer R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

   Where

   I_{mag} = magnetising primary r.m.s. current (A).

   $T = \frac{V_1}{V_2}$

   V_1 = transformer primary r.m.s. voltage (V).

   V_2 = transformer secondary r.m.s. voltage (V).

   The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

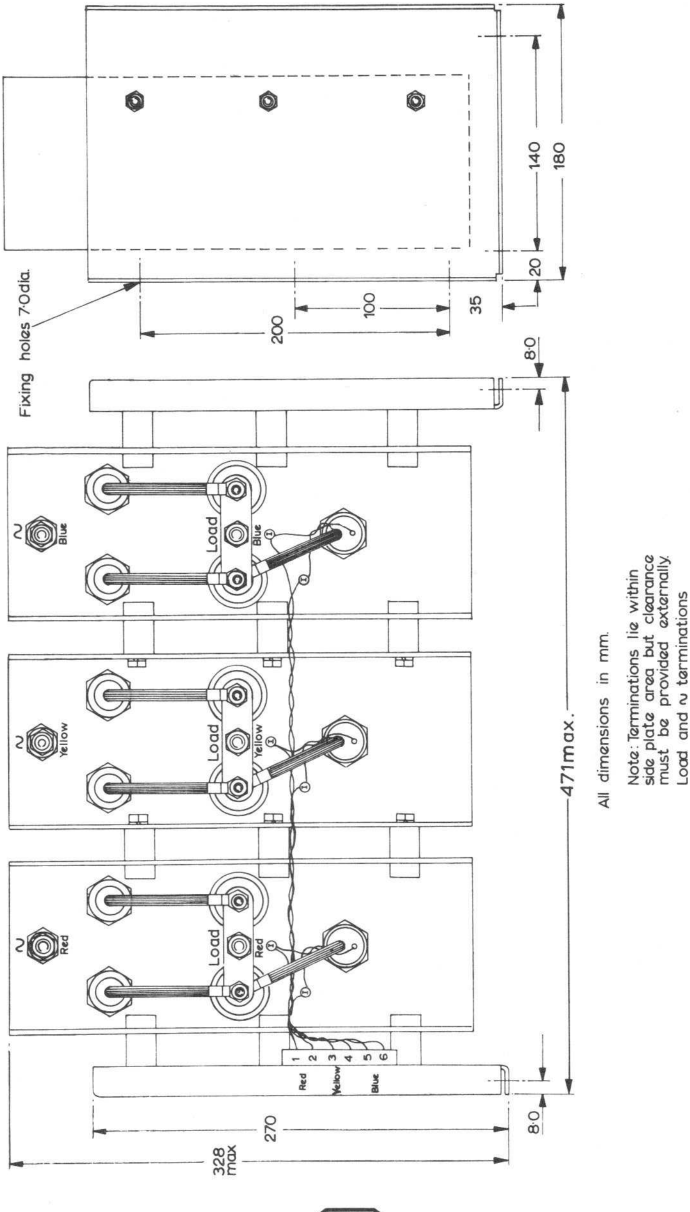
   Peak asymmetrical current = r.m.s. symmetrical current $\times \sqrt{2} \times 1.6$
   See also English Electric G.S.G. Fuse Data.

