INSTRUCTION MANUAL

'CUEMASTER' 77MKV

PROFESSIONAL TRANSPORTABLE RECORDER

Issue 4

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For machines with deck serial nos. 70011 to 70120

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1. INTRODUCTION

The CUEMASTER 77 MkV professional recorder has been designed to provide operational flexibility and reliable performance. It represents the fifth generation of professional reel to reel transportable recorders.

Packaged as a complete recorder, it offers more facilities and features in a transportable case than many sophisticated studio console recorders.

Technical performance meets or exceeds all broadcasting specifications.

Basic features are:

- Three motor - capstan direct drive two speed
- Three heads - micro azimuth adjustment
- Digital tape timer - minutes and seconds
- Automatic tape tension control - constant tape tension from beginning to end of a reel plus different size reel capability
- Deck controls and amplifier monitoring enable accurate dub editing
- Fully solid state electronics
- Built-in serviceability

The deck is available in full track, two track or stereo configuration with one amplifier unit required for each channel.

2. SPECIFICATION

2.1 Deck Specification

Size	Carry Case	527mm wide, 445mm high, 248mm deep
	Deck	433mm wide, 222mm high, 152mm deep
	Amplifier Unit	433mm wide, 89mm high, 152mm deep
Weight	Deck	16.4kg
	2 x Amplifier Unit	7.3kg
	Carry Case	9.5kg
	Total	33.2kg

Tape size	Nominal ¼ in.
Spool sizes	Cine type 7 ins. (BS 1568/1960) 5 or 3 ins.
Power supply	230 to 250V, 50Hz, 150VA, 117V 60Hz optional
Fuses	AC 1 amp. M205 230V, 2 amp. M205 117V DC 2 amp. M205

Heads - Separate Erase, Record and Play heads. Laminated construction

Tape Timer - Driven directly from the tape. Indicates in minutes and seconds. Maximum time 59 mins. 59 secs.

2.2 TAPE DRIVE

Capstan

Capstan is direct-drive from a hysteresis synchronous motor. Speed change is via a slide switch between the RECORD and PLAY push buttons. Power for the motor is derived from the 220 volt power transformer tap.

Spools

Each spool has an induction motor drive powered directly from the 240 (117) volt power line. Tape tension is automatically controlled by a tension sensing feedback system.

Brakes

The brakes are solenoid operated and dynamically assisted. Actuation noise is eliminated by an adjustable poling pin, which stops the solenoid armature from poling.

Pressure Roller

The pressure roller is solenoid operated. Actuation force is controlled by a poling adjustment, which also eliminates noise.

Head Mount

Each head is mounted in a precision machined one piece brass mount. The head mount has provision for precision azimuth adjustment and a positive lock of the azimuth setting.

Controls

Stop, Play, Edit, Spool, Record, and Power On. Indication of power on is via the stop lamp. A sliding potentiometer for spooling in either direction. A reset button for the Tape Timer Counter. Tape Speed selector switch.

2.3 PERFORMANCE DETAILED SPECIFICATION

2.3.1 Deck

Tape Speed	7.5/15 i.p.s. with 3.75/7.5 i.p.s. as an option
Tape Speed Accuracy	+ .1% − 0% short term + .2% − 0% long term
Tape Timer Accuracy	10 secs for 1,200 feet of tape
Wow and Flutter	Better than 0.08% r.m.s. unweighted at 15 i.p.s. Better than 0.1% r.m.s. unweighted at 7.5 i.p.s. Better than 0.15% r.m.s. unweighted at 3.75 i.p.s.
Starting Time	1 second to meet wow & flutter specifications

	Winding Time	Less than 70 seconds for 1,200 feet of tape
	Equalization	I.E.C., N.A.B. optional
2.3.2	Input Signal	
	Line 600,ohms and Bridge (via tip, sleeve and ring jack)	Balanced -12dBm to 20dBm
2.3.3	Input and Output	
	Line Bridge	600 ohm) Return loss better than 10Kohm) 40dB (30Hz to 16KHz)
	Line Output (via tip, sleeve and ring jack)	+21 dBm maximum level before clipping
	Output matching impedance line monitor	 600 ohm balanced 15 ohm unbalanced
	Output source impedance	100 ohm max. (30Hz to 16KHz) TYPICAL 50 ohm
2.3.4	Replay Characteristics	
	Frequency Response:	
	Using test tape BASF DIN 38S at 15 i.p.s.	30Hz to 18KHz $\pm$ 1dB
	Using test tape BASF DIN 19S at 7.5 i.p.s.	30Hz to 16KHz $\pm$ 1dB
	Signal to Noise Ratio:	
	w.r.t. 320 nw/m - MONO 510 nw/m - STEREO	7.5 i.p.s. 62dB 15 i.p.s. 65dB 62dB 65dB
2.3.5	Sync. Characteristics	
	(Replay from Record head)	
	Frequency Response:	7.5 i.p.s. 30Hz to 8KHz $\pm$ 3dB 15 i.p.s. 30Hz to 16KHz $\pm$ 3dB
	Signal to Noise Ratio:	
	w.r.t. 320nw/m - MONO 510nw/m - STEREO	45dB Play only 30dB Record one channel - play the other
2.3.6	Record Characteristics	
	Gain	20dB
	Record/Replay Frequency Response 7.5 i.p.s. 15 i.p.s.	 30Hz to 16KHz + 2dB 30Hz to 20KHz $\mp$ 2dB

Bias and Erase Frequency	100KHZ ± 1KHZ
Maximum input level	+20dBm
Unity Gain Overall Noise	
Using Ampex 406 tape - bias applied 7.5 and 15 i.p.s.	
w.r.t. 320nw/m - MONO	56dB
510nw/m - STEREO	56dB
Overall T.H.D. unweighted	
Using Ampex 406 tape	
320nw/m - MONO	1.5% max.
510nw/m - STEREO	2% (34dB at 0.2dB over bias @ 1KHz)

2.3.7 Monitor Characteristics

The monitor may be switched to record, replay or bias signals.

Power	2 watt into 15ohm
Frequency Response	30Hz to 16KHz ± 3dB at 2W
Signal to Noise Ratio: Record selected	60dB below 2 watts
Distortion	1% (30Hz to 16KHz) T.H.D.

2.3.8 Line to Line

Frequency Response	30Hz - 20KHz ± 1dB
Distortion 30Hz - 20KHz @ +16dBm	Less than 0.5% T.H.D.

3. OPERATION

3.1 Deck Control

With the deck connected to a 250/230 volts and 50Hz supply (optional 117 volt. 60Hz), and the power switch at the lower left-hand corner turned on, the STOP push button will illuminate.

Five push buttons on the lower right-hand corner of the deck control the various modes of operation. There is provision for remote control of all but the EDIT function.

3.1.1 PLAY may be selected at any time and is cancelled by:

(1) Tape break
(2) SPOOL push button
(3) STOP push button

The PLAY push button will cancel RECORD and override the tape break while actually depressed. When selecting PLAY from SPOOL the tape will automatically come to a stop before the PLAY mode is activated.

3.1.2 EDIT is provided to enable manual handling of the tape for various editing purposes. When selected it will release the brakes.

EDIT sets up 4 conditions of operation:

(1) Can be cancelled ONLY by the STOP push button
(2) Cannot be selected if already in the SPOOL mode.
(3) If previously in the PLAY or RECORD mode, the EDIT push button will release the brakes and inhibit the take-up motor to give bin-editing.
(4) A tape break will not cancel EDIT.

3.1.3. The SPOOL mode can be selected to enable fast spooling in either direction. The direction of spooling is controlled by a sliding potentiometer located next to the power switch.

SPOOL will be cancelled by any of 4 conditions:

(1) STOP push button
(2) Tape break
(3) RECORD push button (selects PLAY, not RECORD)
(4) PLAY push button

SPOOL cannot be selected if previously in the EDIT mode.

3.1.4 RECORD can be selected ONLY if previously in the STOP or PLAY RECORD will be cancelled by any of 4 conditions:

(1) Tape break
(2) PLAY push button
(3) SPOOL Push button
(4) STOP Push button.

For recording, the channel safe switch on the Amplifier Unit must also be switched into the record mode.

If the RECORD push button is pressed while in SPOOL mode, the tape will stop and PLAY will be activated.

3.1.5 The STOP push button cancels any other mode and activates the spool motors for dynamic braking, and causes the capstan motor to run for approximately 90 seconds. If a fast start is required the capstan motor will be running (from the last STOP action) or can be started before PLAY or RECORD is selected, by pressing the STOP push button.

3.2 Amplifier Controls

The amplifier has controls for:

Record/Safe/Lockout
Record levels
Output selector
Output level
Monitor selector
Monitor volume

One amplifier is used for one channel. Thus a stereo or two track deck requires two amplifiers.

3.2.1 Record/Safe/Lockout

This three position switch enables RECORD to be selected on the deck when in the RECORD position. When in the LOCKOUT position the RECORD push button on the deck is inoperative and the machine cannot be placed in the RECORD mode.

When in the SAFE position RECORD mode can be selected on the deck but bias is not applied to the Record and Erase head.

3.2.2 Record Levels

The amplifier has two record inputs, input 1 and 2, which are mixed before recording on tape. The level control knobs control the recorded level for each input. Input one has a tip ring and sleeve input socket on the front panel and a Cannon XLR connector on the side. With a jack inserted into the front panel socket the side connector is internally disconnected. Input two has only the side connector. The CAL position on each knob sets unity gain from input to output when the output level knob is also set in its CAL position and play is selected. When in the CAL position the recorded signal for an input of +16dBm will be 320nwb/m for mono and 510nwb/m for stereo.

3.2.3 Output Selector

The amplifier has two output connectors wired in parallel. A tip, ring and sleeve socket below the Output level control and a Cannon XLR socket on the side panel. A jack inserted into the front panel socket internally disconnects the side panel socket.

The signal that appears on these sockets is selected by the three push buttons beside the output level knob. The three signals are:

(1) PLAY - the signal from the replay head

(2) RECORD - the mixed signal from the record input sockets

(3) SYNC - signal from the record head used in playback instead of the normal record mode.

3.2.4 Output Level

The level control knob beside the output selector push buttons sets the output level when either PLAY or SYNC are selected. When RECORD is selected the output level is set only by the INPUT level controls. When in the CAL position the recorder is set for unity gain as described in Section 6.2.2.

3.2.5 Monitor Selector

This set of three push buttons selects what signal is displayed on the VU meter and amplified by the monitor speaker amplifier.

The three positions are:

(1) RECORD - The signal on the two inputs are displayed to enable adjustment of the input level controls.

(2) PLAY - The signal on the output socket (as selected by the OUTPUT selector) is displayed to allow checking and adjustment of the output level.

(3) BIAS - The bias on the record head is displayed to give a check of continuing correct operation and to enable adjustment of bias level for different types of tape. OVU indication is correct bias level for Ampex 406 tape.

3.2.6 Monitor Volume

The selected signal on the VU meter is also fed to the input of a monitor amplifier which drives a speaker mounted in the case. The volume of this speaker is set by the Monitor Volume Control located above the monitor output socket. If a tip, ring and sleeve jack is placed in this socket, the internal speaker is disconnected and the external speaker on the jack is fed by the amplifier.

3.2.7 Tape Speed

Located on the front panel is a slide switch to select the tape speed. The speed may be changed with the recorder on. The tape counter and record and play equilization are also changed to their correct operating mode by this switch.

3.3 Connections

3.3.1 Remote control

1. Spool lamp
2. Spool push button
3. Record lockout (ground to activate)
4. N.C.
5. Record lamp
6. Ground
7. +24V
8. Record push button
9. +12V
10. Play push button
11. Play lamp
12. Stop push button
13. Stop lamp
14. Wind
15. Rewind

Return push buttons to ground - all buttons are momentary action. Return lamps to +24V, -40MA max each.

Mates with Amphenol 17-20150, with 17-1371, and 17-529.

The WIND and REWIND push buttons are enabled only when SPOOL is selected, and active only while actuated.

3.3.2 Input

Front panel input 1	Tip) Ring)	balanced input 10K ohms
	Sleeve ground	
Side panel input 1 Mates with XL P-3-31	1	ground
	2) 3)	balanced input 600ohms -10Kohms
Side panel input 2 Mates with XLP-3-31	1	ground
	2) 3)	balanced input 600ohms -10Kohms

Both inputs are 600 ohm balanced or 10K ohm bridging selected by a slide switch on the side panel. The front panel input 1 is 10 K ohm bridging only.

3.3.3 Output

Front panel

Tip) balanced 600 ohm output
Ring)
Sleeve ground

Side panel
Mates with XL P-3-32

1 ground
2) balanced 600 ohm output
3)

Power Inlet

L 240V 50Hz active
N 240V 50Hz neutral
E ground

Mates with XLR-LNE-11C

Note: 117V 60Hz optional

Fuses

Mains 240V - 1 amp M205
117V - 2 amp M205

DC 2 amp M205

4. MECHANICAL ALIGNMENT

4.1 Brakes

4.1.1 The 77MkV machine employs dynamic braking to allow differential sized reels to be used on the deck. This is accomplished by allowing the machine to stop under tension control, so that any loop formed during the braking period is sensed as a loss of tension and the appropriate motor has additional voltage applied to it to remove the offending loop. Note that the dynamic braking period is set to 2 seconds after which time, the spooling motors are switched off. The dynamic braking period is reactivated whenever the STOP button is pushed.

The brakes are of the differential type, i.e. the braking torque in the "take-up" direction is approximately one-half the torque in the other direction. This is normally sufficient to stop equal sized reels, but when using differential sized reels, the inertia difference between the reels can exceed a 10:1 ratio, so that without dynamic assistance, tape spillage could occur. For mechanical adjustment of brakes, refer to figure 1.

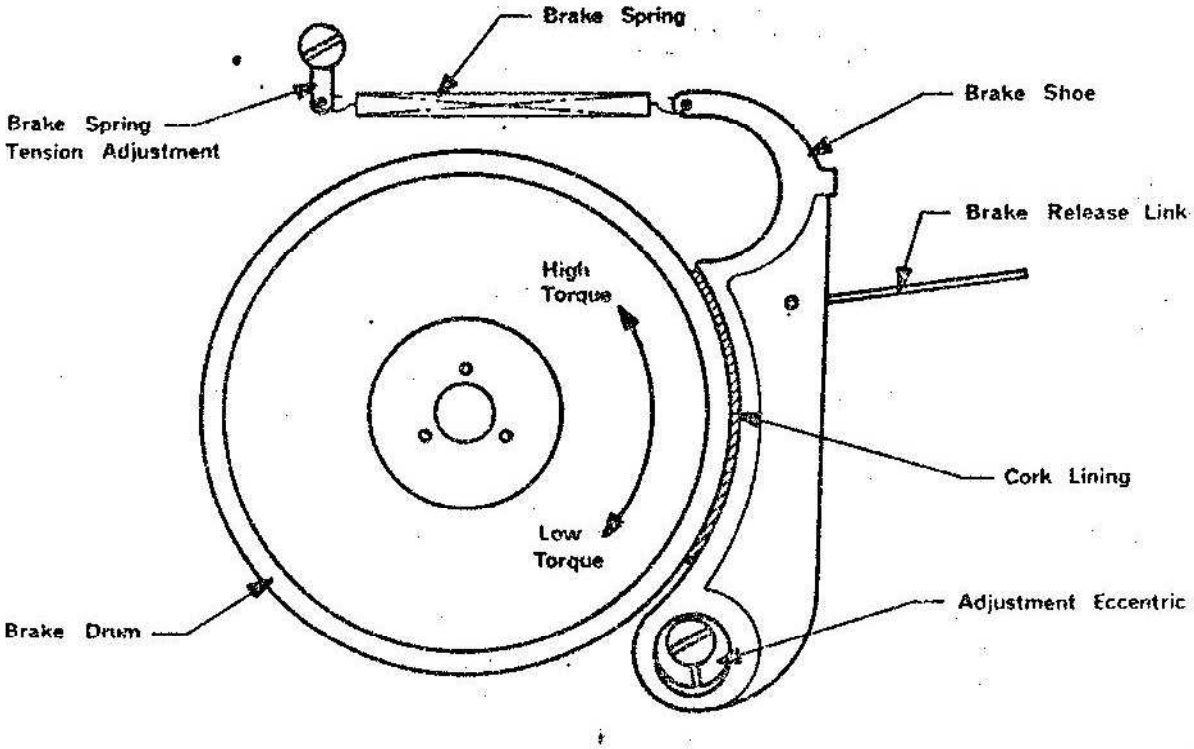


FIG. 1. BRAKE ADJUSTMENTS

4.1.2 Check differential torque on the brake drum. There should be at least a 2:1 ratio. If no significant difference is felt, adjustment of the eccentric is indicated, viz. slacken the lock screw and rotate the eccentric until the heel of the cork lining (nearest the eccentric) just touches the brake drum. Nip the lock screw and check differential torque. A slight variation of the eccentric may be needed to optimise the differential torque. When satisfied, tighten the lock screw.

Note that the eccentric mating hole in the brake shoe is slightly oval in the vertical direction to allow the brake shoe to move in this plane, so that when supplying tape, the shoe is driven away from the eccentric, causing the heel (lower) of the shoe to contact the drum (high braking torque) and when accepting tape the shoe is driven towards the eccentric causing the toe (upper) of the shoe to contact the drum (low braking torque).

4.1.3 Without tape being loaded, push the STOP button. The drums should rotate even though the brakes are activated. Rotate the sensor arm beside the stabilizer roll until the sensor transformer is half covered. The drum should stop rotating. If this is not the case, adjust the brake spring adjustment tag to increase or decrease the braking torque.

Note that the STOP button only activates the dynamic brakes for 2 seconds, so that the STOP button must be repeatedly pressed while testing this function.

4.1.4 After realigning the brakes, check that the release mechanism works satisfactorily, viz. select EDIT mode (releases brakes) and check that the brakes release completely, and hubs rotate freely. Select STOP mode and check that the brake release links are free in the mating hole in the shoes.

If the brakes fail to release either bend the release link to absorb excess slack, or check that the solenoid "poling" adjustment (eccentric "DELRIN" cam on the rear of the deck near the brake solenoid) is correctly set.

This adjustment prevents the solenoid from poling, and hence reduces the audible noise resulting from poling. It is adjusted by releasing the cam lock screw and manually pushing the solenoid "home", then rotating the cam until the cam and the brake solenoid lever arm touch. Rotate the cam slightly further so that the solenoid is just off poling (about 0.25mm or 0.010 inch). Lock the cam locking screw and readjust the brake linkages.

Note total solenoid travel should be less than 2mm (0.08 inch) to minimize acoustic noise.

4.2 Pressure Roller Solenoid

4.2.1 The pressure roller solenoid is also designed to be acoustically quiet and hence must be adjusted so that it does not pole. Refer to figure 2 for adjustment points.

