RANK STRAND TECHNICAL/MAINTENANCE HANDBOOK	STM/T/M Page 1 of 30 STM 10/20 WAY INSTALLATIONS

1. GENERAL INFORMATION

STM DIMMER RACKS are designed for use with the standard range of Rank Strand Control Desks and other Control Panels, to provide a lighting-control installation for stage and studio use. This handbook deals primarily with the Dimmer Racks.

Each Rack houses a set of Dimmer Modules with the associated fuses, fan and other electrical items.

1.1 Equipment

1.1.1 Racks

The standard range of STM Dimmer racks is available in the following variations:

Number of channels per rack: 10-way or 20-way

Supply voltage requirements: 200-250V; 1-phase or 3-phase (4 wire and earth)

Supply frequency: 48 - 63 Hz

Total KW rating of Dimmers:

Racks STM-20 (20-way racks): 100KW max.

Racks STM-10 (10-way racks): 50KW max.

1.1.2 Dimmer Modules

The following table lists the range of Dimmer Modules. The Ref. Number is shown on a label fixed to the Module base-plate.

		MODULE TYPE		CIRCUIT FUSE RATING
KW RATING	2/2½KW 5KW	* STM 20	** STM 25C STM 50C	10A 20A

* : With laminated-core filter unit.

** : With C-core filter unit.

2. CONSTRUCTION AND LAYOUT

2.1 Racks (see Fig. 2.1 Page No. 16).

The racks are of totally enclosed construction, designed for installation as free standing units. An integral bracket with holes is provided at the top of each rack to facilitate securing to a wall or vertical surface; alternatively two similar racks may be mounted back-to-back and secured to each other. The fuse-panel is hinged to provide access to the terminal compartment. The Dimmer Modules are mounted in the remaining part of the rack in columns (of 3 and 7 in STM-10 racks), and metal panels secured by screws provide access for maintenance purposes.

Note: Some module positions may contain "Non-dim" modules or Blank Panels.

Rack (s) containing the following module combinations are fitted with a fan to assist internal ventilation;

1) More than 50% STM 25C modules.
2) More than 3 STM 50C modules in a rack, (2 in a 10 way rack) when the rack is otherwise full of STM 20 modules. In this case, there must not be more than 1 STM 50C module per column.

Air entry is via a grille at the bottom of the rack front panel.

2.2 Dimmer Modules

The Ref. Number for the module is shown on a label affixed to the base-plate. Letter-suffix C to the Ref. Number indicates that the filter unit is of C-core design.

On modules with Plug-in Trigger cards, the plug-in connector is mounted on top of the heat-sinks.

3. INSTALLATION AND CONNECTIONS

Note: Each rack or group of racks is supplied with a Ref. 855 Suppressor Unit consisting of four capacitors. Mount this unit close to the incoming mains-supply busbars; see Fig. 2.2 (Page No. 17) for dimensions and paragraph 3.4.2a for connections.

3.1 Installation

To minimise expensive cable-runs to the lamp loads, site the racks as near to the loads as practicable. Where possible, group two or more racks together at one location. Avoid any accoustically 'live' position in the acting or audience area, since the racks are not completely silent in operation.

An adequately fused isolator for the incoming mains-supply must be provided, preferably one near to each rack. The spare label reading 'High Voltage Insulation Testers Not To Be Used On This Equipment', provided with the rack(s), should be fixed to the main isolator switch. In choosing the location for individual or grouped racks, ensure that free flow of air through each rack (air-inlet at bottom and outlet at top) is not impeded in any way. Also allow enough clearance to the left of the rack to allow the fuse panel to be hinged open more than 90^{o} and permit free access to the terminals.

3.2 Ventilation

The forced ventilation or natural convection in each rack is adequate to disperse the heat dissipated in the rack (less than 2½% of maximum load or supply KW rating, whichever is the smaller), so long as the inlet air temperature does not exceed 35^{o}C (95^{o}F). Air conditioning equipment may be necessary in some locations to maintain the ambient temperature below 35^{o}C.

3.3 Mounting

See figures 2.1 and 2.2 (Page Nos. 16 & 17) for fixing-hole dimensions.

Where racks are grouped, it will be found convenient to arrange them in the correct sequence. Each Dimmer channel is numerically identified, the numbers running in sequence throughout the installation.

3.4 Connections

The channel identification numbering is the key for all connections to lamps loads, associated Desk/Panel, etc., and also for plotting cues and aiding maintenance.

Note: Do not use high-voltage insulation testers to check wiring associated with and connected to Dimmer Racks.

3.4.1 Access to Terminals in the Rack

Hinge open the fuse panel to gain access to incoming-supply busbars, the load terminals and control-wiring connections. A removable panel is provided on top of the rack to facilitate cable-entry.

Note: Do not remove the panels covering the rest of the cabinet except for access to Dimmer Modules for Maintenance.

3.4.2 Incoming-Supply Connections

3.4.2a Suppressor Unit

Rack(s) with 'c' type modules (STM 25/C, STM 50/C), a single Ref. 855 Suppressor Unit must be connected across the main supply intake as detailed in Fig. 3.4. (Page No. 18).

Rack(s) without the benefit of 'c' type filter modules (STM 20) require two Ref. 855 Suppressor Units, connected in parallel across the supply intake.

Note: That the common terminal of the Suppressor Unit capacitors is taken to the Neutral Line. Local electricity authority regulations may require the suppressor unit to be separately fused on each phase.

On single-phase systems (Phase, Neutral and Earth only), two of the capacitors in the suppressor unit are not used.

3.4.2b Racks

The Busbars behind the fuse panel are designed and adequately rated for the appropriate cable-sizes to be used.

In the case of 3-phase applications, the Dimmer Module input supplies are internally connected in Phase sequence Red (Bar P1) to 1, 4, 7, etc. Yellow (Bar P2) to 2, 5, 8, etc. Blue (Bar P3) to 3, 6, 9, etc. unless otherwise specified by the user.

It is imperative to provide an adequate earth/ground conductor for the external wiring and connect it to the earth/ground busbar E in the rack. Do not rely on earthing via conduit or trunking.

3.4.3 'Load' Connections

'Load' and 'Neutral' terminals are numbered to correspond with the Dimmer Modules. Since control of the output to the load involves waveform-switching, the two conductors to each channel - load must be run as a pair of adjacent and equal-length conductors; this will ensure that each conductor in the pair carries equal and opposite current components. If a patching panel or other form of load-selection unit is used, divert the conductors as a pair to and from this unit. Lack of care in this respect may result in strong induced field tending to vibrate the cable-trunking or radiate interference.

If armoured or metallic conduited cables with adequate earthing of the sheaths are not used, separate earth conductors are necessary and should be connected to earth-bar E in the racks.

3.4.4 'Control' Connections

These are made primarily to the associated Desk or Panel.

3.4.4a A-C Supply Connections

A suitable cable (Rank Strand code 35 604 18) is a 3-conductor 1.5 sq. mm. (30/0.25) cable.

Note: that in some installations, the associated desks or panels may require to be fed separately from the mains-supply. Where the desk supply is specifically to be taken from the rack, use the ABE terminals on the 'Control' terminal block in the rack. Note that Terminal A is connected in the rack to the 'Blue' phase (Bar P3) on the AC input supply to the rack, Terminal B is connected to earth/ground (Bar E). Where the desk requires more than one supply from a group of racks, use the ABE terminals of the second rack also.

On grouped racks, spare ABE terminals can be used to power auxiliary circuits so long as the circuit-rating of the 'Control' fuse is not exceeded.

3.3.4b Control-Signal Connections

Use terminals 1 to 10 (or 20) and C on the 'Control' terminal block. Since the wiring has to carry less than 24V at a few mA, any suitable multi-conductor cable can be used subject to local authority regulations. A suitable cable (Rank Strand Electric code 35 601 11) is a 12-conductor or 0.5 sq. mm., (16/0.2) PVC-insulated and sheathed cable, to be used one cable per each 10 channels. This cable has the advantage of 250V-grade insulation and does not have to be segregated from mains-voltage conductors.

Connect each numbered terminal to the appropriate numbered terminal(from the channel lever potentiometer circuits) on the associated Desk or Panel; connect the common return line to Terminal C.

Using the above 12-conductor cable, a consistent sequence of connecting conductors to numbered terminals (e.g. white, slate, brown, red, red/blue, red/white, pink, orange, yellow, blue, violet and black) will facilitate channel identification for maintenance purposes at a later date.

3.4.5 Other Information

When all connections have been made to a rack, remove all cable-ends and other debris from the terminal compartment; check all connections carefully, especially to ensure that insulation is not trapped in the pressure-pad terminals; close the fuse panels.

3.4.5a Lamp-Loads

The Dimmers are designed to control tungsten-load of the same voltage rating as the mains-supply. Each channel-dimmer requires a minimum load of 150W for satisfactory operation; hence smaller test-lamps or neon indicators should not be used as entire loads.

The Dimmers will also control transformer-fed loads provided the load on the Dimmer is in excess of 300 watts, either due to transformers secondary loads or some other ballast. Transformers must be individually fused, and situations such as one transformer feeding one tungsten lamp load with no other ballast avoided, since if this lamp failed, the Dimmer would be subjected to an unloaded transformer load (i.e. a load under 300 watts). Allowance must be made for the transformer magnetizing current when calculating the load current. The maximum continuous current rating of the Dimmers for this purpose is 10 amps (2/2½KW) or 20 amps (5KW).

3.4.5b Load-Line Terminations

These should preferably be to socket outlets numbered to correspond with the channel identification numbers, and for the flexibility usually required of stage and studio lighting, a standard socket outlet should be adopted where possible.

In the United Kingdom, 15 amp, 3-pin BS546 outlets are used in most installations. For high-wattage loads requiring outlets of more than 15A rating, suitably rated receptacles must be used, 32 amp connectors to CEE. 17 are suggested.

For applications in countries other than the UK, local practices or regulations must prevail.

3.4.5c Associated Sound System Installations

Waveform switching, such as provided by thyristor Dimmers, can reveal, in the form of spurious interference, previously unsuspected earth-loops in the associated sound-system installations. Careful inspection of sound-system earthing, screening, etc. may be necessary to remedy any earth loops.

High impedance microphone lines are also susceptible to the pick-up of switching 'noise' from lamp-circuits; low impedance balanced lines such as those used for moving-coil microphones are most suitable, especially if long audio cable-runs are necessary.

3.4.5d Other Connections

Do not connect or operate flash boxes or similar pyrotechnic devices (or any appliance liable to absorb surges of excessive power from the mains-supply) from the Dimmer or associated load circuits. Operate such devices separately from the mains-supply, under local (not remote) control by someone near the device and with a direct view of it.

4. RACK MAINTENANCE

Circuit descriptions and Maintenance information for the modules and trigger cards are contained in a separate appendix according to the dimmers supplied with the racks.

4.1 Rack Circuit Details

Racks can be wired for either star operation (Fig. 4.1.1 Page No. 19) or for Delta operation (Fig. 4.1.2 Page No. 20).

4.1.1 Star Connected Rack

Any module in a rack can be wired on to any phase. This is specified at the time of manufacture. The supply for each module is taken from the appropriate busbar and sent via the module fuse to the phase connection on the module. The neutrals for the modules are linked together in columns.

The load connections to the modules go direct to the load terminal rail, as do the control connections to the modules. The technical earth connections for the modules are linked in columns.

On some installations, the technical earth/mains earth link fitted on the control terminal block, may be removed if this link is made elsewhere in the system.

4.1.2 Delta Connected Racks

These are similar to Star connected racks, except that the "returns" to the modules and loads are individually fused, and routed to the modules separately.

4.2 Check and Test Procedure

Check that the a.c. supply to the rack is switched on: note that the neon on the fuse panel indicates the presence of an a.c. supply on the control and fan (if fitted) supply. Failure of the control fuse will cause the neon to extinguish. With the fuse panel hinged open, check that the fuse holder terminals are 'live'. If a fan is fitted to the rack ensure that it is operating correctly. Air should be blown OUT through the top of the rack.

4.3 Dismantling/Replacement Information

The electrical connections are made via a pressure pad terminal block. The five wires into the module should be disconnected before attempting to remove the module. The module is secured to the rack by four nuts that screw on to studs in the rack that pass through holes in the module base plate.

4.4 Routine Maintenance

Note: Only a qualified electrician familiar with the equipment should undertake replacement or other maintenance work in the racks.