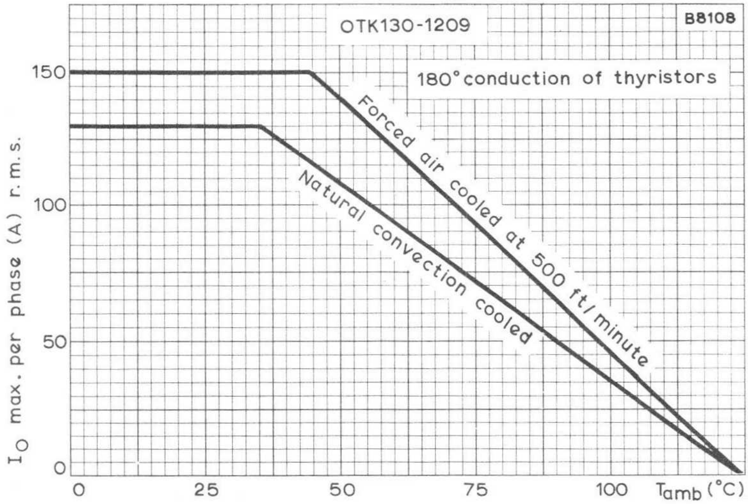
4. **Suitable Replacement Devices**

Thyristors	BTX50-1200R
Diodes	BYX15

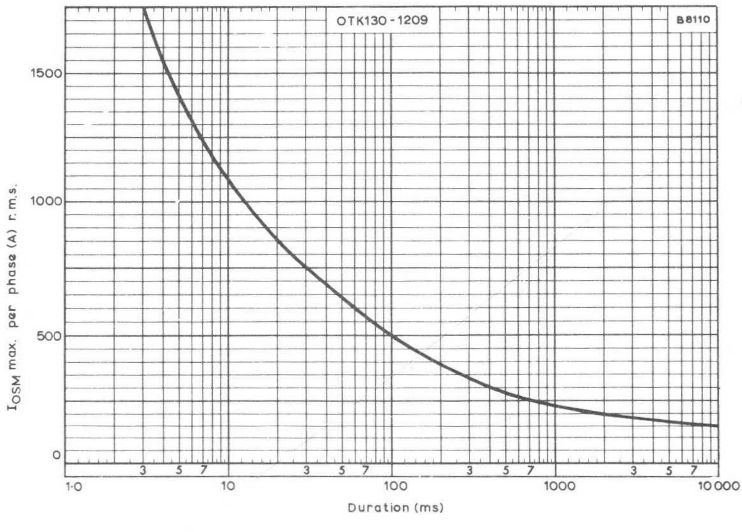
5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

