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Plug-in Professional

THYRISTOR DIMMERS

MAINTENANCE HANDBOOK

Strand Lighting

Strand Lighting

PLUG-IN PROFESSIONAL
THYRISTOR DIMMERS

MAINTENANCE HANDBOOK

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1 INTRODUCTION

This handbook covers the installation, commissioning, operation and maintenance of the Strand Lighting PLUG-IN PROFESSIONAL (PIP) range of stage and studio dimmers.

WARNING: High voltages are present inside PIP Dimmer Racks. Installation and commissioning should be performed only by a qualified electrician familiar with this type of equipment. Repair of faulty equipment beyond first-line maintenance must be entrusted to a Strand Lighting approved agent. Tampering by unqualified persons invalidates any warranty provisions and can be dangerous.

For assistance with service or maintenance, please contact your nearest branch, agent or associate company of Strand Lighting. Details of spare parts and fuse-links available for the equipment are enclosed and a current spares price list is available on application to any of the above.

This handbook has been carefully reviewed and is believed to be reliable; no responsibility will be accepted, however, for any inaccuracies. The handbook is subject to change without notice.

1.1 Using the Handbook

When using this handbook, the following conventions should be noted:

i) Integrated circuits are identified by their component number, prefixed with the letters IC (e.g. IC7). Where an integrated circuit contains more than one logic element, the output pin number of the element concerned is added as a suffix, e.g. IC13/4. In the case of elements with two or more outputs, e.g. bistables, one of the outputs is chosen for identification purposes, depending on the context.

ii) The term 'pin' is used to identify connections to integrated circuits. Connections to printed circuit boards are referred to as 'board terminal' or simply 'terminal'.

2 GENERAL INFORMATION

2.1 Racks

Five standard types of PIP dimmer rack are available: two 120kW configurations - with 48 channels of 10 Amp dimmers or 24 channels of 25 Amp dimmers; and three 60kW configurations - with 24 channels of 10A dimmers, 12 channels of 25A dimmers or 6 channels of 50A dimmers. All standard racks are wired in 'star' configuration.

The racks are of totally enclosed construction, designed for installation as free standing units. Mounting bolt holes are provided at the top of each rack. During transit, they are fitted with lifting eyes, but these may be replaced by the brackets provided to facilitate securing to a wall, or back to back with a similar rack. Cable entry to the Contracting area of the rack is through a removable top panel. Access to the Contracting and termination area is via a removable upper cover, while a door protects the dimmer modules.

PIP 120kW Dimmer Racks
Dimensions - 1800mm (H) x 330mm (D) x 1050mm (W).
Supply Voltage Requirements - 220-250 V three phase or single phase
Power Requirements - 120kW

Note: The mains supply characteristics can, under some circustances, necessitate revision of the fusing arrangements for single-phase operation. If in doubt, contact Strand Lighting or an approved agent.

PIP 60kW Dimmer Racks
Dimensions - 1475mm (H) x 330mm (D) x 725mm (W).
Supply Voltage Requirements - 220-250 V three phase or single phase
Power Requirements - 60kW

2.2 Dimmer Modules

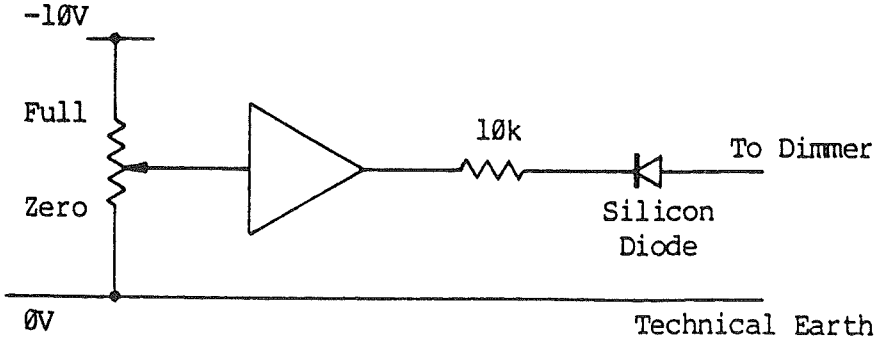
PIP dimmer modules are plug-in units which occupy the lower half of the rack. Each module consists of a printed circuit board (trigger card), a heatsink and a plastic front panel and handle; the PCB and the panel/handle are both fixed to the heatsink. Each module slides into position on two runners, a multipin connector at the rear of the PCB mating with a corresponding socket in the rack. The connectors on the dimmers of different ratings are keyed to ensure that only dimmers of the correct rating may be inserted in each position. There is also a filter choke for each dimmer channel, mounted in the rack behind the corresponding plug-in module.

Five different types of module are available:

PIP 25LP	Dual 10A dimmer	Linear power law, open loop.
PIP 50LP	Single 25A dimmer	Linear power law, open loop.
PIP 25CS	Dual 10A dimmer	Square law, closed loop.
PIP 50CS	Single 25A dimmer	Square law, closed loop.
PIP 100CS	Single 45A dimmer	Square law, closed loop.

Type LP dimmers have a transfer characteristic which combines the S and square laws to suit the eye's perception of intensity; they are primarily intended for use in theatre applications. The CS modules have a square law transfer characteristic; this law is best suited to use in television studios. Additional features of the CS modules are the closed-loop control circuitry, which uses feedback from the dimmer output to stabilise the dimmer level in the presence of voltage fluctuations on the mains supply, and a non-dim facility which gives the dimmer a simple on/off action, rather than the normal graduated control.

The dimmers require a control voltage input of 0 to -10V, -10V corresponding to full output and 0V to zero output. The signal should be fed via a 10k resistor and a silicon diode as shown in Fig. 2.1; this is the standard control interface used on Strand Lighting control desks.



DIMMER CONTROL INTERFACE

Fig. 2.1

2.3 Multiplexed Control

If required, dimmer racks in the PIP range can be supplied with a Demultiplex Control Unit fitted (two in the case of 48-way racks). This permits the direct connection of the dimmers to any Strand Lighting control system which produces a multiplexed output (e.g. Tempus M24), without the need for a separate Multiplex Interface unit.

The Demultiplex Interface Unit is located on the right-hand side of the rack at the bottom of the termination area.

2.4 Overload Protection

In standard PIP dimmer racks, each 10A and 25A dimmer is protected by an appropriately rated miniature circuit breaker. Alternatively, racks may be supplied with Reyrolle HRC cartridge fuses or Diazed fuses. Racks containing 45A dimmers are only available with fuse protection.

CORRECTLY RATED FUSES MUST BE USED.

WARNING: Reyrolle MD10 AND MD20 Fuses

The fuses currently supplied by Strand Lighting and their agents have a different fusing factor to those available from other suppliers. This reduces the likelihood of fuse failure when a cold lamp load is connected and greatly increases the reliability of the dimmer system.

It is therefore recommended that only fuses obtained from Strand Lighting or their agents be used. These may be distinguished by the white ink used to print the rating on the fuse body. Fuses printed with blue ink do not have the improved characteristic and may prove unreliable.

Note that the breaking capacity of these fused is 50kA; this should be borne in mind when using 120kW racks connected to a single-phase of the supply.

When ordering these fuses, please state the following reference codes:

MD10 fuse	Order code 0831814
MD20 fuse	Order code 0832018

2.5 R.F.I. Suppression

Each rack is fitted with Radio Frequency Interference suppression, by way of capacitors fitted between each phase and neutral, earth and neutral, and each load and neutral. These capacitors are mounted on Ref. 1294 printed circuit boards in the Contracting Area of the dimmer rack.

2.6 Connections

Load and control connections are made via terminal blocks in the Contracting area of the rack. The channel identification numbering

is the key for all connections to associated lamp loads, desks, etc. The incoming supply busbars and connectors may also be found in the Contracting area.

2.7 Order Codes

The following lists the order codes for the standard types of PIP dimmer rack. Modules may be omitted to special order.

Dimmers	MCB	Reyrolle	Diazed
LP Specification - Analogue Control			
48 x 10A	0065030	0065010	0065020
24 x 10A	0065031	0065011	0065021
24 x 25A	0065032	0065012	0065022
12 x 25A	0065033	0065013	0065023
LP Specification - Multiplex Control			
48 x 10A	0065030/MUX	0065010/MUX	0065020/MUX
24 x 10A	0065031/MUX	0065011/MUX	0065021/MUX
24 x 25A	0065032/MUX	0065012/MUX	0065022/MUX
12 x 25A	0065033/MUX	0065013/MUX	0065023/MUX
CS Specification - Analogue Control			
48 x 10A	0066030	0066010	0066020
24 x 10A	0066031	0066011	0066021
24 x 25A	0066032	0066012	0066022
12 x 25A	0066033	0066013	0066023
6 x 45A	-	0066014	0066024
CS Specification - Multiplex Control			
48 x 10A	0066030/MUX	0066010/MUX	0066020/MUX
24 x 10A	0066031/MUX	0066011/MUX	0066021/MUX
24 x 25A	0066032/MUX	0066012/MUX	0066022/MUX
12 x 25A	0066033/MUX	0066013/MUX	0066023/MUX
6 x 45A	-	0066014/MUX	0066024/MUX

3 INSTALLATION

3.1 Installation Site

The rack should be sited in a dry, free-ventilating area with easy access for fuse changing. Where possible, group two or more racks together at one location. Avoid any acoustically live position in the acting or audience area, since the dimmers are not totally silent in operation.

In choosing the location for individual or grouped racks, ensure that free flow of air through each rack (air inlet at the base of the front panel, air outlet at the top of the front panel) is not impeded in any way. The natural convection in each rack is adequate to disperse the heat dissipated in the rack, so long as the inlet air temperature does not exceed 35°C (95°F). Air conditioning equipment may be necessary in some installations to maintain the ambient air temperature below 35°C.

Where two or more racks are grouped, it will be found convenient to arrange them in channel number sequence.

3.1.1 Associated Sound Installations

Waveform switching, such as is provided by PIP dimmers, can reveal, in the form of spurious interference, previously undetected earth loops in associated sound installations. Careful inspection of sound system earthing and screening may be necessary to remedy any earth loops.

High impedance microphone lines are also susceptible to 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.

3.2 Preliminary

The rack should be located in the required position and fixed firmly to a wall or other vertical surface using angled brackets. Alternatively, racks may be mounted back to back using flat straps. The two lifting eyes at the top of the rack should be removed and replaced with appropriate brackets and bolts.

Opening the door in the lower part of the rack will reveal a cardboard protector. This is intended to prevent any debris, which may fall from the top of the rack when the wiring installation is carried out, falling into the dimmers where it may cause short-circuits when the equipment is switched on. Do not remove the protector until all the wiring is complete.

Behind the cardboard protector in the base of the rack will be found a plastic bag containing a key operated lock and, if appropriate, the dimmer power fuses. For safety, the upper panel should be replaced and the door closed before the fuses are inserted and the rack switched on.

The key operated lock is provided so that unauthorised access to the rack may be prevented if required. This may be necessary to conform to local regulations. To remove the existing lock, open the door and slide back the catch from the inside until the mechanism can be withdrawn. The new lock is fitted in a similar way.

3.3 Connections

NOTE: Do not use high-voltage insulation testers on this equipment.

The upper panel should be removed to gain access to the contracting area of the rack. The cable entry panel in the top of the rack should also be removed and may be cut to allow for necessary cable and trunking entry. All cables must be routed through the top panel.

3.3.1 Supply Connections

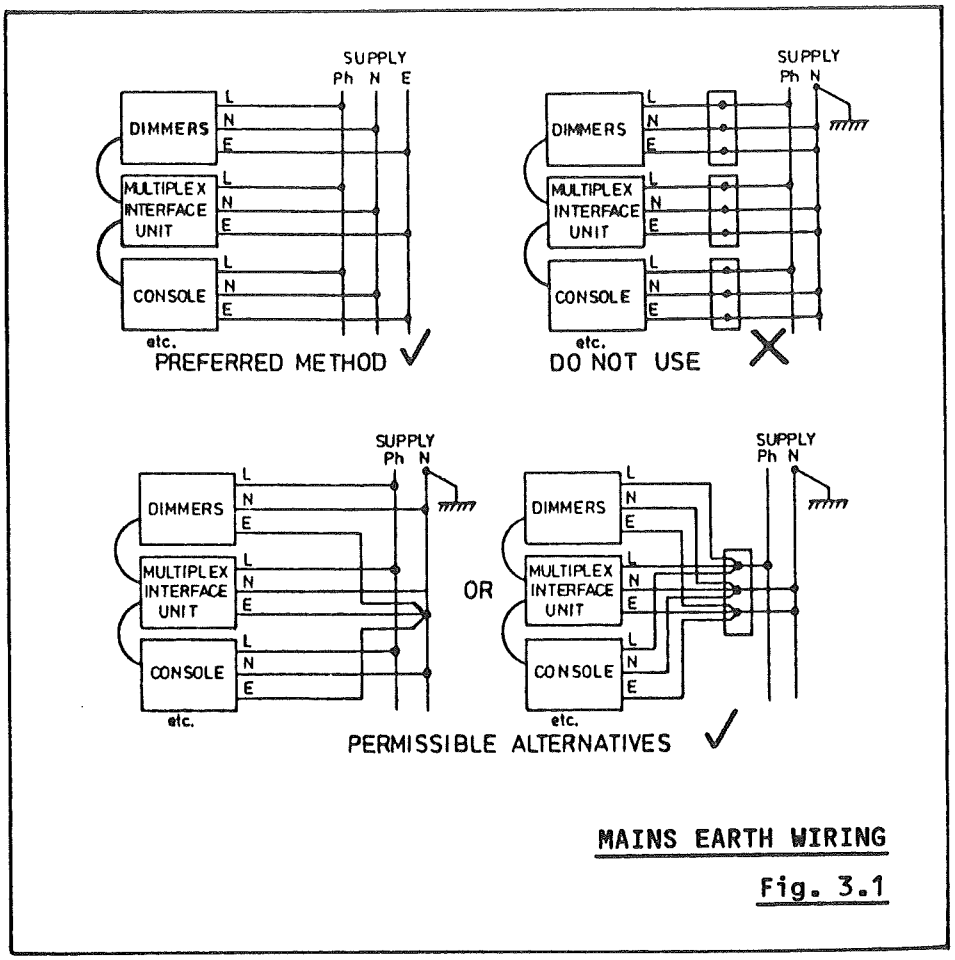
All racks are provided with busbars for the incoming supplies. If the installation is to be a single phase system, the coupling plate provided should be connected across the three phase busbars using the screws available on the busbars. The busbars and their main cable studs are rated at 200A per phase.

Note: It is the responsibilty of the user to determine whether the dimmer circuit breakers (or fuses) will provide adequate protection and, if not, what back-up protection is required.

It is imperative that an adequately rated protective conductor be provided, connected to the earth busbar or terminal as appropriate. Do not rely on earthing via conduit or trunking.

WARNING: Where the control console produces a multiplexed output (e.g. Tempus M24) and the dimmer racks are fitted with Demultiplex Boards, the equipment must be properly earthed if it is to function correctly. IT IS ESSENTIAL THAT EARTH BE AT THE SAME POTENTIAL AT ALL POINTS IN THE SYSTEM. If this is not the case, circulating currents may be generated in the signal earth connections, leading to fluctuating light levels and, in extreme cases, severe damage to the equipment.

In cases where the earth is provided via the supply neutral, all units in the system should ideally be powered



from the same source via adequately rated three core (L. N. E.) cable. If this is not possible, a single earth point must be chosen and all the units earthed ONLY AT THIS POINT (see Fig. 3.1). The conductors used must be able to carry any potential fault current.