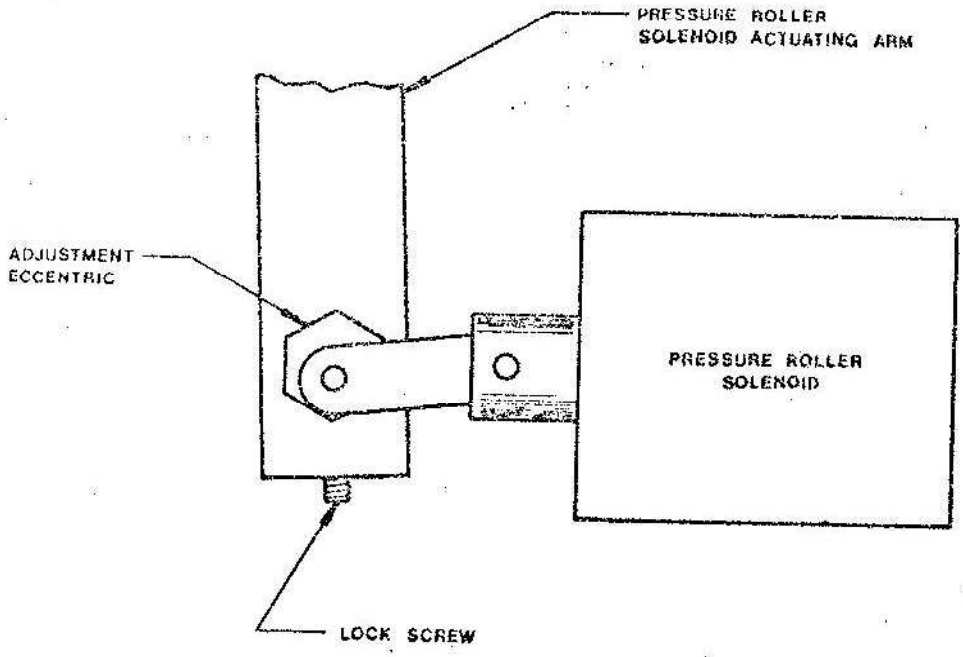


FIG. 2 - PRESSURE ROLLER SOLENOID ADJUSTMENT

4.2.2 Check that when starting the transport the solenoid noise is quiet and the pressure roller force is between 2 and 3 kg. (4 - 7 lbs.). Force is checked by pulling of the pressure roller off the capstan with a spring balance. When tape movement stops the balance indicates the pressure roller force. Note that this check is made with the supply spool empty and the take-up spool full.

Pressure roller force is altered by releasing the locking screw on the solenoid actuating arm and rotating the solenoid adjustment eccentric until the required force is obtained.

Note that if the solenoid "poles", the adjustment has been taken too far.

4.2.3 The tape lift arm is set so that when spooling with the EDIT control disengaged the tape clears the play and record heads by approximately 2mm.

4.3 Tape Path Alignment.

4.3.1. Remove the two tape guides between the Erase and Record heads and between the Replay head and capstan motor. Thread a tape and select PLAY mode. The tape should track centrally across each head. If this is not the case adjust the stabilizer roll heights by changing the shims below the roller bearing. Note that if a shim is removed it should be added to the top of the roller bearing.

4.3.2. Adjust the height of the brake drums to place the tape centrally on the spool.

4.3.3. Repace the two tape guides and check that the tape rides centrally without touching the edges of the guides.

4.4. Tape Tension Setting.

4.4.1. With sensor arms in normal play position (about 3mm deflection), measure the spring return force at the sensor. It should be 8 gm $\pm$ 2 gm and have a hysterysis less than 2 gm (Hysterysis is the change in force required to reverse direction of motion of the sensor arm).

4.4.2. With the sensor covers in place and a full reel of tape on the machine measure tape tension between reel and sensor arm with equal tape on each reel. Adjust RV1 + RV2 on the spooling board to give 40gm of tension. If a tentelometer is not available adjust for 3mm deflection of the tape path.

4.4.3. Check tension at beginning and end of both reels. It must be 45gm $\pm$ 15gm

4.4.4. Place M/C in vertical plane and re-check tension. A 15% variation is normal but should not result in the tape tension exceeding the limits of min 30gm. to a max 60gm.

4.5 Capstan Motor Replacement

If a capstan motor is removed care should be taken in replacement. The motor shaft must be perpendicular to the deck. The spacers used to mount the motor are machined to a tolerance of $\pm$ 0.001 inch, and the same spacers should be used when replacing the motor. Capstan out of square is indicated by tape warp in the area of the capstan. Severe misalignment is evidenced by tape running up or down the capstan and escaping the grip of the pressure roller.

4.6. Spool motor check and lubrication

4.6.1. To check a spooling motor run the motor at full speed without a tape reel in the SPOOL mode. Manually hold the brakes off and press the STOP button. The motors should run on for at least ten seconds. Shorter stopping times indicate bearing friction and the need to lubricate the bearing.

4.6.2 To lubricate a motor remove it from the deck by undoing the four retaining screws on the top of the deck. Remove the four screws from the front of the motor and pull off the front end bell housing. Remove the four screws in the end bell housing and lift it off the plate to expose the felt oil reservoir pad and bearing. Lift out the rotor and shaft assembly and winding from the rear end bell housing.

Note: The motor shaft is mounted on a single ball bearing.

Remove the four screws in the rear end bell housing and lift off the plate to expose the felt oil reservoir pad and bearing.

Saturate both felt oil reservoirs with Shell G960 oil, or an equivalent high grade light spindle oil.

Reassemble the motor in the reverse order of disassembly. After reassembling the motor tap the housings radially to realign the bearings.

4.7 Head Replacement

4.7.1 To remove any of the three heads slacken its azimuth locking screw and then the small allen head grub screw on the azimuth arm. Draw the head forward. To remove the Replay head the pop-up hum shield must first be removed. This is achieved by pulling the shield up off the post. The post is removed by rotating it 90 degrees and lifting up.

4.7.2 Replacement is the reversal of removal. Take care to align the gap perpendicular (by eye) before tightening the azimuth arm locking grub screw.

4.7.3 The location of the head mount blocks is not critical and has been factory set and should never need to be disturbed. If the blocks are moved several checks can be made to ensure that they are still at their optimum positions.

4.7.4 The Replay head position is set to give equal angle tape wrap on each side of the gap. A visual check gives satisfactory accuracy. The actual total wrap angle can best be optimised while playing the azimuth section of a BASF DIN 19S test tape. Adjust the azimuth for peak output. If the output level can be increased by increasing the tape tension by holding back the supply reel, then either the tape tension is too low, or the Replay wrap angle is insufficient. Check tape tension as per section 4.4. If holding back the supply reel to increase tape tension now produces an increase in output level by more than 0.5dB the wrap angle is insufficient. Move the Replay head mount forward. A point will be reached at which forward movement produces no further increase in output. At this position the level will also display an increased steadiness.

4.7.5 The Record and Erase heads are less critical than the Replay head and should give adequate performance when set within the tolerance of the head block mounting screws.

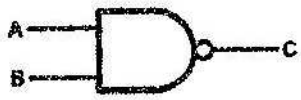
5. CIRCUIT DESCRIPTION

5.1 Deck Control Logic -- Refer drg. 23-879

The deck control logic circuits control the correct operating sequences of the deck, and ensure that undesirable operating states cannot occur. It consists of five bistable memories to store commands from the push buttons, solenoid drivers, capstan motor timer, dynamic brake timer, and interlocking logic.

The two basic logic elements used in the circuit are CMOS NAND and NOR gates operating on a +12V supply.

NAND GATE



$C = \overline{A \cdot B}$

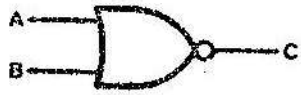
Truth Table

A Input	B Input	C Output
0	0	1
0	1	1
1	0	1
1	1	0

By De Morgan's Law:

If all inputs are 1, the output will be 0
or if any input is 0, the output will be 1.

NOR GATE



$C = \overline{A + B}$

Truth Table

A Input	B Input	C Output
0	0	1
0	1	0
1	0	0
1	1	0

By De Morgan's Law:

If all inputs are 0, the output will be 1
or if any input is 1, the output will be 0.

NOTE: Either type of gate, with all inputs connected together, acts as an Inverter.

Each of the bistables consists of a two input NOR gate and a transistor. The EDIT bistable is described in detail. U1/8 is normally high via R19 and R21. U1/9 is normally low. Thus U1/10 is low and transistor Q5 is off, and its collector is high, maintaining the high drive to U1/8.

Pushing the EDIT push button takes U1/8 low and since both inputs to the NOR gate are now low, its output U1/10 goes high which immediately turns on Q5 into saturation. Q5 collector going low takes U1/8 low through R19. This positive feedback through R19 holds U1/8 low even after the push button is released. Thus the bistable is in a stable condition as long as neither input to the NOR gate is forced high. Q5 being low is used to control deck functions in line with EDIT requirements.

To reset the bistable the condition of both inputs low on the NOR gate must be changed. Either input going high will force the output U1/10 low, Q5 will turn off and allow U1/8 to go high and so maintain the reset condition. This resetting action comes from U3/8 which is normally low and goes high when deck conditions necessitate the resetting of the EDIT bistable.

Note that the NOR gate is powered from a +12V supply and R19 will place +24V through R21 on input pin 8. This does not exceed the absolute maximum rating of the device since all gate input pins have internal diode clamps to ground and +12V. Thus the actual voltage appearing on the input will be +12.6V and the diode will conduct approximately $\frac{11.4V}{100\ K}$ = 114 micro amps to the +12V supply.

5.1.1 Play Mode

PLAY mode is selected by setting two consecutive bistable memories. The output of each bistable controls different elements on the deck to implement tape playing.

(a) The first bistable is formed by U1/1,2,3, and Q1. Pressing the PLAY push button sets the bistable if the reset input (U1/3) is low.

Resetting action occurs when U3/3 is forced high by either the STOP or SPOOL push buttons or the TAPE BREAK switch making, and causing U3/2 or U3/1 to go low.

Once this bistable is set, U1/1 turns on the spooling and capstan motors through Q7 and Q6 respectively.

(b) The brake and pressure roller solenoids, the play lamp, and the pulse start to the spooling motor control board will not be energised until the second bistable, formed by U1/4,5,6 and Q2, is set.

The bistable is set by the motion sense input, from the tape timer board going low, and reset by the output of the first PLAY bistable going high. That is, set at U1/5 and reset at U1/6. Once the first bistable is set, the second will be set when tape motion ceases and the motion sense line on the logic board edge connector pin 14 goes low.

When this occurs, 3 events take place simultaneously:

(i) U1/4 provides a pulse start to the spooling board through Q8

(ii) U6/8 energises the brake solenoid through U4/12, Q9 and Q12

(iii) Q2 collector energises the pressure roller solenoid through Q11 and also turns on the PLAY push button lamp

(c) U3/3 goes to the TAPE TIMER board via the LOGIC board edge connector pin 6 and artificially creates a "no motion" signal (low) on the motion sense line (pin 14) when either SPOOL, TAPE BREAK or STOP contacts are made.

SPOOL and TAPE BREAK have no effect on the overall performance in this circuit but the STOP push button creating an artificial "no motion" state, allows alternate STOP-PLAY button pushing which would normally be inhibited by the built-in delay in motion sensing (½ sec. after motion stopped).

(d) The PLAY push button resets the SPOOL bistable through U6/2.

5.1.2 Stop Mode

(a) When the STOP push button is pushed, U4/10 going low sets the monostable multivibrator formed by U1/11,12,13 and U4/8,9,10,11. This monostable is reset by U3/11. The monostable output turns on Q7 to run the spooling motors and also provide dynamic braking. The period is set to be just longer than the worst case braking time (approximately 2 seconds).

NOTE: The PLAY push button also sets the brake timer. This is necessary when going directly from SPOOL mode to PLAY mode without selecting STOP as an intermediate step.

The timer is reset by U3/11 charging the timing capacitor quickly through CR14. Either the SPOOL or EDIT push buttons will reset the timer. This is necessary since both these modes can be selected regardless of tape motion, and if selected during dynamic braking will give incorrect tape behavior.

(b) The STOP button resets the PLAY, RECORD and SPOOL bistables through U3/1, U5/2 and U6/1 respectively (wired OR through CR7 with U5/8, which is the tape break).

(c) It also resets EDIT directly through U3/10 and sets the capstan motor timer formed by U3/4,5,6 and U2/11,12,13. This timer keeps the capstan motor running for approximately one and a half minutes through Q6. If, during the one and a half minute period, the STOP button is pushed again, CR6 discharges the timing capacitor C10 so the timing period commences from zero again.

(d) The STOP lamp is illuminated through Q10 when U4/3,4 and 5 are all high. This state is realized when neither PLAY, SPOOL nor EDIT modes are active. This condition includes RECORD since RECORD cannot be active without PLAY first being selected.

5.1.3 Record Mode

The record bistable is formed by U2/4,5,6 and Q3.

(a) The RECORD push button takes U2/5 low to set the RECORD bistable and U1/2 low through CR11 to set the first PLAY bistable. When the motion sense line goes low indicating no tape motion, the second PLAY bistable is set. U1/4 which is normally low holds the RECORD bistable reset through U5/5 and enables the bistable to be set when it goes high.

(b) The SPOOL bistable is reset through U6/4 when the RECORD push button is pushed. Q3 going low illuminates the RECORD lamp and starts the bias oscillator in the amplifier chassis.

(c) The RECORD LOCK-OUT switch in the amplifier chassis holds the RECORD bistable reset through U5/1.

The PLAY push button also resets the RECORD bistable through U5/4.

5.1.4 Spool Mode

The SPOOL bistable is formed by U2/1,2,3 and Q4.

(a) The SPOOL bush button sets the bistable through U1/8. The bistable is reset by the following:

(i) PLAY push button through U6/2

(ii) RECORD push button through U6/4

(iii) STOP push button and tape break through U6/1

(iv) It is held reset by the EDIT bistable output Q5 through U6/5. This resetting action ensures that SPOOL cannot be selected once EDIT is active

(b) The collector of Q4 is low when SPOOL is selected and earths the wiper of the SPOOL control potentiometer enabling control of tape motion left and right.

(c) Q4 collector also holds the EDIT bistable reset through U3/9 so that once in SPOOL, EDIT cannot be selected. U2/3 energises the brake solenoid through U4/2 when SPOOL is active.

5.1.5 Edit Mode

(a) The EDIT push button sets the EDIT bistable through U1/8 which in turn energises the brake solenoid through U4/13.

(b) Q5 collector (low) inhibits the take-up motor through CR 16 so that when PLAY is also selected a "BIN EDIT" control is achieved.

(c) The bistable is held reset by SPOOL through U3/9 and the STOP push button through U3/10.

(d) The tape break switch does not reset EDIT. If the machine is in the "BIN EDIT" mode the tape break switch will reset the PLAY bistable and set the machine back to the EDIT mode.

5.1.6 Tape Break

A tape break (tape break-switch closed) must remove all modes of operation except EDIT.

U5/8 goes low when the tape break switch makes and resets all mode bistables through U3/1, U5/2 and U6/1. U5/8 will not go low if either the PLAY, RECORD or SPOOL push button is selected. This control is through U5/9, U5/12 and U5/10 respectively, and enables the three push buttons to override the tape break.

5.2 Monitor - Ref. drg. 23-1332

The signal selected by S5 to be displayed on the VU Meter is amplified by Q1 and Q2, which form a wideband (flat to 300KHz) class A amplifier with a closed loop gain of 10. The collector of Q2 drives the VU Meter through R11 and drives the monitor volume potentiometer direct. The wiper of the monitor volume pot drives the monitor speaker amplifier formed by Q3 to Q9. Q3 and Q4 are a high gain darlington input buffer driving the power drivers Q6,Q8 and Q7,Q9. Q5 provides D.C. bias to eliminate cross-over distortion in the output stage. Gain is set at approximately 20 by R12 and R14.

5.3 Spooling Motor Control - Ref. drg 23-1330

Control of the two spooling motors to provide correct operating and braking tension, and wind and rewind speed, is achieved by two tension control systems sensing tape tension, and controlling the spooling motors through a transistor in a bridge rectifier in series with the motor.

The take up and supply motor circuits are almost identical so only the take up circuit is described.

Transistor Q1 and transformer T5 form a tuned collector oscillator with a fixed frequency of approximately 170KHz.

The transformer T5 is mounted on the deck below the tape arm. As tape tension changes, the tape arm swings across T5 to change its "Q". The changing "Q" adjusts the output level on the secondary S2. Thus tape tension is directly proportional to S2 output voltage. The oscillator oscillates only when Q1 emitter is earthed through diodes CR1 to CR4.

Secondary S2 is rectified and filtered by CR9 and C3, and this level drives the base of Q3 which is in series with the motor via a bridge rectifier formed by CR11 - CR14. Thus Q3 controls the motor current and therefore, the tape tension to hold the tape arm at the preset position over the sensing transformer T5. C5 and R8 provide feedback on Q3 to provide a clean sinusoidal current waveform to the motor. C7, 8 and 9 are the phase lead capacitors for the motor start winding.C13 protects Q3 from mains transients.

When PLAY is selected, pin 12 on the spooling motor control board is grounded and forward biases CR4 and CR7. Thus the oscillators begin oscillating and turn on the motors. For about 100 millisecs after play has been selected, pin 8 is held to ground, forward biasing CR1 and CR5. This causes the oscillators to provide maximum base drive to Q3 for the 100 milliseconds regardless of the position of the tape arms, and thus give a full 240V drive to the take up motor. R17 in series with CR5 reduces the level of this pulse drive to the supply motor. This high torque pulse gets the tape up to speed quickly and reduces initial tape bounce and flutter. RV1 and RV2 control the preset tension on the spooling motors.

After the STOP button is pressed, pin 12 is held at ground for approximately 2 seconds, and forward biases CR4 and CR7. This provides dynamic braking drive to the motors while the brakes are applied, but removes the drive after the tape is stopped, 2 seconds being longer than the worst case stopping time.

When SPOOL is selected the wiper of the spooling potentiometer is grounded. Shifting the pot left(right) places less (more) resistance in series with CR6 (CR2) through pin 13 (7) and the supply (take up) oscillator increases (decreases) in output to move the tape left (right) onto the supply (take up) reel. To provide a large neutral area in its mid position, the pot is large in resistance so neither oscillator runs in the pot's centre area. To provide a controlled minimum tension when passing through this mid position pin 9 is also grounded to maintain both oscillators running in the normal constant tension mode, through CR3 and CR8.

Selecting EDIT disables the take up motor by grounding pin 4 and hence the base of Q1. The motor is disabled so that when EDIT and PLAY are selected together a BIN EDIT mode results.

5.4 Capstan Motor Control - Ref. drg 23-1326

The capstan motor runs when Q6 on the deck logic PCB earths the LED in PC1 and causes approximately 22mA to flow through it, illuminating the LDR (light dependent resistor) in the optical isolator, which drops from many mega-ohms to below 50K ohms. C3 and diac DC1 then go into a relaxation oscillation mode and turn on triac TC1. The triac is turned on during the zero crossing of the load current due to the leading voltage on the diac caused by C2. This action produces a clean spike-free switching for the motor current. R3 and C4 remove the possibility of false firing of the triac by suppressing transient voltages caused by the back E.M.F. of the motor. C5-C8 are the phase lead capacitors for the start winding of the motor.