OUTLINE AND DIMENSIONS

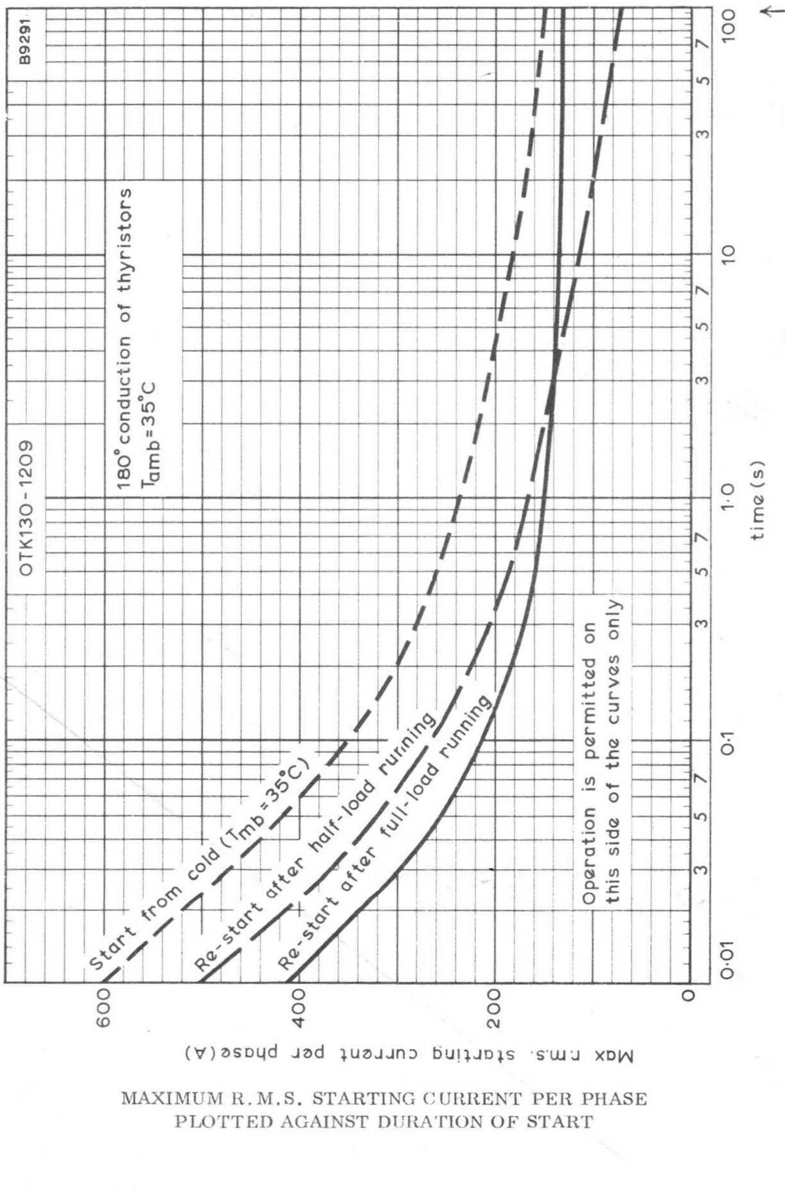




MAXIMUM R.M.S. OUTPUT CURRENT PER PHASE
PLOTTED AGAINST AMBIENT TEMPERATURE



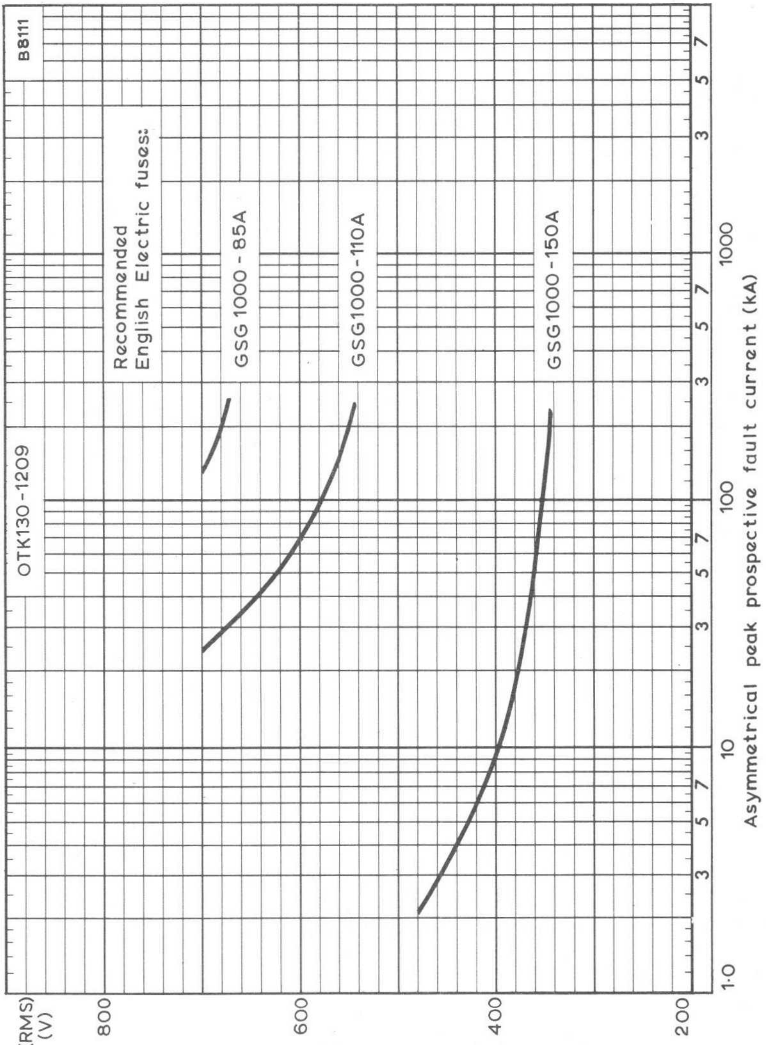
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
DURATION OF SURGE (FOR FUSE AND CIRCUIT BREAKER SELECTION)