If damage is caused as a result of failure to observe the above recommendations, any warranty will be invalidated. If in doubt, your local Strand Lighting agent will be pleased to advise.

3.3.2 Control Connections

3.3.2.1 Analogue Control

The control terminals are numbered to correspond to the load terminals. Since the wiring has to carry less than 30 volts at a few milliamps, any suitable multi-conductor cable can be used subject to local authority regulations. Suitable cable is detailed in section 6 - Spares. Ideally, this cable should not be run in the same conduit as mains or load cables. If necessity dictates this, ensure the cable is of adequate voltage rating. Connect each numbered terminal to the appropriate numbered terminal on the

associated desk or panel. Connect the common return line to terminal TE (technical earth/ground).

It should be noted that technical earth is connected to mains earth within the rack. On many installations (e.g. those with Galaxy or Tempus M24 control desks) the connection is made elsewhere and it may be necessary to remove this link; the link is a single green insulated wire between two of the control terminals.

3.3.2.2 Multiplex Control

The multiplexed control input signal connects via a four-way, plug-on terminal block (PL3) on the De-multiplex Interface Unit. Connections sould be made using single core 0.5mm^2 screened cable, as follows:

PL3 Terminal	Connection
SCRN	Screen (common)
ANLG	Multiplexed Control Signal (DMX)
SYNC-	Not Normally Used
SYNC+	Not Normally Used

The SYNC- and SYNC+ terminals are provided to allow the use of an alternative, four-wire system.

In the case of 48-way racks, the multiplexed input must be connected to the two Demultiplex Interface units in 'daisy chain' fashion - see Fig. 3.2. Similarly, if the installation comprises two or more dimmer racks, the multiplexed input must loop from rack to rack.

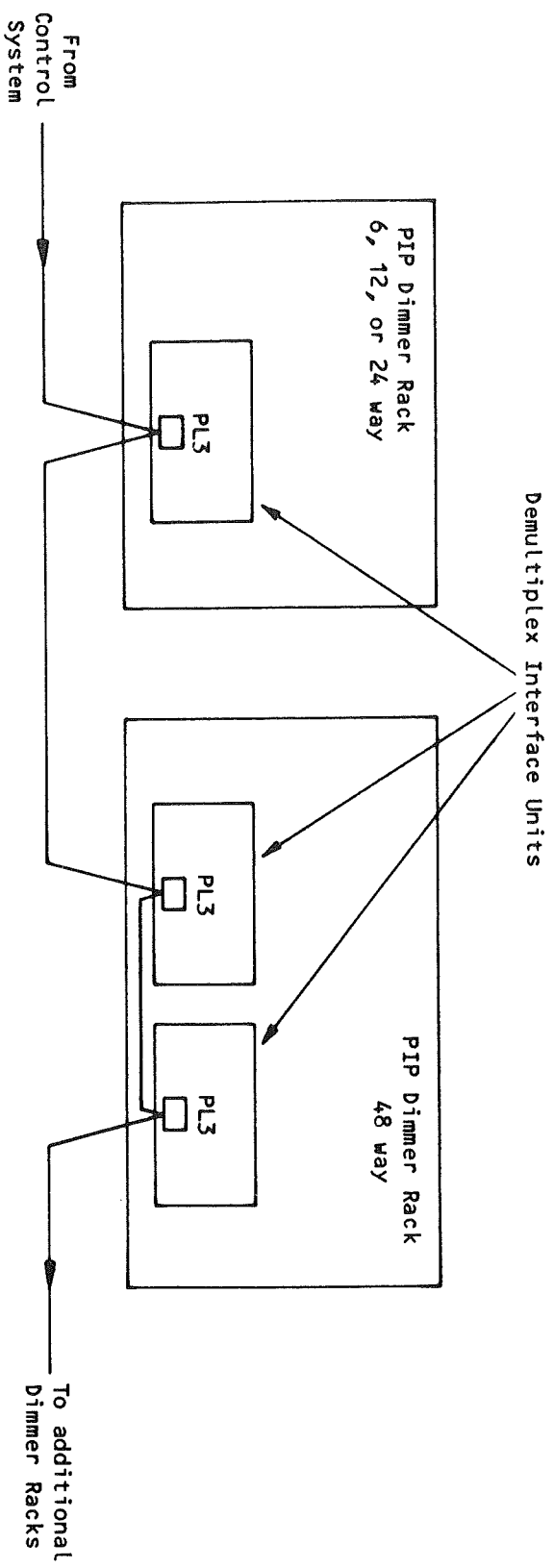
The connection at the control system is normally by means of a 3-pin type XLR connector, wired as follows:

Pin 1	Screen	0V
Pin 2	Red	FMX - Multiplexed Input (to control system)
Pin 3	Blue	DMX - Multiplexed Output (from control system)

The pin 2 connection is not used on PIP demultiplex installations.

3.3.3 Loads

PIP dimmers are designed to control tungsten lamp loads of the same voltage rating as the main supply. The maximum continuous current rating of the dimmer channels is 10 Amps for the 2.5kW version and 20 Amps for the 5kW version. Low loads, down to 5W, may be controlled. The dimmers will also control transformer fed loads, provided that the transformers are individually fused and the dimmers are derated to allow for the transformer magnetisation current.



MULTIPLEXED CONTROL CONNECTIONS

Fig. 3.2

Do not connect to a dimmer or associated load circuits, any flash boxes or similar pyrotechnic devices or any appliance liable to absorb excessive surges of power from the mains supply.

Open-loop dimmers can be used to control hot or cold cathode fluorescent lamps, but specially designed control gear must be used and the dimmer ratings must be reduced to allow for losses in the control gear. On closed-loop dimmers, some modification of the dimmer law is inevitable, as the output waveform will be distorted by the reactive load. Great care is necessary in this type of installation, and the quality of control is inferior to that achieved with tungsten lamp loads. You are advised to contact the local Strand Lighting agent concerning such installations.

3.3.3.1 Load Connections

A Load, a Neutral and an Earth terminal is provided for each channel. Except where multicore cables are used, a separate protective conductor must be provided for each load position. Under no circumstances should shared neutrals be used.

Since control of the output to the load involves waveform switching, the load and neutral return conductors to each channel load must be run as a pair of equal length, adjacent 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 fields tending to vibrate the cable trunking or radiate interference.

3.3.3.2 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 often used in large installations. For high voltage loads requiring outlets of more than 15 Amp 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 Check and Test Procedure

When all the connections have been made to the rack, remove all cable ends and other debris from the rack. Then open the door and

remove the cardboard protector covering the dimmer modules. Remove any debris found inside the rack. In racks which are provided with dimmer power fuses, the fuse-links will be found packed in the lower half of the rack, and these should be located in the fuseholders. Check all connections carefully, especially to ensure that insulation is not trapped in the pressure pads of the load or control terminals.

Replace and secure all covers and close the door.

When the rack is fully installed, turn on the a.c. supply to the rack. The three phase indicator neons on the left of the upper panel indicate the presence of the a.c. supply; all three neons should be on.

Each dimmer channel should be successively raised to full and then taken to zero several times to check it functions properly. Complete failure of any one channel to light is usually caused by a blown lamp or fuse (if provided). Note that a test plug is provided on the front panel of all CL modules and this permits the trigger card power rails, the incoming control signal and the dimmer output to be monitored; the dimmer output is isolated by means of a low voltage transformer.

Reference to section 4, Maintenance, should be made in the event of any problems occurring with the functioning of the PIP dimmer rack.

3.5 Setting-up

3.5.1 Dimmer Modules

A topset potentiometer is provided on the trigger card for each dimmer. This is accessible via a hole marked '$\bar{1}$1' (or '$\bar{1}$2') in the front panel of the module and allows the full level to be adjusted for optimum dimmer performance. The level is set before despatch, but following repair readjustment may be necessary.

Connect the dimmer to a 1kW load and set it to full level. Use a true RMS voltmeter to monitor the appropriate load terminal at the top of the dimmer rack. The dimmer output should be set to 5-6V below the measured supply voltage for that channel.

WARNING: Removing the top cover exposes terminals at mains potential. Great care must be taken when making these adjustments.

The bottom setting of the dimmer is automatic and no adjustment is possible.

CS modules include a non-dim facility which gives the dimmer a simple on/off action, rather than the normal graduated control.

This is selected by changing the position of link LK1 on the printed circuit board (on dual 10A dimmers a second link, LK2, is provided for the second channel). If the link is in the position closest to the LK1 (LK2) legend, the dimmer functions normally; with the link in the other position, the non-dim facility is enabled.

3.5.2 De-multiplex Control Unit

If it becomes necessary to fit a new De-multiplex Control unit, the dimmers must be assigned to their correct channel numbers. The numbers concerned must be consecutive and the first number must be within the valid range of the control system.

The three rotary Channel Group Selector switches represent, from bottom to top, the hundreds, tens and units of the first channel number in the group, i.e. that assigned to dimmer 1. For instance, to assign the dimmers to channels 1 to 24, set the three switches to (from bottom to top) 0, 0, 1; dimmer 1 will then be assigned to channel 1, 2 to 2, 3 to 3, etc. Similarly if the channels required are numbers 25 to 48, the switch settings will be 0, 2, 5.

Notes: 1) If the first number is within 24 of the maximum valid channel number, or if the rack contains less than 24 dimmers, there will be some spare control outputs; for example, if the switches are set to channel 37 on a 48 channel installation, outputs numbers 13 to 24 will be unused.

2) Two or more dimmer racks may be assigned to the same lighting channels. This provides a simple method of patching multiple dimmers to single channels.

When the equipment is in operation, a 'Communication' indicator on the board lights to show that a valid multiplex signal is being received.

4 MAINTENANCE

This section is included as a guide to ascertain the extent of any fault which may occur on a PIP dimmer rack, and indicate a solution. Reference should be made to section 5, Technical Description, in the event of any repair work which may be required.

Maintenance of Strand Lighting PIP dimmer modules should only be carried out by a qualified electrician familiar with this type of equipment. High-voltage insulation testers must not be used. Note that a test plug is provided on the front panel of all CL modules and this permits the trigger card power rails, the incoming control signal and the dimmer output (isolated by means of a low voltage transformer) to be monitored. A suitable connector is 3M 'click' socket, type 3473-6000.

WARNING: ISOLATE THE MAINS SUPPLY BEFORE REMOVING THE TOP COVER. Take suitable precautions when testing and measuring with the supply switched on.

The racks require little routine maintenance. A periodic inspection of each rack's associated wiring and connections is recommended.

4.1 Single Channel Fault

If a single channel will not light, it is most likely that a Circuit Breaker has tripped, or that a fuse (where provided) or lamp has blown. Examining and, if necessary, resetting the appropriate circuit breaker, or replacing the suspected fuse and/or lamp will isolate the fault further.

If the control channel still fails to operate, turn off the power to the dimmer rack and swap the suspect dimmer with one of the same rating corresponding to a channel which functions correctly. In the case of a faulty dimmer, when power is restored the original channel will now work and the second channel will have become inoperative; the dimmer concerned should then be replaced. Repair at electronic component level should only be carried out by an approved Strand Lighting agent or qualified engineer. Circuit descriptions are included in section 5, Technical Description.

If the same channel remains inoperative, check the control system and cables, and also for broken wiring or loose connections within the rack. Rectify any faults as necessary.

Note: Before opening the dimmer rack to check the internal wiring, the dimmer rack must be isolated from the source of mains supply. The checks should be carried out by a qualified electrician familiar with the equipment.

4.1.1 Demultiplex Control Unit

In racks fitted for multiplex operation, the appropriate output of the Demultiplex Control Unit (see Drawing No. 6A28237) should be checked to ensure that the correct control signal (0V to -10V) is present. If not, the unit must be removed and returned to an approved Strand Lighting service agent for repair. To remove the board, unplug the mains input, multiplexed input and control outputs, and lift the board off its mounting pillars.

WARNING: The demultiplexed control signals can normally only be monitored with the top cover removed and the rack in operation. Great care must be taken as terminals and other components at mains potential are exposed under these circumstances. This should be only be done by a qualified electrician familiar with the equipment.

4.2 Failure of a Phase

When groups of channels allocated to a single phase fail, this is probably due to failure of supply on that phase.

4.3 Failure of all or half the Dimmers in the Rack

In racks fitted for multiplex operation, each Demultiplex Control Unit generates the control signals for 24 dimmers. If an entire group of 24 dimmers fails and these are all in the same rack, a fault in the Demultiplex Control Unit is likely. The unit should be checked as described in section 4.1.1 above and, if faulty, removed and returned to an approved Strand Lighting service agent for repair.

4.4 Thyristor Faults

Generally a thyristor fails in one of two ways: either short circuit, in which case the load will be turned on fully all the time; or open circuit, in which case the dimmer will control the load from out to about 50% intensity. In the latter case, there will be noticeable flicker if one of the pair of thyristors still functions.

5 TECHNICAL DESCRIPTION

5.1 Phase Control of Mains Current

A thyristor dimmer functions as a fast-acting switch, operating every half-cycle to connect the mains supply to the load. The electrical energy applied to the the load is controlled by changing the switch-on period (conduction angle) of each half-cycle, a process known as phase control.

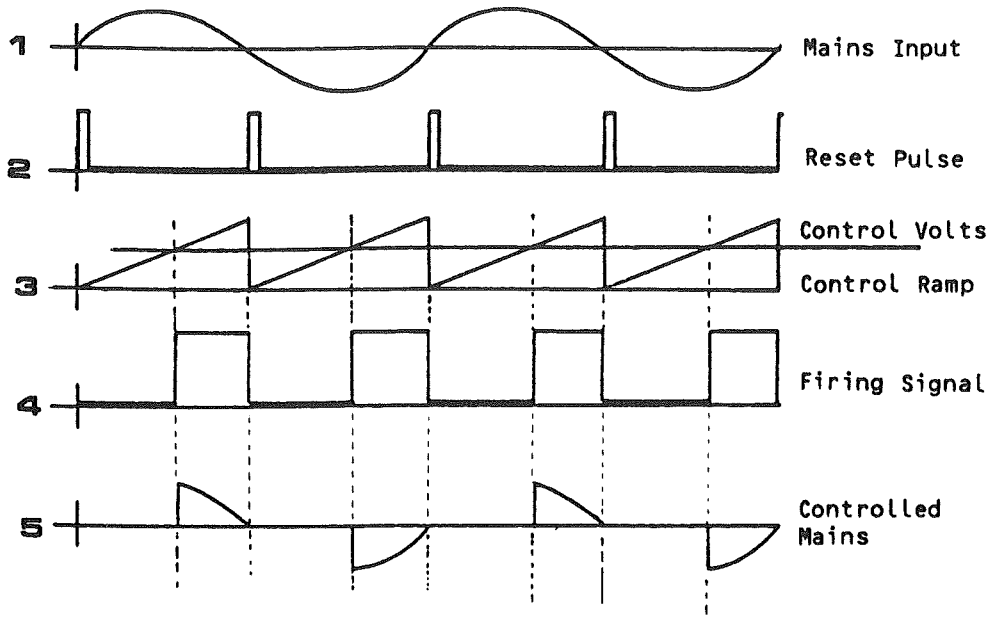
A thyristor is a three terminal device, having a main current path which becomes conducting when a pulse is applied to the third (gate) terminal. Once triggered, a thyristor will remain conducting until the current falls to zero at the end of the half-cycle. The device can only pass current in one direction and thus, if operation over the full mains cycle is to be achieved, a second device must be connected in inverse parallel with the first. This second device is triggered on alternate half-cycles to pass current in the other direction.