When current is not flowing in the LED the LDR in the optical isolator is many mega-ohms in resistance and does not allow any voltage to appear on the diac. Thus the triac does not conduct, and the motor does not run.

Two speeds can be selected via the tape speed select switch.

(1) High speed - earthing the switch (i.e. energising both relay A and B)

(2) Low speed - opening the switch

The relay contacts switch the motor windings to give a 6 or 12 pole configuration. The high speed requires more torque and therefore, more phase lead capacitance (by switching in another 0.47uF capacitor C1) for the start winding of the motor.

5.5 Power Supply - Ref drg. 23-1109

The 31 volt secondary of the power supply transformer is rectified by BR1 and filtered by C1 to produce 40 volts. This is fused by F1 and then used to drive the two solenoids and the 24 volts regulator.

The 24 volt regulator uses three transistors to accomplish regulation.

Zener diode CR1 forms a stable 12 volt reference connected to the emitter of Q3. The output voltage is sampled by a resistive divider R5 and 6, and compared with the reference. The difference is amplified by Q3 and used to drive Q2 and Q1 which turn on or off to reduce the difference to zero. If the output were to fall, the divider R5 and R6 would sense the fall and remove base drive from Q3. This reduces the collector current of Q3 and, hence more of the current being supplied by R1 and R3 goes into the base of Q2, which, in turn, increases the drive to Q1. Q1 turns on further to restore the original output voltage and reduce the difference between reference voltage and sampled voltage.

R2 in series with Q2 collector limits the base drive to Q3 so if the output is shorted, the short circuit current is limited to a safe level before the fuse blows.

Unregulated voltage	35 to 45 V
Regulated voltage	24 V
Maximum output current	1 amp
Short circuit current	3 to 5 amps
Regulation at 1 amp	50 millivolts
Ripple at 0.2 amp	5 millivolts peak to peak
DC fuse	2 amp M205
AC fuse	1 amp M205 - 240 V 2 amp M205 - 117 V

5.6 Replay Amplifier

- Ref. drg. 23-1337

Transistors Q1, Q2 and Q3 form a low noise DC coupled equalized preamplifier with a mid band gain of approximately 40dB. Speed equalizator networks are selected by earthing the gates of field effect transistors Q4 or Q5. RV2 (RV4) provide independent level adjustments for the low (high) speed and RV1 (RV3) provide independent high frequency compensation adjustment for the low (high) speed.Resistor R15 (R16) sets the low frequency for the low (high) speed.

The output of the preamplifier is wired to the front panel OUTPUT potentiometer. The input to the program amplifier is switch selectable to be the output of the preamp (in PLAY and SYNC modes) or the RECORD input. This input has an OVU nominal level of -15dBm for PLAY and RECORD switch settings and -35dBm for SYNC switch selection. The input is driven through a filter L4 to remove bias.
The program amplifier has a nominal gain of 18dB. The output of the program amplifier is connected to the output balancing transformer which has a 6dB voltage gain. The balanced output impedance is typically 50 ohms. The capacitor across the balanced output of the transformer rolls off the frequency response beyond 20KHz and at 100KHz the output is in excess of 40dB down.

In SYNC mode Relay RL1/1 is energised. This disconnects the play head from the input to the preamplifier and substitutes the record head. Since the record head has been optimised for "record" performance its output level is approximately 20dB lower than the play head, hence an additional 20dB gain is required in the program amplifier to bring the SYNC level up to the PLAY level. This network is "switched in" by earthing the gate of FET Q7 (automatic in SYNC REPLAY mode). RV7 controls the SYNC gain. Note that there is additional logic behind selecting SYNC mode.

If SYNC mode is selected when the deck is recording, SYNC operation is inhibited, thus returning the replay channel to replaying from the replay head. Additionally in two track machines, if the front panel SAFE switch is in SAFE mode, SYNC operation is permitted in this channel, while recording takes place in the other channel.

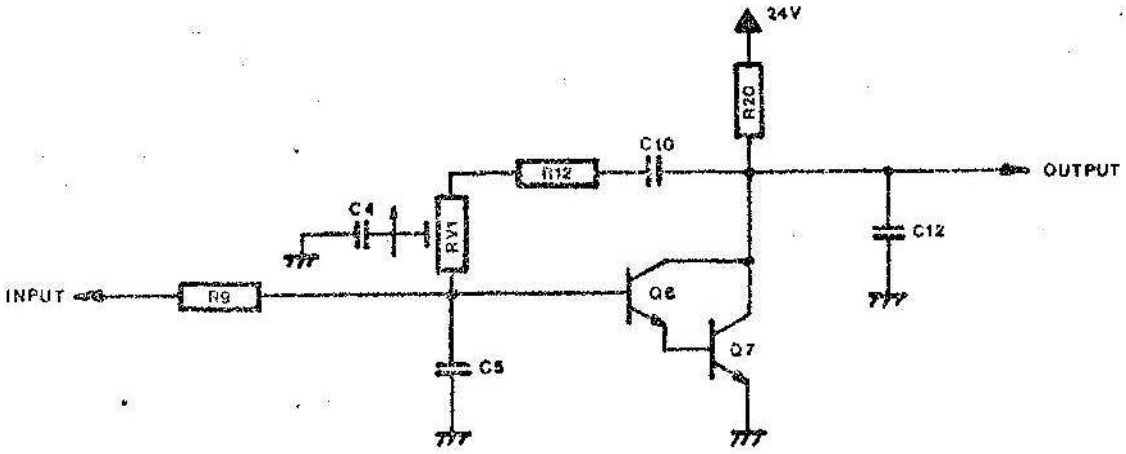
WARNING: In the SAFE mode, this channel can be replaying from the record head while the other channel is recording ONTO the other channel of the same record head. The channel to channel crosstalk of the record head is about -60dB. However the record track can have up to 2 volts RMS of high frequency audio on it, which means that there will be a high crosstalk between channels in this mode especially above 10KHz.

This mode should only be used for FOLDBACK and not used to remix into the recording channel, otherwise a danger exists of the recording channel oscillating at 15KHz to 20KHz

5.7 Record Amplifier - Ref. drg. 23-1338

Transistors Q1 and Q2 form a low noise low distortion mixing preamplifier with a gain of 12dB. The preamplifier mixes two line inputs which are atenuated by the respective front panel RECORD LEVEL controls.

The preamplifier output is passed on to the low (high) speed level preset potentiometer RV2 (RV4). The equalizing amplifier, Q6 and Q7 is self-biased via resistors R17, 18 and 19 and capacitor C13. The speed equalizing networks are selected by earthing the gates of Q3 (low speed) or Q4 (high speed).



The above circuit is the equivalent equalizing circuit when low speed is energised (biasing components removed).

It forms a 3 "pole" adjustable active filter. Phase delay network R9/C5, R20/C12 and RV1/C4 delay the phase of the feedback signal with respect to the input to such an extent that the network can self oscillate (180 degrees phase shift) under maximum phase delay. R12 is used to reduce the phase delay to

less than 180 degrees to prevent oscillation but still permit the required high frequency boost to be given to the record head driver.

The phase delay is controlled by RV1 and C4. Figure 3 shows the maximum, minimum and typical frequency responses of this network.

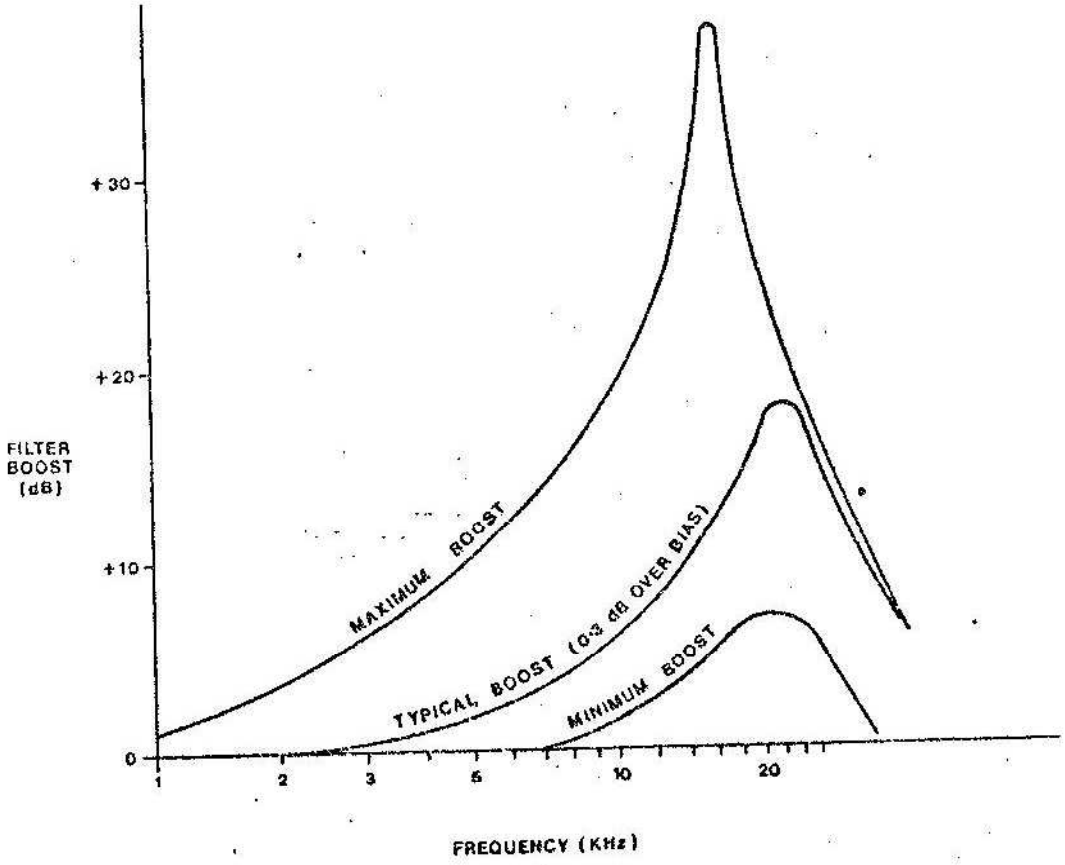


FIG. 3

RECORD EQUALIZER BOOST CHARACTERISTICS

Capacitor C10 is used to provide the 3180 microsecond NAB break point if reduced to 0.047UF, i.e. 3dB boost at 50Hz.

Since the recording process is basically a constant flux characteristic, a constant head current is required when frequencies are below 3KHz. Above 3KHz the head current requires to be boosted a certain amount to compensate for head losses and tape losses. To implement this current drive to the heads the collector load of Q8 is a 10mA current source formed by Q9 and associated components.

Transistor Q8 works as an emitter follower so that the collector current in Q8 is directly proportional to the emitter voltage which in turn is equal to output of the equalizer stage.

Since the load on Q8 is a constant current any change in current through Q8 must be compensated for by an equal and opposite change in the current through capacitor C16, i.e. the head current.

Thus the record head driver is a voltage to current converter with a transconductance of 5mA/volt with a maximum current drive of 10mA P-P and a limiting voltage of 15V P-P. The source impedance of the current drive is equal to R24 (47K).

The record head current is passed through bias trap L1/C18 to isolate bias frequencies from the record head driver. Capacitor C16 absorbs any stray bias which happens to leak through the bias trap.

Bias, derived from the bias oscillator, is adjusted by RV7 and passed through capacitor C19 to the record head. C19 has a high impedance at audio frequencies and prevents any of the audio current being bypassed by the bias level control.

SYNC relays RL1/1 and RL2/1 are energised in PLAY mode to direct the record head output to the replay amplifier SYNC relay so that in SYNC REPLAY mode the record head is accessible to the replay amplifier.

In RECORD mode relays RL1 and RL2 de-energise and connect the record head to the record amplifier.

Both leads of the record head are switched to prevent earth loops forming in SYNC mode since the same head is shared between two circuits.

Control of relays RL1 and RL2 is designed for a fast de-energise and a slow energise to ensure that the record head is never switched when there is bias on it.

This timing function is performed by Q1 on the mother board to de-energise relays in less than 10mSec and energise in about 100mSec.

5.8 Tape Timer - Ref. drg. 23-1333 and 23-1328

The tape timer counts revolutions of the top stabilizer roll on the deck and converts this to an equivalent tape playing time, at the speed selected. The complete circuit is divided onto two printed boards: the display and sensor and the counter board.

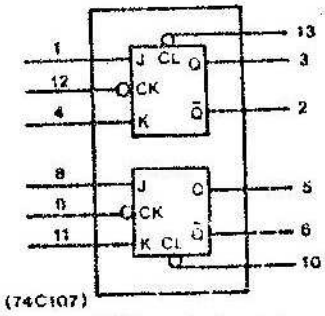
5.8.1 The following diagrams and tables provide easy reference on the operations of the JK Flip-Flop (74C107), counter (F4029) and bilateral switches (F4016). These three integrated circuits form the major functional blocks in the timer.

JK Flip-Flop (74C107)

Pin Names

J,K	Synchronous Inputs
CK	Clock Input (H L Edge-Triggered)
CL	Asychronous Direct Clear Input (Active LOW)
Q	True Output
$\overline{Q}$	Complement Output

LOGIC DIAGRAM



VDD = Pin 14
VSS = Pin 7

Truth Table

Synchronous Inputs			Outputs	
CK	J	K	Qntl	$\overline{Q}$ntl
	L	L	No change	
	H	L	H	L
	L	H	L	H
	H	H	$\overline{Q}$n	Qn

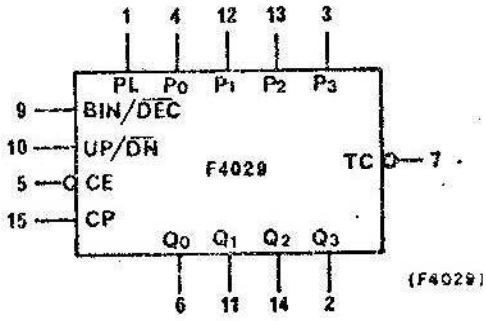
Condition: CL = HIGH

Synchronous Up/Down Counter (F4029)

Pin Names

PL	Parallel lead input
P_o-P_3	Parallel date inputs
BIN/$\overline{DEC}$	Binary/decade control input
UP/$\overline{DN}$	Up/down control input
$\overline{CE}$	Count enable input (Active LOW)
CP	Clock input (L H Edge-Triggered)
Q_o-Q_3	Buffered parallel outputs
$\overline{TC}$	Terminal count output (Active LOW)

LOGIC SYMBOL



VDD = Pin 16
VSS = Pin 8

Mode Selection Table

PL	BIN/$\overline{DEC}$	UP/$\overline{DN}$	$\overline{CE}$	CP	MODE
H	X	X	X	X	Parallel load (P_n Q_n
L	X	X	H	X	No change
L	L	L	L		Count down, decade
L	L	H	L		Count up, decade
L	H	L	L		Count down, binary
L	H	H	L		Count up, binary

H = High level, L = Low Level, X = Don't care, = Positive - Going Transition

Quad Bilateral Switches (F4016)

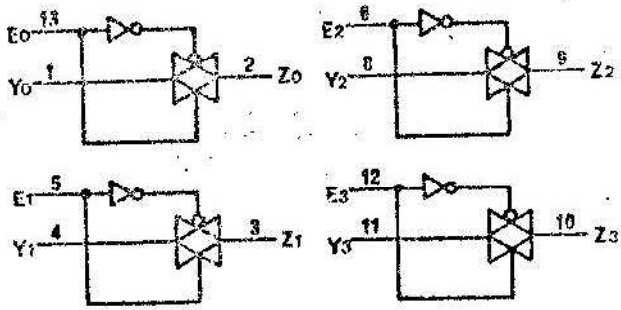
Pin Names

E_o-E_3 Enable Inputs (Active HIGH)

Y_o-Y_3 Input/output terminals

Z_o-Z_3 Input/output terminals

LOGIC SYMBOL



5.8.2 Counting, and the direction of count (either up or down) are sensed by blocking the infra-red light (from LED1 and LED2) to the photo transistors Q1 and Q2. When the light is blocked Q1 (Q2) turns off, Q3 (Q4) turns off and Q2/1 (U2/3) goes high which in turn produces a low at U2/2 (U2/4). R3, C1 and R2 (R6, C2 and R5) provide positive feedback around the sensor to give a clean transition on the output of U2. When both Q1 and Q2 are covered U3/2 and U3/3 are both low. This gives a low at U2/12 which indicates a "coincidence". This coincidence pulse is used to clock the counter chain to produce the timing indication.

5.8.3 The stabilizer roll has a diameter of 3.75 inches, and one revolution produces two coincidence pulses for 3.75 inches of tape. U4 is set as a binary counter and produces four outputs; divide by 2, 4, 8 and 16 on pins 2, 14, 16 and 6 respectively. It is clocked by the coincidence pulse so each output produces one pulse per second if the tape speed is 3.75, 7.5, 15 and 30 i.p.s. respectively.

The appropriate output of U4 is gated to the inputs of the first two counter stages, U6/15 and U7/15, by grounding the appropriate control line on U5.

The counter chain that counts the selected clock pulse is formed by U6 to U9.

5.8.4 Since tape can be wound in both directions the timer must decrease its reading when tape is being spooled back on to the supply reel. Direction of rotation is sensed by U1. U2/5,6 and U2/9,8 and R7,R8, and C3 form a 250KHz oscillator that clocks the first flip-flop of U1. U1/3 will be high at the leading edge of coincidence when counting up and so U1/5 will be clocked high by U2/12. This line is used to control the count direction (either up or down) of the counter chain U6 to U9. If the direction of rotation is reversed U1/3 will be low at the leading edge of coincidence and U1/5 will go low causing the counter chain to count down. An error condition can exist if the direction of rotation is reversed during coincidence and the particular coincidence pulse is about to clock the counter chain. In this situation the timer will count one second in the wrong direction. At 7.5 i.p.s. this can occur on every fourth pulse.

5.8.5 U6 to U9 are set as binary counters. U7 has additional logic to make it a modulo 5 counter for tens of seconds. U6 and U7 are wired as synchronous counters, with the clock output on U5/2,3,9 and 10 connected to clock inputs U6/15 and U7/15. U7 is enabled by the terminal count from U6/7 and clocked on the next clock pulse on U7/15.

5.8.6 When counting up and a count of 59 seconds is reached the next clock pulse will try to set 60 seconds. U10/12 and U10/13 detect the BCD 6 on U7/14 and U7/11 and U16/11 triggers the monostable formed by C9,R13,U10/4,5 & 6 and U3/4,5 and 6. The output of the monostable U3/4 clocks the next counter U8/15 and is gated with the reset push button so U10,8 enables the preset pin U7/1 and the four preset inputs U7/3,13,12 and 4 set the outputs U7/2,14,11 and 6 to 0. Thus when counting up and a count of 59 seconds is reached the next clock pulse will increase the units minutes by one and show 00 seconds.

