Instruction Manual

No. EB 2170B

for

Digital Synchronizer TF 2170B

mi Technical Publications

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

Contents

Chapter 1 GENERAL INFORMATION

1.1 Introduction 3
1.2 Data summary 4
1.3 Accessories supplied 4

Chapter 2 OPERATION

2.1 Fitting TF 2170B to Signal Generators TF 2002 series 5
2.2 Connecting TF 2170B to Signal Generator TF 2002B 5
2.3 Connecting to local a.c. supply ... 5
2.4 Controls and connectors 6
2.5 Fuses 6
2.6 Setting the signal generator frequency 6
2.7 Incremental tuning 7
2.8 Independent use of signal generator 7
2.9 Modifications to TF 2002AS to accommodate TF 2170B 7
2.10 Modifications to TF 2002 to accommodate TF 2170B 8

Chapter 3 TECHNICAL DESCRIPTION

3.1 Introduction 9
3.2 Mechanical characteristics ... 9
3.3 Summarized function 9
3.4 Input amplifier 9
3.5 Trigger and prescaler 11
3.6 Variable ratio divider 11
3.7 Reference oscillator and amplifier 11
3.8 Standard frequency divider ... 12
3.9 Phase detector 12
3.9.1 Ramp generator 12
3.9.2 Sample and hold circuit ... 12
3.9.3 Principle of operation ... 12
3.10 Sample and hold driver circuit ... 13
3.11 False lock prevention and detection circuits 13
3.12 Output amplifier 13
3.13 Meter circuit 13
3.14 Power supply 14

Chapter 4 MAINTENANCE

4.1 Introduction 15
4.2 Screw fasteners 15
4.3 Access and layout 15
4.4 Preliminary checks 15
4.5 Test equipment 15
4.6 Overall performance tests ... 15
4.7 Circuit checks and adjustments ... 19
4.8 DC supply checks 19
4.9 Reference oscillator 19
4.10 Standard divider 19
4.11 Ramp generator 19
4.12 Sample and hold circuit 19
4.13 False lock prevention circuit ... 19
4.14 Input amplifier 19
4.15 Schmitt trigger circuit 20
4.16 Prescaler circuit 20
4.17 Variable ratio divider 20
4.18 Checking output levels and locking 20
4.19 Meter adjustment... 21
4.20 Final checks 21
4.21 Cleaning rotary switches... ... 21

Chapter 5 REPAIR

5.1 Introduction 22
5.2 Power supply 22
5.3 Reference oscillator and divider... 22
5.4 Standard divider 22
5.5 Ramp generator circuit 22
5.6 Sample and hold circuit 22
5.7 Input amplifier 23
5.8 Trigger and prescaler 23
5.9 Variable ratio divider 23
5.10 Additional information 23

Chapter 6 REPLACEABLE PARTS

Introduction and ordering 24

Chapter 7 CIRCUIT DIAGRAMS

Circuit notes 30

Fig. 7.1 Input amplifier and part of synchronizer... 31
Fig. 7.2 Part of synchronizer ... 33
Fig. 7.3 Power unit 35

Chapter 1

General information

1.1 INTRODUCTION

Digital Synchronizer TF 2170B (Fig. 1.1) is a self contained instrument designed expressly for use with the TF 2002 series of signal generators.

The synchronizer is constructed to be easily fitted to the signal generator and when the instruments are used together, the combination can be classified as an accurate and stable phase locked frequency synthesizer covering a range 32 kHz to 88 MHz when used with signal generator TF 2002B or 100 kHz to 72 MHz when used with TF 2002 or TF 2002AS.

The setting up procedure is extremely simple and calls only for the positioning of the TF 2170B frequency switches and the tuning of the signal generator to obtain a 'locked on' condition which holds the frequency of the signal generator to within 1 p.p.m. of the frequency indicated by the synchronizer switches for ambient temperatures from $+10^{\circ}$ to 35°C.

Used together, the combination provides an r.f. source with many applications.

Solid state circuits are employed throughout to ensure long term reliability and the design provides for easy access to all components for servicing.

If desired, the signal generator can be used independently without disconnection, by operating a switch located on the front panel of TF 2170B.