The earlier the gate pulse occurs in each half-cycle the greater the power applied to the load. For example, if the gate trigger pulse is produced five milliseconds after the start of each half-cycle (assuming a 50Hz supply), conduction only occurs during the second half of the half-cycle, reducing the mean load power by half.

Because of the fast switching times of the thyristors and the much distorted output waveform, harmonics are produced and these must be suppressed by means of a choke and other interference suppression components. Even with these components fitted, care must be taken to ensure that load cables are not installed in close proximity to audio cables.

In the case of low or inductive loads (e.g. tungsten lamps of less than 100W, fluorescent tubes or low-voltage transformer-fed lamps) it is possible for the thyristor to cease conduction before the end of the half-cycle. To overcome this, the thyristors in PIP dimmers are 'd.c. fired', i.e. the firing pulse lasts until the end of the conduction period.

The firing pulse is produced by comparing the signal from the control desk with a ramp signal. The latter is locked to the mains frequency by means of a reset pulse which appears each time the mains cycle passes through 0V (see Fig. 5.1).



PHASE CONTROL OF MAINS CURRENT

Fig. 5.1

5.2 Dual 10A Open-loop Dimmer Module (Ref. 1870)

Drawing No. 6B29562.

WARNING: HAZARDOUS VOLTAGES ARE PRESENT ON THIS CARD.

This section describes the printed circuit board used on the PIP 10LP dimmer.

5.2.1 Power Supplies

The incoming mains supply is routed via self-resetting fuse X1 to transformer TRX1, which produces an output at 10V a.c. This is rectified by D1-4 and smoothed by C1 and C2 to give positive and negative rails of about +14V and -13V.

5.2.2 Ramp Generator

A negative-going, unsmoothed, full-wave-rectified waveform with a peak of about -14V is derived from the incoming 10V a.c. supply by diodes D3 and D4; diode D5 provides isolation from the negative d.c. rail. This signal is routed via a potential divider formed by R1 and R2, to the base of transistor VT1. The latter detects the

positive going peaks of the waveform and thus produces a signal, negative-going to -5.6V, with timing corresponding to the zero crossover of the mains waveform. The -5.6V reference applied to VT1 is derived from the negative rail by zener diode D8 and resistor R8.

The zero-crossover pulse is used to reset a ramp generator formed by IC1/14, IC1/1, and their associated components. At the end of each half-cycle of the mains waveform the output of IC1/1 (and thus the pin 12 input of IC1/14) will be close to 0V. When the reset pulse appears, IC1 pin 14 will be driven high (+14V), forward biasing D7. The output on pin 1 of IC1 will then move rapidly negative as a result of the Miller effect of R4 and C3, until the two inputs of IC1/14 are equal at -5.6V. Once this equilibrium state is established it does not change until the end of the reset pulse.

When the collector of VT1 returns to 0V, the equilibrium at the inputs of IC1/14 is disturbed, forcing the output of this device high. D7 therefore becomes back-biased and this allows the output of IC1/1 to rise at a rate determined by R6 and C3. A ramp waveform which rises from -5.6V towards 0V is thus produced.

The shape of this waveform is modified by modulation with the rectified sine-wave from the junction of D3, D4, D5 and R1 via C4 and R5, in order to improve the dimmer control characteristics.

5.2.3 Automatic Bottom-set Circuit

In addition to the modulation mentioned above, the slope of the ramp may be adjusted by means of a circuit formed by VT2, VT3 and their associated components; the latter circuit provides automatic Bottom-set adjustment by controlling the voltage offset applied to pin 3 of IC1/1 and thus the voltage across R6.

A reference voltage of about -0.6V is derived from the -5.6V rail by resistors R13 and R14; this voltage is applied to the base of VT3 and represents the required 'top of ramp' voltage. The ramp output from IC1/1 is applied to the base of VT2; as the ramp rises from -5.6V towards 0V, VT2 is conducting, D10 is reverse biased, and C5 charges slowly via R9.

If the ramp voltage exceeds -0.6V, VT2 turns off, forward biasing D10. C5 then discharges rapidly via D10 and R10, until the next reset pulse from VT1 resets the ramp generator and VT2 turns on again.

The voltage on C5 is applied to the non-inverting input (pin 3) of IC1/1 and provides a voltage offset which has the effect of controlling the voltage across R6. This in turn controls the integrator time constant and thus the voltage which the ramp will reach in the 20ms between reset pulses.

Each time power is applied to the dimmer rack, the voltage on C5 will be adjusted on successive mains half-cycles by the bottom-set circuit until an equilibrium is established; this is normally at about -0.3V. This effect may be observed by monitoring pin 1 of IC1 on switch on; the ramp will be seen to stabilise during the first few cycles of the mains.

5.2.4 Firing Circuit

The incoming control signals for the two dimmers are respectively connected via terminals 9 and 10 of PL5 to topset adjustment potentiometers VR1 and VR2. Taking VR1 as an example, the output from the wiper of the latter is compared with the ramp waveform from IC1/1 in comparator IC1/8, the output of which controls a firing circuit formed by OP1, VT4, TH1 and their associated components.

At the beginning of each half-cycle the ramp is more negative than the control signal and the output of IC1/8 is at about -12V. The LED in OP1 is therefore back-biased and the associated photo-transistor is turned off.

When the ramp becomes more positive than the control signal, IC1/8 produces a high output (about +13V), forward biasing the LED and switching on the photo-transistor. The resulting signal is routed via transistor VT4 to thyristor TH1. The latter generates gate drive signals for the two power thyristors on connectors PL1 and PL2 (terminal 1 in each case). Diodes D13/D17 and D14/D16 ensure that the appropriate thyristor is enabled each half-cycle of the mains waveform.

5.2.5 Ripple Rejection Filter

Connector PL6 allows the fitting of the Strand Lighting Ripple Rejection Filter Board in situations where this is found to be necessary. The connector carries +14V, -13V, 10V a.c. and 0V. The output from the filter is a zero-crossover pulse which, applied to the junction of R1 and R2, overrides the u.d.c. waveform from D3 and D4.

5.3 25A Open-loop Dimmer Module (Ref. 1871)

Drawing No. 6B29565.

The PIP 50LP dimmer uses a de-populated version of the trigger card described in the previous section; this drives a 40 Amp thyristor module. The trigger circuit is identical to that described above, but the second comparator and firing circuit are omitted.

5.4 Dual 10A Closed-loop Dimmer Module (Ref. 1872)

Drawing No. 6B29608.

WARNING: HAZARDOUS VOLTAGES ARE PRESENT ON THIS CARD.

This section describes the printed circuit board used on the PIP 10CS dimmer.

5.4.1 Power Supplies

The incoming mains supply is routed via self-resetting fuse X1 to transformer TRX3, which produces an output at 10V a.c. This is rectified by REC3 and smoothed by C13 and C14 to give positive and negative rails of about +14V and -13V.

5.4.2 Ramp Generator

A negative-going, unsmoothed, full-wave-rectified waveform with a peak of about -14V is generated from the output of transformer TRX3 by bridge rectifier REC3; diode D8 provides isolation from the negative rail. This signal is routed via a potential divider formed by R39 R40, to the base of transistor VT3. The latter switches off only at the positive-going peaks of the waveform and thus produces a signal, negative-going to about -5.6V, with timing corresponding to the zero crossover of the mains waveform. The reference of about -5.6V, which is applied to VT3, is derived from the negative rail by zener diode D1 and resistor R5; stabilisation is provided by unity-gain buffer IC1/7.

The zero-crossover pulse is used to reset a ramp generator formed by IC2/7, IC2/14, IC2/1 and their associated components. At the end of each half-cycle of the mains waveform the output of IC2/14 (and thus the pin 5 input of IC2/7) will be close to 0V. When the zero-crossover pulse appears, pin 7 of comparator IC2/7 will be driven high (+14V), forward biasing D7. The output on pin 4 of IC2 will then move rapidly negative, as a result of the Miller effect of R37 and C10, until the two inputs to IC2/7 are equal at about -5.6V. Once this equilibrium state is established it does not change until the end of the zero-crossover pulse.

When the collector of VT3 returns to 0V, the equilibrium at the inputs of IC2/7 is disturbed, forcing the output of this device high. D7 therefore becomes back-biased and this allows the output of IC2/14 to rise at a rate determined by R35 and C10. A ramp waveform which rises from -5.6V towards 0V is thus produced.

5.4.3 Automatic Bottom-set Circuit

In addition to the modulation mentioned above, the slope of the ramp may be adjusted by means of a circuit formed by IC2/1 and its associated components; the latter circuit provides automatic Bottom-set adjustment by controlling the voltage offset applied to pin 12 of IC2/14 and thus the voltage across R35.

A reference voltage of -0.6V is derived from the -5.6V reference by resistors R33 and R34; this voltage is applied to pin 3 of IC2/1 and represents the required 'top of ramp' voltage. The ramp output from IC2/14 is applied to pin 2 of IC2/1; as the ramp rises from -5.6V towards 0V the output of IC2/1 is high (about +12.5V), D6 is reverse biased and C9 discharges slowly via R31.

If the ramp voltage exceeds -0.6V, the output of IC2/1 goes low, forward biasing D6. C9 then discharges rapidly via D6 and R30, until the next reset pulse from VT3 resets the ramp generator and IC2 pin 1 returns high.

The voltage on C9 is applied to the non-inverting input (pin 12) of IC2/14 and provides a voltage offset which has the effect of controlling the voltage across R35. This in turn controls the integrator time constant and thus the voltage which the ramp will reach in the 10ms between zero-crossover pulses.

Each time the dimmer pack is switched on, the voltage on C9 will be adjusted on successive mains half-cycles by the bottom-set circuit until an equilibrium is established; this is normally at about -0.3V. This effect may be observed by monitoring pin 14 of IC2 on switch on; the ramp will be seen to stabilise during the first few cycles of the mains.

5.4.4 Feedback Circuit

The incoming 0V to -10V control signals are connected via PL7 terminals 9 and 10. Taking dimmer 1 as an example, the signal is applied to a potential divider formed by VR2 (the '$\bar{1}$1' topset control) and R10. The square CS dimmer law is produced by means of feedback which tends to oppose this signal as the dimmer output increases.

The feedback is generated by rectifying the dimmer output (routed via 12V transformer TRX1). On negative half-cycles the feedback signal is processed by D4, R23, C4, R22, R21 and C3, these components having been chosen to give the required dimmer law. The control signal and the two feedback components (i.e. that on the positive and negative half-cycles) are combined in a summing network formed by VR2, R14 and R20, some integration being provided by C2. Any ripple present on the resulting signal is removed by a second, linear integrator formed by IC1/8, R4 and C5.

5.4.5 Non-dim Facility

The above describes the operation of the control input circuit when link LK2 is in the position shown on the circuit diagram (i.e. in the position closest to the LK2 legend on the printed circuit board. If the link is moved to the other position, the dimmer feedback circuit is disabled and positive feedback via R13 gives IC1/8 a regenerative comparator function. The threshold is determined by VR2, R10 and R15, and may therefore be adjusted by means of the 'T1' topset control.

5.4.6 Firing Circuit

The output from IC1/8 is compared with the ramp waveform from IC2/14 in comparator IC1/1. The output of the latter controls a firing circuit formed by OP1, VT1, TH1 and their associated components.

At the beginning of each half-cycle the ramp is more negative than the control signal and the output of IC1/1 is at about -12V. The LED in OP1 is therefore back-biased and the associated photo-transistor is turned off.

When the ramp becomes more positive than the control signal, IC1/1 produces a high output (about +13V), forward biasing the LED and switching on the photo-transistor. The resulting signal is routed via transistor VT1 to thyristor TH1. The latter generates gate drive signals for the two power thyristors on connectors PL3 and PL4 (terminal 1 in each case). Diodes D10/D13 and D12/D11 ensure that the appropriate thyristor is enabled each half-cycle of the mains waveform.

5.4.7 Ripple Rejection Filter

Connector PL2 allows the fitting of the Strand Lighting Ripple Rejection Filter Board in situations where this is found to be necessary. The connector carries +14V, -13V, 10V a.c. and 0V. The output from the filter is a zero-crossover pulse which, applied to the junction of R39 and R40, overrides the u.d.c. waveform from REC3.

5.5 25A Closed-loop Dimmer Module (Ref. 1873)

Drawing No. 6B29611.

The PIP 50CS dimmer uses a de-populated version of the trigger card described in the previous section; this drives a 40 Amp thyristor module. The trigger circuit is identical to that described above, but the second comparator and firing circuit are omitted.

5.6 45A Closed-loop Dimmer Module

Drawing No. 6B29611.

The PIP 100CS module uses the same printed circuit board as the PIP 50CS. There are, however, several differences between the two types:

i) The trigger card drives a 90 Amp thyristor module.

ii) The thyristor supply and load connections are via additional high-current terminals (PL8 and PL9 respectively).

iii) The 45A modules occupy alternate positions within the dimmer rack. In each case, the space to the right of the module is used for the filter choke and this is covered by a blank module.

5.7 R.F.I. Suppression Card (Ref. 1877)

Drawing No. 6C25219.

In order to provide radio frequency interference suppression, 0.47 microfarad capacitors are fitted from each phase to neutral, earth to neutral, and each load channel to neutral. These are located on Ref. 1877 printed circuit boards, one of which is fitted for every twelve dimmers.

5.8 De-multiplex Control Board (Ref. 1866)

Drawing No. 6A28237

5.8.1 General

The De-multiplex Control Board receives a multiplexed analogue signal from the associated Control Console and generates the dimmer drive outputs for 24 channels. The multiplexed signal is sampled to extract the levels for the channels controlled by the board and these levels are stored on capacitors. The levels are typically refreshed or updated about every 50ms.

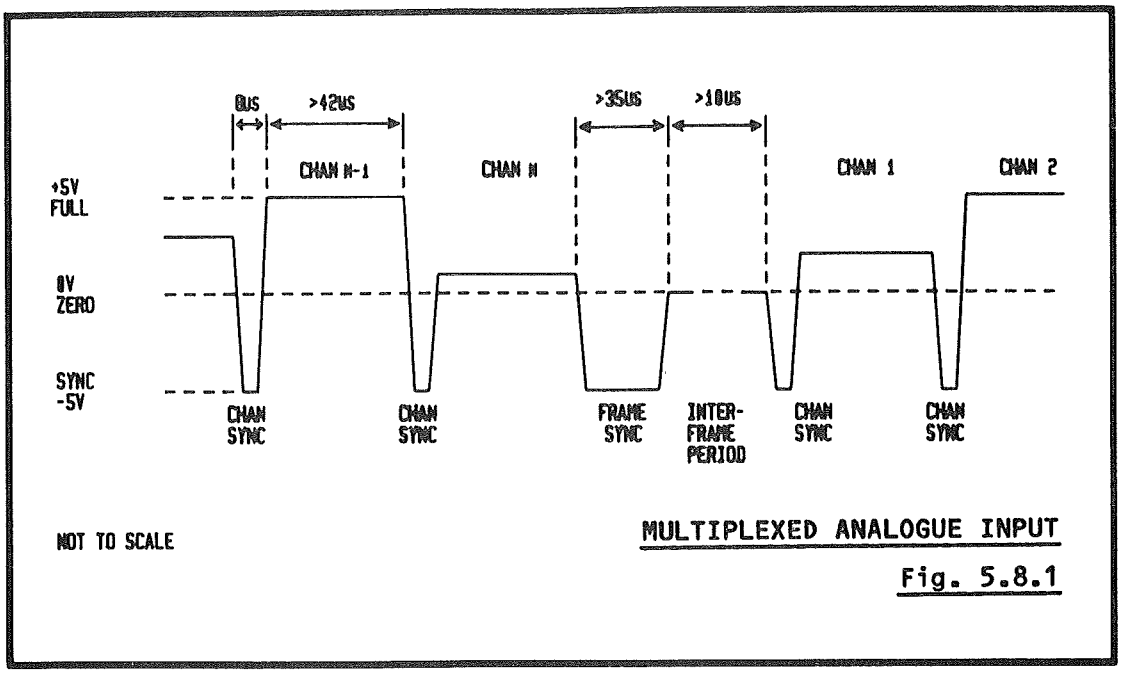
5.8.2 Multiplexed Analogue Input

The incoming multiplexed analogue signal appears on terminals 1 and 2 of connector PL3 and, terminated by capacitor C12 and resistors R15 and R16, is applied to a differential amplifier formed by IC4/1 and its associated components. IC4/1 has a gain of three, set by resistors R17, R57, R58 and R59, to ensure stability. However, the incoming signal is routed via potential divider R17/R60, thus giving

an overall gain of unity. The circuit ensures that the multiplexed signal remains isolated from ground, thus preventing interference which may be caused by earth loops.