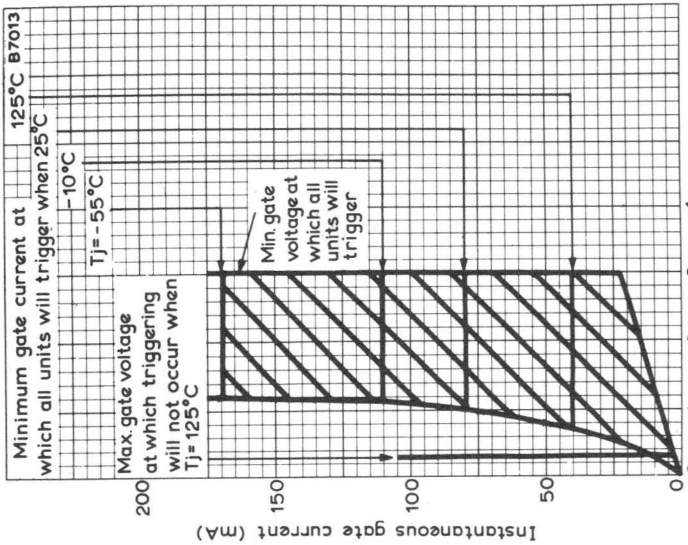
MAXIMUM R.M.S. STARTING CURRENT PER PHASE
PLOTTED AGAINST DURATION OF START

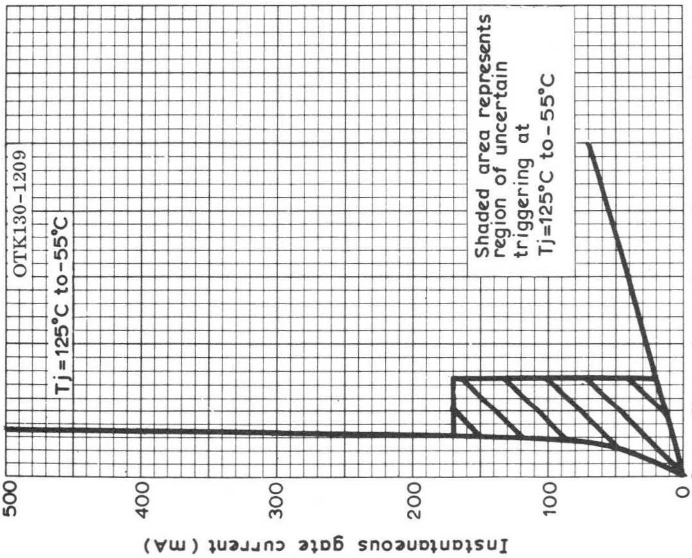
THREE-PHASE THYRISTOR STACK

OTK130-1209



R.M.S. INPUT VOLTAGE PLOTTED AGAINST
ASYMMETRICAL PEAK PROSPECTIVE FAULT CURRENT
(PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL $\times \sqrt{2} \times 1.6$)





THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE TOP GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN

THREE-PHASE THYRISTOR STACK

OTK160-1208A

TENTATIVE DATA

The OTK160-1208A is a half-controlled three-phase thyristor stack with flywheel diode intended for 440V mains. It is suitable for natural convection or forced air cooling and is capable of supplying up to 170A at an ambient temperature of 55°C.

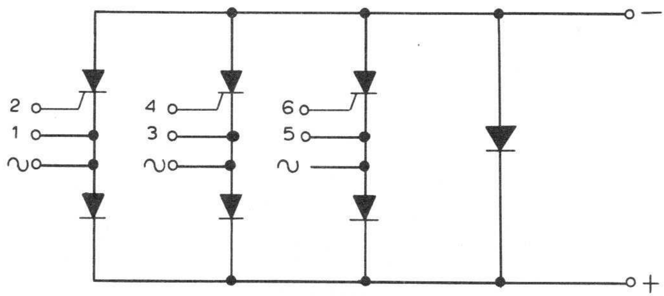
QUICK REFERENCE DATA

Input			
$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
Output			
V_O	Max. average voltage	770	V
I_O	Max. average current (natural convection cooling, T_{amb} = 35°C)	160	A

OUTLINE AND DIMENSIONS

For details see page D5

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system. The following ratings apply for the frequency range 50 to 400Hz.