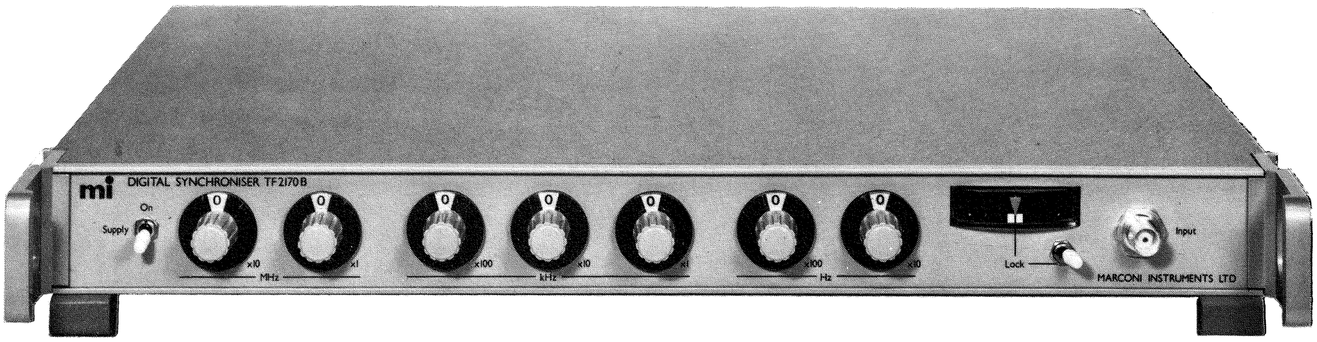


Fig. 1.1 Digital Synchronizer TF 2170B

Although this manual refers to the use of TF 2170B with TF 2002B the information given is, in general, applicable to TF 2002 and TF 2002AS.

1.2 DATA SUMMARY

Characteristic	*Performance*	*Supplementary information*
CARRIER FREQUENCY		
Range :	32 kHz to 88 MHz.	Will operate from 10 kHz to 99.9999 MHz.
Frequency selection :		By seven in-line decade switches for frequency selection in 10 Hz steps.
Accuracy :	When TF 2002B has been locked to TF 2170B the frequency of the signal generator will be held stable to within 1 p.p.m. of the frequency indicated by the synchronizer switches for ambient temperatures from + 10 to + 35 C. This condition is attained three minutes after switching the instruments on.	
Crystal aging tolerance :		±1 p.p.m. per year.
RF INPUT	Compatible with counter output levels of TF 2002, TF 2002AS and TF 2002B.	
Level :		Not less than 30 mV into 50 Ω.
DC OUTPUT	Two selectable levels to suit 1) TF 2002 2) TF 2002AS and TF 2002B.	
Level :		Total range of output 2 V to 12 V negative.
POWER REQUIREMENTS		
AC supply :		95 to 130 V (extreme limits) 190 to 264 V (extreme limits) 45 to 500 Hz.
Power consumption :		20 V A (nominal).

DIMENSIONS AND WEIGHT :	*Width*	*Height*	*Depth*	*Weight*
	428 mm (17 in)	65 mm (2.5 in)	390 mm (15.5 in)	6 kg (13 lb)

1.3 ACCESSORIES SUPPLIED

2 interconnecting cables fitted BNC (male) connectors.	Code No. 43122-155
1 mains supply cable fitted with instrument connector.	Code No. 43122-017
1 modification kit.	Code No. 46883-137

Chapter 2 Operation

2.1 FITTING TF 2170B TO SIGNAL GENERATORS TF 2002 SERIES

Since TF 2170B is intended to operate in conjunction with the TF 2002 series of signal generators it is dimensioned and constructed to be fitted on the top of these instruments so that the combination forms a complete unit.

The synchronizer is supplied with fitted clips and brackets to enable it to be easily attached to the signal generator.

With TF 2170B located on top of the signal generator, the two front clips are positioned under the front projection of the signal generator case.

For purpose of packing, the two rear brackets are fitted in reverse. They must be removed and refitted to allow them to be clamped by the two screws located at the rear of the signal generator - see Fig. 2.1.

2.2 CONNECTING TF 2170B TO SIGNAL GENERATOR TF 2002B

Only two connections are required between the synchronizer TF 2170B and signal generator TF 2002B and these are made using the interconnecting cables supplied.

One cable is used to connect the COUNTER OUTPUT socket on TF 2002B to the INPUT socket on TF 2170B located on the front panels.

The other cable is used to connect the OUTPUT socket on TF 2170B to the INPUT socket on TF 2002B located on the rear panel.

Check that the switch at the rear of TF 2170B is set to suit the signal generator being used.

2.3 CONNECTING TO LOCAL AC SUPPLY

The a.c. supply cable is fitted with a connector which mates with the mains connector on the rear panel; the cable is held to the instrument with a 'P' clip.