Note that early, 'Issue 2' boards have the alternative circuit shown on the diagram. The incoming signal on terminal 2 of PL3 is terminated by capacitor C12 and resistors R15 and R16, and applied to unity-gain buffer IC4/1.

The multiplexed signal takes the form shown in Fig. 5.8.1. The analogue channel level varies between +5V (full level) and OV (zero), while the sync pulses are negative-going to -5V.



MULTIPLEXED ANALOGUE INPUT

Fig. 5.8.1

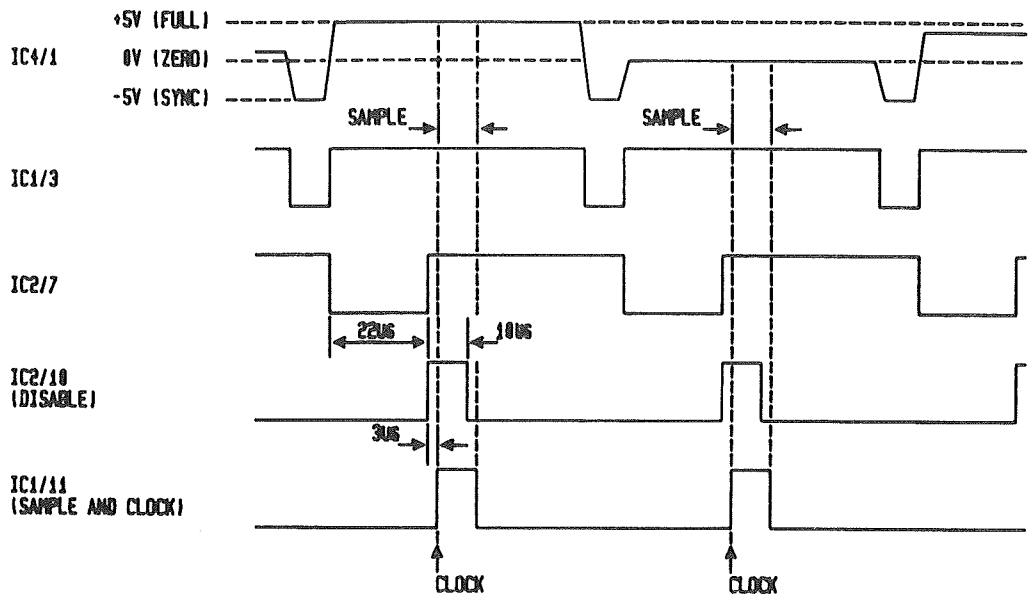
Some equipment may use an alternative, four-wire system which has separate analogue and sync signals. In the latter case, the sync signals appear on terminals 3 and 4 of PL3 and are applied to Op-amp IC4/7 which acts as a differential line receiver.

5.8.2.1 Channel Sync Pulses

The output of IC4/1 is applied to the base of transistor VT3 which passes only the negative-going Channel Sync pulses. The base/collector diode of the transistor provides isolation from the analogue signals when the four wire system is in use, while resistor R53 protects the output of IC4/7 on two-wire systems.

The combined outputs of VT3 and IC4/7 are routed via Schmitt trigger IC1/3; the input of the latter is protected by diode D1, which clamps the positive-going excursions of the signal. The positive-going edges of the output from IC1/3 (i.e. the trailing edges of

the sync pulses) trigger monostable IC2/7, which produces a 22us negative-going pulse on pin 7 (see Fig. 5.8.2). On the trailing edge of the latter signal, IC2/10 is triggered and the negative-going output (pin 9) of this monostable, routed via delay circuit R3/C10 (3us) and Schmitt trigger IC1/11, enables analogue switch IC7/2.



ANALOGUE SAMPLING WAVEFORMS

Fig. 5.8.2

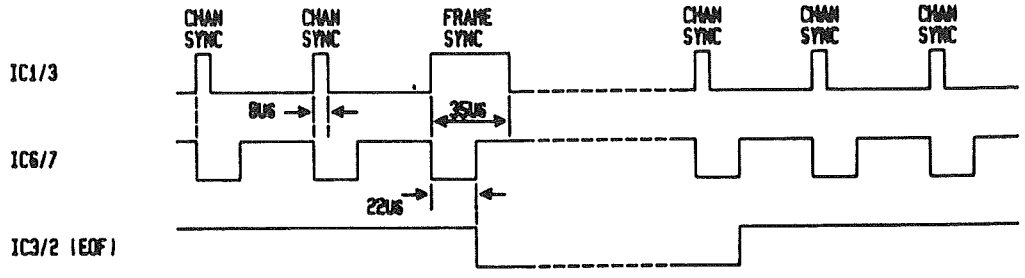
5.8.2.2 Analogue Sampling

IC4/1 also feeds Op-amp IC4/8 which, has a gain of 2 and inverts the signal to produce the 0V to -10V control signals required by the dimmers. The output of IC4/8 is applied to the analogue input of IC7/2. When the latter device is enabled, the output of IC4/8 is applied to capacitor C17, which therefore charges to the analogue level of the channel currently being sampled (see Fig. 5.8.2).

5.8.2.3 Frame Sync

At the end of each frame of channel level data, a Frame Sync pulse with a duration of at least 35us appears on the multiplexed analogue input. This is detected by means of monostable IC6/7 (22us), which is triggered on the leading edge of every sync pulse by the output of IC1/3. On the trailing edge of the 22us pulse from IC6/7, IC3/2

is clocked and its output is set low or high, depending on the state of its D input. In the case of the Channel Sync pulses, IC1 pin 3 returns high after 8us and IC3 pin 2 is therefore set high. When the longer Frame Sync pulse appears, however, IC1 pin 3 is still low after 22us and pin 2 of IC3 is set low.



NOT TO SCALE

FRAME SYNC WAVEFORMS

Fig. 5.8.3

The end of Frame (EOF) signal thus produced is used to reset the channel counter as described in section 5.8.2, and to trigger multiplex detector IC6/10. The latter device has a period of 0.5s and it is therefore continually retriggered. Its output is used, via transistor VT1, to drive the 'Communication' indicator LED (Mux OK) and, if the multiplex signal ceases, to reset bistable IC3/12.

5.8.3 Channel Counter

The channel counter is formed by IC11, IC5, IC8, and IC10. It is divided into two sections. IC5, IC8 and IC10 are clocked by sync pulses from IC2/9 and count down from a preset value which depends on the particular group of channels served by the board; the latter is set on the Channel Group Selector switches, SW1, SW2 and SW3, and is loaded by the End of Frame pulse from IC3/2. When a count of zero is reached, IC5 pin 12 (First Channel) goes high and this part of the counter is inhibited.

The other half of the counter (IC11) is enabled only when First Channel is high; it is also clocked by the channel sync pulses - taken in this case from IC1/11 - and produces the C0 - C4 signals which select each analogue output circuit in turn as the 24 channels are scanned (see section 5.8.3.1).

32 channels after First Channel appears, bistable IC3/12 is clocked by the pin 4 output (C5) of IC11. The pin 12 output of the bistable

(Last Channel) is applied to decoder IC14/10, to disable the analogue demultiplexer.

5.8.4 Dimmer Drive Outputs

5.8.4.1 Output Enable

The output of Schmitt trigger IC1/11 is also applied to the clock input of counter IC11 (see section 5.8.2). This produces outputs which are used to route the sampled analogue signal to the appropriate dimmer drive circuit. The counter outputs change on the front edge of the clock pulse.

A second counter, formed by IC5, IC8 and IC10, is clocked by the pin 9 output of IC2/10. The output from pin 12 of IC5 is a signal (First Channel) which becomes high at the beginning of the transmission period of the 24 channels served by the board. A second signal (Last Channel), from IC3 pin 12, appears 32 channels later. These two signals are applied to the select inputs of decoder IC14/10, on pins 13 and 14 respectively. The pin 10 output of the decoder is only selected with First Channel and Last Channel both high (i.e. for 32 channels following the appearance of the First Channel signal) and during this period, the output of IC2/10 (Disable) is routed via IC14/10 to enable the second half of decoder IC14 (on pin 1).

The latter device receives select inputs (C3 and C4) from the counter and produces a low output on one of pins 4, 5, or 6. These are each connected to the enable input of one of three 8-channel analogue demultiplexers which receive select signals C0 - C2 from the counter. The analogue input to the demultiplexers is from Op-amp IC4/14, the input to which is the analogue voltage stored on C17.

The Disable signal from IC2/10 inhibits IC14/10 during the sample period for each channel (see Fig. 5.8.2) and thus, via the second half of the decoder, disables the selected demultiplexer. This ensures that the voltage on C17 is not connected to the selected output until it has attained a stable state.

Because there are only three 8-channel demultiplexers, only the first 24 of the 32 channels appear on a dimmer drive output. The remaining 8 are ignored, but may be processed by a demultiplexer in another rack if required.

5.8.4.2 Output Circuits

During the Output Enable period (i.e. while IC14 pin 10 is low) the output of IC4/14 is applied, via the selected analogue demultiplexer, to one of twenty four capacitors (C21 - C28,

C31 - C38 and C41 - C48). These each provide the input to a unity gain Op-amp which, via a resistor and a diode, feeds the dimmer drive line for the corresponding channel. The diodes allow the outputs to combine on a Highest-takes-precedence basis with those of other control systems, while the resistor provides current limiting and protection against high voltages in the event of a fault.

When IC14 pin 10 goes high, the analogue demultiplexer channel is disabled and presents a high impedance to the capacitor. As the input to the Op-amp is also high impedance, the capacitor retains its charge until refreshed on the next frame of the multiplexed analogue signal.

5.8.5 Power-up and Power-down Inhibit

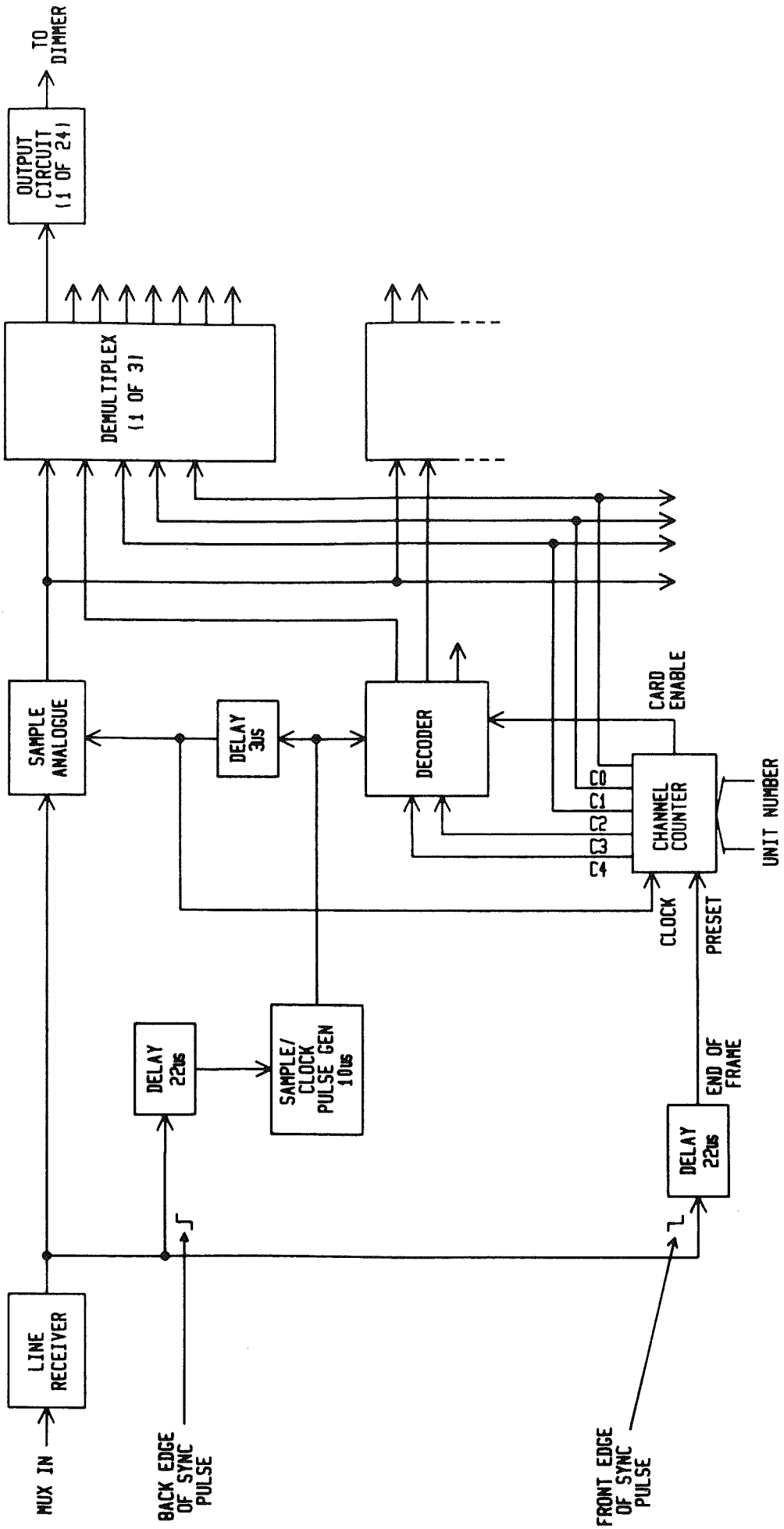
When power is applied to the board, VT2 is initially off, C39 is discharged and IC6/10 is reset via D30. When the -15V rail reaches about -10V, D5 conducts and VT2 switches on, back biasing D30 and charging C39. IC6/10 remains reset, however, via R24, until C39 reaches the threshold of the monostable; hysteresis about this threshold is produced by positive feedback via R54.

When the power is switched off, the -15V rail rapidly collapses to below -10V, switching off VT2 and resetting IC6/10 via D30. D4 ensures that C39 discharges rapidly.

5.8.6 Power Supplies

The incoming mains connects via plug PL1 and is routed via a self-resetting fuse (R1) to transformer TRX1; the output of the latter is full-wave rectified by REC1 and smoothed by C1 and C6. The resulting 24-0-24V d.c. supply is applied to regulators REG2 and REG1 which respectively generate +15V and -15V rails.

A third rail (-0.7V) is produced by D32 and R2. This rail supplies all the CMOS logic, but is primarily needed to ensure that the analogue demultiplexers can pass the full control voltage range (0V to -10V).