5.8.7 When counting down and a count of 00 seconds is reached the next clock pulse must produce a reading of 59 seconds and decrease the units minutes display by one. U7/2 will go high when the tens of seconds counts to 9. This triggers the monostable formed by R12,C8,U3/8,9,10 and U10/1,2,3. The output of the monostable U10/3 goes high and sets the preset pins U7/3,13,12 and 4 to a binary 5. At the same time U7/2 triggers the other monostable which enables the preset enable pin U7/1, and also clocks the next counter U8/15. Thus, instead of indicating 99 seconds, the indication is now 59 seconds and the units of minutes counter is clocked and will now indicate one minute less.

5.8.8 U9 is clocked by terminal count of the preceding stage on U8/7. All counters have their UP/DOWN control lines wired in common to U1/5. The reset button takes U2/10 high to enable the preset inputs and set the outputs to 0.

5.8.9 The motion sense signal is generated on U3/13 by rectifying and filtering the output of one sensor on U2/2. When tape is in motion U2/2 will be alternately high and low. C4 A.C.- couples this signal to D2 which will hold C5 discharged. When motion ceases C5 will charge through R9 and U3/13 will change from high to low when the charge on C5 reaches half supply. This short delay in signalling no motion to the deck logic board is to ensure that tape has definitely stopped before PLAY mode begins.

Motion sense control high will force U3/13 low regardless of the state of U3/12.

5.8.10 Display and Sensor Circuit - Ref. drg. 23-880

The BCD outputs from the counters U6 to U9 are connected to the display circuit board via a 24 way flat cable. U1 to U4 take the BCD data and decode it to drive the seven segments of the displays U5 to U8. Resistors R1 to R28 are in series with each segment to limit brightness.

5.9 Bias Oscillator - Ref. drg. 23-1329

When the deck is in the RECORD mode, pin 11 on the bias oscillator PCB is grounded and will turn on Q4 if the SAFE switch is in the RECORD position. Q4 turning on will turn on Q1 over a period of approximately 60 milliseconds. Q2, Q3, and L11 form a class C push-pull oscillator which runs when supplied with 24V D.C. from the collector of Q1. Thus when bias is turned on, it increases to its maximum level over a period of 60 milliseconds, and when turned off decreases to zero level over the same period. This controlled rise and fall of bias eliminates recorded "clicks" on tape. In a two track configuration the oscillators in each amplifier must run at the same frequency to stop beat notes being generated. C6 couples the emitter of Q3 in each oscillator to synchronize their frequencies.

6. AMPLIFIER ALIGNMENT

6.1 Preliminary

Before the audio performance of the machine is checked, or a primary alignment made, the deck must be fully functional and the tape path must be clean and demagnetized.

CAUTION:
1. Switch off power before demagnetizing the heads
2. Do not make D.C. resistance measurements on the heads
3. Use an inert solvent such as methylated spirits to clean the heads and tape path

6.2 Replay

6.2.1 Select a tape speed of 7.5 i.p.s. : LO on a 7.5/15 i.p.s. machine and HI on a 3.75/7.5 i.p.s. machine. Thread a BASF DIN 19S test tape, select PLAY on the output selector push buttons, and place the output level control at the CAL position. Place an A.C. voltmeter across the balanced output and load the output with 600 ohms.

6.2.2 Play the test tape. The first section of tone enables the correct CAL level to be set. Adjust LO LEVEL RV2 on the replay board to give a reading of +16dBm on the output for a mono head and +13dBm for a stereo head. With the first 1kHz section still playing adjust the azimuth to peak the output level. RV2 may now need to be readjusted to the specified levels above. To set the azimuth slacken the locking screw and rotate the adjusting screw until the output level peaks. Do not overtighten the locking screw. A light lock is sufficient.

CAUTION: Beware of secondary peaks on either side of the true azimuth setting.

6.2.3 The next section of the test tape enables azimuth to be set at 10kHz. The azimuth should be adjusted to a peak steady output level.

The rest of the tape enables frequency response to be checked. The output should not vary by greater than ± 1dB over the range 30Hz to 16kHz. High frequency levels can be adjusted by RV1 -H.F. COMP LO. on the replay board. Note that the H.F. COMP control affects the 1kHz level slightly, so this must be checked after adjusting the high frequency response. Low frequency response below 60Hz can be adjusted by changing R15. Decreasing R15 decreases the level.

Remove the test tape and select PLAY mode. Check that the noise on the output is less than -46 dBm. This corresponds to a signal to noise ratio of -62dB WRT +16dBm.

6.2.4 Select HI speed (15 i.p.s. on a 7.5/15 i.p.s. machine) and thread a BASF DIN 38S test tape. Set the HI LEVEL RV4 on the replay board for +16dBm for mono and +13dBm for stereo. Azimuth should not be adjusted since it is set with the 7.5 i.p.s. tape. Check frequency response - + 1dB 30Hz to 18kHz. High frequency response is adjusted by RV3, HF COMP HI. Low frequency can be increased by increasing R16. Noise with PLAY selected, but no tape against the head, should be below -49dBm. This corresponds to a signal to noise ratio of -65dB WRT +16dBm.

6.3 Line to Line

6.3.1 Connect an audio oscillator set for +8dBm to INPUT 1 and set the RECORD 1 LEVEL control at CAL. Select RECORD on the output selector and measure the signal on the output loaded with 600 ohms. Adjust the TRANSFER GAIN RV4 on the mother board to give +8dBm on the output.

6.3.2 With RECORD still selected on the OUTPUT switch increase the input level to +16dBm. Measure total harmonic distortion on the output. It should be less than 0.5% at 1kHz.

6.3.3 Reduce the input level back to +8dBm and check the frequency response from input to output. It should be ±1dB 30Hz to 20kHz.

6.3.4 Increase the RECORD 1 LEVEL control to maximum, select RECORD on the OUTPUT selector switch and decrease the oscillator output until the output is 0dBm. Measure the oscillator output. It should be -20dBm or less which gives a maximum record gain of 20dB or more.

6.3.5 Select RECORD on the OUTPUT selector and set the oscillator for 100kHz at 8dBm. Rotate the slug of the replay bias trap L4 on the mother board to give a null or the output.

6.4 Record

Select RECORD on the RECORD/LOCKOUT switch and select RECORD mode on the deck.

6.4.1. Monitor the bias oscillator at TP2 with a Hi impedance meter or oscilloscope. The level should be 55V RMS (170V P.P.). Connect a frequency meter at TP1 on the monitor board (Drg 23-1332) and adjust the bias oscillator coil slug to give a 100kHz ± 500HZ output. Check that safe stops the oscillator.

6.4.2. Connect an oscilloscope at TP3 on the Record PCB and rotate L10 for a null in 100 kHz level. The level should be less than 2V P-P.

Connect a low distortion audio oscillator set for +8dBm to INPUT 1 and set the RECORD 1 LEVEL control to CAL. Select PLAY ON THE OUTPUT selector, and set the OUTPUT LEVEL control to CAL. Connect an AC voltmeter to the output and load it with 600 ohms. Thread a reel of Ampex 406 bulk erased tape on the deck. Set the BIAS LEVEL RV7 on the Record board to approximately 3/4 clockwise rotation and set the input audio oscillator 1 kHz. Push the RECORD button on the deck. Adjust the LEVEL LO RV2 control on the Record board for +8dBm on the output at 7.5 i.p.s. Adjust the LEVEL HI RV4 for +8dBm on the output at 15 i.p.s.

6.4.3. At 7.5 i.p.s. set the Record head azimuth for peak output at 1kHz. Adjust RV7 BIAS LEVEL for peak output at 1KHz. Change the oscillator frequency to 15kHz and re-adjust the azimuth for a peak steady output level. Set the oscillator to 10kHz and increase the bias level by rotating the trimmer clockwise until the output level drops by 1dB.

6.4.4. Re-adjust the LEVEL LO controls RV2 and RV4 for 8dBm output at 1kHz. Check the overall frequency response of the machine at 0dBm, both speeds. The high frequency response is adjusted by HF COMP LO RV1 and 7.5 i.p.s. and HF COMP HI RV3 at 15 i.p.s. The output should be within +2dB from 30Hz to 16Khz at 7.5 i.p.s. and 30HZ to 20kHz for 15 i.p.s.

6.4.5. Set the oscillator to 1kHZ and increase its level until the output is +16dBm. Connect a distortion meter across the output and load it with 600 ohm. Measure the distortion. It should be less than 1.5% THD for a mono deck and less than 2% THD for a stereo deck.

6.4.6. Change the oscillator frequency to 50Hz and check that distortion is within the specified limits.

6.4.7. Record a length of tape with 50Hz at + 16dBm. Re-record over the section with no input signal present than replay again in PLAY mode only. The output while replaying is a measure of the erasing ability. The output should be less than -40dBm to give an erasure of 56dB at 50Hz.

6.4.8. Record a section of tape with no input signal. Replay the section of tape in PLAY mode only. The output noise should be less than -40dBm at 7.5 i.p.s. and 15 i.p.s. to give an overall signals to noise ratio of 56dB.

6.5 Monitor

6.5.1 Connect an audio oscillator set for +8dBm at 1kHz to INPUT 1 and set the RECORD 1 LEVEL control to CAL. Load the output with 600 ohm and connect an AC voltmeter across it.

6.5.2 Select RECORD on the output selector and PLAY on the monitor selector. Adjust the MONITOR PLAY LEVEL RV2 on the mother board for 0 VU indication on the VU meter.

6.5.3 Select RECORD on the monitor selector. Adjust the MONITOR RECORD LEVEL RV1 on the mother board for 0 VU indication.

6.5.4 Select RECORD mode on the deck and BIAS on the monitor selector. Adjust MONITOR BIAS LEVEL RV3 on the mother board for 0 VU indication.

Select RECORD on the monitor selector. Place a 15 ohm load across the tip and ring of the monitor jack and connect a noise and distortion meter across it. Set the MONITOR LEVEL to 5.5 V RMS to give an output power of 2 watts. Measure the distortion. It should be less than 1% THD.

6.5.5 With the MONITOR LEVEL still set at 2 watts, check the frequency response. It should be within ±3dB, 30Hz to 16kHz.

6.5.6 Reduce the MONITOR LEVEL to minimum and measure the noise across the 15 ohm load. It should be less than 5.5 millivolts RMS to give a signal to noise ratio of 60dB.

6.6 Sync

6.6.1 Connect an audio oscillator set for +8dBm at 1kHz to input 1 and an AC voltmeter loaded with 600 ohm on the output. Thread a reel of bulk erased Ampex 406 tape on the deck and select RECORD mode. Record a section of 0 VU at 1kHz. Replay the 0 VU tape with SYNC selected on the output selector and adjust the SYNC LEVEL RV7 on the replay board for +8dBm output level.

6.6.2 Select LOCKOUT on the SAFE switch and thread a BASF DIN 19S test tape on the deck. Select SYNC on the output selector and check frequency response at 7.5 i.p.s. It should be within ±3dB 30Hz to 10kHz. With a BASF DIN 38S test tape the frequency response at 15 i.p.s. should be within ± 3dB 30Hz to 15kHz.

6.6.3 Remove the tape. Select PLAY mode and with SYNC still selected on the output selector measure the noise on the output. The level should be less than -29 dBm to give a signal to noise ratio of 45dB.

6.6.4 On a two channel deck noise is also checked with channel one recording and channel two playing back in the SYNC mode. Reduce the RECORD LEVEL controls to minimum. Select RECORD on the channel one SAFE switch and SAFE on the channel two SAFE switch. With the A.C. voltmeter connected on the output of the channel two amplifier measure the noise with the deck in RECORD mode. The noise level should be better than -14dBm to give a signal to noise ratio of 30dB.

6.7 Wow and Flutter Check

6.7.1 Thread a reel of bulk erased Ampex 406 tape on the deck. Connect an oscillator to RECORD INPUT 1 and set it to 3KHz. Set RECORD 1 LEVEL to CAL and record a tape with 3KHz, at the required speed.

Set output level to CAL. Then select PLAY on the output selector and connect a Wow and Flutter meter across the output connector. Place the deck in PLAY mode and at each tape speed, measure the "Total Unweighted R.M.S. Wow and Flutter". It should be less than:

0.08% @ 15 i.p.s.
0.1% @ 7.5 i.p.s.
0.15% @ 3.75i.p.s.

7. SPARE PARTS LISTING

7.1 Amplifier

Extender PCB assy	40-871
Bias oscillator PCB assy	40-1329
Record amplifier PCB assy	40-883
Replay amplifier PCB assy	40-882
Monitor PCB assy	40-885
Mother PCB assy	40-886
Input transformer	04-322
Output transformer	04-315
Bias transformer L11	22-046
Replay bias trap L4/5	22-042
Record bias trap L10	22-045
VU Meter FB-30	07-0016
VU Meter lamp BA7R7	08-4039
Input bridging switch	08-3026
Monitor and Output switch assy	08-3126
Monitor and Output switch cap.	08-3127
Pot, Input Output & Monitor 10KC	02-661
Record-lockout switch 7103 KY ZGE SPDT	08-3157
National RS24V relay	20-034

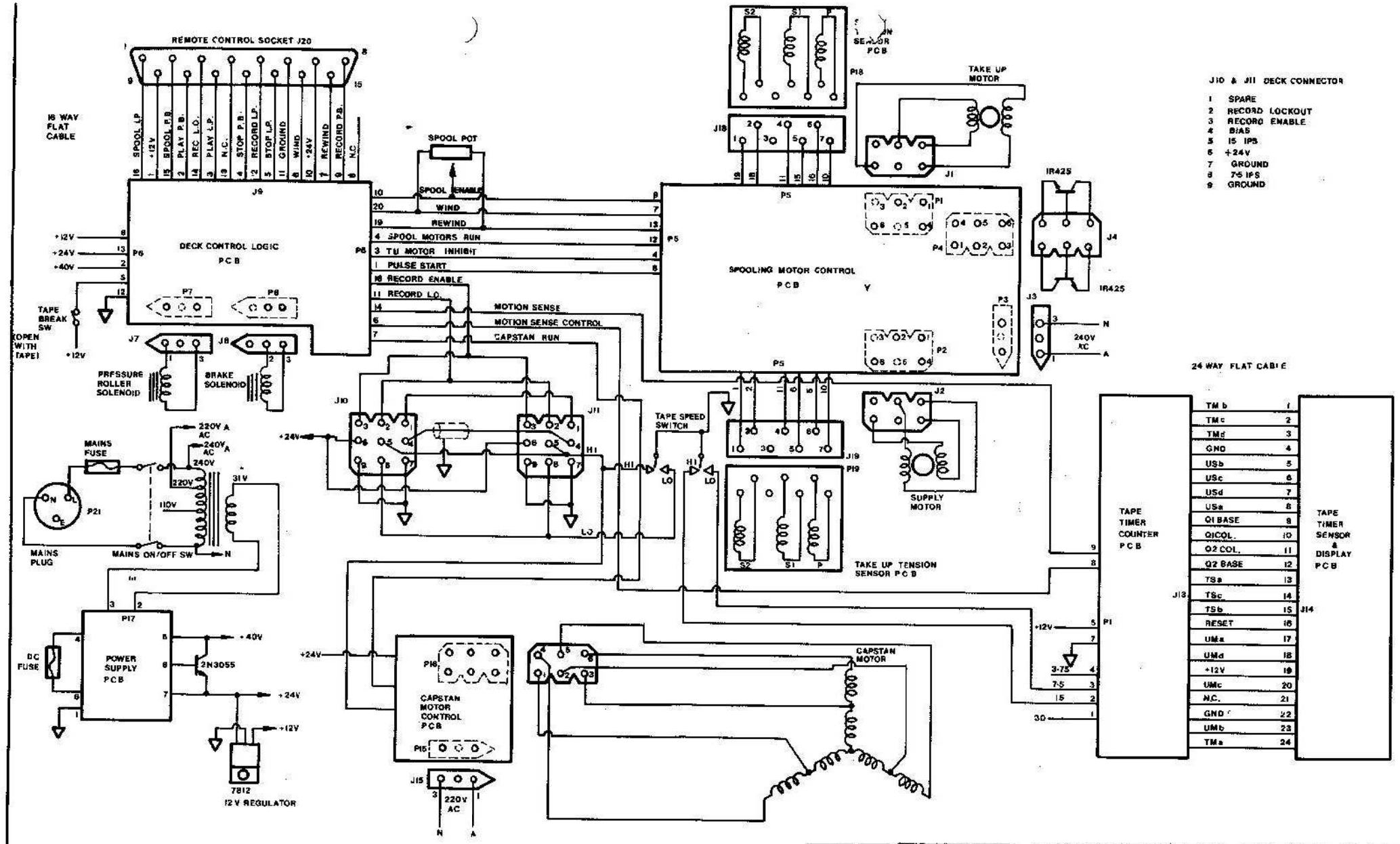
7.2 Below Deck

Capstan motor	23-1229
240V spool motor	23-1074
Pressure roller solenoid	23-1054
Brake solenoid	23-1053
Mains transformer	04-031
117V spool motor	23-1318
Fuse holder	
D.C. regulator PCB assy	08-2910
Tape timer counter PCB assy	40-865
240V 50Hz capstan motor PCB assy	40-881
240V 50Hz spool motor PCB assy	40-878
Deck connector pin male H900 2	40-877
Deck connector pin female H900 1	08-2098
Nylon PCB support pin	08-2087
Capstan PCB relay SRE D24	150
24 way flat cable assy	20-045
Capstan PCB optical isolator	23-1242
117V 60Hz capstan motor PCB assy	23-1040
117V 60Hz spool motor PCB assy	40-900
	40-901