Always switch off the supply to the rack before undertaking any maintenance work. Remember that the thyristor heatsinks are at mains potential and take suitable precautions when testing and measuring with the supply switched on.

The racks require little routine maintenance apart from attention to the fan if fitted. A periodical inspection of the rack's associated wiring and connections is recommended and, in very dust prone environments, inspect the rack interior for any accumulation of dust; use a soft brush and a vacuum cleaner to remove any accumulated dust.

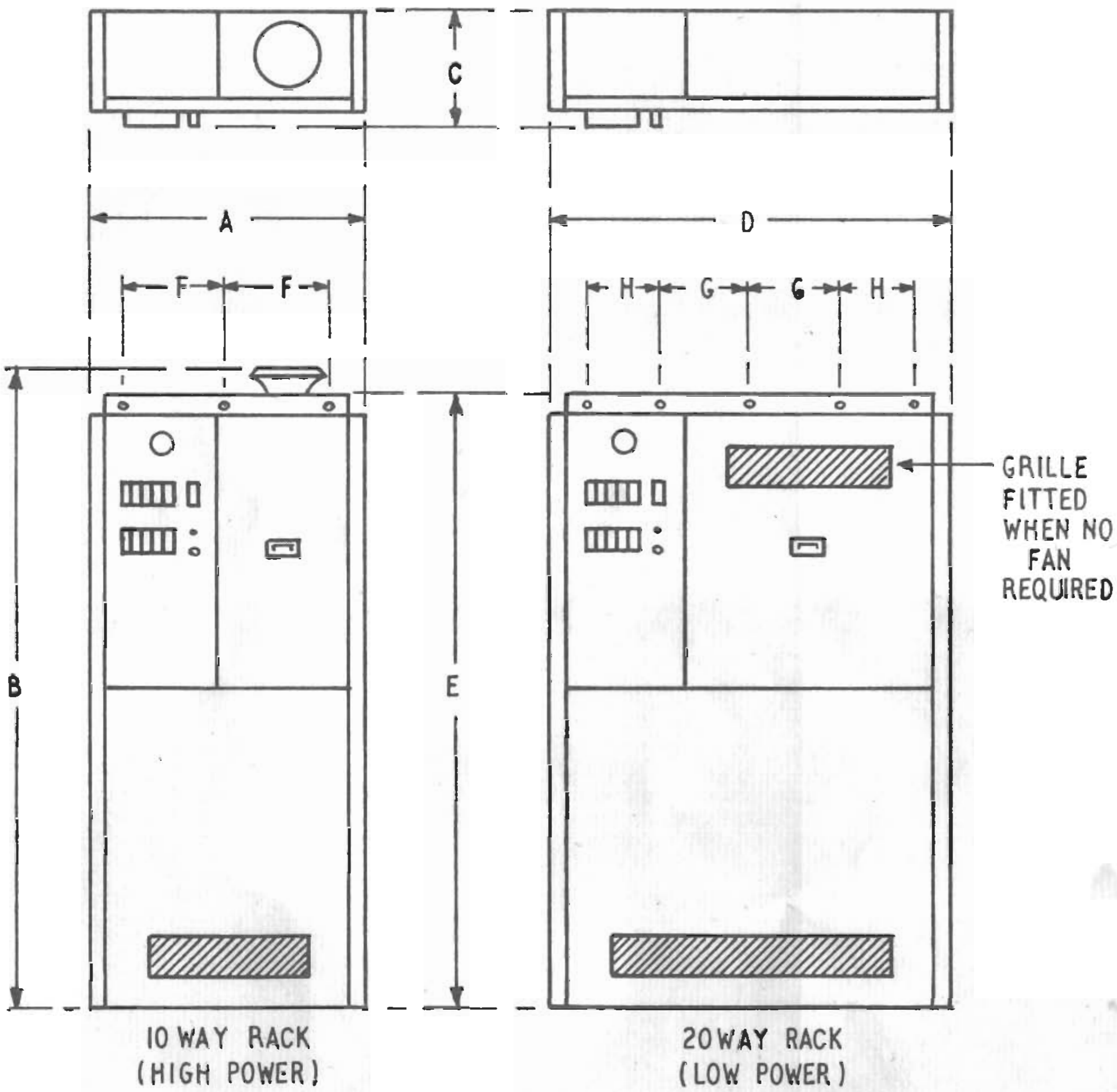
4.5 Fans

The fan manufacturers advise that the fans used have sealed lubrication for the bearings and this is normally adequate for 10,000 hrs operating time. Contact the Rank Strand Service department at the end of this period for bearing replacement.

4.6 Fault Diagnosis

Failure of a.c. supply to associated Desk and Indicator neon (and fan if fitted): Check 'Control' fuse.
Complete failure of power to a module: Check the module fuse in the fuse panel.

No output from a dimmer module but power supplied to module: Replace the dimmer module as a complete unit. Set up the new module as described in the appropriate appendix of the handbook.



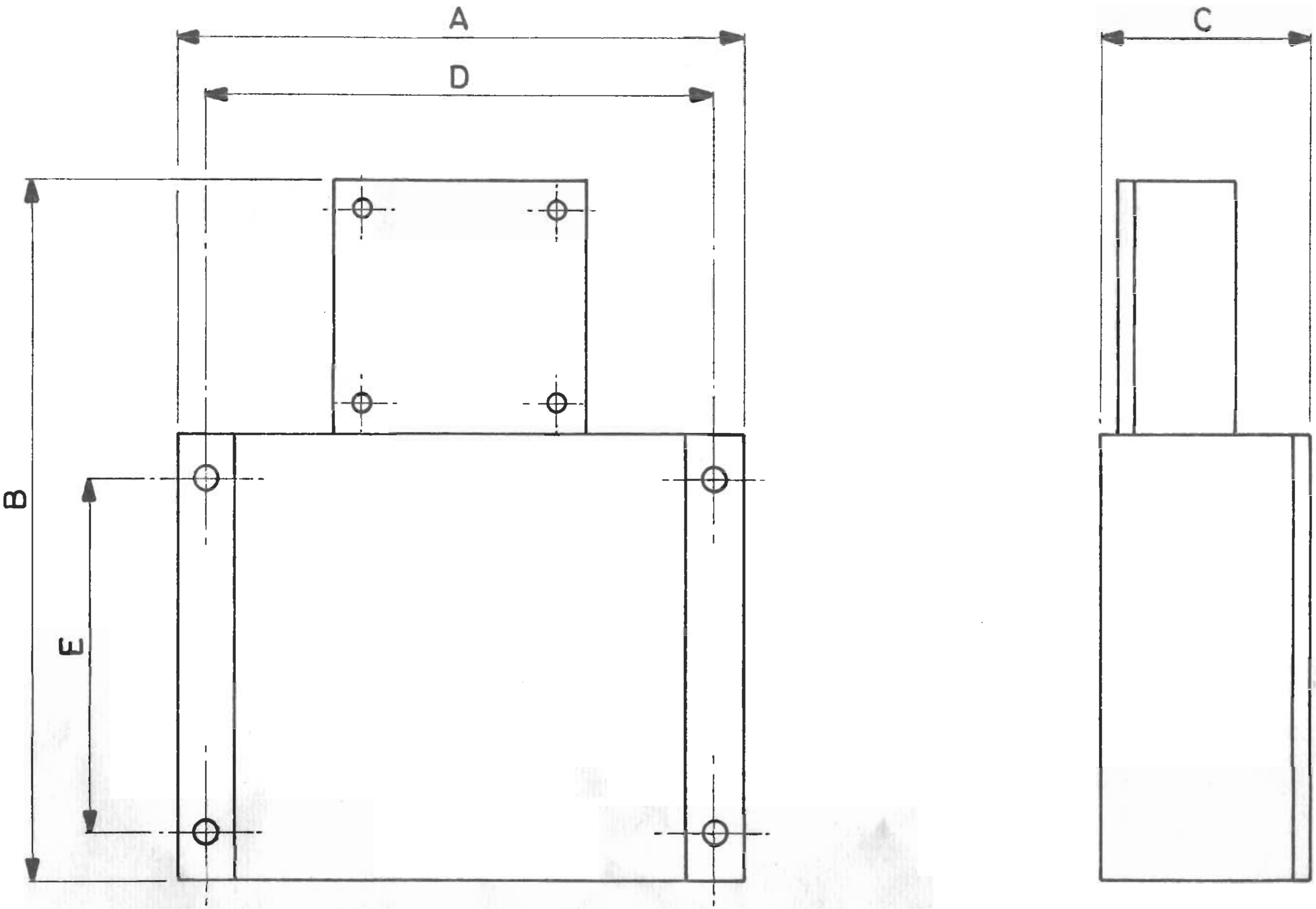
OVERALL DIMENSIONS

A = 660 mm (26")
B = 1570 mm (61·75")
C = 280 mm (11")
D = 965 mm (38")
E = 1475 mm (58")

FIXING DIMENSIONS

F = 267 mm (10·5")
G = 241 mm (9·5")
H = 178 mm (7")

Fig. 2.1



OVERALL DIMENSIONS A = 197 mm (7.75")
B = 242 mm (9.5")
C = 73 mm (2.87")

FIXING DIMENSIONS D = 178 mm (7")
E = 122 mm (5")

R.F. SUPPRESSOR UNIT REF 855

Fig. 2.2

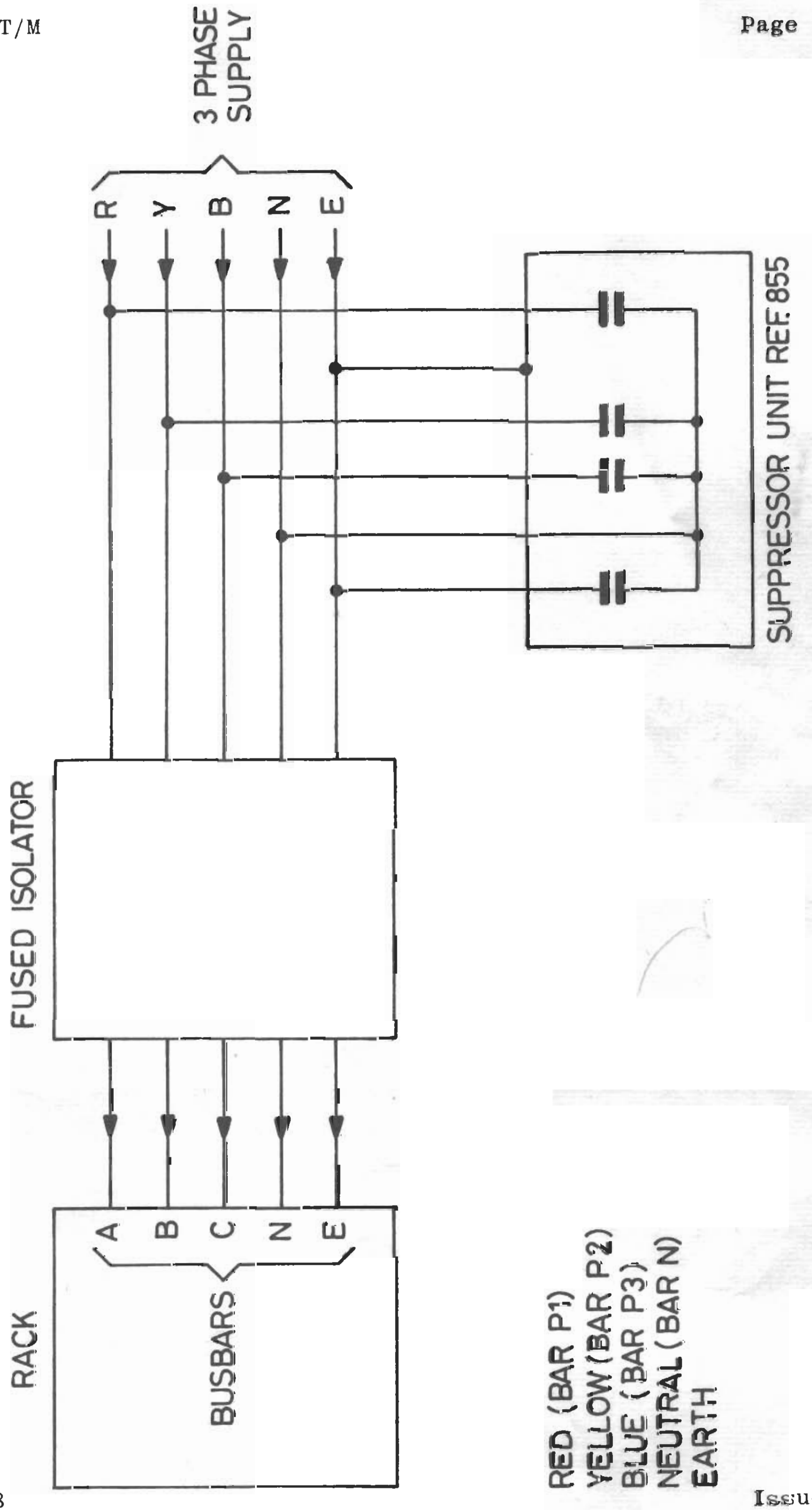

3 PHASE SUPPLY
R
Y
B
N
E
SUPPRESSOR UNIT REF. 855
FUSED ISOLATOR
RACK
BUSBARS
A
B
C
N
E
RED (BAR P1)
YELLOW (BAR P2)
BLUE (BAR P3)
NEUTRAL (BAR N)
EARTH