ANALOGUE DEMULTIPLEXER

Fig. 5.8.4

6 SPARES AND ACCESSORIES

The following accessories and spares for PIP dimmer racks are available from Strand Lighting.

6.1 Accessories

Power supply unit for Tempus desk	0865005
Ripple rejection card	0866026
Adjustment Screwdriver	0866011

6.2 HRC Fuse-links

MD 10A HRC Reyrolle fuse-link (10)	0831814
MD 20A HRC Reyrolle fuse-link (10)	083200T
40A HRC Reyrolle fuse-link (10)	0832105
10A Diazed fuse-link (10)	0800115
25A Diazed fuse-link (10)	0800123
50A Diazed fuse-link (10)	0866014

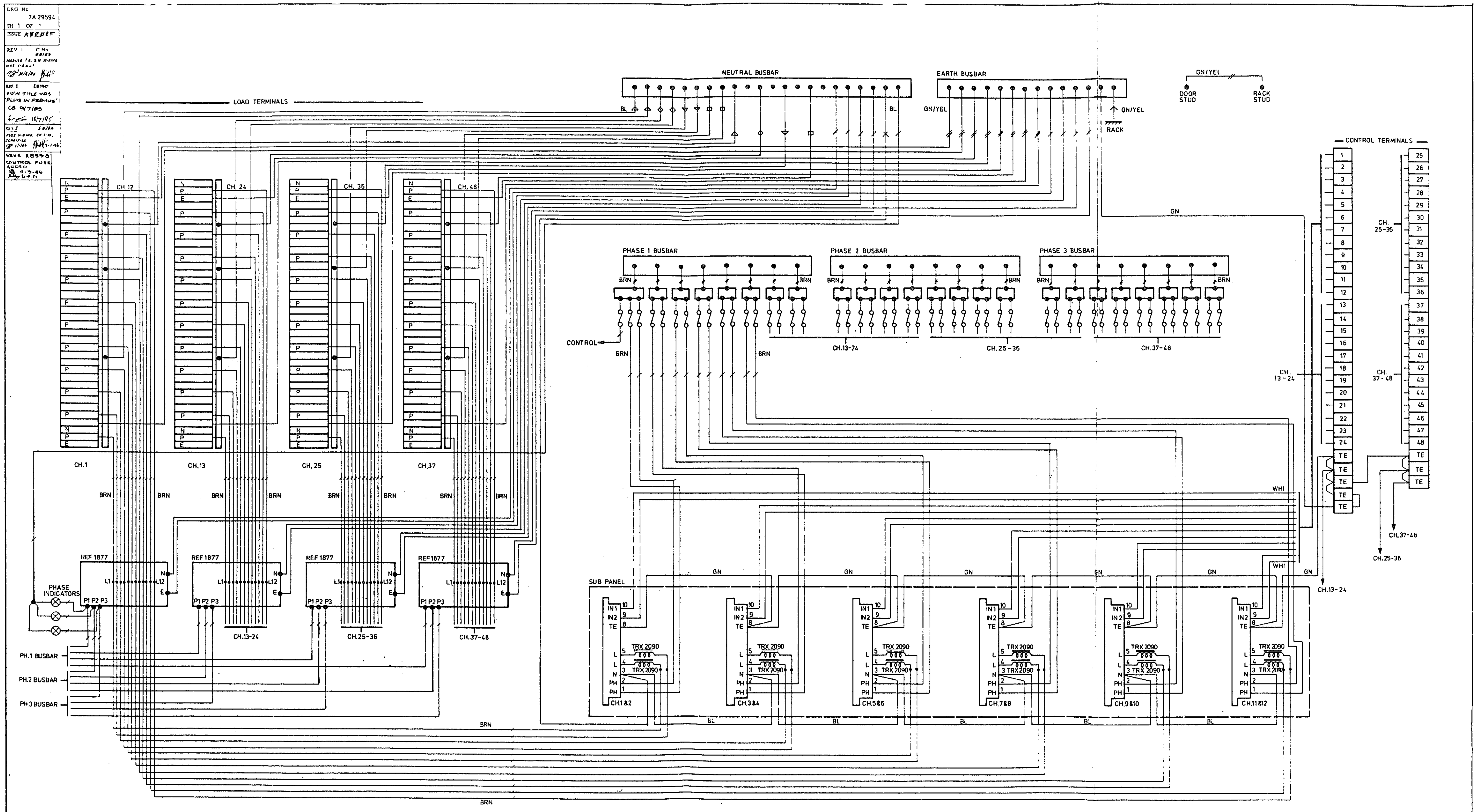
6.3 Dimmer Modules

PIP 25LP Dual 10A Open-loop dimmer module	0651103
PIP 50LP 25A Open-loop dimmer module	0651104
PIP 25CS 10A Closed-loop dimmer module	0651100
PIP 50CS 25A Closed-loop dimmer module	0651101
PIP 100CS 45A Closed-loop dimmer module	0651102
Blank module	0651599

6.4 Other Spares

10A Circuit Breaker (2)	0866012
25A Circuit Breaker (2)	0866013
Red pullcap fuse carrier (10)	0809512
Black pullcap fuse carrier (10)	0807108
25A Diazed fuse-cap (10)	0800202
63A Diazed fuse-cap (5)	0866018
10A Filter	0866015
25A Filter	0866016
Dual 10A filter	0866017
45A Filter	0889239
Power Supply Transformer (5)	0866019
Feedback Transformer (5)	0866020
10A Thyristor (2)	0866021
25A Thyristor Module	0866022
40A Thyristor Module	0866023
Module Connector - module (5)	0866024
Module Connector - rack (5)	0866025

Control terminal block (2)	0860009
Control cable - 25 core	0860600
Control cable - 12 core	3560111
Control cable - 8 core	3560024
Twin 8-pin control socket box	043721T
Quadruple 8-pin control socket box	0437315



NOTE
CHANNELS 13-24, 25-36 & 37-48 TO BE WIRED AS SHOWN FOR CHANNELS 1-12. (EXCLUDING CONTROL FUSE) ie. CH 1=FS1, CH2=FS2, etc.

WIRE SIZES
1·5mm²
2·5mm²
6·0mm²
16·0mm²

3×EQUAL LENGTHS 16·0mm²

ALL OTHER WIRES 0·75mm²

Rank Strand Ltd

TITLE: PIP 48×2·5KW RACK WIRING DIAGRAM

DRG No 7A 29594

DRG No 7A29593
SH 1 OF 1
ISSUE A B C D E F G

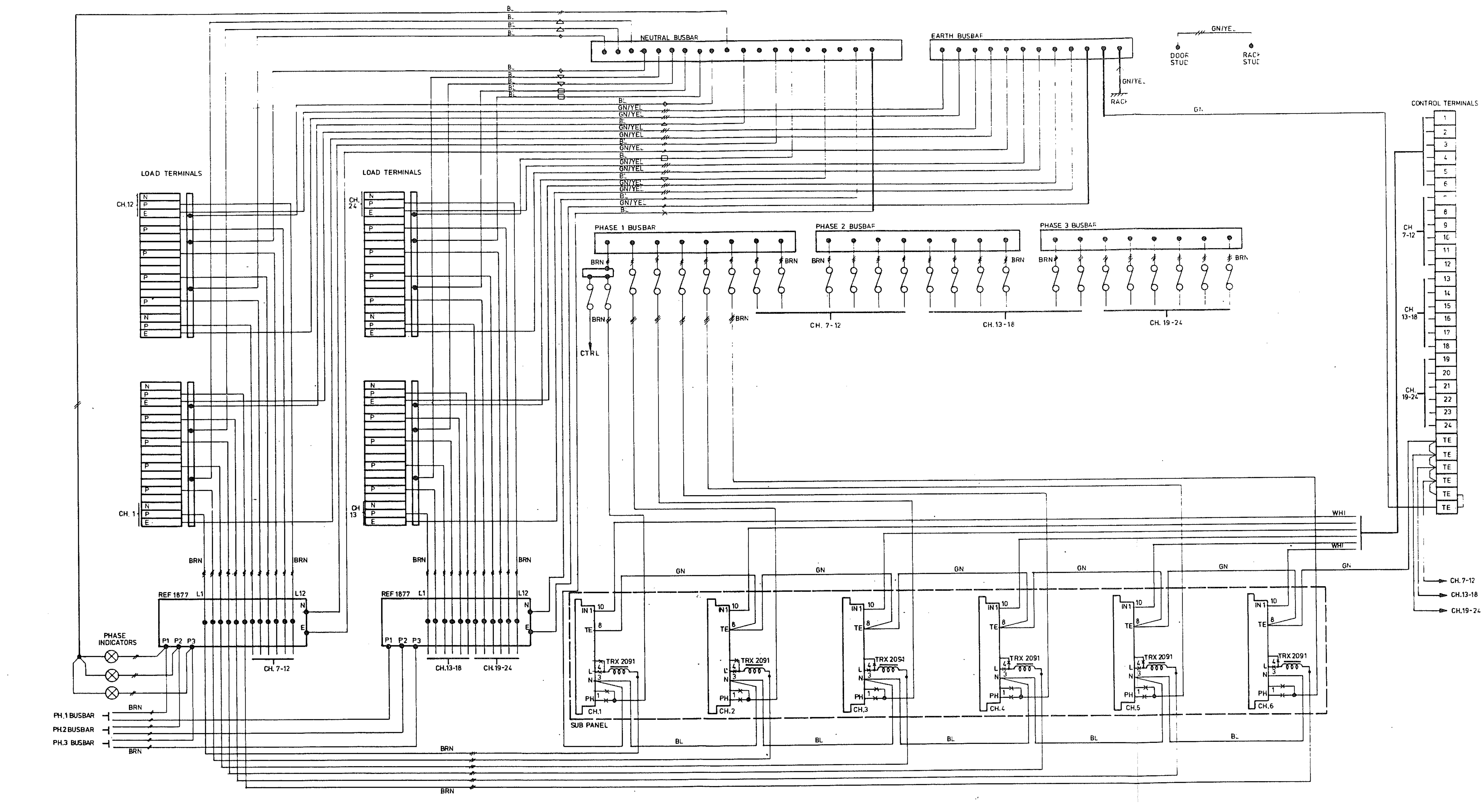
REV 1 C No E8048
1·5mm² WIRE INTO BUS-PERMUC CONN ... WAS 2·5mm²

REV 2 E8151
MODULE T.E & N. WIRING WAS 1·5mm²

REV 3 E8190
'PIP' IN TITLE WAS 'PLUG IN PERMUC'
CB 9/7/85

REV 4 E8417
4·0mm² WIRE DELETED (NOW 6·0mm²)

REV 5 E8598
CONTROL FUSE ADDED
4-9-86



NOTE
CHANNELS 7-12, 13-18 & 19-24 TO BE WIRED AS SHOWN FOR CHANNELS 1-6. (EXCLUDING CONTROL FUSE)

WIRE SIZES
16 mm²
6·0mm²
2·5mm²
1·5mm²
ALL OTHER WIRES 0·75mm²
3×EQUAL LENGTHS 16·0mm²

		DATE
DRAWN		16-6-84
CHECKED		
APP'D		

Rank Strand Ltd

SCALE	—
DIMENSIONS IN mm	
PROJECTION	
TOLERANCES	
1 DEC PLACE	±0.4mm
2 DEC PLACES	±0.1mm
ANGULAR	±0.25°
UNLESS OTHERWISE STATED	

MATERIAL —
FINISH —
FIRST USED ON: K20607

TITLE
PIP 24×5KW RACK
WIRING DIAGRAM

ISSUE A B C D E F G
DRG. No. 7A 29593
SH. 1 OF 1

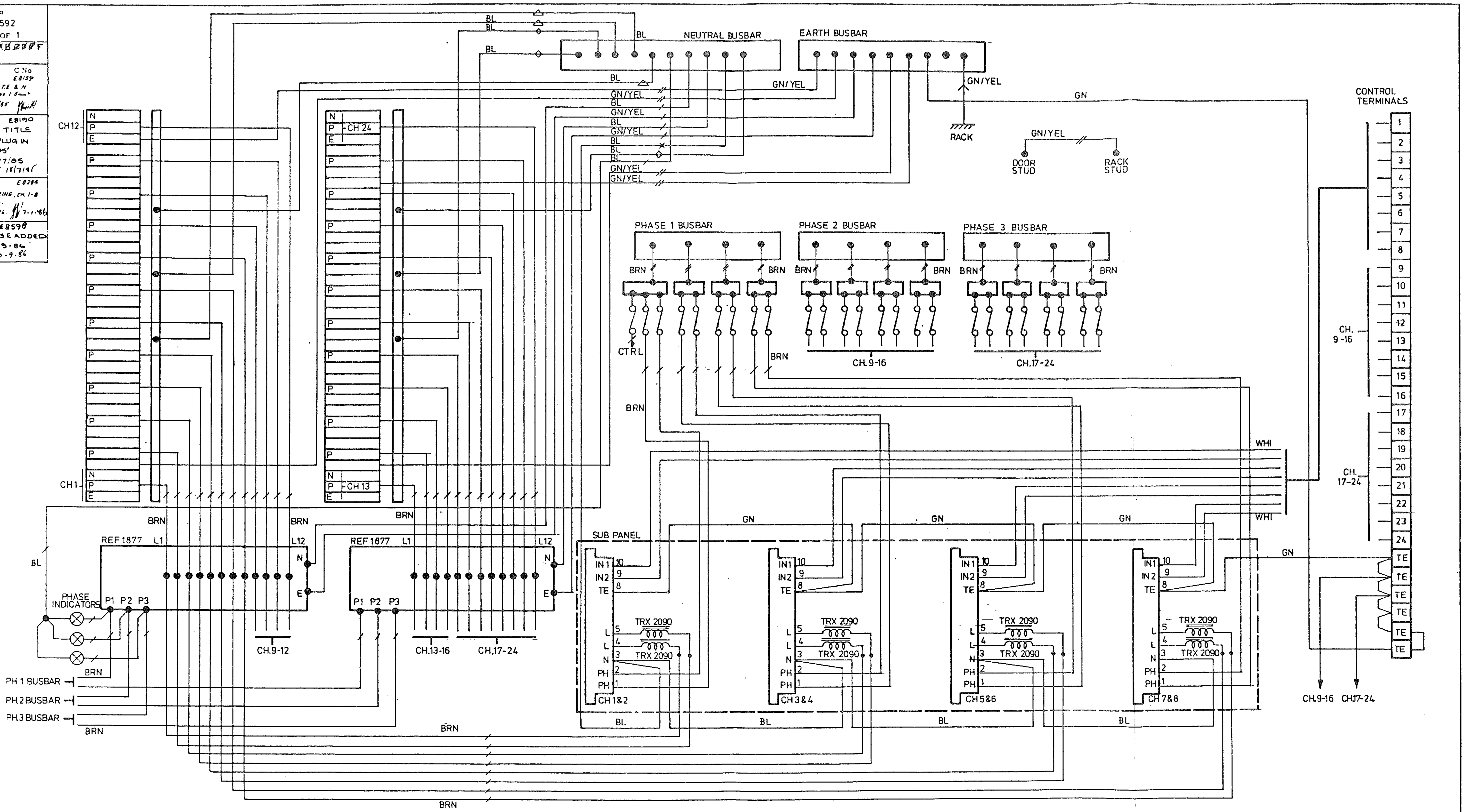
DRG No 7B29592
SH 1 OF 1
ISSUE ~~A B C D E~~ F

REV 1 C No E8159
MODULE T.E & N WIRING WAS 1·5mm²
30/4/85

REV.2 E8190
'PIP' IN TITLE WAS 'PLUG IN PERMUS'
CB 9/7/85
18/7/85

REV 3 E8284
FUSE WIRING, CH 1-8 CLARIFIED.
6/1/86 7-1-86

REV4 E8598
CTRL FUSE ADDED
3-9-86
30-9-86



NOTE
CHANNELS 9-16 AND 17-24 TO BE WIRED
AS SHOWN FOR CHANNELS 1-8 (EXCLUDING CONTROL FUSE)
i.e. CH1=FS1, CH2=FS2, etc.