7.3 Above Deck

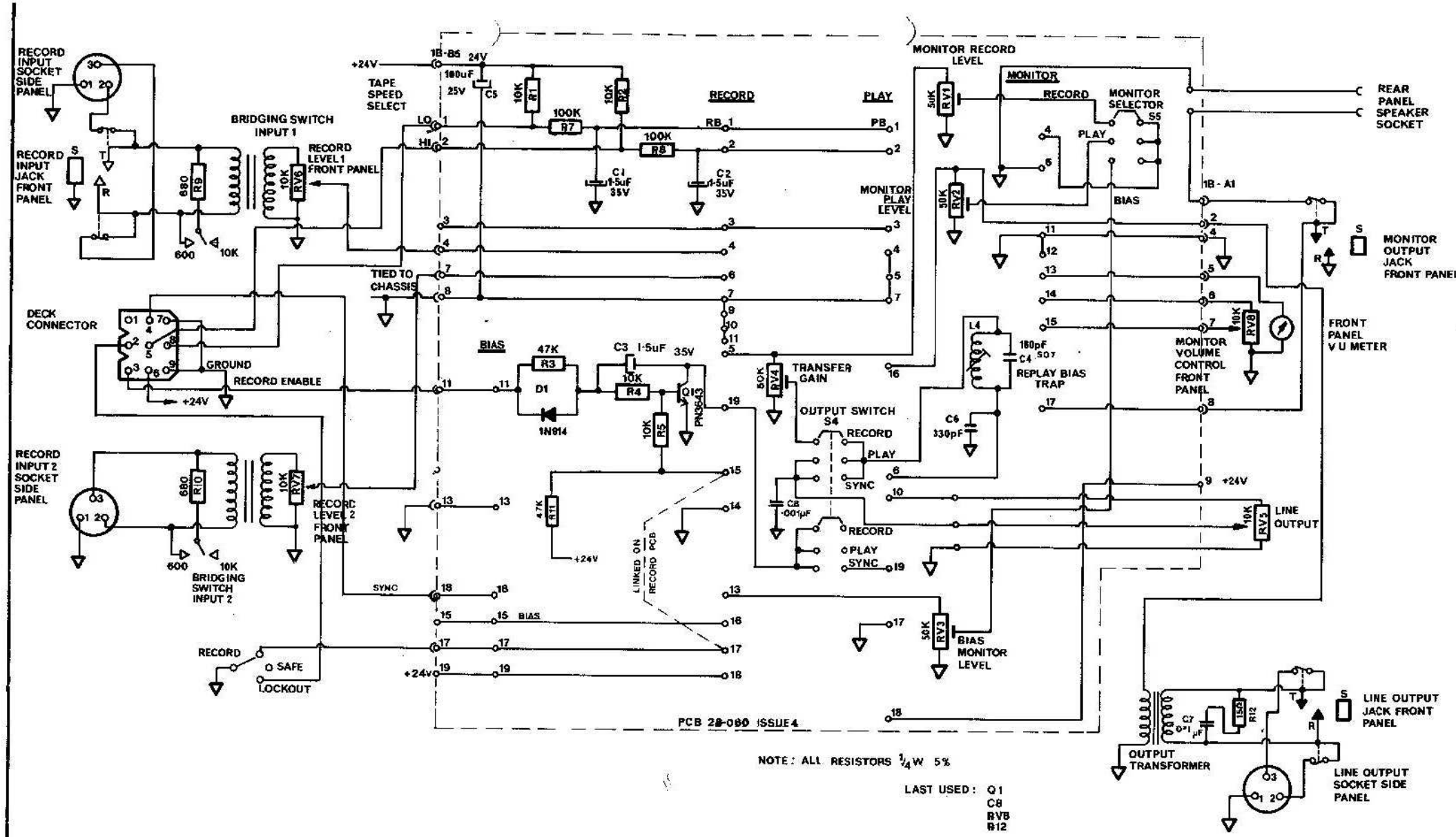
Replay head - full track	23-1309
- half track	23-1226
Record head - full track	23-1310
- half track	23-1227
Erase head - full track	23-1225
- half track	23-1228
Record and replay head humshield	23-1072
Pop-up humshield	23-1207

Spool retaining knob	23-1049
Top stabilizer roller assy	23-1316
Bottom stabilizer roller assy	23-1317
Stabilizer roller cover	16-785
Pressure roller	23-1064
Pressure roller cover	16-786
Tape lifter arm	16-719
Tension sensor arm top	16-720
Tension sensor arm bottom	16-721
Brake drum assy	23-1063
Brake shoe assy	23-1062
Tape brake micro switch 311SM3-T	11-915
Tape lifter spring	09-525
Brake spring	09-525
Tape arm spring	09-526
Tension sensor PCB assy	40-867
Tape timer display PCB assy	40-880
Spool potentiometer	11-900
Spool potentiometer knob	09-047
Transistor IR425	10-164
Mains switch 7201-J1-Z-Q-RED	08-3147
Deck logic PCB assy	40-879
Stop push button	08-3143
Play push button	08-3145
Edit push button	08-3144
Spool push button	08-3146
Record push button	08-3142
Push button lamp CM 388	08-3112
Tape timer reset push button 8632-N-Q	08-3148
Speed change switch	08-3026



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 −0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		DECK BLOCK DIAGRAM 77MkV	3rd ANGLE PROJ.
	SCALE		DRAWING No. 23-1334
	DRAWN J.BANOS 20-11-77	R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA	© A 3 ISSUE B
	CHECKED 21-11-77		

T.M. P.K.
LB 11-5-78
8 WAS +24V
7 WAS RECORD ENABLE
6 WAS 7½ IPS
4 WAS RECORD LOCKOUT
3 WAS GROUND
2 WAS BIAS
B

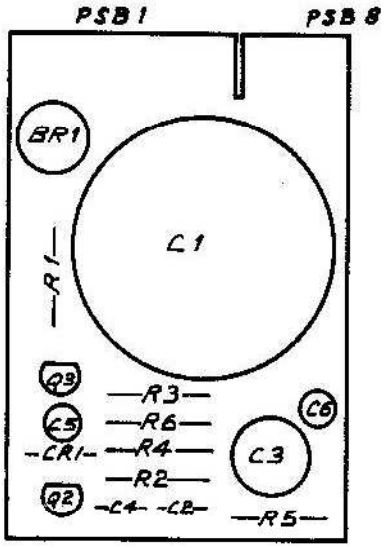


NOTE: ALL RESISTORS 1/4W 5%

LAST USED: Q1
C8
RV8
R12

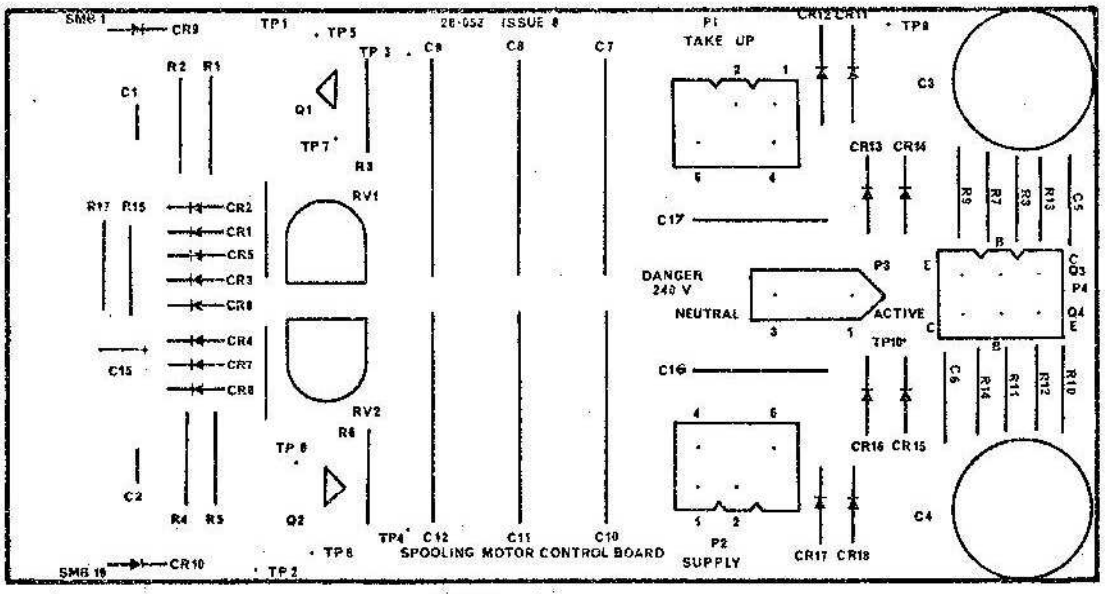
C	ISSUE 'B'	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 −0 ANGULAR ± 0.5°	FINISH MAT'L.	USED ON MAT'L. No.
		SCALE	AMPLIFIER INTERCONNECTIONS 77MkV	3rd ANGLE PROJ.
		DRAWN J. Banos 19-11-77	R. REDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA	DRAWING No. 23-1336
		CHECKED	©	A 3 ISSUE C

26-211

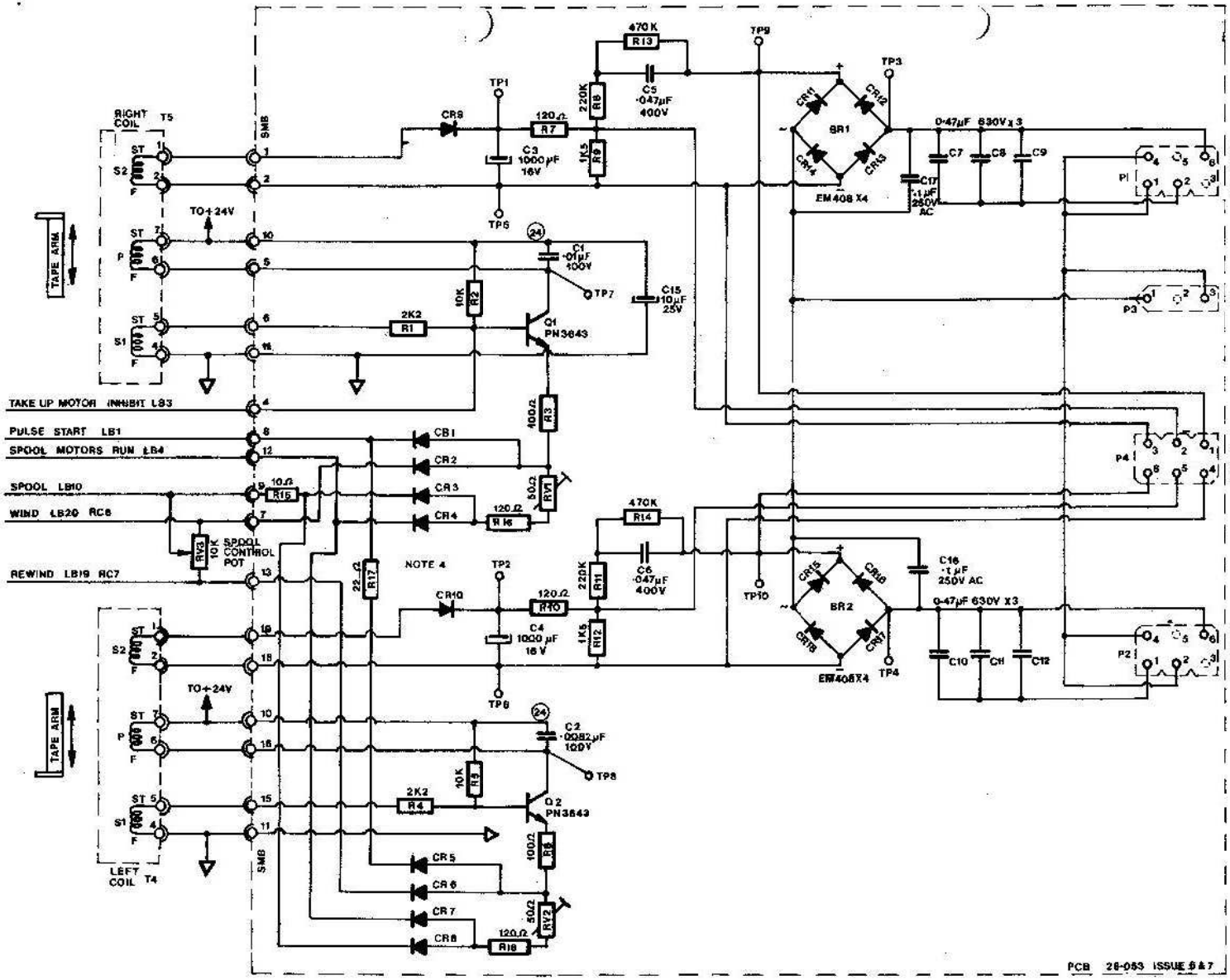


ASSEMBLED P.C.B. PART N°. 23-865
BLANK BOARD PART N°. 28-051

CHANGES	TOLERANCE UNLESS OTHERWISE SPECIFIED FRACTION ± 1/64" DECIMAL ± .005" ANGLE ± 1/2°	ROUTING.
		NEXT ASSY. / MAT'L.
		FINISH
	DESIGNED	R. MEDDING & ASSOCIATES PTY. LTD. 505 LYGON ST., E. BRUNSWICK ©
	DRAWN 22-6-76 S. THOMPSON / T. HANSEN	COMPONENT LAYOUT.
	CHECKED P. Medding	REGULATED POWER SUPPLY. C.M. 2000/77MK2.
	SCALE FULL SIZE.	A 4
		DRAWING NUMBER 26-211
		ISSUE - "A"



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		SPOOLING MOTOR CONTROL PCB COMPONENT LAYOUT ISS.8 77MkV	3rd ANGLE PROJ.
	SCALE 1:1		DRAWING No. 26-266
SS	DRAWN J.BRAVOS 8-12-77 CHECKED T.HANSEN 31-8-78 PWG	R. NEDDOUS & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE A



NOTES:

1. ALL RESISTORS ¼W 5%
2. ALL DIODES IN914
3. (24)—DC VOLTAGES
4. R17 220OHM NOMINAL SELECTED ON TEST FOR MIN SUPPLY REEL START

LAST USED: RV1 Q4 R18 C17 CR18

S.B. 10-3-78 T.H. PK — R17 WAS 220 Ω, R18 & R10 OMMITTED.	J.B 25-5-78 — RV2 WAS 200Ω, RV1 WAS 200Ω, 100Ω R18 ADDED. — C	J.B. 24-6-78 C17 WAS C15 — C3 WAS 4700µF 25 V, R5 WAS 1K, NOTE 4 ADDED, C15 WAS ·47µF 630V, C4 WAS 4700µF 25 V, R12 WAS 1K, C2 WAS ·01µF, C16 WAS C14 ·47µF 630V — /SS. B

REVISIONS

UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS

TOLERANCES
LINEAR 0. ± 0.5
0.0 ± 0.1
HOLE DIA'S + 0.25 −0
ANGULAR ± 0.5°

SCALE

DRAWN J. BANOS 28-11-77

CHECKED T. HANSEN 25-7-78 PK

FINISH

MAT'L.

USED ON

MAT'L. No.

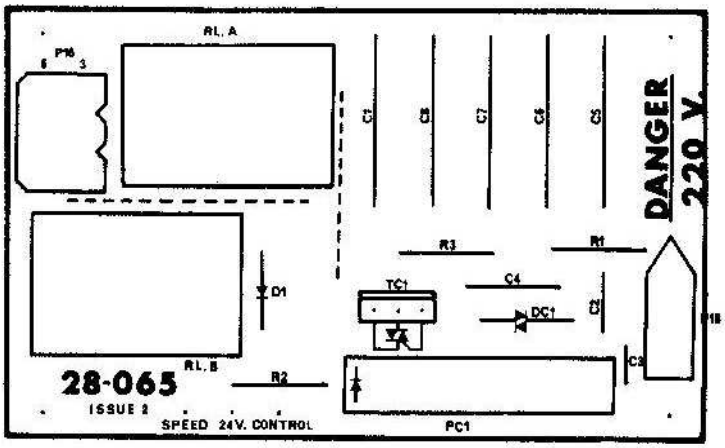
SPOOLING MOTOR CONTROL
PCB CIRCUIT
77 MkV

3rd ANGLE PROJ.