Fig. 3.4

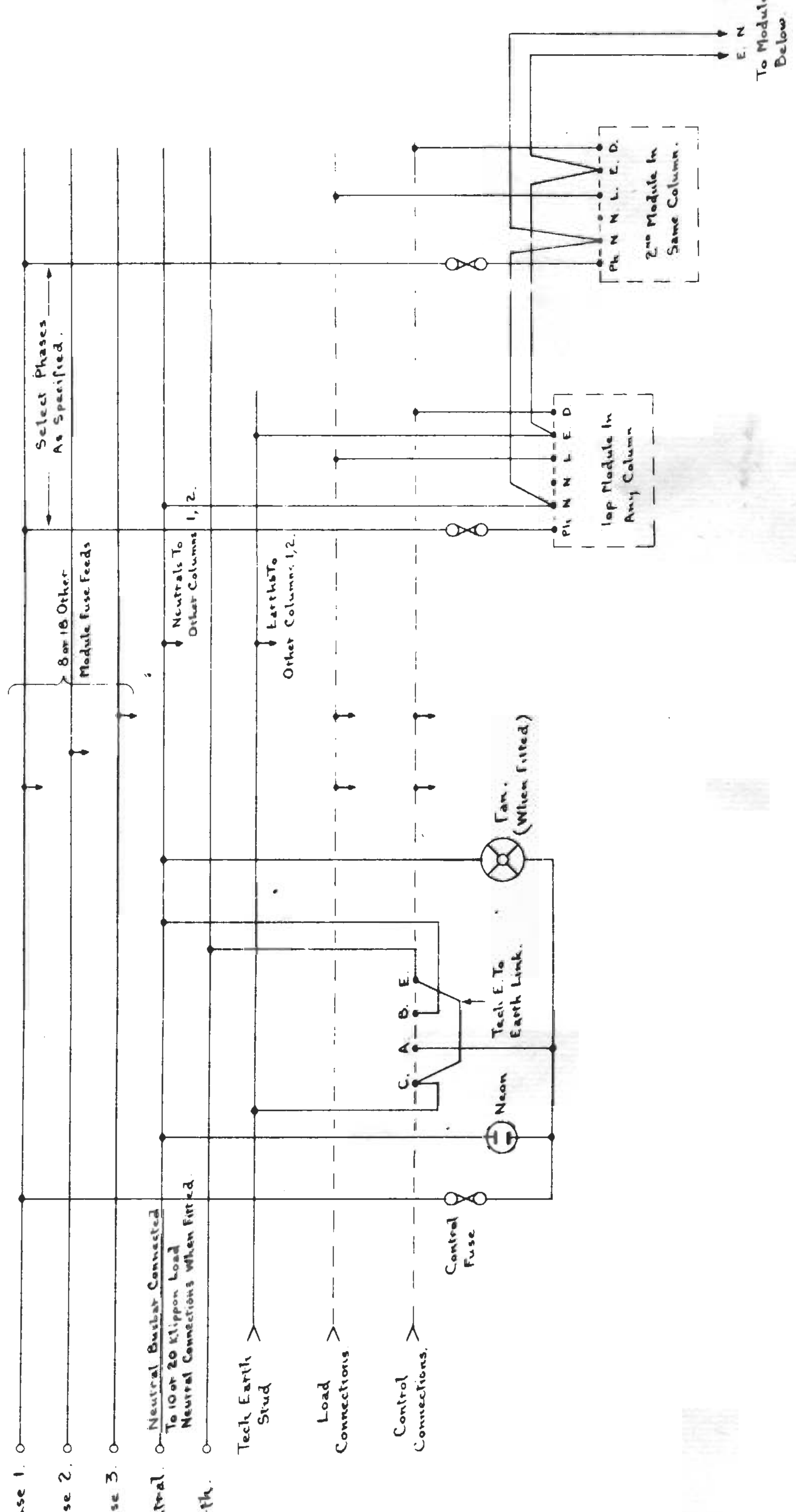

Phase 1.
Phase 2.
Phase 3.
Neutral
Earth.
Neutral Busbar Connected
To 10 or 20 Klippon Load
Neutral Connections When Fitted.
Tech Earth Stud
Load Connections
Control Connections.
Control Fuse
Neon
Fan. (When Fitted)
C.
A
B.
E.
Tech. E. To Earth Link.
8 or 18 Other Module Fuse Feeds
Neutrals To Other Columns 1, 2.
Earths To Other Columns 1, 2.
Select Phases As Specified.
Ph N N L E D
Top Module In Any Column
Ph N N L E D.
2nd Module In Same Column.
E. N
To Module Below

Fig. 4.1.1

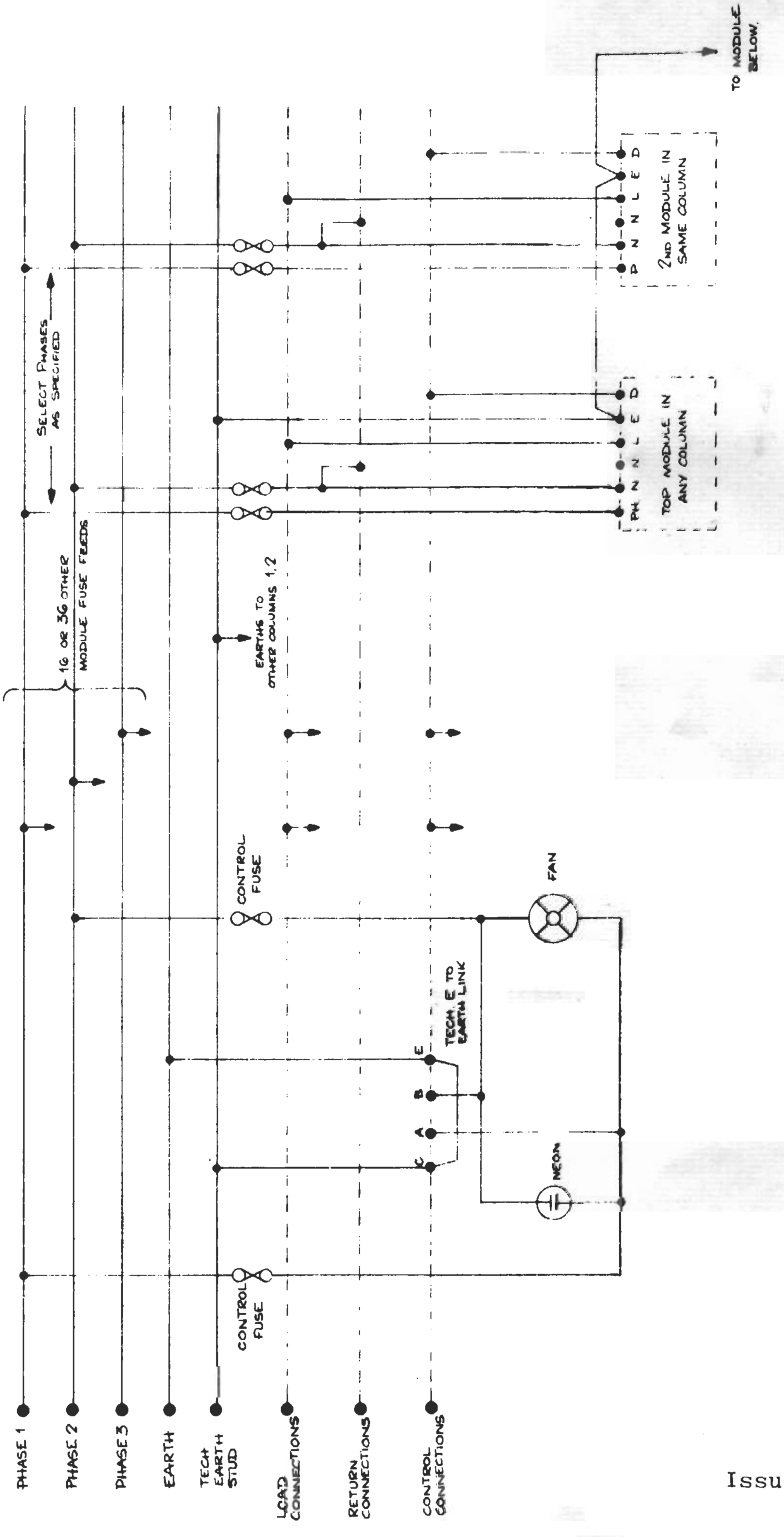

TO MODULE BELOW.
2ND MODULE IN SAME COLUMN
P N N L E D
TOP MODULE IN ANY COLUMN
PH N N L E D
SELECT PHASES AS SPECIFIED
16 OR 36 OTHER MODULE FUSE FEEDS
EARTHS TO OTHER COLUMNS 1,2
CONTROL FUSE
FAN
TECH. E TO EARTH LINK
E
B
A
C
NEON
CONTROL FUSE
PHASE 1
PHASE 2
PHASE 3
EARTH
TECH EARTH STUD
LOAD CONNECTIONS
RETURN CONNECTIONS
CONTROL CONNECTIONS

Fig. 4.1.2

APPENDIX 'A' STM OPEN LOOP MODULES MAINTENANCE

A.1 Module Size

STM 20
STM 25C
STM 50C

A.2 Circuit Description Fig. A.2 (Page No. 25)

A.2.1 Principle of Operation

An inverse-parallel connected pair of thyristors SCR1 and SCR2 are supplied with firing pulses from the trigger card such that each thyristor is switched on at the same relative instant during the appropriate half cycle of the mains. The value of the control signal into the trigger card determines the firing instant, hence determining the RMS output voltage presented to the load.

A.2.2 Circuit Description

The control signal to the dimmer is applied via terminals D and E on the module terminal block to connections 3 and 5 on the trigger card. The control signal is normally derived from a 10v source, via one diode and a 10k ohm resistor. This may vary with some older control systems.

Terminal D is negative with respect to E (technical earth). Full output of the dimmer occurs when D is fully negative.

Firing pulses to the thyristor gates are supplied via pairs of connections 11/12 and 14/16 on the trigger card.

The inductor L1 is used to extend the current risetime of the dimmer output when the thyristors switch on. The inductor combined with capacitor C1 and the Ref. 855 suppressor unit (fitted external to the dimmer rack) serves to reduce any audio and radio frequency interference generated by the switching on of the thyristors.

A.3 Dismantling/Replacement Information

A.3.1 Modules

The electrical connections to a module are made via pressure pad terminal block mounted on the module. The five wires into the module should be disconnected before attempting to remove the module.

The module is secured to the rack by four nuts that screw on to studs mounted in the rack. These pass through holes in the module base plate.

A.3.2 Thyristors

Do not attempt to remove the heatsinks from the module base plate as these are riveted in position and sealed for electrical isolation on the underside of the base-plate

Unsolder the thyristor gate connection at the trigger card, and disconnect the thyristor cathode from the opposite heatsink. Remove the thyristor from the heat-sink.

When replacing a thyristor make sure that the replacement is the correct one for the module.

Table A.3.2 (Page No. 26) gives the correct thyristor types with their specified mounting torque. Do not over tighten new thyristors onto the heatsink. If possible use a heatsink compound or silicone grease to increase thermal conduction.