WIRE SIZES
1·5mm²
2·5mm²
6·0mm²
16·0mm²

3×EQUAL LENGTHS 16·0mm²
3×EQUAL LENGTHS 16·0mm²

ALL OTHER WIRES 0·75mm²

		DATE
DRAWN	P McB	16-9-84
CHECKED		
APPR'D		

Rank Strand Ltd

SCALE	—
DIMENSIONS IN mm	
PROJECTION	
TOLERANCES	
1 DEC PLACE	± 0.4mm
2 DEC PLACES	± 0.1mm
ANGULAR	± 0.25°
UNLESS OTHERWISE STATED	

MATERIAL: —
FINISH: —
FIRST USED ON: IL29607
TITLE: PIP 24 × 2,5KW RACK WIRING
ISSUE ~~A B C D E~~ F
DRG. No. 7B 29592
SH. OF

DRG No 7B 29591
SH 1 OF 1
ISSUE A B C D E F G

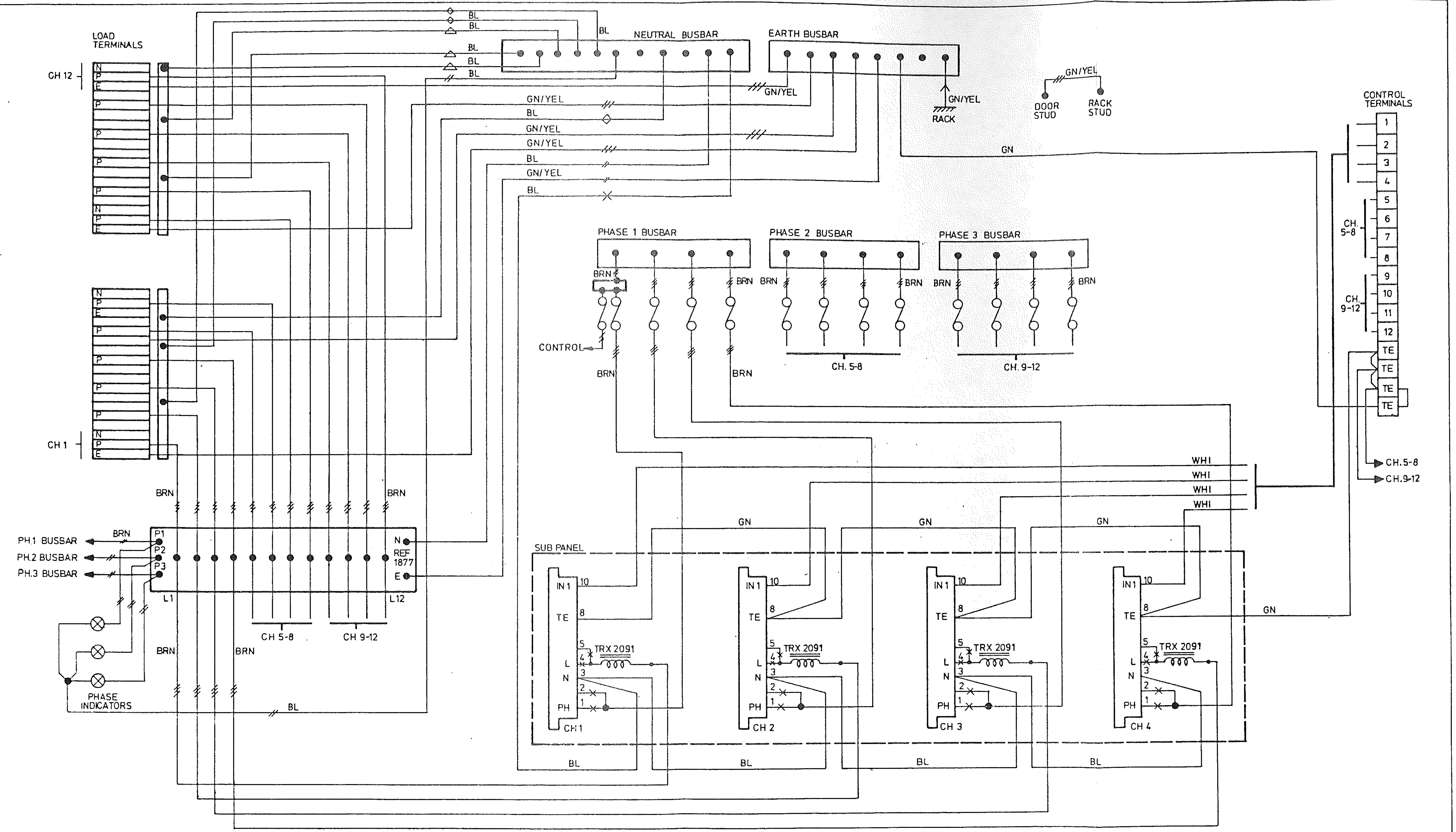
REV 1 — C No E8048 — 1.5mm² WIRE INTO SUB-PANEL CONN^NS WAS 2.5mm²

REV. 2. E8159 — MODULE TE. & N. WIRING WAS 1.5mm² — 26/6/85

REV. 3. E8167 E8190 — GREEN WIRING DELETED AND 'PIP' IN TITLE WAS 'PLUG IN PERMUS' — CB 9/7/85

REV. 4 E8417 — 6.0mm² WIRE DELETED. (NOW 6.0mm²) — 26/3/86

REV 5 E8598 — CONTROL FUSE ADDED — 3-9-86 — 30-9-86



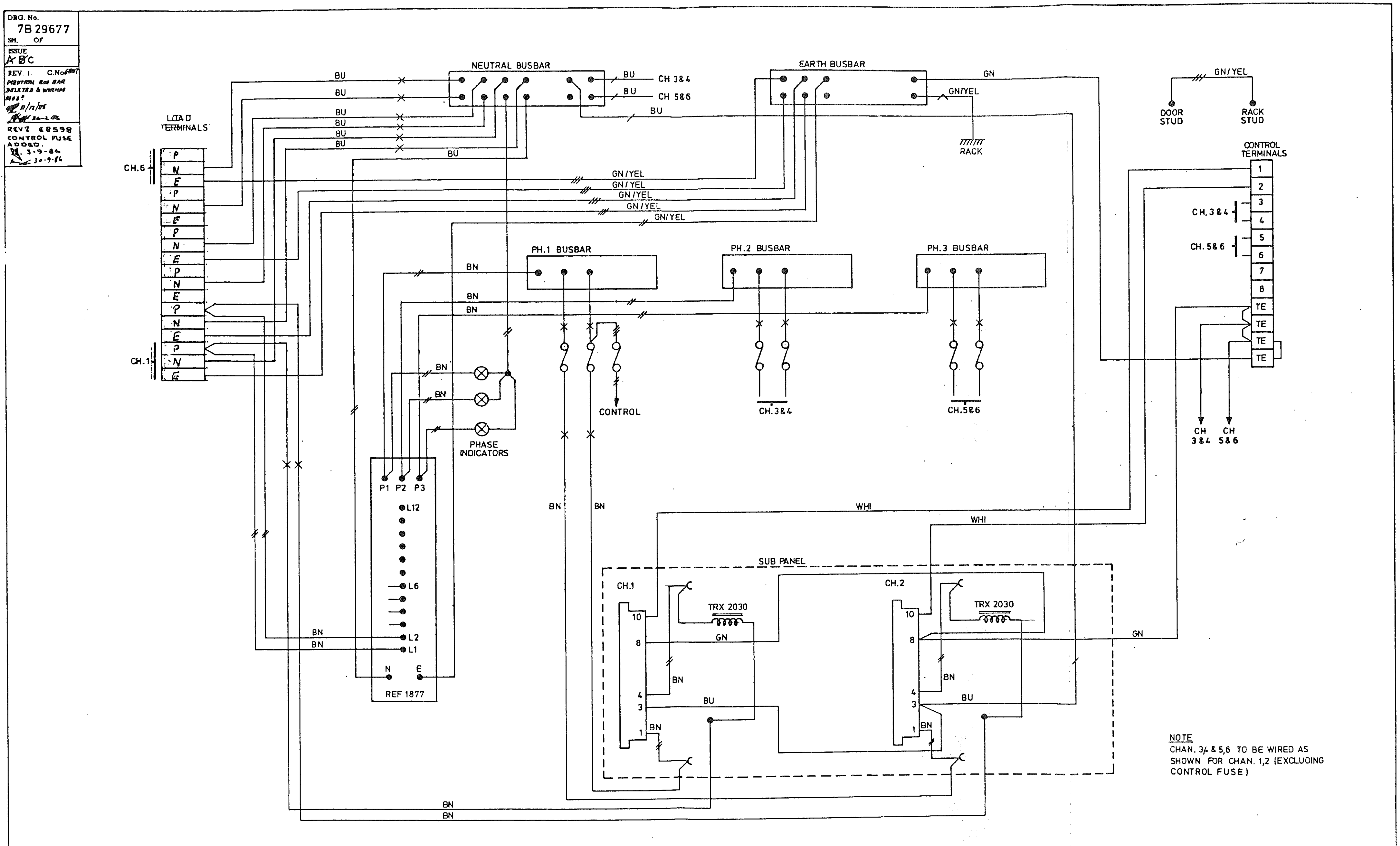
NOTE
1 CHANNELS 5-8 AND 9-12 TO BE WIRED AS SHOWN FOR CHANNELS 1-4. (EXCLUDING CONTROL FUSE)

WIRE SIZES

- 6·0mm²
- 2·5mm²
- 1·5mm²
- 16·0mm²
- 3×EQUAL LENGTHS 16·0mm²
- 3×EQUAL LENGTHS 16·0mm²

ALL OTHER WIRES 0·75mm²

Rank Strand Ltd	SCALE — / DIMENSIONS IN mm / PROJECTION	MATERIAL —	TITLE: PIP 12×5KW RACK WIRING DIAGRAM.
Head Office PO Box 51 Gt West Rd Brentford Middx TW8 9HR Telephone 01 568 9222 Telex 27976 / Factory Mitcheldean Industrial Estate Kirkcaldy Fife KY 3LY	TOLERANCES: 1 DEC PLACE ±0.4mm; 2 DEC PLACES ±0.1mm; ANGULAR ±0.25° UNLESS OTHERWISE STATED	FINISH — / FIRST USED ON IL25G07	ISSUE A B C D E F G / DRG No. 7B 29591 / SH. 1 OF 1



NOTE
CHAN. 3,4 & 5,6 TO BE WIRED AS SHOWN FOR CHAN. 1,2 (EXCLUDING CONTROL FUSE)

WIRE SIZES

- 16·0 mm^2
- 10·0 mm^2
- 6·0 mm^2
- 2·5 mm^2
- 1·5 mm^2

ALL OTHER WIRES 0·75 mm^2

		DATE
DRAWN	KGR	17/5/85
CHECKED		2.12.85
APP'D		12.12.85

Rank Strand Ltd

SCALE
DIMENSIONS IN mm
PROJECTION
TOLERANCES
1 DEC PLACE ±0.4mm
2 DEC PLACES ±0.1mm
ANGULAR ±0.25°
UNLESS OTHERWISE STATED

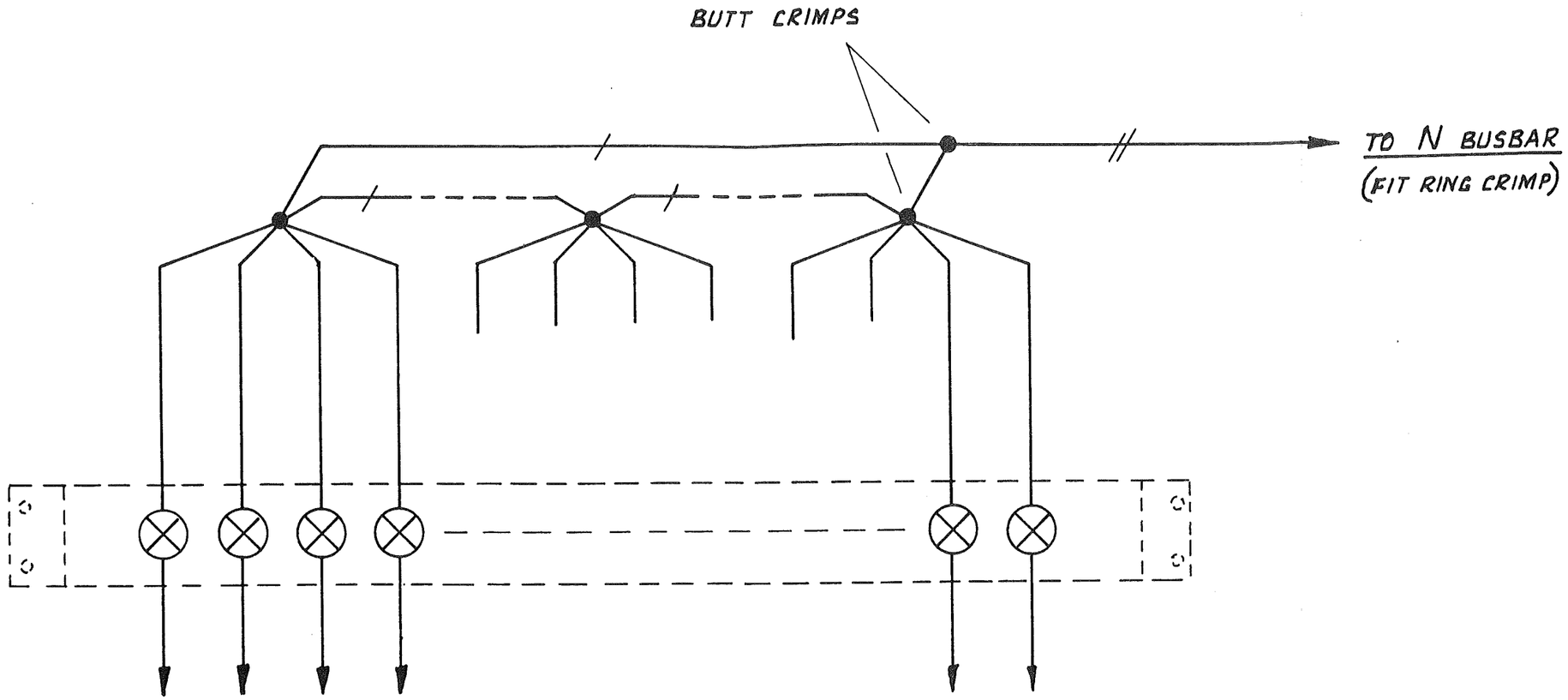
MATERIAL:-
FINISH:-
FIRST USED ON: 1L 29607 P.I.P.

TITLE: 6× 10KW RACK WIRING.

ISSUE ABC

DRG. No. 7B 29677 SH. OF

DRG. No.
7D 29633
SH. OF
ISSUE A
REV. 1. C.No.