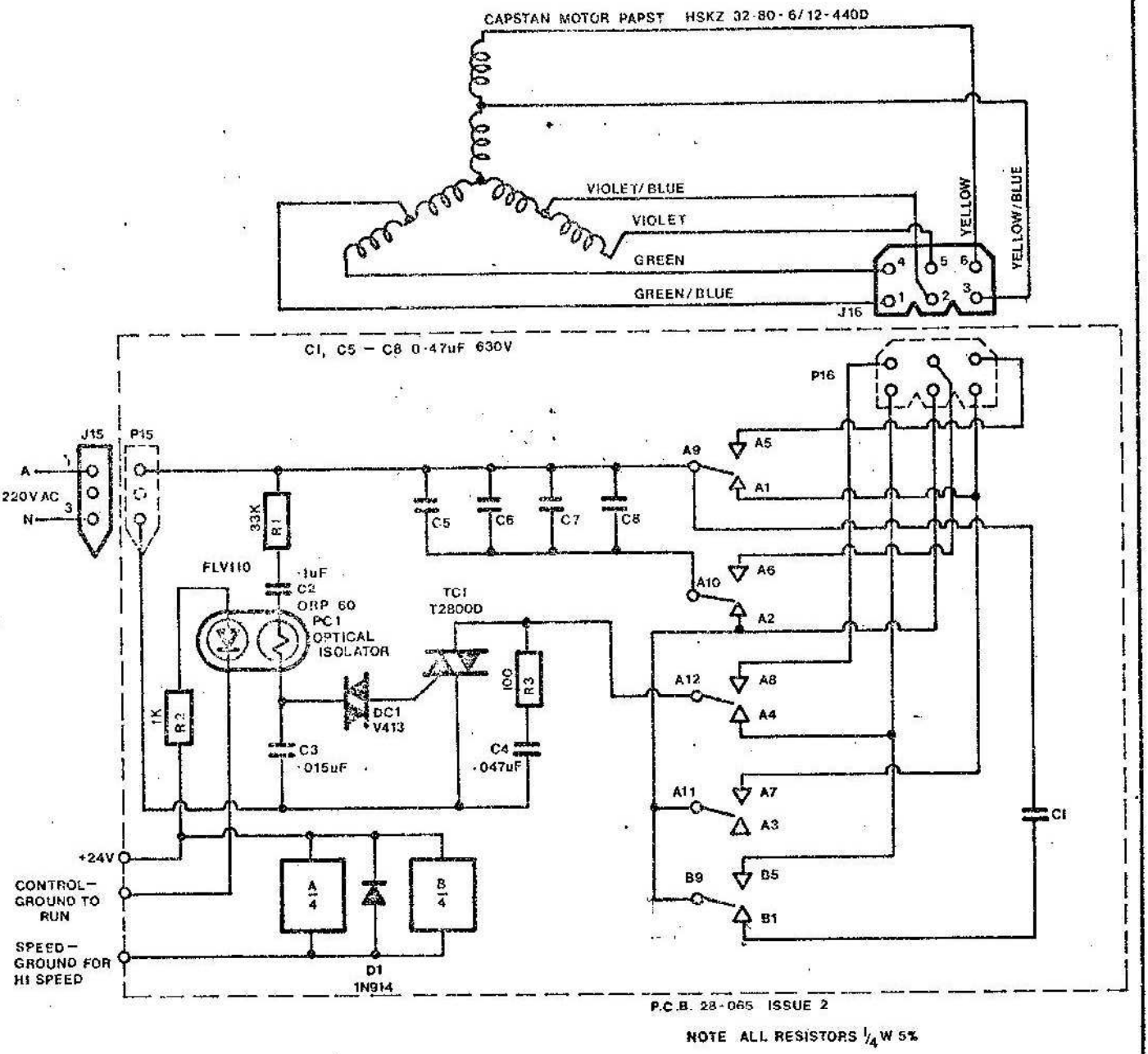
DRAWING No. 23-1330

R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA

A 3 ISSUE D

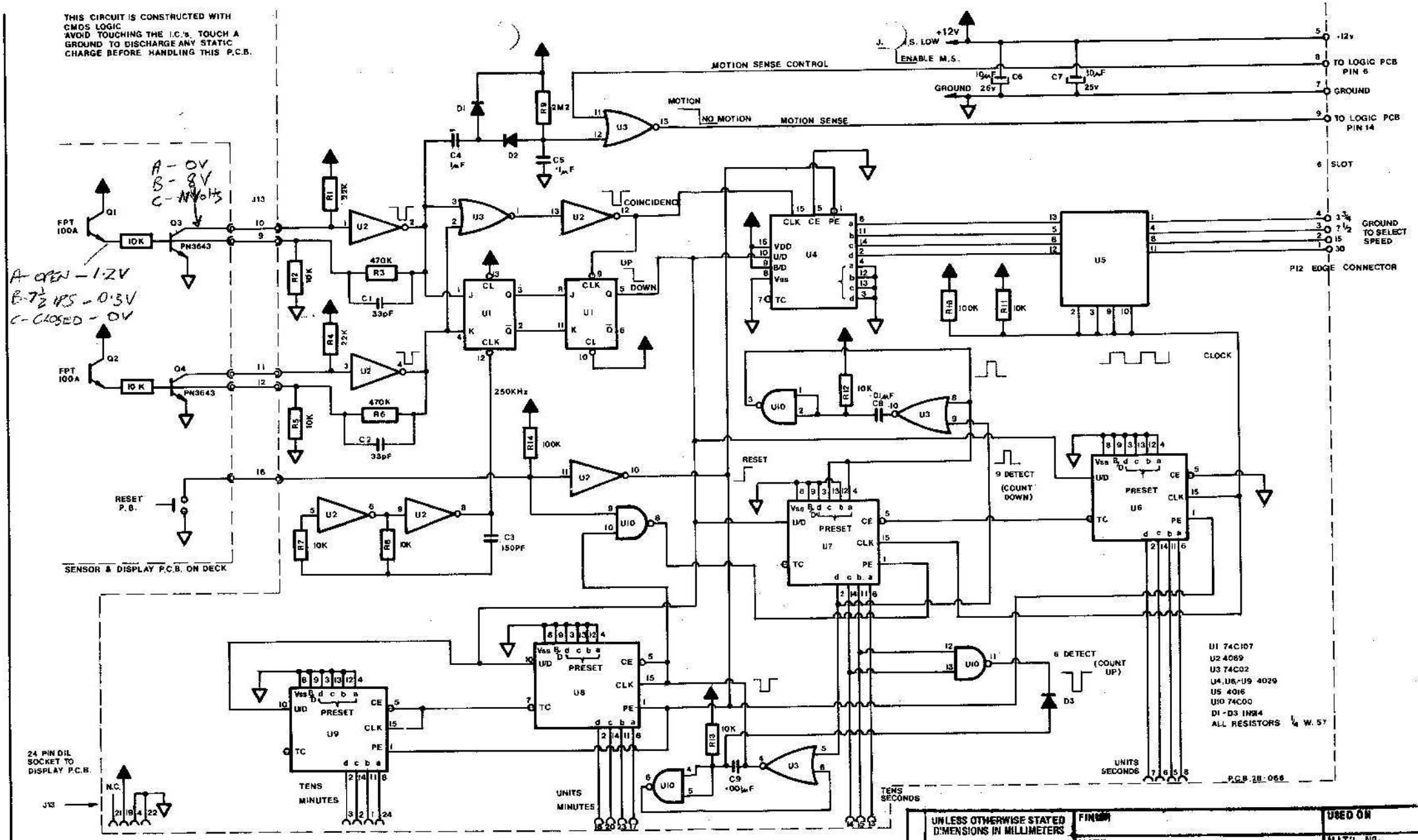


REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 −0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		CAPSTAN MOTOR CONTROL PCB COMPONENT LAYOUT 77MkV	3rd ANGLE PROJ.
	SCALE 1:1		DRAWING No. 26-262
ISS.	DRAWN J. BANOS 8-12-77 CHECKED F. HANSEN 21-8-78	R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE A



UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 – 0 ANGULAR ± 0.5°	FINISH MAT'L.	USED ON MAT'L. No.
SCALE	CAPSTAN MOTOR CONTROL PCB CIRCUIT CM2000/77MkV	DRAWING No. 23-1326
DRAWN J BANOS 21-9-77 CHECKED K HANSEN 31-0-78	R. NEUMAN & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA.	A 4 ISSUE A

REVISIONS



REVISIONS	
V.B. 25-5-78	C1 & C2 ADDED
F.M. 24-1-78	R3 WAS 2K2
Pty	R4 WAS 22K
	R2 WAS 100K
	R6 WAS 100K
	R5 WAS 100K
	PIN 14 WAS 4
	C2 DELETED
	C1 DELETED
'C'	ISSUE 'B'

UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS

TOLERANCES
LINEAR 0. ±0.5
0.0 ± 0.1
HOLE DIA'S. + 0.25 − 0
ANGULAR ± 0.5°

FINISH

MAT'L.

SCALE

DRAWN J. BANOS 26-11-77

CHECKED Y. FANNEN 26-7-78 PK

TAPE TIMER COUNTER
PCB CIRCUIT
77MkV

R. MEDDING & ASSOCIATES PTY. LTD.
MELBOURNE AUSTRALIA ©

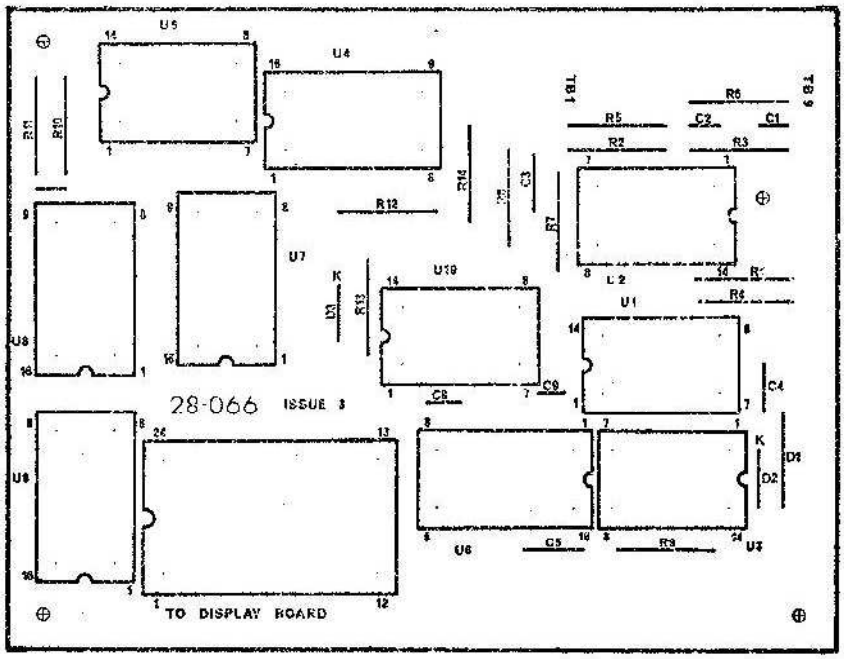
USED ON

MAT'L. No.

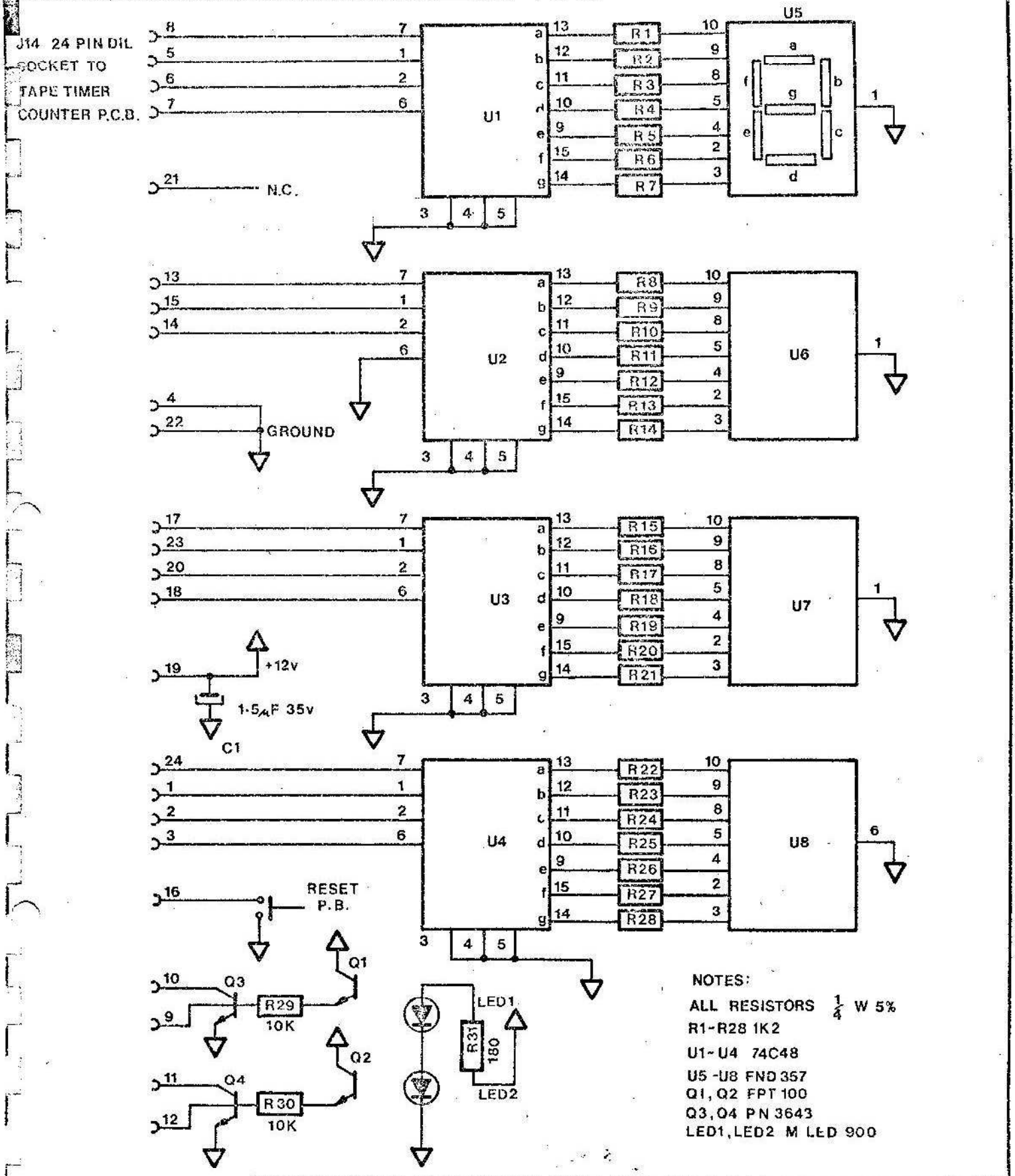
3rd ANGLE PROJ.

DRAWING No.
23-1333

A 3 | ISSUE C



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 −0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. NO.
	SCALE 1:1	TAPE · TIME COUNTER PCB COMPONENT LAYOUT 77 MkV	3rd ANGLE PROJ.
	DRAWN J.E.R.H.S. 8-12-77	D. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA	DRAWING NO. 26-260
	CHECKED K.HANSEN 81-8-29		A 4 ISSUE A



NOTES:

ALL RESISTORS $\frac{1}{4}$ W 5%

R1-R28 1K2

U1-U4 74C48

U5-U8 FND 357

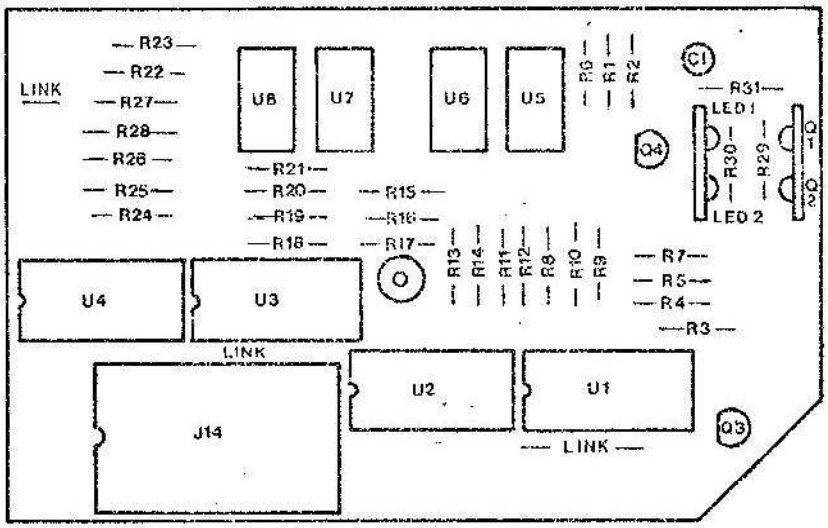
Q1, Q2 FPT 100

Q3, Q4 PN 3643

LED1, LED2 M LED 900

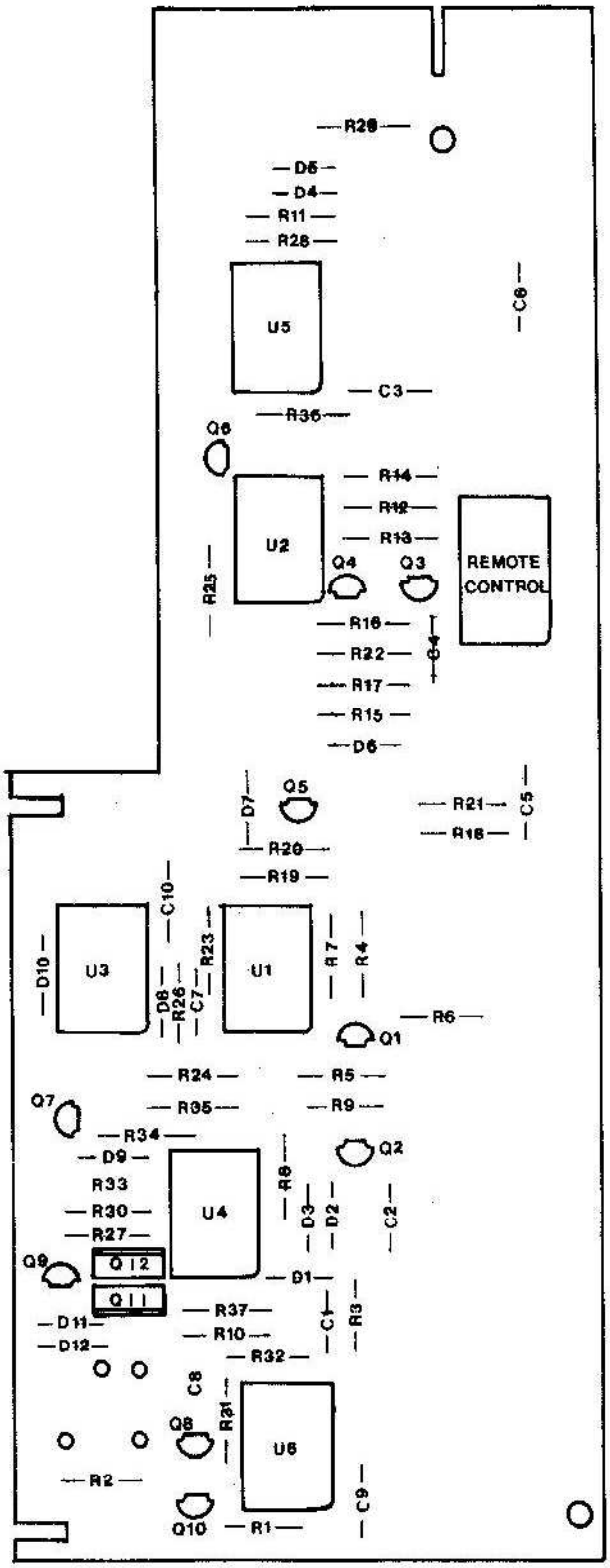
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH MAT'L.	USED ON MAT'L. No.
SCALE	TAPE TIMER DISPLAY PCB CIRCUIT 77 MkV	3rd ANGLE PROJ.
DRAWN J. Barnes 25-11-77 CHECKED [illegible]	D. HEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA	DRAWING No. 23-1328 SHEET 4 REV. A