Electrical

Input voltage

$V_{I(RMS)}$	Max. r.m.s. voltage	570	V
V_{IWM}	Max. crest working voltage	800	V
V_{IRM}	Max. repetitive peak voltage	1100	V
V_{ISM}	Max. non-repetitive peak voltage (t< 10ms, see note 5)	1100	V

Output voltage

V_O	Max. average voltage	770	V

Output current

I_O	Max. average current, resistive or inductive load, 120^o conduction of each thyristor, natural convection cooled		
	$T_{amb} \leq 35^oC$	160	A
	$T_{amb} > 35^oC$	See curve on page C1	
	Forced air cooled at 500ft/minute		
	$T_{amb} \leq 55^oC$	170	A
	$T_{amb} > 55^oC$	See curve on page C1	
I_{ORM}	Max. repetitive peak current	500	A
I_{OSM}	Max. surge current	See curve on page C2	

Temperature

T_{stg} max.		125	^oC
T_{amb} max.	(see also curves on page C1)	125	^oC

THYRISTOR TRIGGERING CHARACTERISTICS (see curve on page C4)

V_{GT}	Min. instantaneous trigger voltage to initiate turn-on at $T_j = 25^oC$	3.0	V
I_{GT}	Min. instantaneous trigger current to initiate turn-on at $T_j = 25^oC$	80	mA
V_{GD}	Max. continuous gate non-trigger voltage	250	mV

INSULATION

Designed to withstand 5kVr.m.s. between all electrical terminations joined together and the frame.

MECHANICAL DATA

Weight (approx.)	16	kg
	35	lb
Dimensions	See outline drawing on page D5	

OPERATING NOTES

1. Suppression of transient voltage surge due to stored energy in transformer core.

A damping circuit should be placed across the transformer if there is a possibility of the maximum non-repetitive peak reverse voltage being exceeded due to transient surges caused by the stored energy in the transformer core. A series R-C circuit or voltage dependent resistor may be used.

The values of R-C components of the damping circuit may be calculated as follows.

$\frac{V_{ISM}}{V_{IRM}}$	R-C in primary of transformer		R-C in secondary of transformer	
	C (μF)	R×C (μs)	C (μF)	R×C (μs)
2.0	$200\frac{I_{mag}}{V_1}$	150	$225\frac{I_{mag}T^2}{V_1}$	200
1.5	$400\frac{I_{mag}}{V_1}$	225	$400\frac{I_{mag}T^2}{V_1}$	275
1.0	$800\frac{I_{mag}}{V_1}$	300	$900\frac{I_{mag}T^2}{V_1}$	350

Where

I_{mag} = magnetising primary r.m.s. current (A).

$T = \frac{V_1}{V_2}$

V_1 = transformer primary r.m.s. voltage (V).

V_2 = transformer secondary r.m.s. voltage (V).

The capacitance values calculated from the above tables are minimum values and should be increased to take account of circuit variations such as component tolerances.

2. To ensure that all thyristors trigger, the firing circuit must provide both the minimum instantaneous trigger voltage and the minimum instantaneous trigger current to initiate turn-on at the operating junction temperature. To do this, the source resistance load line on the gate characteristic must pass through, or above and to the right of, the intersection of the minimum instantaneous trigger voltage and current, providing the absolute gate voltage, current and power ratings are not exceeded.

   Trigger Modules are available for this stack (Type Nos. MY5001, MY5011)

3. **Fusing**

   When selecting a fuse to protect the stack against short circuit the following rules must be adhered to.

   (a) The steady r.m.s. current through the fuse must not exceed its nominal current rating.

   (b) The applied voltage must not exceed the nominal peak rated voltage of the fuse.

   (c) The stack it is protecting must have a transient reverse voltage in excess of the arc voltage of the fuse.