A.3.3 Trigger Card

If these are wired in, they are either secured to the top of the heatsinks by four nylon press fit studs, or four insulated pillars depending on the type of trigger card.

A.4 Check and Test Procedure

Note: The thyristor heatsinks on the dimmer module are at mains potential.

The module should be fed with a control signal provided by the circuit in Fig. A.4 (Page No. 27) and have a load of 150W or greater.

A.4.1 Check the output of T1, this should be in the region of 12V a.c., and can easily be measured on connections 7 and 9 of the trigger card.

A.4.2 Check that a control signal is presented to the trigger card on connections 3 and 5 when the fader lever is "up". And that it varies as the fader level varies.

A.4.3 Check that the load waveform and voltage of the dimmer varies as the fader level changes. See Fig. A.4.3 (Page No. 28) for the correct output waveform.

A.4.4 Check that a train of pulses, of approximately 15v amplitude, is applied to the thyristor gates when the fader is on. The length of the train should vary as the fader level varies. See Fig. A.4.3 (Page No. 28).

A.5 Fault Diagnosis

A.5.1 Failure to get Full Output from a Module

Check the output waveform. If it is like Fig. A.5.1 (Page No. 29) then check that the gate pulses to the appropriate thyristor are present. If they are, change the thyristor, if not check the trigger card.

A.5.2 Failure to get Zero Output from a Module

Check the output waveform. If it is like Fig. A.5.2 (Page No. 30) then check the gate pulses. If the pulses are correct change the thyristor that is conducting all the time, if not, check the trigger card.

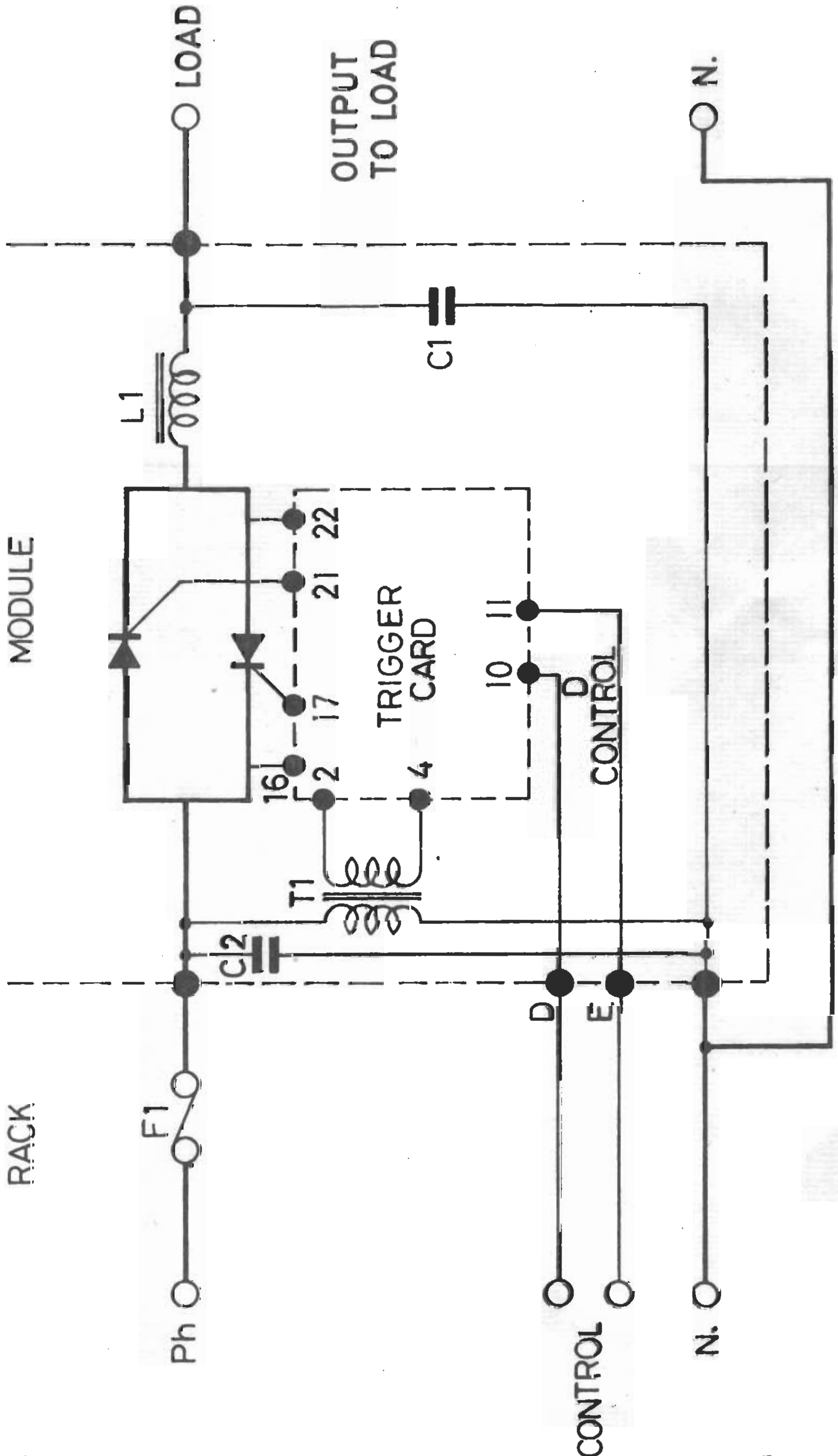

LOAD
OUTPUT TO LOAD
N.
C1
L1
MODULE
TRIGGER CARD
22
21
17
16
2
4
11
10
D
CONTROL
T1
C2
D
E
RACK
F1
Ph
CONTROL
N.

Fig. A2

OPEN LOOP MODULE THYRISTORS

MODULE	WESTING HOUSE	A.E.I.	MULLARD	RANK STRAND
S T M 20	U1210/B5	RS 2/5	BTW 92-600RSA	161/B024
			BTW 40-600RSA	
S T M 25C	U1210/B5	RS 2/5	BTW 92-600RSA	161/B029
			BTW 40-600RSA	
S T M 50C	U1288/B5	RS 5/5	BTW 24-600RSA	161/B033
X T M 2.5		RS12/5	BTW 92-600RSA	161/B037
X T M 5	U1342/B5	RS13/5	BTW 24-600RSA	161/B038

TIGHTENING TORQUE ALL DEVICES 4·0 LB. FT.