TO RACK SIDE OF FUSES.
(FIT CRIMP SPILLS)

1·5 mm²

2·5 mm²

		DATE
DRAWN	V.C.R.	29/11/84
CHECK'D		7-12-84
APPR'D		7-12-84

Rank Strand Ltd
Head Office: PO Box 51. Gt. West Rd., Brentford. Midd'x. TW8 9HR
Telephone 01 568 9222 Telex 27976
Factory: Mitchelston Industrial Estate. Kirkcaldy. Fife. KY1 3LY
Telephone 0592 52333 Telex 72300

SCALE
DIMENSIONS IN mm
PROJECTION
TOLERANCES
1 DEC PLACE ±0.4mm
2 DEC PLACES ±0.1mm
ANGULAR ±0.25°
UNLESS OTHERWISE STATED

MATERIAL:-

FINISH:-

FIRST USED ON:- IL29607
R.I.P.

TITLE:- WIRING DIAGRAM.
FUSE INDICATOR PANEL.

ISSUE A

DRG. No. 7D 29633 SH. OF

H&T PDS 9029

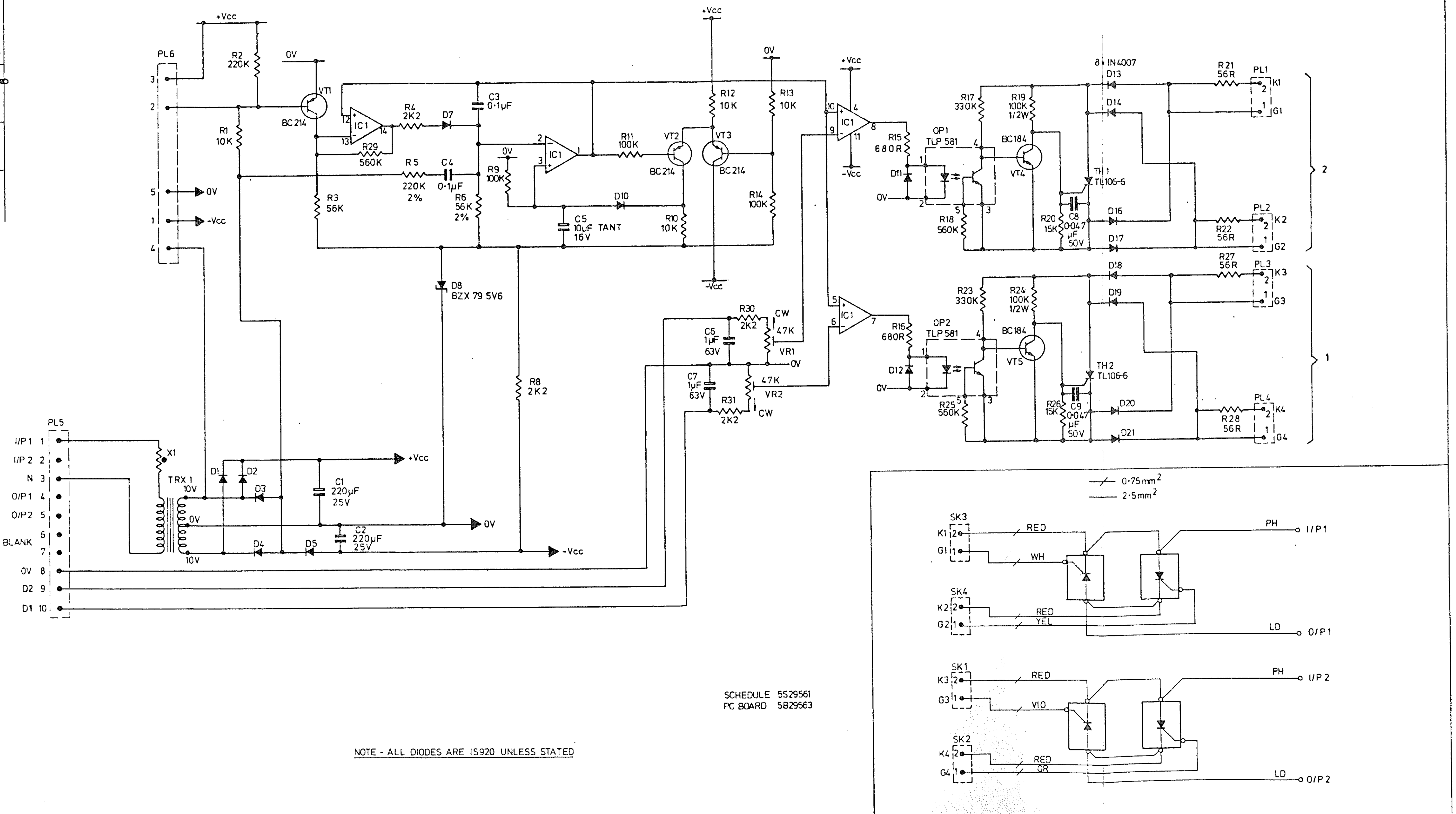
DRG No. 6B 29562
SH. 1 OF 1
ISSUE ~~A B C D E~~ F

REV 1. C No E8082
WIRE COLOURS ADDED.

REV 2. E8284
PL6/9 WAS D1
PL5/10 WAS D2
SK3 WAS SK1
SK4 WAS SK2
SK1 WAS SK3
SK2 WAS SK4
'1' & '2' ADDED ADJ. TO PL3+4, & PL1+2.

REV 3 E8594
R19 & 24: ¼W ADDED
16.8.86
16-10-86

REV 4 E8637
BOARD MOD'D
24 3 87
24-3-87



		DATE
DRAWN	PMcB	22-6-84
CHECKED		6-12-84
APPR'D		

Rank Strand Ltd

SCALE —
DIMENSIONS IN mm
PROJECTION
TOLERANCES
1 DEC PLACE ± 0.4mm
2 DEC PLACES ± 0.1mm
ANGULAR ± 0.25°
UNLESS OTHERWISE STATED

MATERIAL:
FINISH:
FIRST USED ON: IL 29607
P.I.P.

TITLE: DUAL CHANNEL OPEN LOOP TRIGGER CARD

PCB 899/4 REF 1870

ISSUE ~~A B C D E~~ F
DRG No. 6B 29562
SH. 1 OF 1

DRG. No. 6B 29565
SH. 1 OF 1
ISSUE ~~A B C D E F~~ G

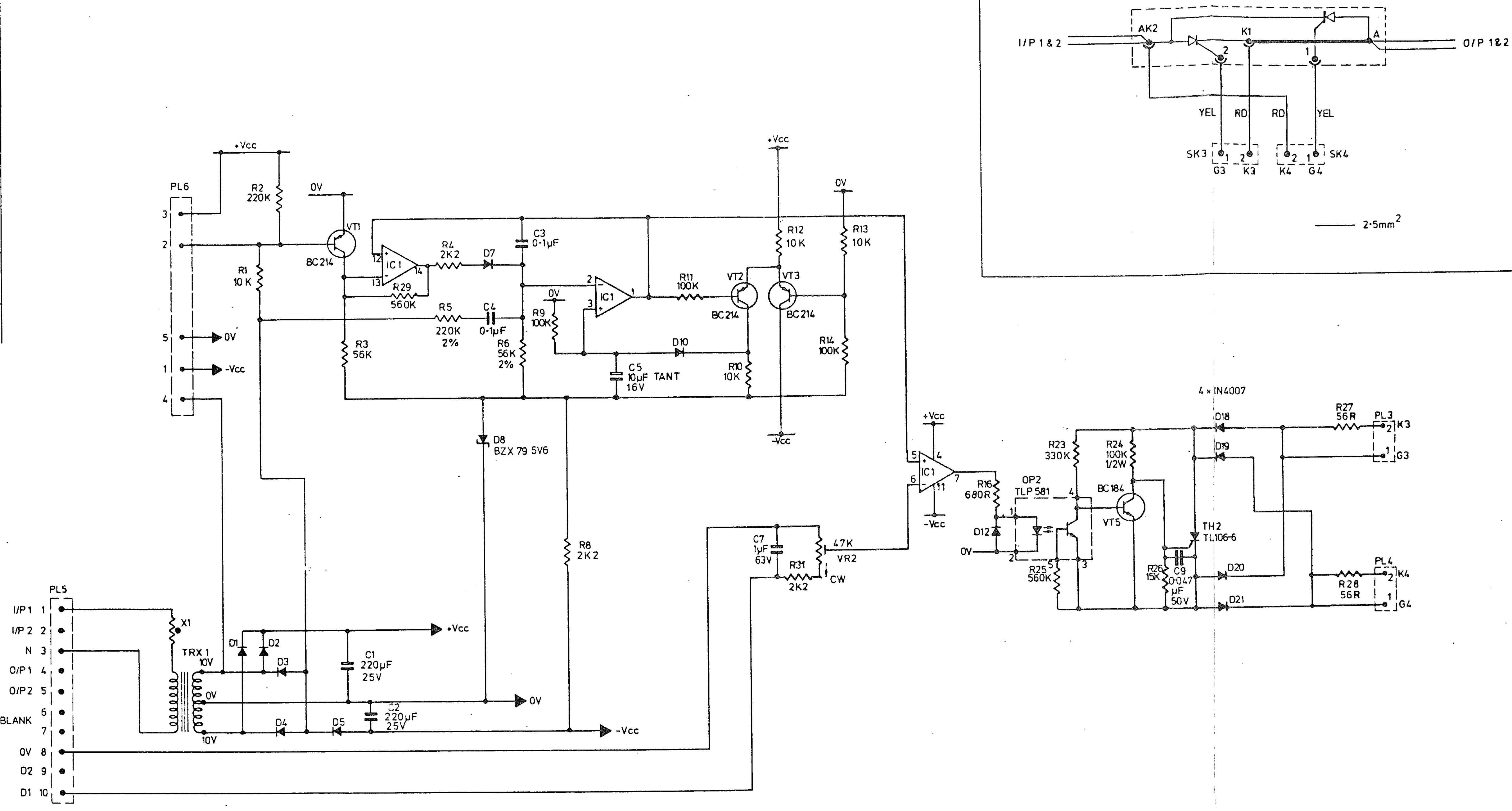
REV. 1. C No. E8083
WIRE COLOURS ADDED

REV 2 E8284
PL6 - LEADS 3 & 1 REVERSED

REV 3 E8401
WIRING TO SK3 & 4 ... 2.5mm² WIRE DELETED

REV 4 E8594
R24: '½W' ADDED
15.8.86
16-10-86

REV 5 E8637
BOARD MOD'D
KCY 24.3.87



SCHEDULE 5S 29564
PCBOARD 5B 29563

NOTE - ALL DIODES ARE 1S920 UNLESS STATED

		DATE
DRAWN	PMcB	22-6-84
CHECK'D		7-11-84
APPR'D		7-11-84

Rank Strand Ltd

SCALE	—
DIMENSIONS IN mm	
PROJECTION	
TOLERANCES	
1 DEC PLACE	±0.4mm
2 DEC PLACES	±0.1mm
ANGULAR	±0.25°
UNLESS OTHERWISE STATED	

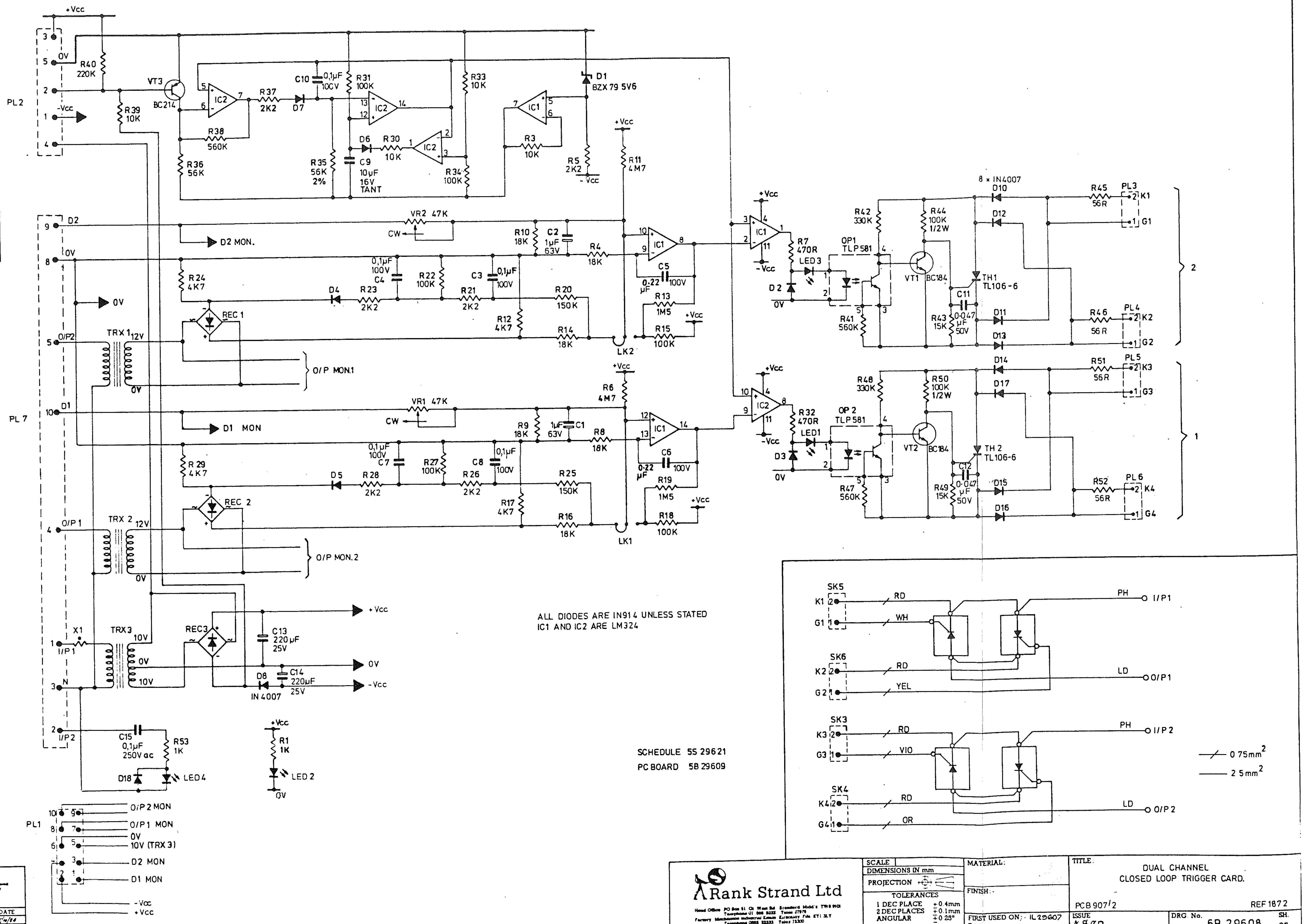
MATERIAL: —
FINISH: —
FIRST USED ON:- IL29607
P.I.P.

TITLE: SINGLE CHANNEL OPEN LOOP TRIGGER CARD
PCB 899/4
REF 1871
ISSUE ~~A B C D E F~~ G
DRG. No. 6B 29565
SH.1 OF 1

DRG. No. 6B 29608
SH. OF
ISSUE A B C D

REV. 1. C No. E8786
PL7/10 was 22
PL7/8 was PL7/5, O/P2
PL7/9 was 21
PL7/6 was PL7/4, O/P1
PL8/8 was O/P1 MON.
PL1/7 was O/P2 MON
PL1/1, PL1/2 LEGENDS REVERSED
PL1/6 was 0V.
PL1/8 was 10V (TRX3)
LED's 1 & 3 REVERSED
SK5 & 4, SK6 & 6 REVERSED

REV 2 E8504
R44 & 50: ½W ADDED
15.8.86
16-10-86



DRAWN		DATE 5/4/84
CHECK'D		23.5.85
APPR'D		23.5.85

Rank Strand Ltd
Head Office PO Box 51 Gt West Rd Brentford Middx TW8 9HR Telephone 01 568 9222 Telex 27976
Factory Manchester Industrial Estate, Kirkcaldy Fife KY1 3LT Telephone 0592 52333 Telex 72300

SCALE
DIMENSIONS IN mm
PROJECTION
TOLERANCES
1 DEC PLACE ± 0.4mm
2 DEC PLACES ± 0.1mm
ANGULAR ± 0.25°
UNLESS OTHERWISE STATED

MATERIAL:
FINISH:-
FIRST USED ON:- IL 29607
P.I.P.