   The prospective currents must be limited according to the fuse data. The impedance to limit the prospective current is given by:-

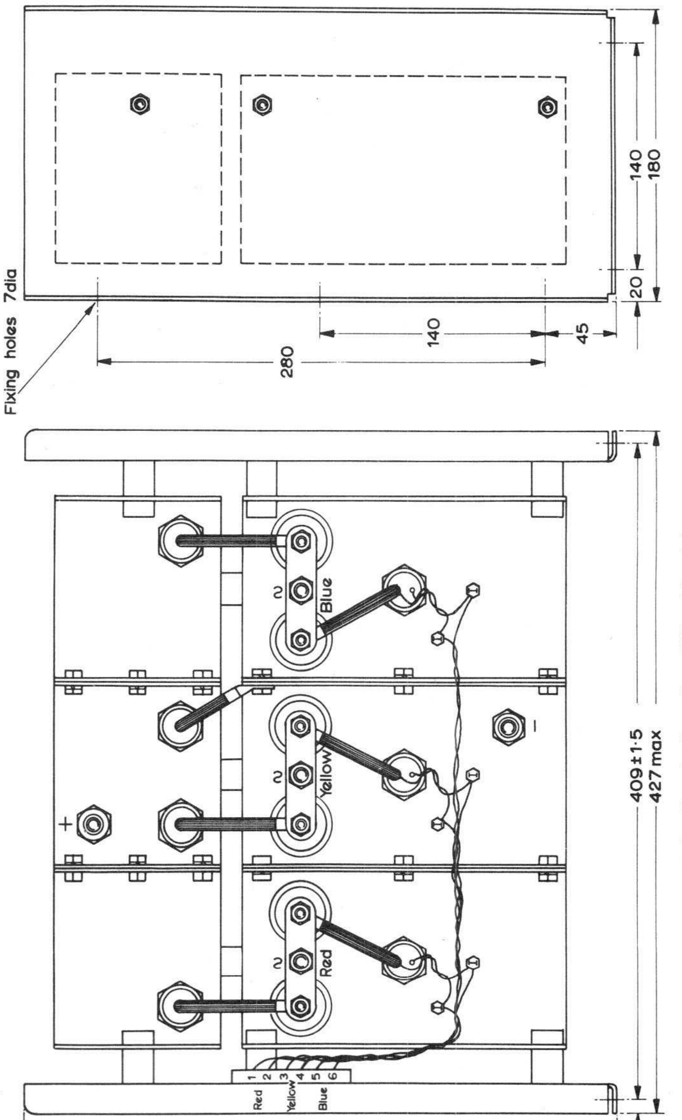
$$Z = \frac{\text{r.m.s. applied voltage}}{\text{r.m.s. symmetrical current}}$$

   Peak asymmetrical current = r.m.s. symmetrical current $\times\sqrt{2}\times 1.6$
   See also English Electric G.S.G. Fuse Data.

4. **Suitable Replacement Devices**

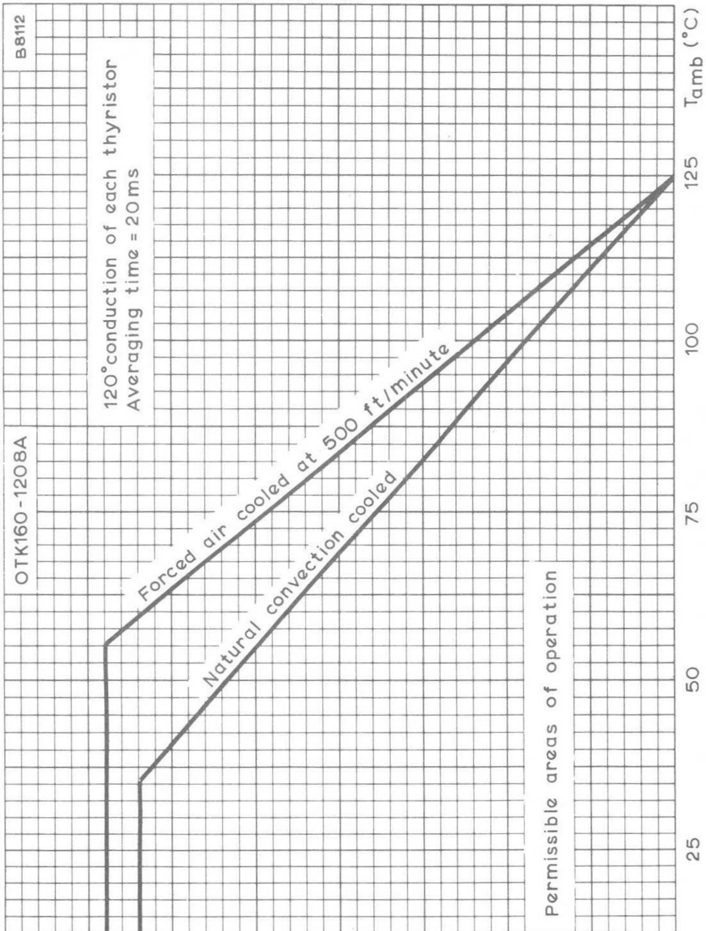
Bridge diodes	BYX32-1200
Thyristors	BTX50-1200R
Flywheel diode	BYX32-1200