TABLE A 3.2

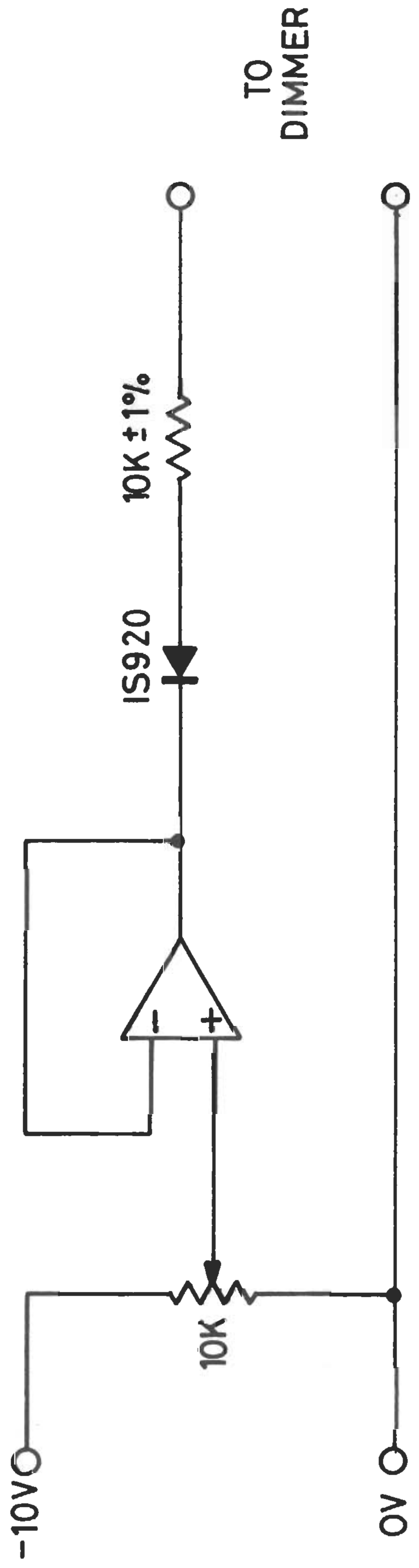


Fig. A 4

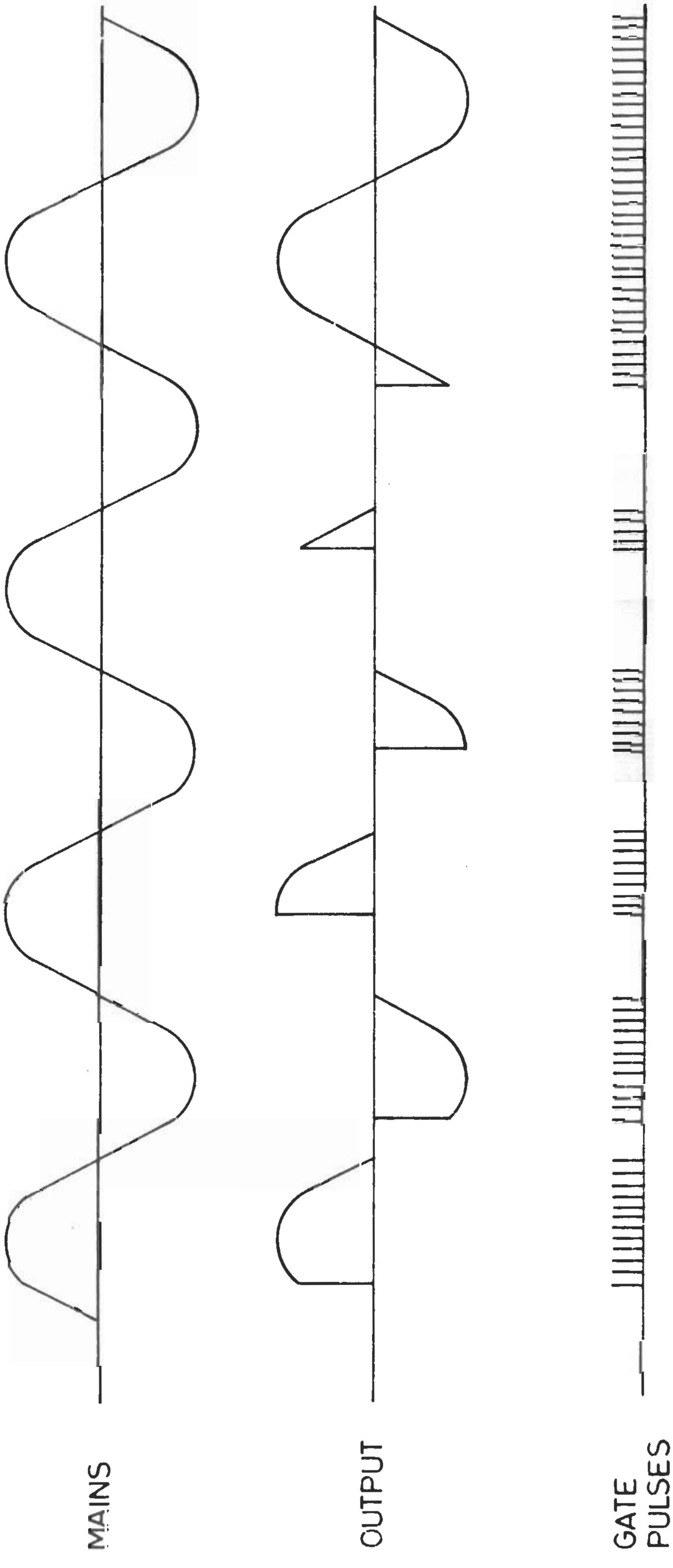


Fig. A 4.3

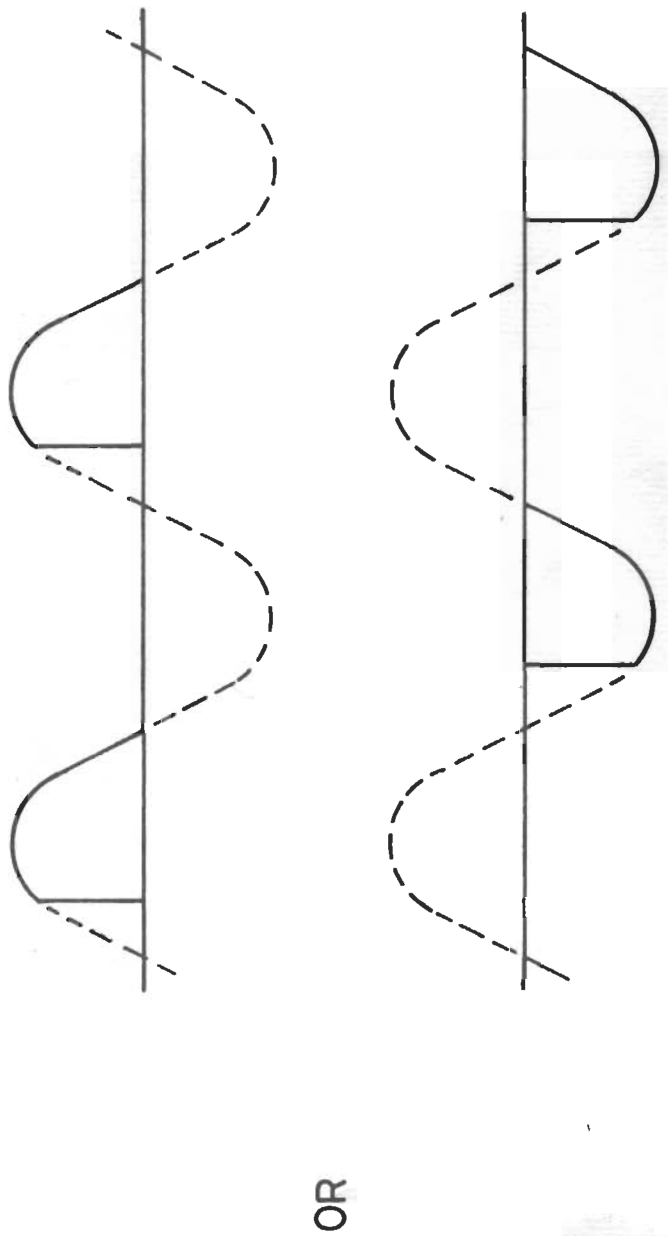
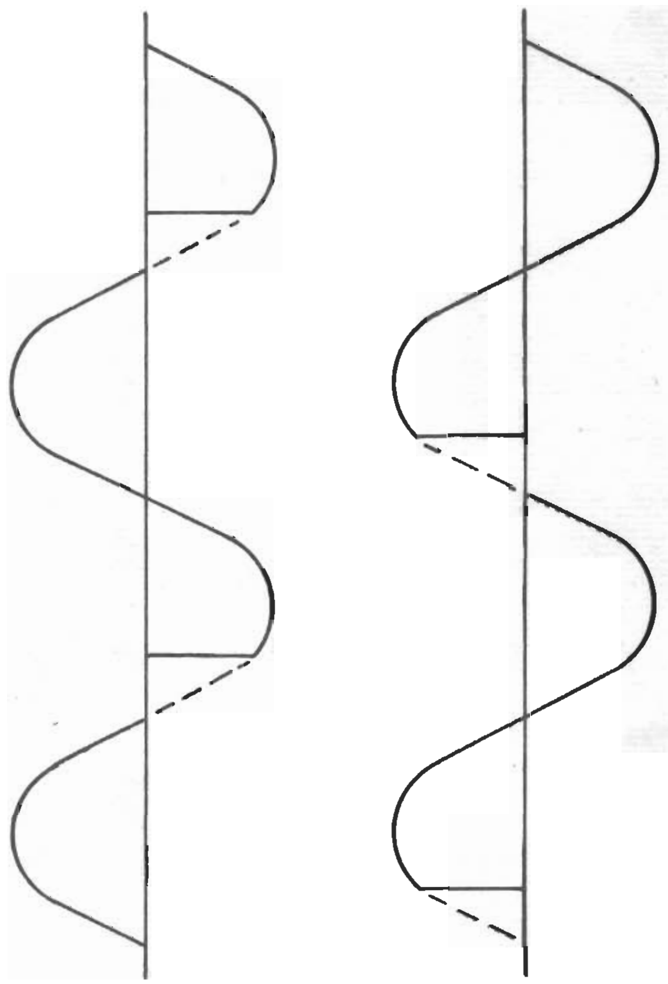


Fig. A 5.1.

Fig. A5 2



OR

'S' - LAW TRIGGER CARD

C.1. This circuit description covers the following dimmer trigger-cards:-

Ref.	1105	Standard	JTM/STM
Ref.	1101	Plug-in	JTM/STM/PTM
Ref.	1181	XTM	

The component numbers refer to Fig. C.2. at the end of this section.

C.2. CIRCUIT DESCRIPTION (Refer to Fig. C.2.)

In this section, unless otherwise stated voltages are with respect to the negative end of C1 on the trigger card.

The transformer feed to the bridge rectifier MR1-4 (normal 14 volts RMS) is rectified and charges C1 via MR5 on voltage peaks. The anode of MR5 displays a full wave rectified waveform, and the cathode a smoothed waveform, which supplies the blocking oscillator circuit VT6 and 7, the zero pulse generator VT1, and the stabilized supply for the rest of the circuitry, provided by two zener diodes MR7 and 8 and R4. The stabilized supply is further smoothed by C2.

R1 provides an I (CB) leakage current shunt path, ensuring VT1 switches off when the transformer voltage approaches zero. The base current of VT1 via R2 is normally more than adequate to fully support its collector current, except when the transformer voltage approaches zero. This corresponds to the mains crossover point. For a certain period either side of this point, VT1 is switched off allowing base current to flow in VT2 via R3 and MR6. This discharges capacitor C3 within a few millivolts of the emitter potential of VT2 (nominal +5 volts). R6 limits the peak discharge current in VT2.

MR6 prevents reverse breakdown in the base emitter junction of VT2. The total discharge time is approximately 500μS.

During the remainder of each half cycle, VT2 is cut off, and C3 charges from the +10 volt supply via R5. The waveform on the (VT3) end of C3 is a ramp repetitive at twice the mains supply frequency (10 mS), sweeping between +5 and approximately +8v. The ramp is applied to the base of VT3.

R9, R10 and RV1 form a potential divider between the +5 and the +10 volt supplies. By adjusting RV1, the potential of the base of VT4 can be made the same as that of VT3 at the top of the ramp, and adjusted to compensate for any differences in the V(be) voltages of VT3 and VT4. The dimmer control voltage is applied across RV2 via R18, so that a proportion of it can be added to the offset voltage set on RV1. Its sense is arranged so that as the control voltage is increased negatively with respect to Tech. Earth, the base voltage of VT4 decreases from its normal setting (approximately +8v) towards the +5 volt rail.

When the VT4 base voltage is more positive than the ramp, the base current in VT3 is very low, thus not appreciably modifying the ramp shape. In this condition VT4 is conducting, and VT3 cut off. When the ramp exceeds the VT4 base voltage, VT3 switches on, and VT4 off. A balanced pair of transistors is used in order to aid temperature stability. The common tail resistor R7 provides the current switching action between the transistors. R8 provides an I (CB) leakage current path for VT5. C5 ensures that on switch-on, no spurious trigger pulses are produced, and C4 provides some noise immunity on the input signal in conjunction with R18. Therefore, before the trigger point (each half cycle), VT4 is conducting and VT3 cut off, and vice versa after the trigger point. Thus, before the trigger point, VT5 is also conducting, causing VT6 to conduct (via R11 and R12). This inhibits any blocking oscillator action.

When the trigger point is reached, VT4, 5 and 6 switch off, causing C6 to charge via R13, the base winding of the blocking oscillator transformer and R14. When the voltage on the base of VT7 exceeds approximately 1.2 volts, it starts to turn on. This action is regenerative to the positive feedback applied to the base circuit via the transformer. The nett effect is to cause VT7 to turn on very quickly, producing a positive trigger output. The transformer primary inductance is such that the current now rises slowly in the collector circuit (approximately 50mA/100µS), with a standing collector current of approximately 750 mA. Base current flows around the circuit C6, R14, the transformer base winding, the b-e junction of VT7, and MR11 due to the voltage induced in the transformer base winding.

This current decreases as C6 charges, until it is no longer adequate to support the collector current. This occurs after approximately 40µS. The transistor then switches off, using a similar regenerative action as was used during switch on, terminating the trigger pulse. The base of VT7 then swings negative of the supply rail, due to the change on C6, which slowly discharges via R14 and R13, until the base voltage is once again high enough to switch on VT7, when the cycle repeats itself. This occurs approximately once every 1 mS, until the end of the mains half cycle when VT6 conducts, and removes any base current, inhibiting the oscillator action. MR10 prevents VT6 going into reverse transistor action and thus modifying the oscillator period.

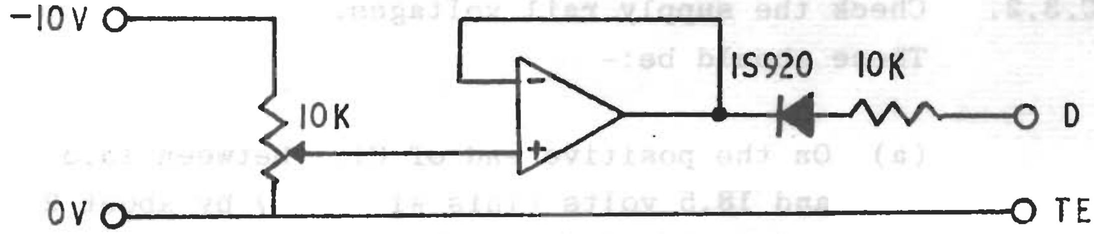
MR9 prevents reverse voltage transients on the transformer primary, and also prevents the thyristor gates becoming excessively reverse biased.

MR11 biased by R17, limits the current due to reverse breakdown in the base-emitter junction of VT17, and also increases the starting threshold, enabling MR10 to be included in the collector circuit of VT6.

R15, 16, limit the maximum gate current in the thyristors. On some version of the card, a power output is available, connected to the negative end of C1, to drive one fader lever. When this is used the dimmer must be set up to suit the particular fader used, as the current in the fader alters the setting required on RV1 and RV2.

C.3. TEST PROCEDURE

The trigger card should be tested in a module, or test rig using the same circuit, with the control input fed from the following circuit.



The module should be loaded to 1KW.

Equipment needed:-

Oscilloscope

Multimeter, sensitivity greater than 10,000 ohm/V

Dynamometer type voltmeter

All voltages and waveforms are measured with respect to the negative end of C1, unless otherwise stated. Most waveforms can be observed with the oscilloscope displaying a 20mS time interval across its screen, synchronized to the mains waveform.

C.3.1 View the waveform on the collector of VT7. This should be a series of pulses, that start at a particular point each half cycle determined by the fader setting, and finish at the end of each half cycle.

(a) With the fader at zero, adjust RV1 to display trigger pulses, and then turn it back until the pulses just vanish.

(b) With the fader set at full, adjust RV2 to give a conduction time of 7.5mS each half cycle, i.e. so that pulses occupy 7.5 of the 10mS half cycle length.

(c) Move the fader evenly from full to out. The leading pulse should move smoothly across the screen, the number of pulses decreasing as it does, until all pulses disappear at position zero.

C.3.2. Check the supply rail voltages. These should be:-

(a) On the positive end of C1: Between 13.5 and 18.5 volts (This will vary by about 2 volts with fader position).

(b) On the positive end of MR7: 10.2 volts ± 10%

(c) On the positive end of MR8: 5.1 volts ± 10%

C.3.3. Check the ripple on the supply rails. The ripple should always be full wave (i.e. repetitive every 10mS) and will also show spikes due to the oscillator.

(a) On the end of C1: Less than 2 volts p-p

(b) On the end of MR7: Less than 100mV p-p

(c) On the end of MR8: Less than 100mV p-p

C.3.4. Check the waveform on the collector of VT7. The oscillator should give a pulse width of approximately 40μS and a pulse separation of approximately 800μS, though these values may well vary by over 50%. Their ratio should be approximately 1 : 20.

C.3.5. If all these tests are satisfactory, the dimmer can set up as in Section C.4. Otherwise, the waveform notes in Section 5 should help locate any faults.