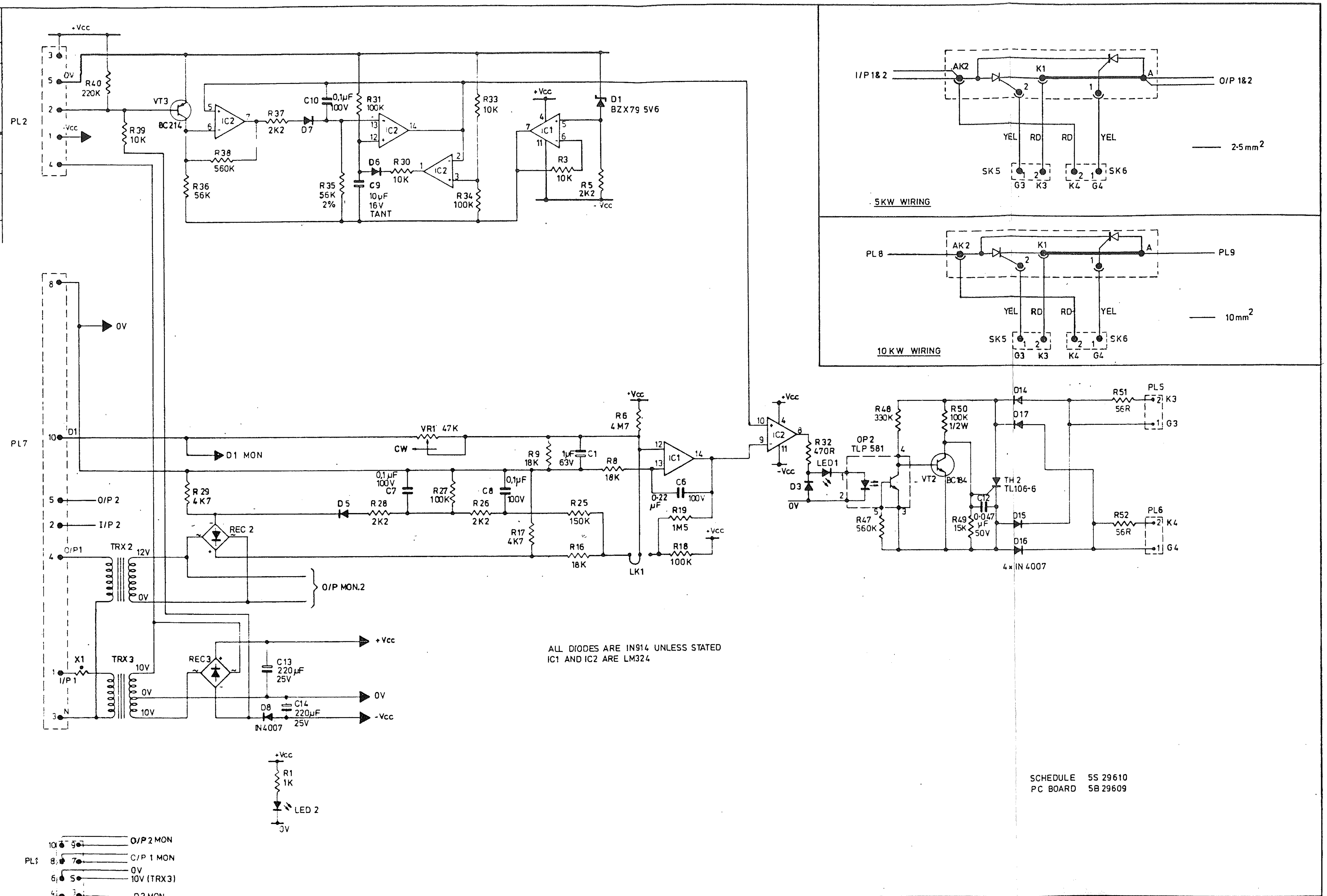
TITLE.
DUAL CHANNEL
CLOSED LOOP TRIGGER CARD.
PCB 907/2
REF 1872
ISSUE A B C D
DRG. No. 6B 29608
SH. OF

DRG No 6B 29611
SH. OF
ISSUE ABCDE

REV 1 C No 59286
PL7/10 - D1 WAS D3. PL7/4 WAS PL7/6 & O/P1 WAS O/P2. PL7/2 & PL7/5 ADDED. PL7/7, PL7/9 LEGENDS REVERSED. PL1/1, PL1/2 LEGENDS REVERSED. PL1/6, PL1/8 WERE 0V. LED1 WAS LED3.

REV 2 E8601
5KW + 10KW WIRING MOD. TO SK5 & 6. 0.75mm² WIRE DELETED.

REV 3 E8594
R50: ½W ADDED
15.8.86
16-10-86

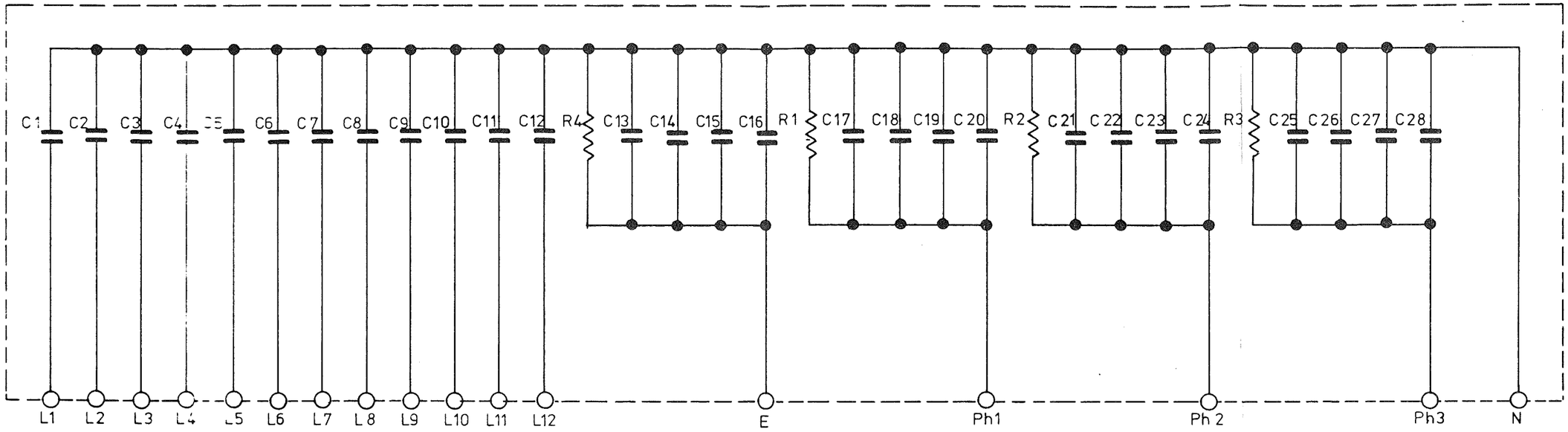


		DATE
DRAWN		5/11/84
CHECKED		23.5.85
APPR'D		23.5.85

Rank Strand Ltd

SCALE	MATERIAL	TITLE SINGLE CHANNEL CLOSED LOOP TRIGGER CARD
DIMENSIONS IN mm		
PROJECTION	FINISH	PCB 907/2 REF 1873
TOLERANCES 1 DEC PLACE ± 0.4mm; 2 DEC PLACES ± 0.1mm; ANGULAR ± 0.25°	FIRST USED ON: IL 29607	ISSUE ABCDE; DRG. No. 6B 29611
UNLESS OTHERWISE STATED	P.I.P.	

DWG. No 6C 25219 ISSUE XXZ3



NOTE

ALL CAPACITORS ARE 0·47 µF 250 Vac

ALL RESISTORS ARE CR 25 330K

SCHEDULE 5S 25220
PC BOARD 5A 25221
} REF 1294

SCHEDULE 5S 29622
PC BOARD 5A 29623
} REF 1877

REV 1 C N°54349 RAISED TO PROD.N° ISSUE 1 C.E.BARNETT 13-4-82
REV 2 E8190 14-6-82 '12 WAY' IN TITLE WAS 'PERMUS' CB 9/7/85 10/7/85
REV.3 E8428 REF. TO REF. 1877 ADDED 18/3/86

RANK STRAND ELECTRIC
P.O. Box 70 Great West Road Brentford Middlesex TW8 9HR
Telephone 01-568 9222 Telex 27976
A DIVISION OF
RANK AUDIO VISUAL LIMITED

DIMENSIONS IN INCHES/MILLIMETRES
THIRD ANGLE PROJECTION

TOLERANCES	
IMPERIAL	METRIC
FRACTION ± 1/64"	1 DEC PLACE ± 0·4 mm
DECIMAL ± ·005"	2 DEC PLACE ± 0·1 mm
ANGULAR ± 0·25°	
UNLESS OTHERWISE STATED	

USED ON :- 1L25700
PERMUS

		DATE
SCALE		
DRAWN	P McB	26-6-80
CHECKED		31-3-81
APPROVED		8.9.81

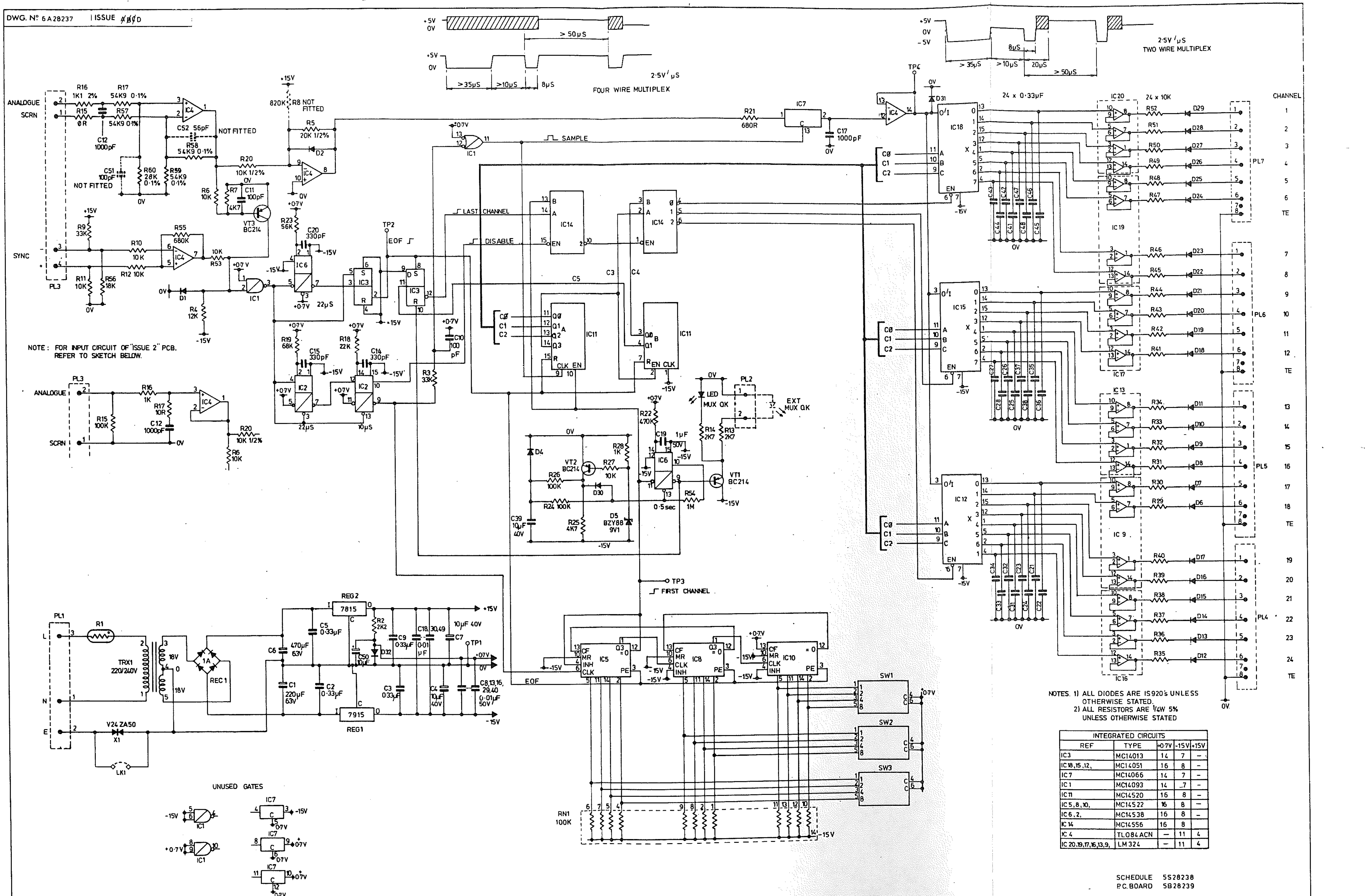
MATERIAL :-
FINISH :-

TITLE :- '12 WAY' RFI CIRCUIT DIAGRAM

PCB 913 REF 1877
PCB 783'1 REF 1294

ISSUE XXZ3 DWG. N° 6C 25219

DWG. Nº 6A28237 ISSUE ~~ABC~~D



NOTES. 1) ALL DIODES ARE IS920's UNLESS OTHERWISE STATED.
2) ALL RESISTORS ARE 1/4W 5% UNLESS OTHERWISE STATED

INTEGRATED CIRCUITS				
REF	TYPE	+0·7V	-15V	+15V
IC3	MC14013	14	7	–
IC18,15,12,	MC14051	16	8	–
IC7	MC14066	14	7	–
IC1	MC14093	14	7	–
IC11	MC14520	16	8	–
IC5,8,10,	MC14522	16	8	–
IC6,2,	MC14538	16	8	–
IC14	MC14556	16	8	
IC4	TL084ACN	–	11	4
IC 20,19,17,16,13,9,	LM324	–	11	4

SCHEDULE 5S28238
P.C. BOARD 5B28239

REV.2. C Nº E 7035 X1 WAS VEGZA8.
REV.3. C Nº E 7102 INPUT CIRCUIT MODIFIED PCBS UP ISSUED.

RANK STRAND ELECTRIC
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A DIVISION OF
RANK AUDIO VISUAL LIMITED

DIMENSIONS IN INCHES/MILLIMETRES
THIRD ANGLE PROJECTION

TOLERANCES	
IMPERIAL	METRIC
FRACTION ± 1/64"	1 DEC PLACE ± 0·4mm
DECIMAL ± ·005"	2 DEC PLACE ± 0·1mm
ANGULAR ± 0·25°	
UNLESS OTHERWISE STATED	
USED ON:- IL 283666	

SCALE	–	DATE
DRAWN	C HAYWARD	25·4·83
CHECKED		
APPROVED		
MATERIAL:-		
FINISH:-		

TITLE:- PERMUS DEMULTIPLEX

PCB 882/3 REF1866

ISSUE ~~ABC~~D DWG. Nº 6A28237