5. The limit of 1100V for non-repetitive input voltage is to prevent the thyristors from switching on by forward break-over. If the occasional one cycle into the load can be tolerated, the non-repetitive rating can be increased to 1200V.

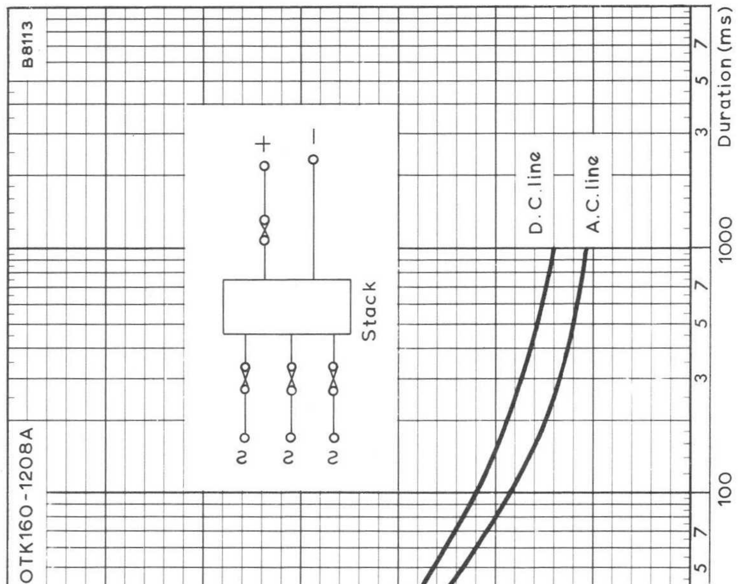


All dimensions in mm.

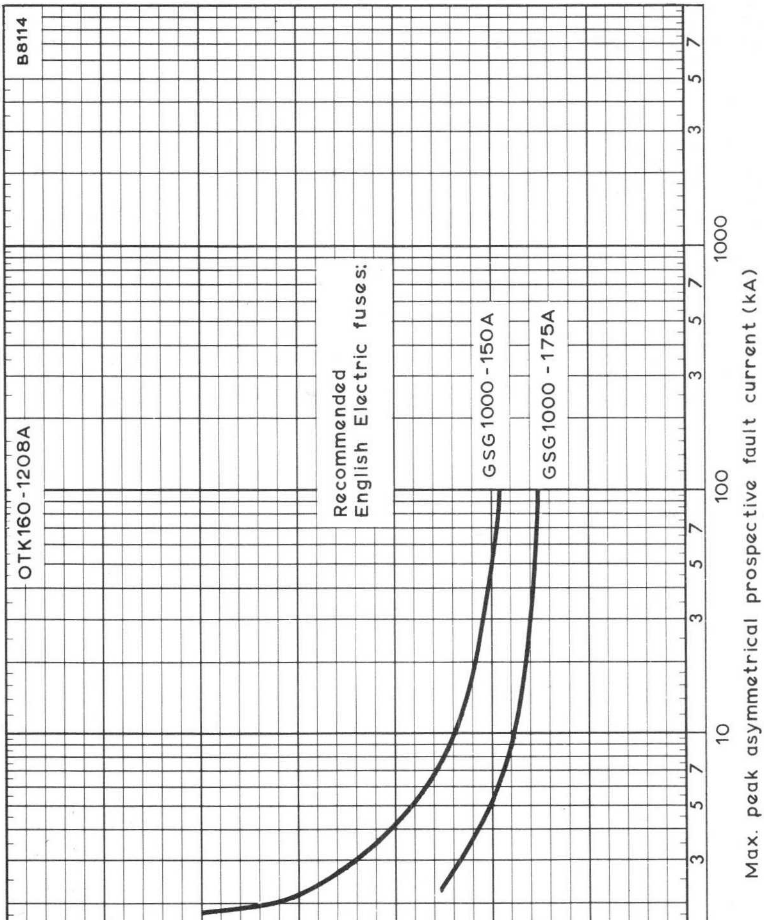
Note: Terminations lie within side plate area but clearance must be provided externally.
+, − and ∿ terminations are 3/8" UNF.
A.C. terminations are split to permit fusing if required.