C.4. SETTING UP PROCEDURE

C.4.1. Connect the dynamometer across the mains. If it reads 240 to 245 volts, the following need not be compensated. Otherwise, compensate the voltage readings given to be proportional to the mains voltage (e.g. 10% mains change, compensate the output voltage at fader position 5 by 10%). Before setting any dimmer up, ensure that no Test Instruments (e.g. oscilloscopes, voltmeters) are connected to the trigger card. A 1kw lamp should be used to load the dimmer.

C.4.2. Connect the Dynamometer across the dimmer output.

C.4.3. MANUAL CONTROL SYSTEMS AND IDM manual wing. Adjust RV1 with the fader lever at '1' to give a load voltage of 10 volts RMS. Adjust RV2 with the fader lever at '5' to give a load voltage of 152 volts RMS.

Check both settings, and, re-adjust if necessary. With the lever at full, check that the dimmer output is within 10 volts of the mains voltage. This must be measured by measuring the mains voltage and the load voltage, and not by measuring the voltage directly across the dimmer.

C.4.4. SYSTEM MSR/MMS/AMC

Proceed as above, but set to 160 volts at lever position 5.

C.4.5. SYSTEM DDM/LIGHTBOARD

With these systems, lever positions have no relevance, so 'bit outputs' are used to define the dimmer levels. Their range is 0 (equivalent to lever position 0) to 255 (equivalent to lever position 10). The following points should be set.

Bit output	Load voltage
40	27 volts RMS
128	160 volts RMS

Both should be compensated proportionally to any mains change and re-checked and re-set until correct. See the relevant control system Operators/Maintenance Handbook for the current procedure to set up the bit levels.

C.5. WAVEFORMS - See Figs. C.2. & C.5.

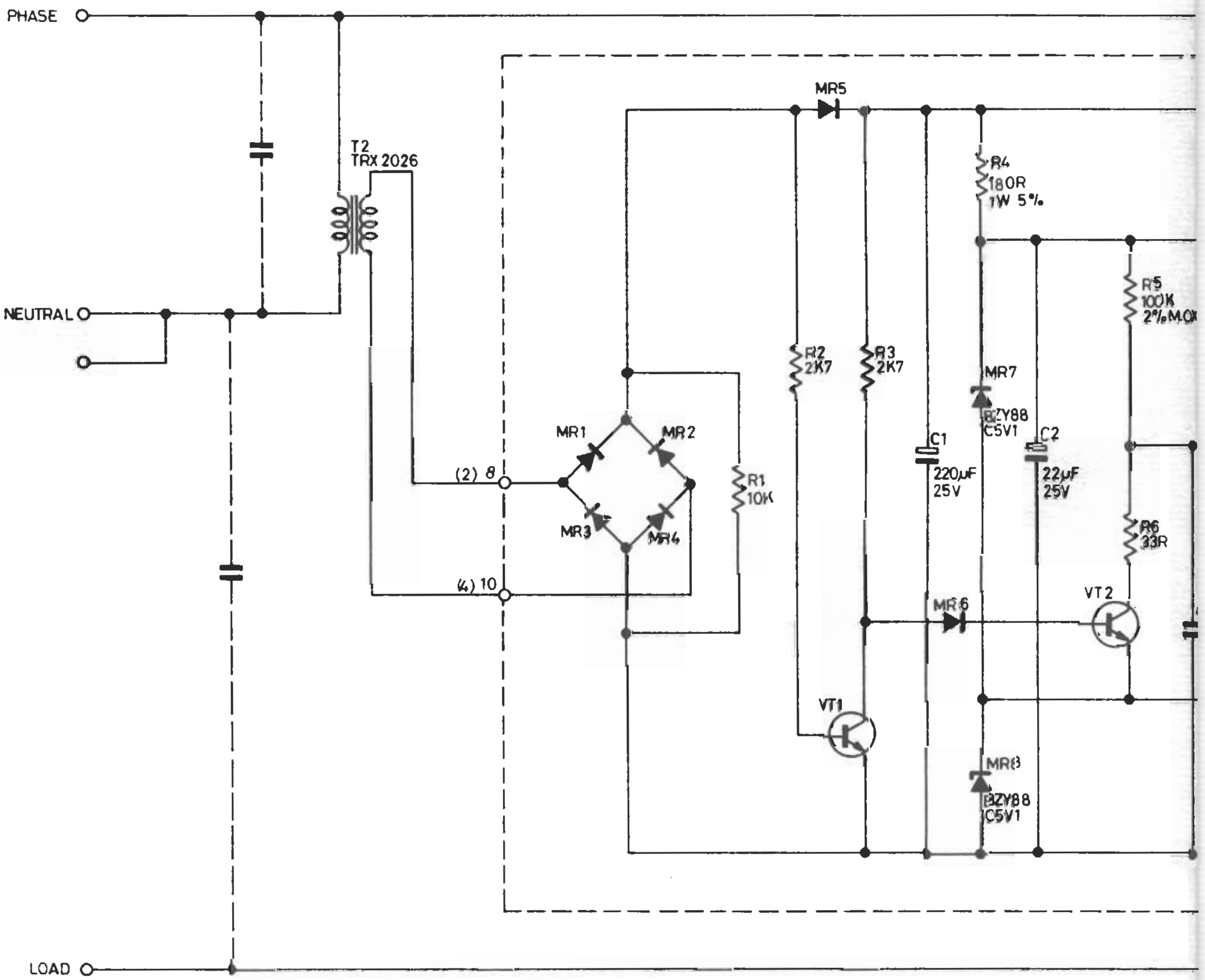
All waveforms are with respect to the negative end of C.1.

(a) Negative end of MR5: Limited full wave rectified A.C. Amplitude approximately 18 volts.

(b)	Collector of VT1:	Positive going pulses, repetition time 10mS. width between 370 and 740μS.
(c)	East of VT3:	A positive going ramp, amplitude approximately 3 volts, repetition time 10mS, starting at +5 volts.
(d)	Base of VT4:	At fader position 0, approx. +8 volts, adjustable by RV1. At other lever positions, this voltage should fall, so that at fader position 10 it can be adjusted by RV2 to approx. +5 volts.
(e)	Base of VT5:	A small amplitude switching waveform, approx. 0.6 volts from the +10 volt supply before the trigger point each half cycle and at the +10 volt supply while the blocking oscillator is running.
(f)	Collector of VT5:	The same switching waveform, but inverted and amplified to switch between +10 volts and 0 volts.
(g)	Base of VT7:	See drawing. (Fig. C.5.)
(h)	Collector of VT7:	Negative going pulses after trigger point amplitude approx. 15 volts, width - period as described in Section C.3.4.

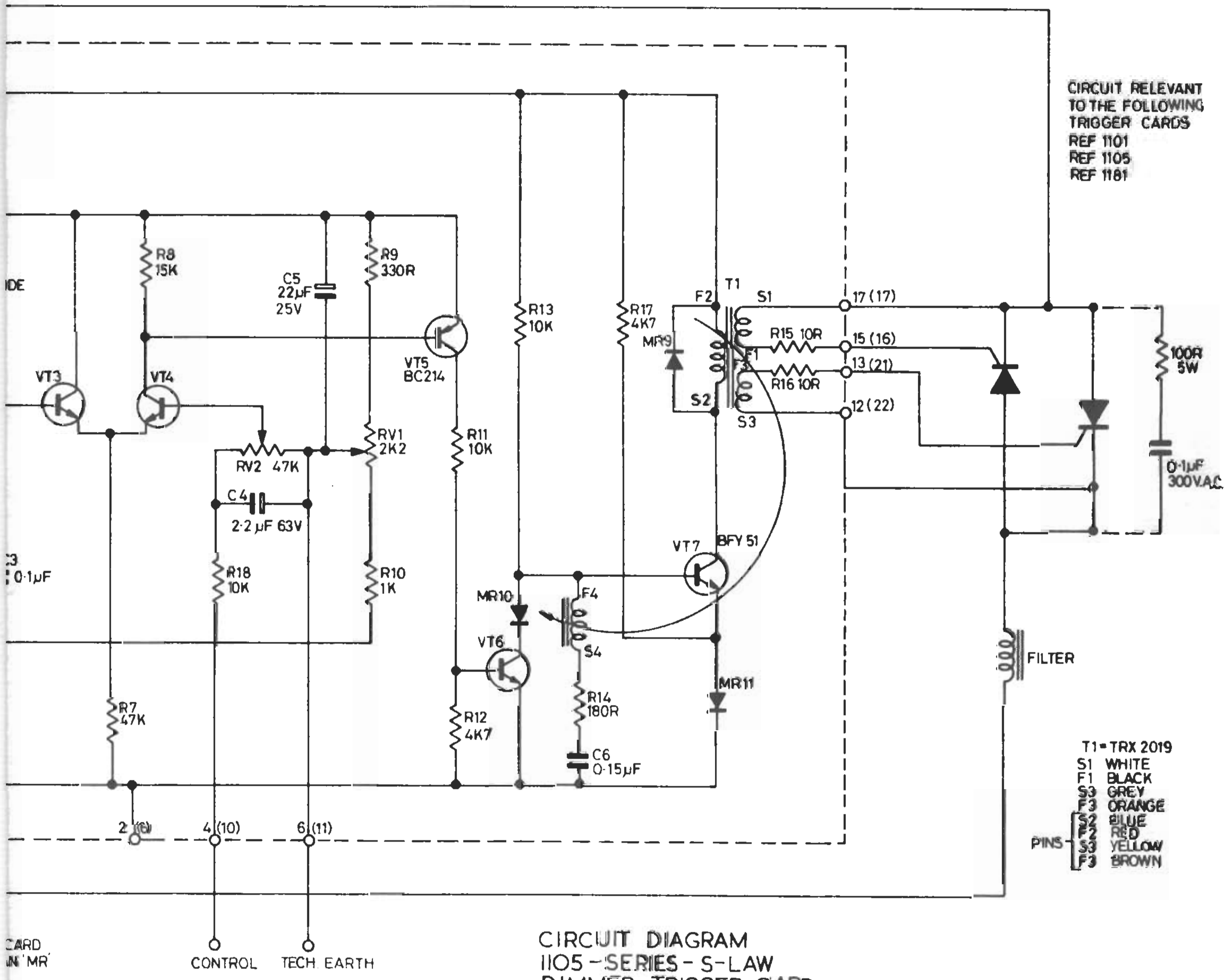
(j) Each trigger pulse output:	Positive going pulses, amplitude approximately 3 volts, between each pair of gate - cathode outputs.

Beware - The gate and cathode outputs, R5 and R6 are at Mains potential.