DEVISIONS

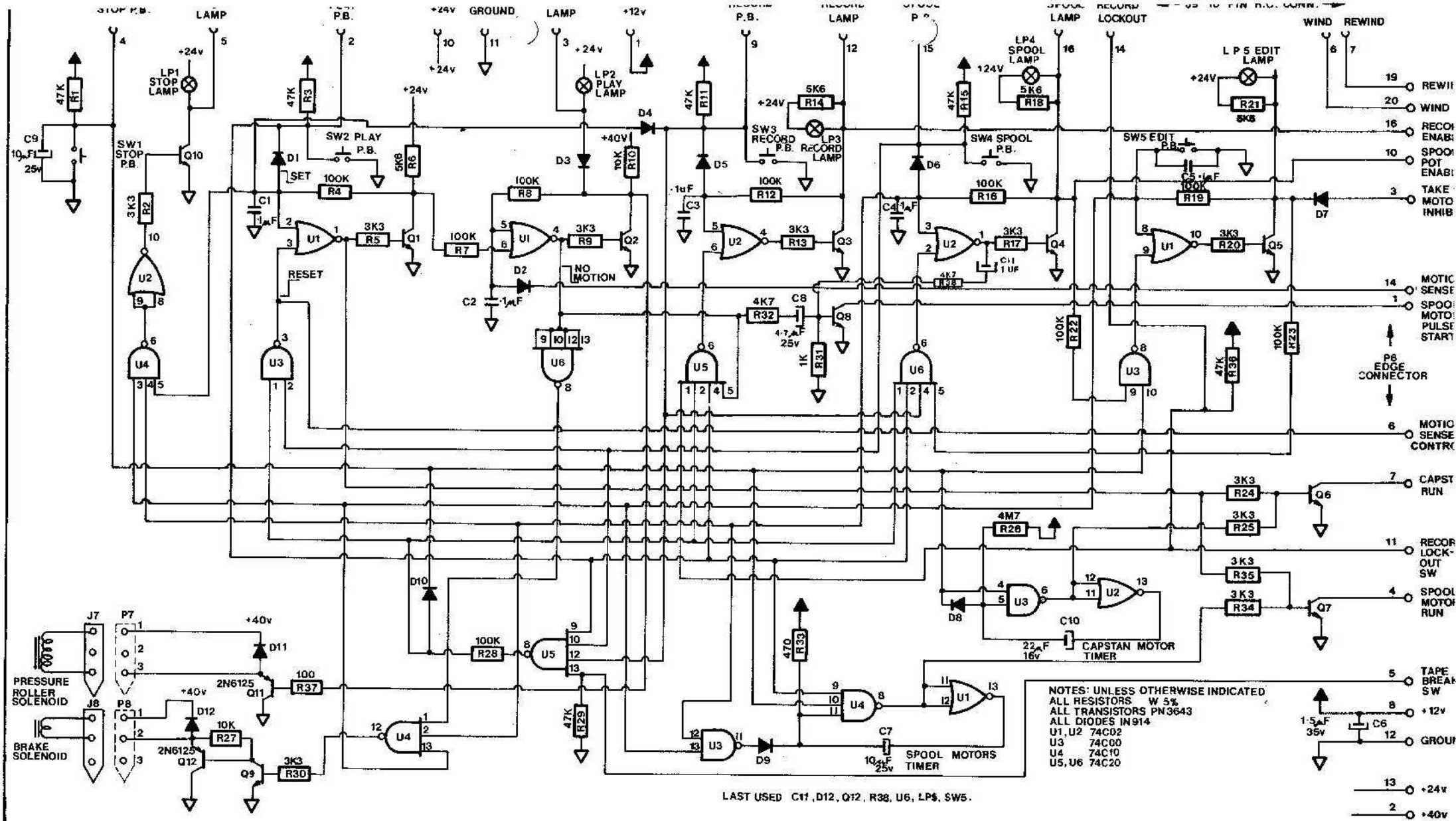


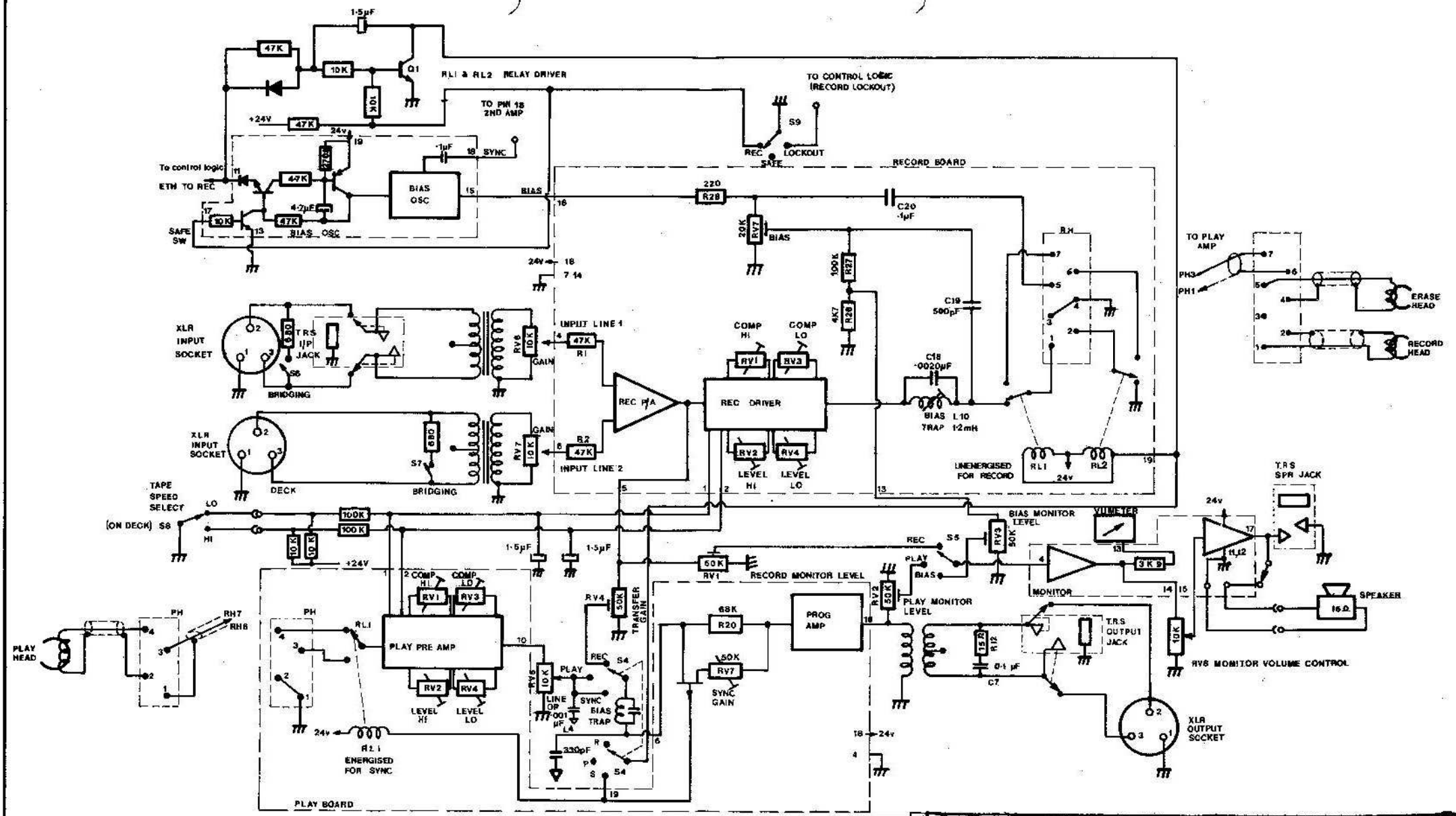
TOP VIEW

REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5° SCALE 1:1 DRAWN J. Brooks 29-11-77 CHECKED [illegible]	FINISH MAT'L. TAPE TIMER DISPLAY PCB COMPONENT LAYOUT 77 MkV G. McGRATH & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA
		USED ON MAT'L. No. 3rd ANGLE PROJ. DRAWING No. 26-257 A 4 SIZE A



	3.0 10-7-78 T.N. PS Q11 & Q12 REORIENTED	REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH	USED ON
				MAT'L.	MAT'L. No.
				DECK LOGIC PCB COMPONENT LAYOUT 77MkV	3rd ANGLE PROJ.
			SCALE 1:1		DRAWING No. 26-255
	B	ISS.	DRAWN J.BANOS 28-11-77 CHECKED T.HANSEN 26-7-78 PS	R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE B


LP1 STOP LAMP
LP2 PLAY LAMP
SW1 STOP P.B.
SW2 PLAY P.B.
SET
RESET
NO MOTION
SW3 RECORD P.B.
LP3 RECORD LAMP
SW4 SPOOL P.B.
LP4 SPOOL LAMP
RECORD LOCKOUT
SW5 EDIT P.B.
LP 5 EDIT LAMP
WIND
REWIND
P6 EDGE CONNECTOR
CAPSTAN MOTOR TIMER
SPOOL MOTORS TIMER
PRESSURE ROLLER SOLENOID
BRAKE SOLENOID
NOTES: UNLESS OTHERWISE INDICATED
ALL RESISTORS W 5%
ALL TRANSISTORS PN3643
ALL DIODES IN914
U1,U2 74C02
U3 74C00
U4 74C10
U5,U6 74C20
LAST USED C11, D12, Q12, R38, U6, LP5, SW5.
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS
TOLERANCES
LINEAR 0. ± 0.5
0.0 ± 0.1
HOLE DIA'S. + 0.25 − 0
ANGULAR ± 0.5°
FINISH
MAT'L.
USED ON
MAT'L. No.
DECK LOGIC
PCB CIRCUIT
77MkV
SCALE
3rd ANGLE PROJ.
DRAWING No.
23-1331
R. MEDDINGS ASSOCIATES PTY. LTD.
MELBOURNE AUSTRALIA
REVISIONS
SIZE A3
ISSUE C



REVISIONS	RELAYS WERE DESIGNATED 'S' M.W. 4-5-78 T.H.	T. HANSEN	
	T. HANSEN 26-7-78		
	C7 WAS 4·2 µF	27-1-78	

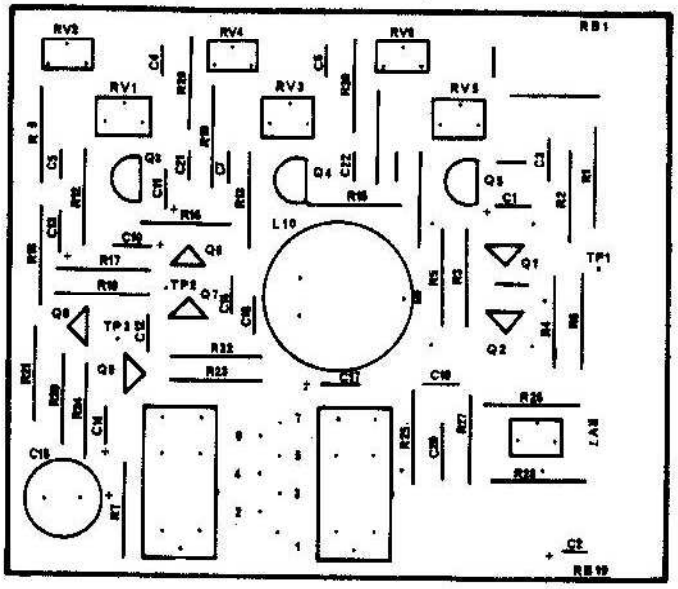
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS
TOLERANCES
LINEAR 0. ± 0.5
0.0 ± 0.1
HOLE DIA'S. + 0.25 −0
ANGULAR ± 0.5°

FINISH
MAT'L.
SCALE
DRAWN J. BANOS 23-11-77
CHECKED T. HANSEN 28-7-78

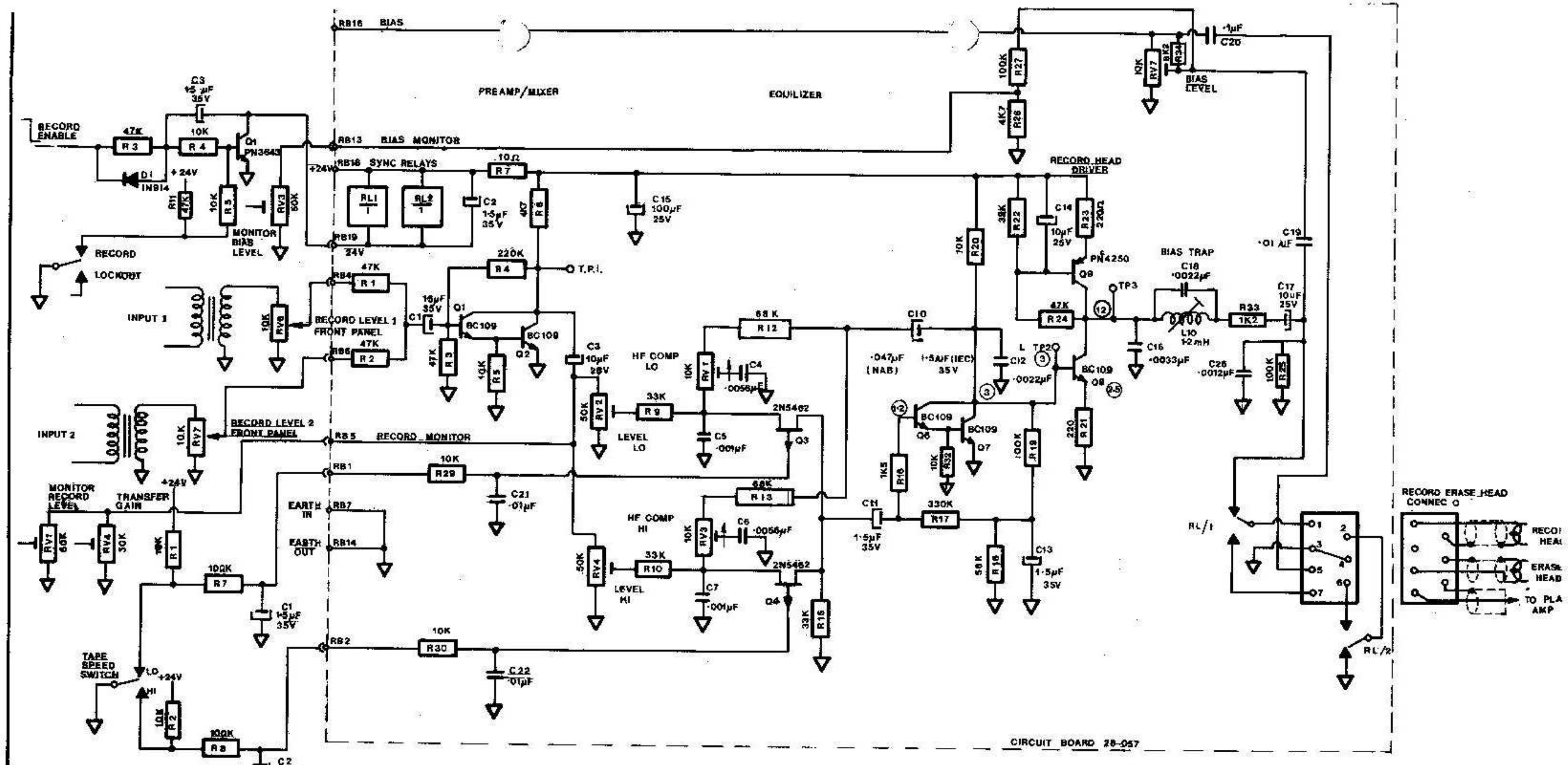
AMPLIFIER BLOCK DIAGRAM
77 MkV

R. MEDDING & ASSOCIATES PTY. LTD.
MELBOURNE AUSTRALIA

DRAWING No. 23-1335
A 3 ISSUE D



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		RECORD PCB COMPONENT LAYOUT	3rd ANGLE PROJ.
	SCALE 1:1		DRAWING No. 26-265
ISS	DRAWN J.BANOS 8-12-77 CHECKED V. HANSEN 21-2-78 PKy	R. HEDDEN & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE A



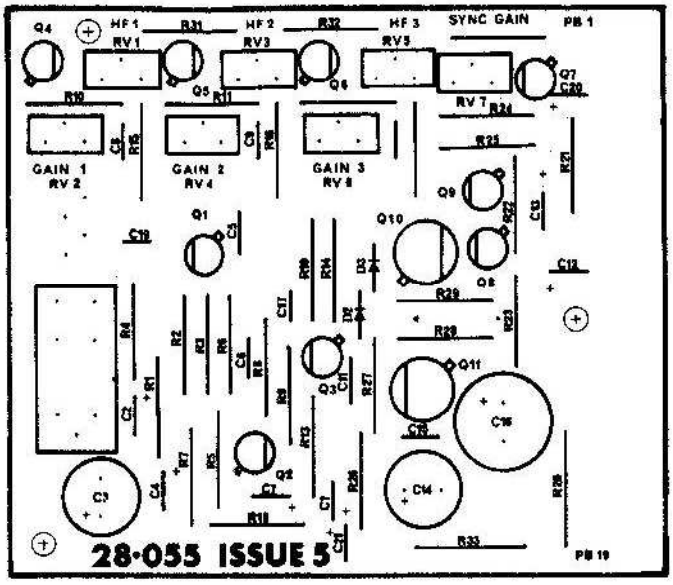
NOTES:
1 ALL RESISTORS ¼ W 5%
2 (12) DC VOLTAGES

LAST USED:
Q9
R34
C27
RL2
RV7
L10

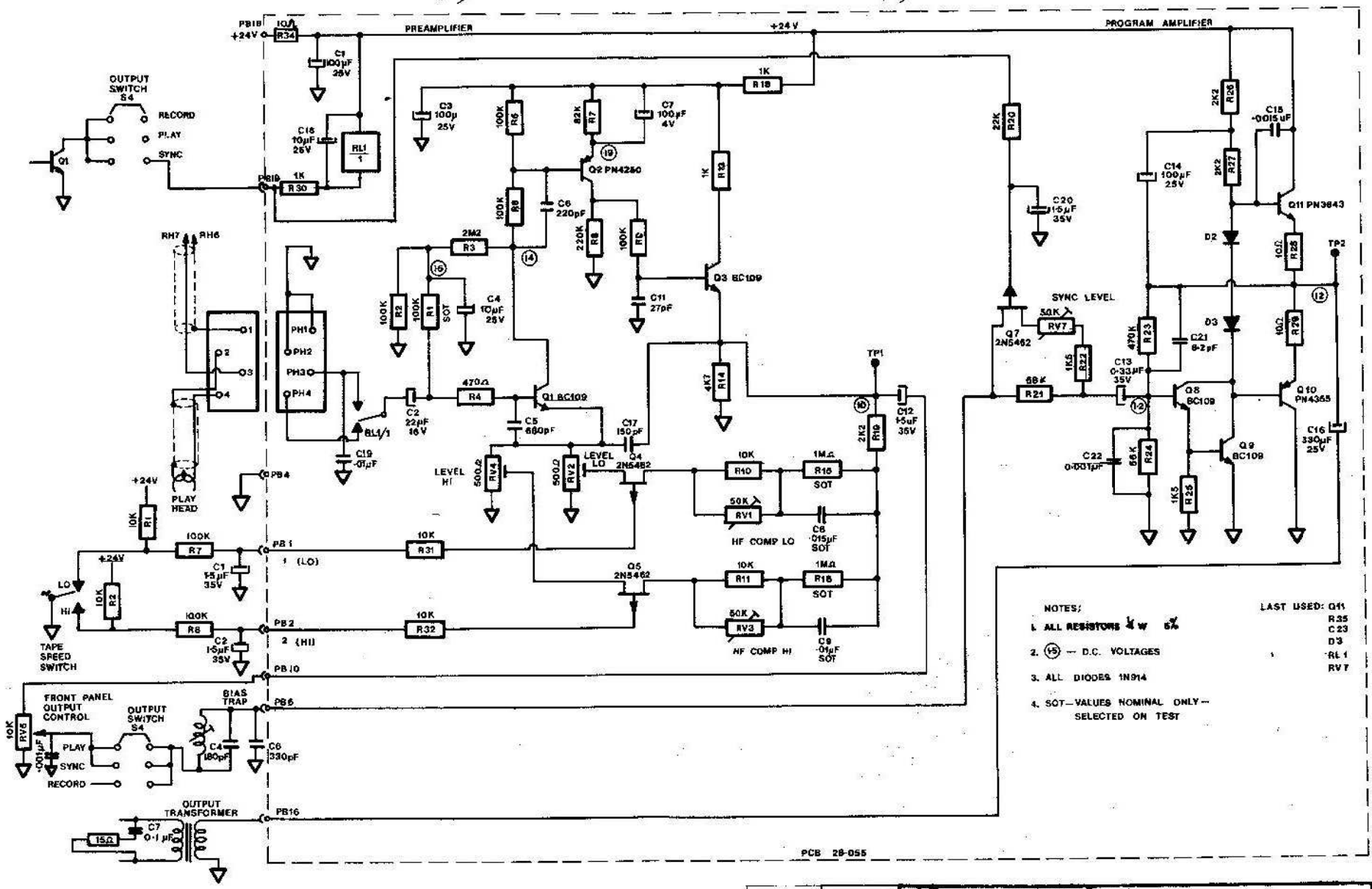
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS
TOLERANCES
LINEAR 0. ± 0.5
0.0 ± 0.1
HOLE DIA
ANGULAR ± 0.5°
SCALE
DRAWN J. BANOS 26-11-77
CHECKED 25-7-78