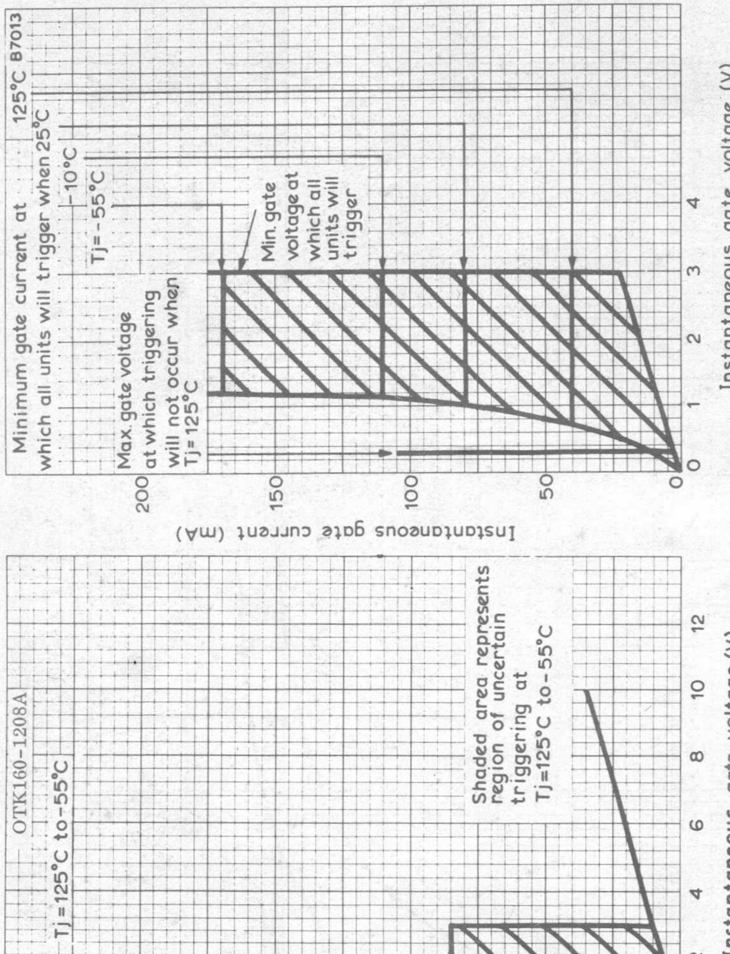
MAXIMUM MEAN OUTPUT CURRENT PLOTTED AGAINST
AMBIENT TEMPERATURE



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST
SURGE DURATION (FOR FUSE AND CIRCUIT-BREAKER SELECTION)



R.M.S. INPUT VOLTAGE PLOTTED AGAINST MAXIMUM PEAK ASYMMETRICAL PROSPECTIVE FAULT CURRENT (PEAK ASYMMETRICAL = R.M.S. SYMMETRICAL × $\sqrt{2}$×1.6)



THYRISTOR GATE TRIGGERING CHARACTERISTICS
THE RIGHT HAND GRAPH IS AN ENLARGEMENT
OF THE PORTION OF THE GRAPH NEAR THE ORIGIN