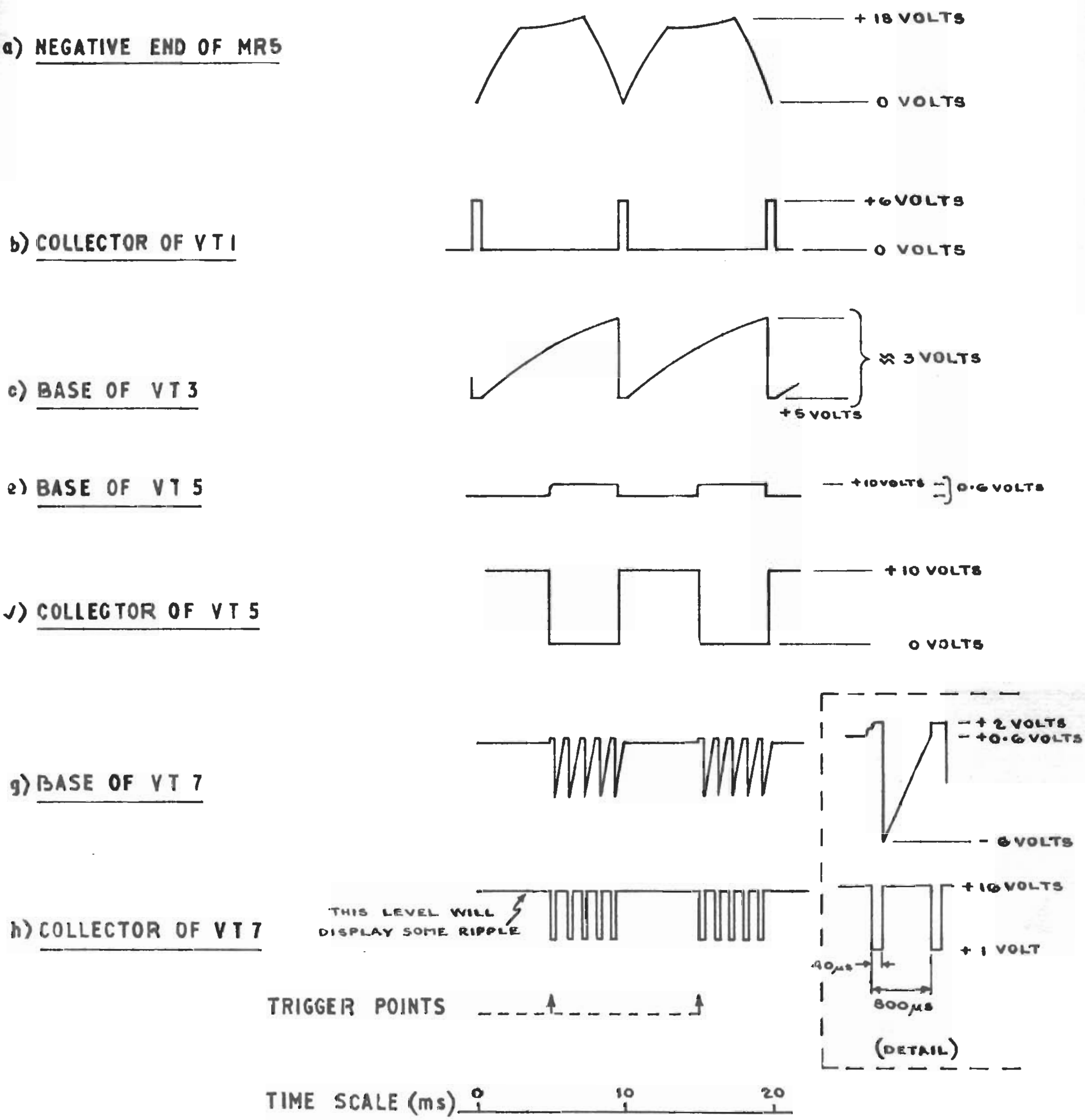
ALL TRANSISTORS ARE BC184 UNLESS OTHERWISE SPECIFIED
" DIODES ARE 1S920 " " "
RESISTORS 1/4 W ± 5% " " "

NOTE:- EXTERNAL CIRCUITRY FOR INFORMATION ONLY
PIN NUMBERS IN BRACKETS REFER TO REF 1181
DIODES MAY BE REFERED TO AS 'D' RATHER THA
ON SOME VERSIONS.



CIRCUIT DIAGRAM
1105 – SERIES – S–LAW
DIMMER TRIGGER CARD

FIG. C2



ALL VOLTAGE LEVELS ARE APPROXIMATE.
WAVEFORMS REF 1101/1105 TRIGGER CARD. DWG. Nº 6C02179

FIG. C5

Square Law Trigger Cards

D.1. This circuit description covers the following open-loop square law dimmer trigger cards:

Ref. 1114 - TM Dimmers
Ref. 1115 - JTM/STM Dimmers
Ref. 1116 - JTM/STM/PTM Dimmers (plug in)
Ref. 1192 - XTM Dimmers

The component numbers refer to Fig. D.2. at the end of this section.

D.2. CIRCUIT DESCRIPTION (Refer to Fig. D.2.)

The transformer feed to the bridge rectifier D1-D4 (nominal 14 volts R.M.S.) is bridge rectified and charges C1 via D5 on voltage peaks. The Anode of D5 displays a full wave rectified waveform, and the cathode a smoothed waveform, which supplies the zero-point detector VT1, the blocking oscillator and its gating transistors VT8 and VT7. The remainder of the circuit is fed from a supply sub-stabilised from this supply by R16, D13 and D14, further smoothed by C8 and C6.

R1 provides an I(CB) leakage path (via R2) to ensure that VT1 switches off when the transformer voltage approaches zero. During the major part of the mains cycle, VT1 is conducting, reverse - biassing D6 and providing no base current to VT2. For about 200μS each side of the mains crossover point (when the mains voltage crosses zero each 10mS), VT1 turns off, causing VT2 to conduct due to base current via R23 and D6. This discharges C2 via D8, C3 via D9 and C4 via D10. R24 limits the peak discharge current through VT2. R3 ensures that D8, D9 and D10 are reverse biassed when VT2 is cut off.

When VT2 switches off soon after the start of each half cycle, a ramp is generated as follows:

VT3 is connected as a constant current source, the current being determined by R5 in its emitter, and RV2/R4 in its base. D7 temperature stabilises the current produced. The current can be adjusted by varying the setting of RV2. This current is used to charge C2, producing a linear ramp until such time as the voltage on the top of C2 almost reaches the emitter voltage of VT3. This normally occurs shortly after the mid point of each half cycle, but depends upon the setting of RV2. The ramp waveform is further modified by R6/C3 and R7/C4, producing a waveform with a slowly increasing rate of rise from the zero point. The ramp is clipped by D11/R9/RV3 and the potential divider D12/R14/R15 connected across the lower half of the 5v stabilised supply. When the waveform reaches approximately 95% of the centre stabilised voltage (about 0.5v below it), it is clipped at a rate determined by the setting of RV3. D11 and D12 offset each other to improve temperature stability. The resultant waveform at the junction of R7 and C4 is an elongated "S" shape with a considerable amount of shape adjustment possible by using RV2 and RV3.

VT4 and VT5 form a long-tailed pair with R10 determining emitter current. The ramp waveform is applied to the base of VT4, and compared with a voltage level derived from the control signal. When the ramp exceeds the base voltage of VT5, VT5 switches off, removing the base drive from VT6.

The dimmer control signal is smoothed by C5 and then a proportion of it, determined by RV1 and R13 is applied to the base of VT5. Its sense is such that at zero lever position, the base of VT5 is at the same potential as the D13/D14 junction, and as the fader lever setting is increased, the base becomes more negative, until at position 10 the base voltage can be adjusted to be the same voltage as the start point of the ramp.

VT6 receives base drive from VT5 until the trigger point is reached each cycle, when the base drive is removed. This causes VT6 to cut off, removing the base drive to VT7. VT7 then cuts off, allowing the blocking oscillator to run, R11, 17 and 18 prevent I(CB) effects and limit the maximum drive into VT7.

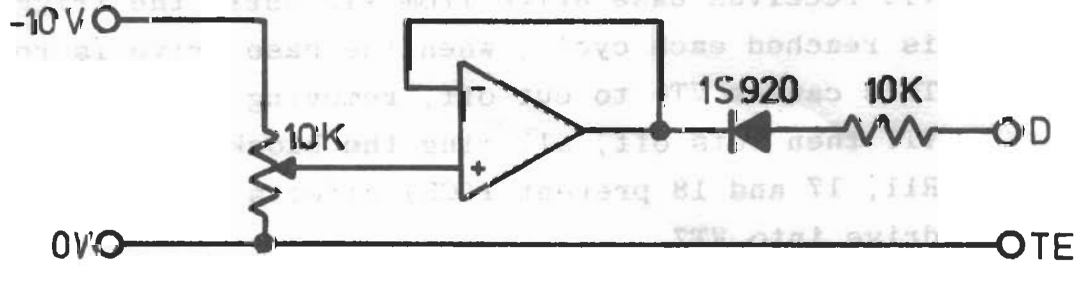
When VT7 switches off, C7 charges via R19, R20 and the base winding of T1, until the voltage on the base of VT8 is sufficient to cause it to conduct. It then switches on regeneratively due to positive feed back via T1. The regenerative voltage induced in the base winding of T1 by the transition, charges C7 via R20, D15 and the b - e junction of VT8. As C7 charges, the base current drops, until it is no longer adequate to support the collector current in VT8 (10 - 100µS after switch on). VT8 then switches off, causing the voltage on the anode of D15 to swing negative by a few volts. C7 then charges towards the positive rail until its voltage is high enough to cause VT8 to conduct again (400 - 100µS after switch off).

D15 and D17 prevent reverse transients across the base emitter junction of VT8. D16 suppresses reverse voltage transients on the collector of VT8. The gates of the two thyristors are fed from two further windings on the pulse transformer, via current limiting resistors R21 and R22.

On some versions of the card, a power output is available, connected to the negative end of C1, to drive one fader lever.

D.3. TEST PROCEDURE

The trigger card should be tested in a module, or test rig using the same circuit, with the control input fed from the following circuit:-



The module should be loaded to 1KW.

Equipment needed:-

Oscilloscope
Multimeter, sensitivity greater than 10,000/V
Dynamometer

All voltages and waveforms are measured with respect to the negative end of C1, unless otherwise stated. Most waveforms can be observed with the oscilloscope displaying a 20mS time interval across its screen, synchronized to the mains waveform.

D.3.1. View the waveform on the collector of VT8. This should be a series of pulses, that start at a particular point each half cycle determined by the fader level setting and finishes at the end of each half cycle.

a) If the trigger card is not in reasonable adjustment set all potentiometers to their centre positions.

b) With the fader level at full, adjust RV1 to give a conduction time of about 8mS.

c) With the fader level at 5, adjust RV2 to give a conduction time of 3mS.

d) With the fader lever at zero, adjust RV3 to give just zero conduction time.

e) Repeat the adjustments b - d until no further adjustment is necessary to obtain the correct settings.

D.3.2. Check the supply rail voltages. They should be:-

a) Across C1 - 13 to 20 volts.
(This will vary with fader lever position).

b) Across C8 - 8.6 to 11.4 volts.

D.3.3. Check the waveforms outlined in section 5.

D.4. <u>SETTING UP PROCEDURE</u>

D.4.1. Connect the dynamometer across the mains. If it reads 240 to 245 volts, the following need not be compensated. Otherwise, compensate the voltage readings given to be proportional to the mains voltage (e.g. 10% mains change, compensate the output voltage at fader position 5 by 10%). Before setting any dimmer up, ensure that no Test Instrument e.g. oscilloscopes, voltmeters) are connected to the trigger card. A 1KW lamp should be used to load the dimmer.

D.4.2. Connect the dynamometer across the dimmer output.

D.4.3. Adjust RV1 with the fader lever at full to give a load voltage of 6 volts below the supply voltage.

Adjust RV2 with the fader lever at '5' to give a load voltage of 160 volts (RMS).

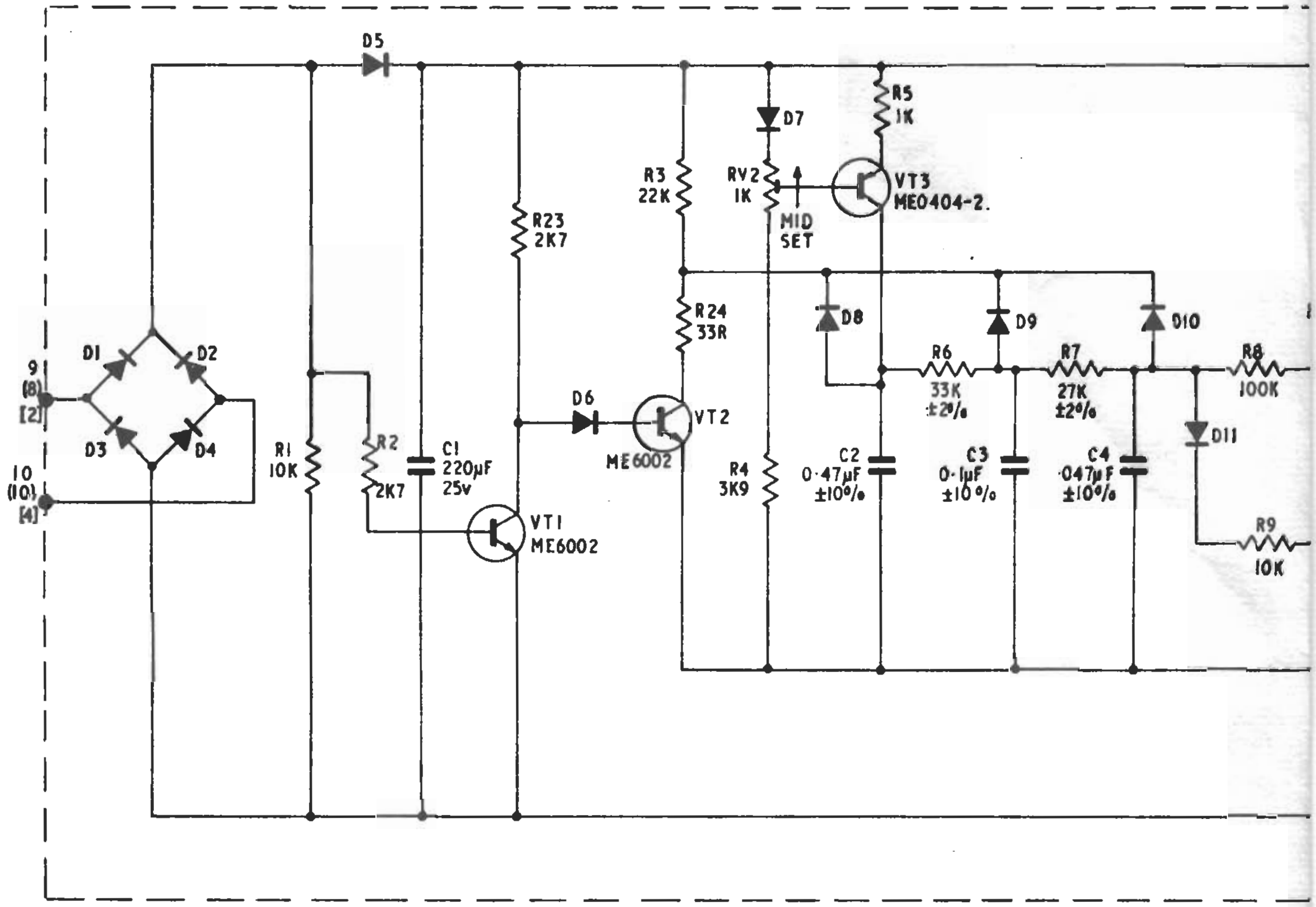
Adjust RV3 with the fader lever at zero to give an output of zero volts.