REVISIONS

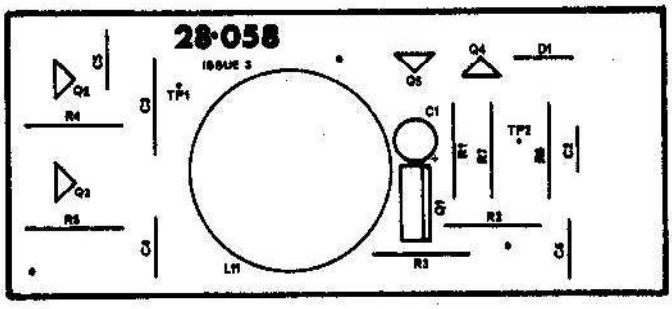
FINISH
MAT'L
RECORD PCB CIRCUIT
77MK9
R. MEDDING & ASSOCIATES PTY. LTD., MELBOURNE AUSTRALIA
USED ON
MAT'L. No.
3rd ANGLE PROJ.
DRAWING No.
23-1338
A 3 ISSUE F



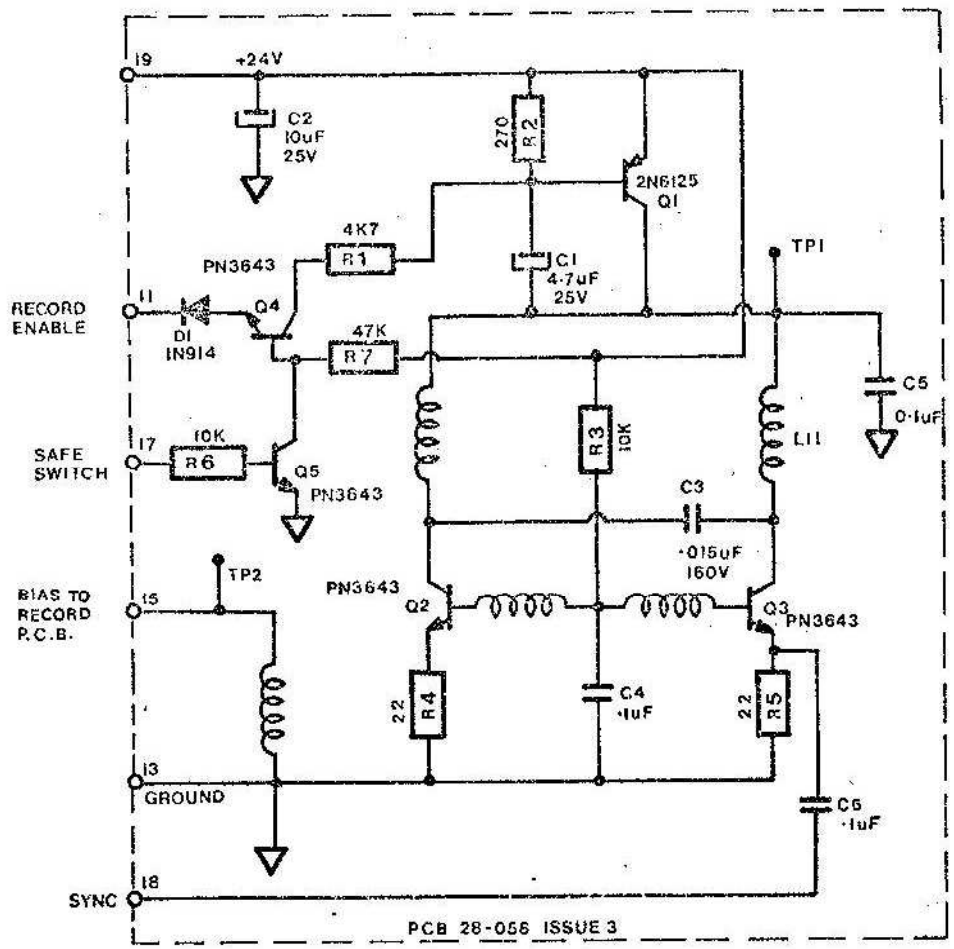
REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		REPLAY AMP PCB COMPONENT LAYOUT 77MkV	3rd ANGLE PROJ.
	SCALE 1:1		DRAWING No. 26-263
ISS.	DRAWN J. BANOS 8-12-77 CHECKED Y. HANSEN 21-8-78	R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE A



REVISIONS	UNLESS OTHERWISE SPECIFIED TOLERANCES LINEAR 0. ± 0.5, 0.0 ± 0.1, HOLE DIA'S. + 0.25 − 0, ANGULAR ± 0.5°	FINISH	USED ON
	SCALE	MAT'L	MAT'L No.
	DRAWN J. Bands 2/11/77	REPLAY AMP PCB CIRCUIT 77MkV	3rd ANGLE PROJ.
	CHECKED 8-7-78 P Kay	R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA	DRAWING No. 23-1337
C	Iss. B		A 3 ISSUE C



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		BIAS OSCILLATOR SYNCHRONIZED PCB COMPONENT LAYOUT 77MkV	G.T. ANGLE PROJ.
	SCALE 1:1		DRAWING No. 26-264
	DRAWN J.BANOS 8-12-77	R. MEDDING & ASSOCIATED PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE A
	CHECKED T. ANDERSEN 21-8-78 PKay		

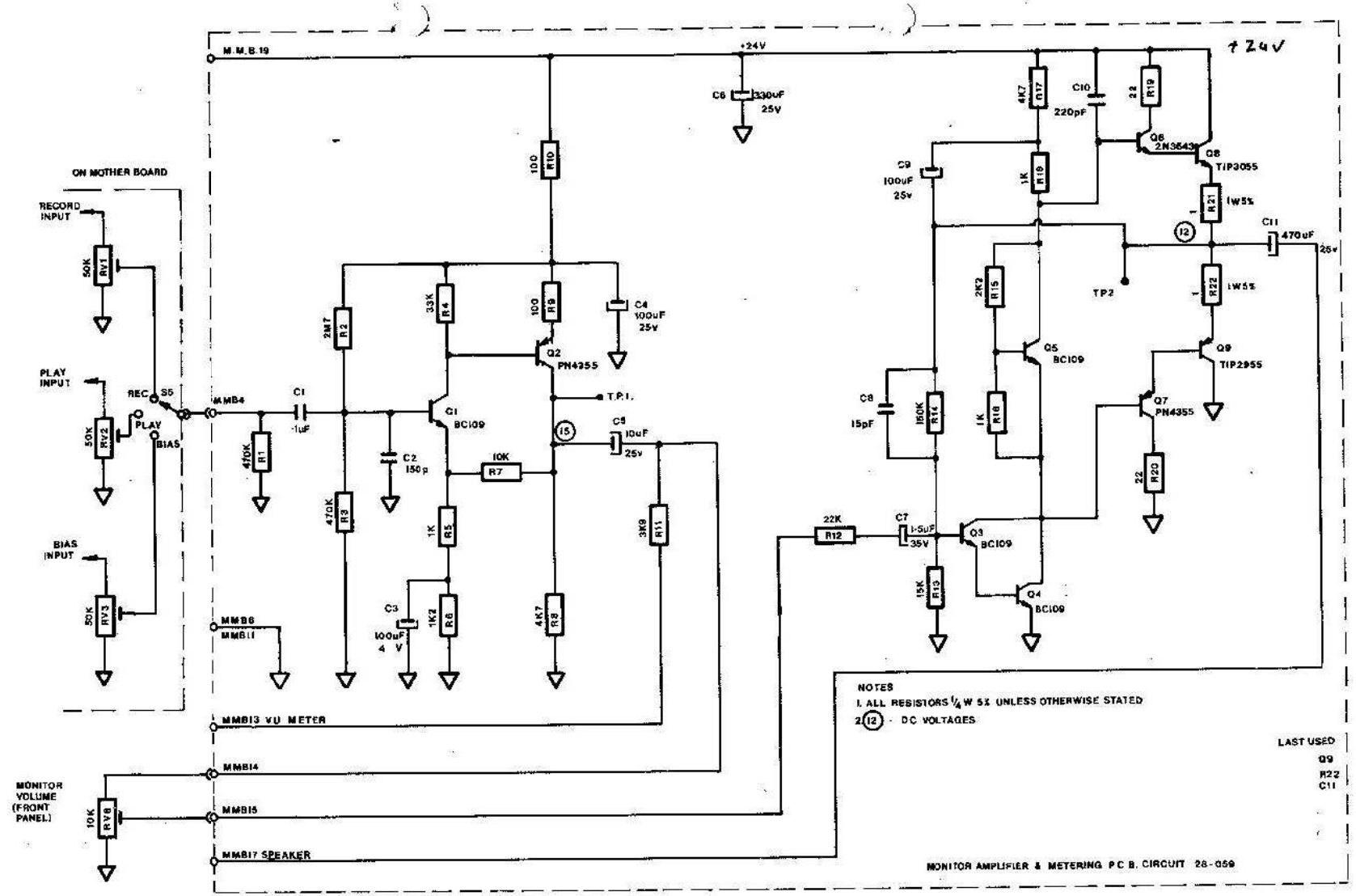


NOTE: UNLESS OTHERWISE STATED
1. ALL RESISTORS 1/4 W 5%
2. C3 PHILLIPS POLYESTER 160V

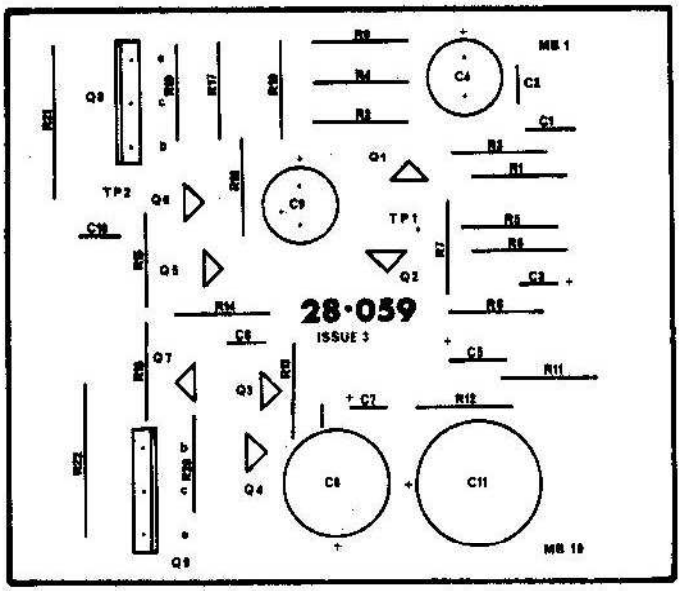
LAST USED Q5
R7
C6
D1
L11

77 Mk V Bias Oscillator -Synchronized

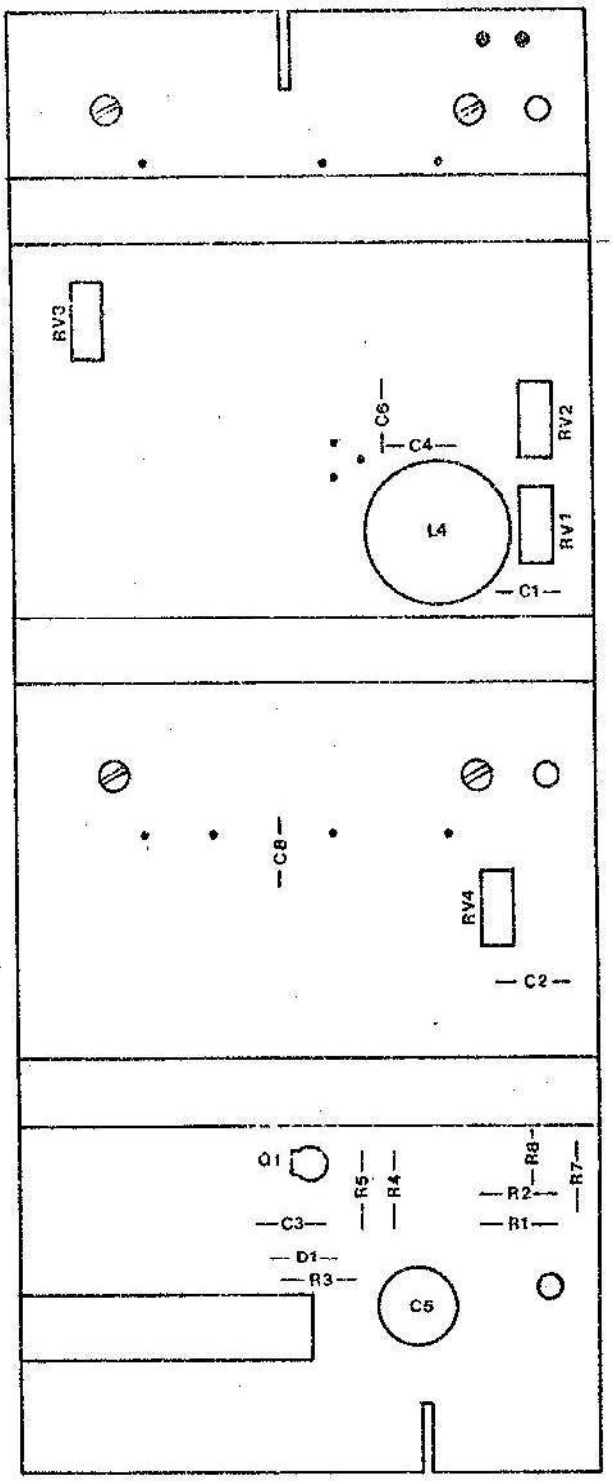
	S.D. 10-7-78. T.H. PK R4 & R5 WERE 33Ω	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 .0 ± 0.1 HOLE DIA'S. + 0.25 −0 ANGULAR ± 0.5°	FINISH MAT'L.	USED ON MAT'L. No.
	REVISIONS	SCALE	BIAS OSCILLATOR SYNCHRONIZED PCB CIRCUIT 77MkV	3rd ANGLE PROJ. DRAWING No. 23-1329
B	IS	DRAWN J. BANOS 20-11-77 CHECKED T. HANSEN 26-7-78 PK	R. NEWBOULD & ASSOCIATES PTY. LTD. BOX ROCKLEA AUSTRALIA	1/ 4 B



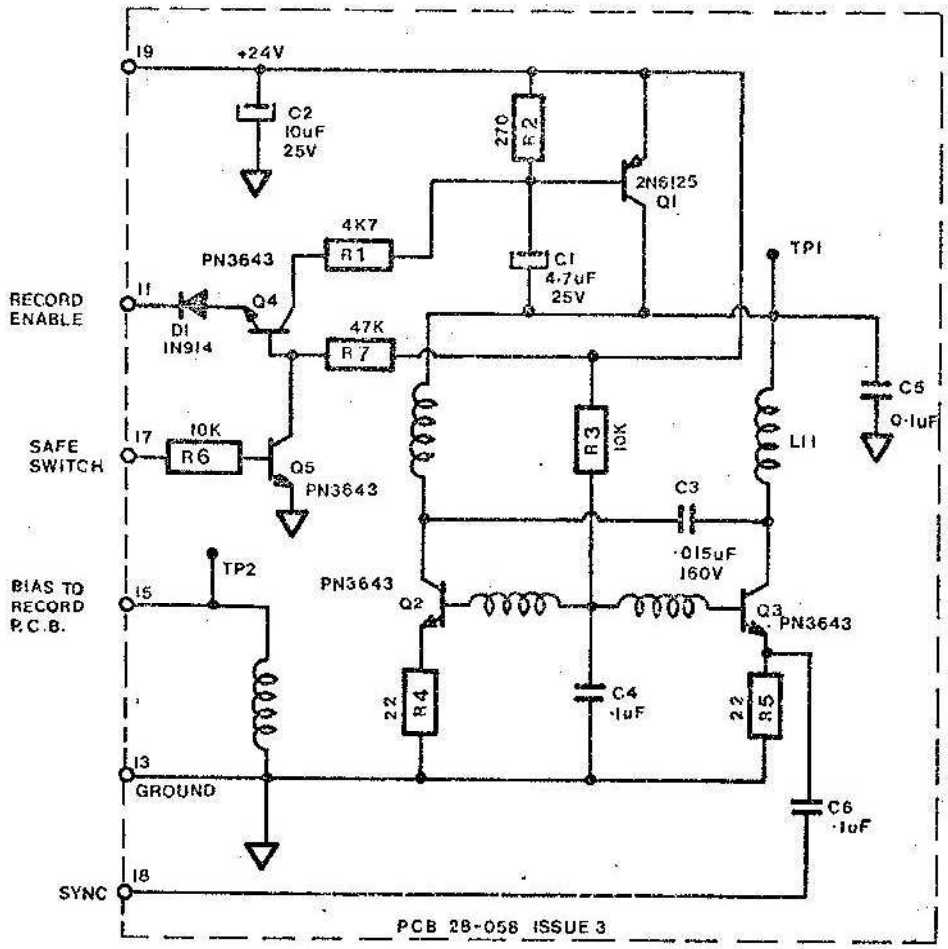
10-1178 S.R. R15 was 2K7, R14 was 470K, R16 was 47K	REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 −0 ANGULAR ± 0.5° SCALE DRAWN J. Banos 27-11-77 CHECKED T. HANSEN 28-7-78 PK	FINISH MAT'L MONITOR AMP PCB CIRCUIT 77MKV B. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©
8	SIZE		USED ON MAT'L. No. 3rd ANGLE PROJ. DRAWING No. 23-133 A 3



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		MONITOR AMP PCB COMPONENT LAYOUT 77Mk V	3rd ANGLE PROJ.
	SCALE 1:1		DRAWING No. 26-261
ISS	DRAWN J. BANOS 8-12-77 CHECKED V. HANSEN 9/-8-78	R. MEDDING & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE A



REVISIONS	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5 0.0 ± 0.1 HOLE DIA'S. + 0.25 − 0 ANGULAR ± 0.5°	FINISH MAT'L.	USED ON MAT'L. No.
J.H. 24-1-78 C.S. added.	SCALE 1:1 DRAWN J.Barnes 28-11-77 CHECKED T.Hansen 31-8-78	MOTHER PCB COMPONENT LAYOUT 77 MkV	3rd ANGLE PROJ. DRAWING No. 26-256
		R. MEDDINS & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA ©	A 4 ISSUE B



NOTE: UNLESS OTHERWISE STATED
1. ALL RESISTORS 1/4 W 5%
2. C3 PHILLIPS POLYESTER 160V

LAST USED Q5
R7
C6
D1
L11

77 Mk V Bias Oscillator -Synchronized

S.D. 10.7.78. T.H. PK R14 & R5 WERE 33Ω	UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETERS TOLERANCES LINEAR 0. ± 0.5, .0 ± 0.1, HOLE DIA'S. + 0.25 −0, ANGULAR ± 0.5°	FINISH	USED ON
		MAT'L.	MAT'L. No.
		BIAS OSCILLATOR SYNCHRONIZED PCB CIRCUIT 77MkV	3rd ANGLE PROJ.
	SCALE		DRAWING No. 23-1329
B	DRAWN J. JANOS 20-11-77	R. NEDDUS & ASSOCIATES PTY. LTD. MELBOURNE AUSTRALIA	
	CHECKED T. HANSEN 26-7-78 PK		1/4 F