D.5. <u>WAVEFORMS</u> (See Fig. D.5.)

a)	Across R1	Limited full wave rectified A.C. amplitude approximately 18v.
b)	Collector VT1 w.r.t. emitter	Positive going pulses, repetition time 10mS width between 370 and 740 µS.
c)	Across C2	A clipped ramp, clipped at approximately 9v. Time and voltage of clipping dependent on setting of RV2.
d)	Across C3	"S" shaped ramp amplitude approximately 8 volts.
e)	Across C4	Modified "S" shaped ramp amplitude approximately 6 volts.
f)	Base VT6 w.r.t. neg. end of C1	A small amplitude switching waveform approximately 0.6 volts from the +10 volts supply before the trigger point in each half cycle, and at the ten volt supply while the blocking oscillation is running.
g)	Collector VT6 w.r.t. neg. end of C1	The same switching waveform but invented and amplified to switch between +10 and 0 volts.
h)	Collector of VT8 w.r.t. neg. end of C1.	Negative going pulses after trigger point amplitude 15 volts.

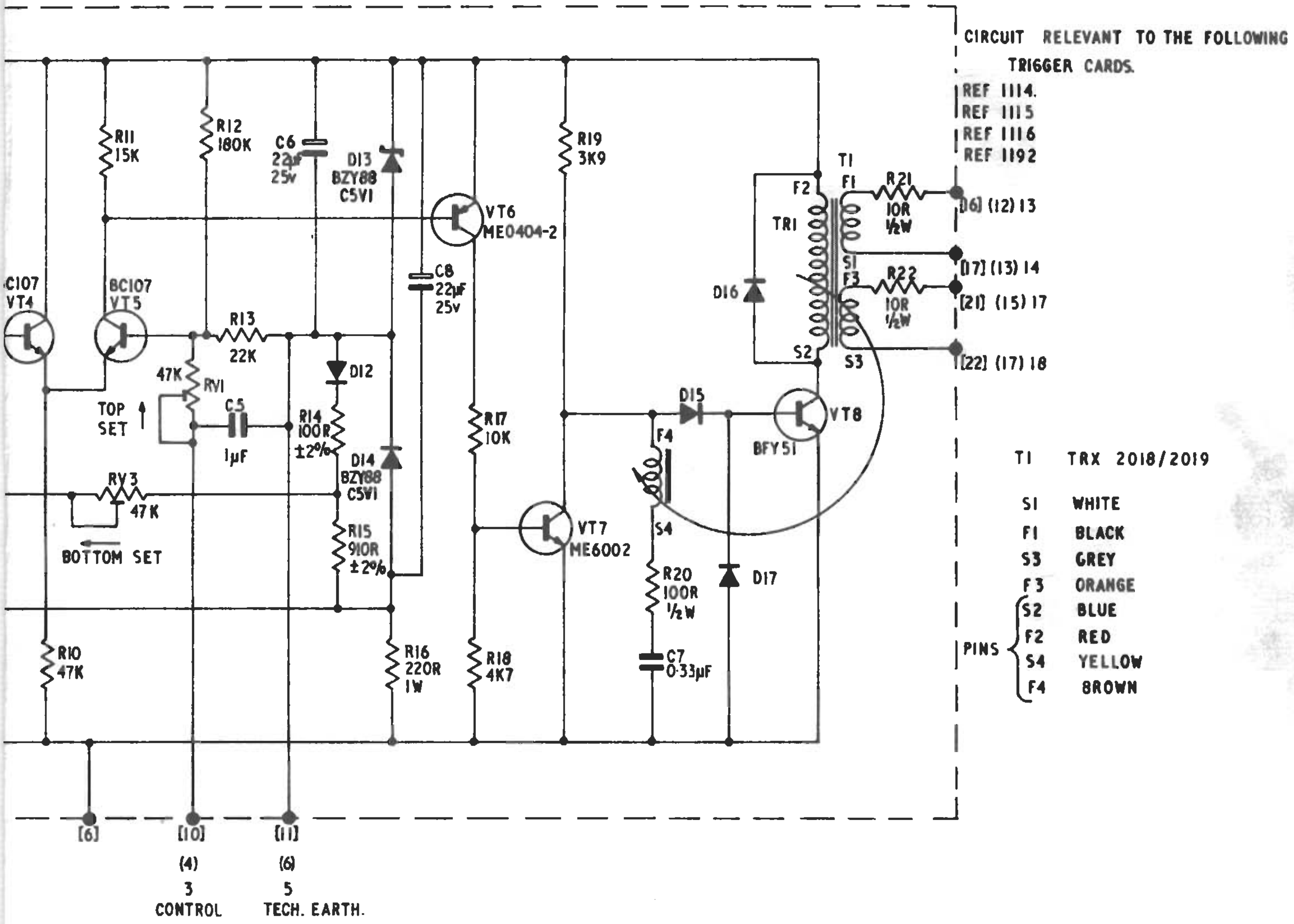
i)	Each trigger output	Pulses, amplitude approximately 3 volts between each pair of gate-cathode outputs.

<u>BEWARE</u> - The gate-cathode outputs may be at mains potential.



NOTES:
1. ALL DIODES 1S920 UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ¼W ±5% METAL OXIDE UNLESS OTHERWISE SPECIFIED
3. CONNECTIONS IN ROUND BRACKETS ARE FOR REF. 1115/1116 CARDS.
4. CONNECTIONS IN SQUARE BRACKETS ARE FOR REF. 1192 CARDS.

REF.
SQUAR



1114 -SERIES OPEN LOOP
E LAW TRIGGER CARDS.

FIG. D2

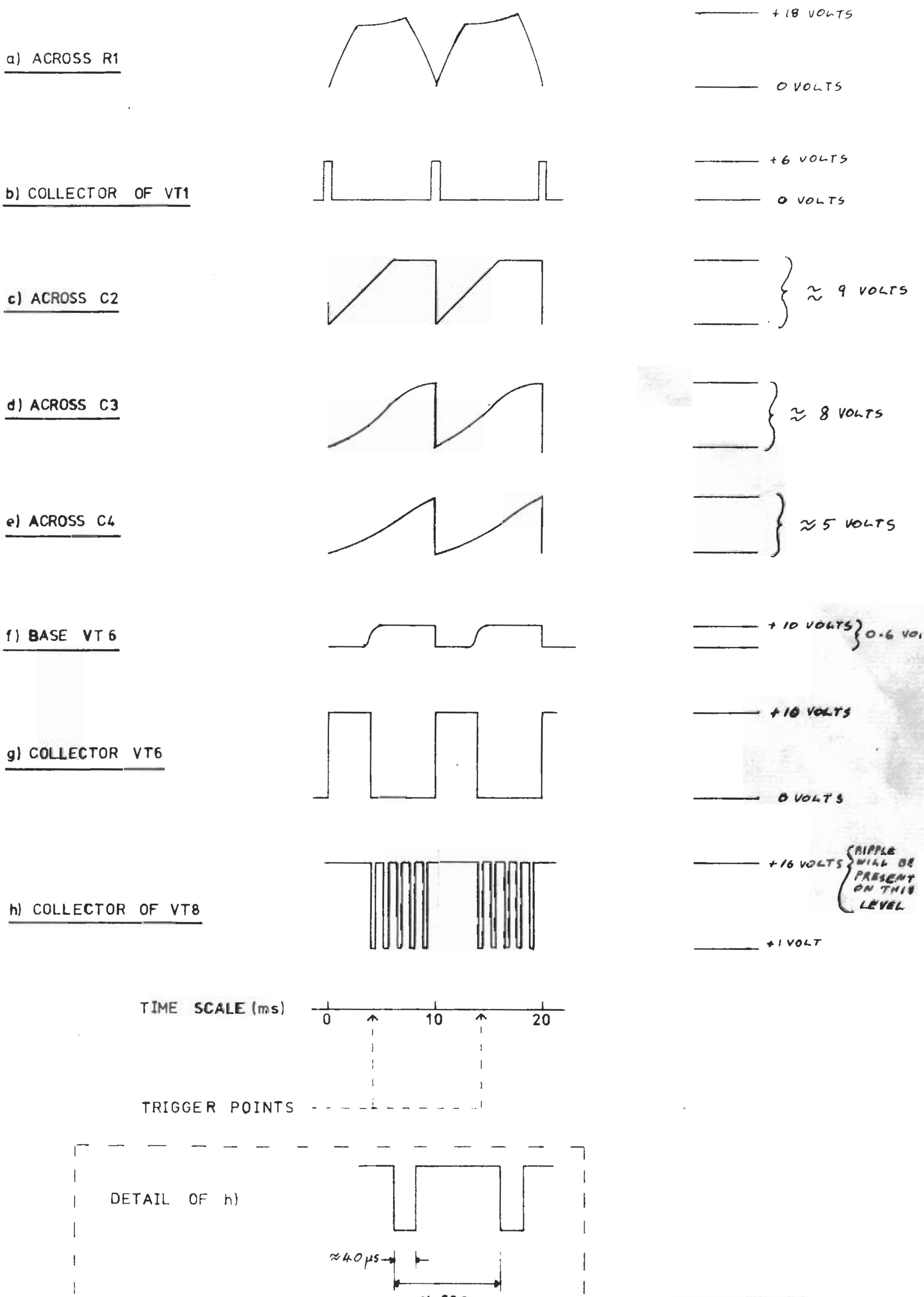

a) ACROSS R1
+ 18 VOLTS
0 VOLTS
b) COLLECTOR OF VT1
+6 VOLTS
0 VOLTS
c) ACROSS C2
≈ 9 VOLTS
d) ACROSS C3
≈ 8 VOLTS
e) ACROSS C4
≈ 5 VOLTS
f) BASE VT 6
+ 10 VOLTS
0.6 VOL
g) COLLECTOR VT6
+10 VOLTS
0 VOLTS
h) COLLECTOR OF VT8
+16 VOLTS
RIPPLE WILL BE PRESENT ON THIS LEVEL
+1 VOLT
TIME SCALE (ms)
0
10
20
TRIGGER POINTS
DETAIL OF h)
≈40 μs
≈ 800 μs

Fig. D 5.

SCOPE

This handbook contains information normally required for installation commissioning and maintenance of Rank Strand STM Dimmers and their associated racks.

SERVICE ASSISTANCE

For assistance with servicing or maintenance, please contact the nearest branch, agent or associate company (see list at the end of this handbook) and state the Order Reference, Equipment Reference or other relevant information as well as an indication of all fault-symptoms encountered. Refer to the current Rank Strand Electric spares price list for details of spare parts and fuse links available for this equipment.