When fitting a suitable supply plug to the cable ensure that conductors are connected as follows :

LIVE	-	Brown
NEUTRAL	-	Blue
EARTH	-	Green/Yellow

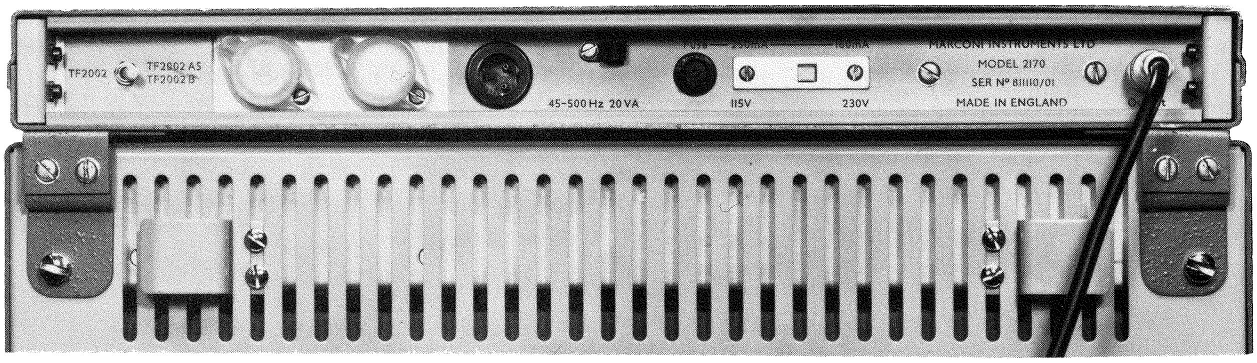


Fig. 2.1 Rear mounting brackets

Normally, the instrument is supplied with a fuse rated at 160 mA and with the mains voltage selector switch set for supply voltages of 190 to 264 V. For mains voltages 95 to 130 V, change the fuse for one rated 250 mA. Remove the switch plate, position the switch at 115 V, reverse the plate and refit.

2.4 CONTROLS AND CONNECTORS

The following outlines the functions of the controls and connectors.

1. AC SUPPLY SWITCH. Positioned UP to switch ON.

2. LOCK SWITCH. When this switch is positioned to the RIGHT, i.e. NOT towards LOCK the output of TF 2170B is disconnected from TF 2002B this enables the signal generator to be operated independently.

3. DECADE FREQUENCY SWITCHES. Positioned to provide the required frequency. The switches are intended to be set to cover frequencies 32 kHz to 88 MHz in steps of 10 Hz.

4. METER. The meter indicates the locked condition i.e. the meter pointer is held steady when the signal generator frequency is 'locked' to the frequency of the internal standard. When the signal generator is 'out of lock' the meter pointer swings over the scale.

5. INPUT CONNECTOR. Output from the counter socket on the signal generator is applied to the synchronizer through SKA.

6. OUTPUT CONNECTOR. The d.c. control signal from the synchronizer is applied to the signal generator through SKB.

7. MAINS INPUT CONNECTOR. The a.c. supply is connected to the synchronizer through SKC.

8. VOLTAGE SELECTION SWITCH. Selects either 95 or 130 V or 190 to 264 V. Voltage is selected to suit local a.c. supply.

2.5 FUSES

95 to 130 V a.c. input: 250 mA (quick blow).
190 to 264 V a.c. input: 160 mA (quick blow).

2.6 SETTING THE SIGNAL GENERATOR FREQUENCY

The setting up procedure is as follows:

(1) With both instruments switched on, set the frequency switches on TF 2170B to the required frequency and the lock switch to LOCK, i.e. to the left.

(2) Select the appropriate frequency range on the signal generator and set its incremental control at '0'.

(3) Using the tuning control, set the signal generator to the required frequency then slowly adjust the tuning to position the pointer of the TF 2170B meter at the centre mark.

The signal generator frequency is then locked to the standard frequency produced by the synchronizer.

When the instruments are used together all the features of Signal Generator TF 2002B are retained but the f.m. function can be slightly affected by introduction of the synchronizer. Consequently, when TF 2002B is switched for a frequency modulated output, it is necessary to verify that it is tuned to set the pointer of the TF 2170B meter at the centre mark to ensure that the change in f.m. accuracy is small and for most purposes can be ignored. With the meter pointer outside the white box area the deviation error can become appreciable.

When TF 2002B is switched for an a.m. or c.w. output the r.f. frequency will be locked to TF 2170B with the pointer of the TF 2170B in any position providing the pointer is not swinging over the scale.

2.7 INCREMENTAL TUNING

When the signal generator frequency is locked to the synchronizer the incremental control on TF 2002B is inoperative. However, much more accurate incremental changes (up to ±0.5%) can be obtained by setting the TF 2170B frequency switches. This feature is useful when it is desired to quickly and accurately check narrow bandwidths, response of highly selective tuned circuits, or the response of s.s.b. receivers.

Incremental changes using the synchronizer will cause the position of the meter pointer to vary but the signal generator will remain locked to the incrementally selected frequency provided the pointer is stationary i.e. not swinging over the scale.

2.8 INDEPENDENT USE OF SIGNAL GENERATOR

Signal Generator TF 2002B can be used as an independent instrument without disconnecting the synchronizer.

When it is required to use the signal generator independently, the LOCK switch on TF 2170B must be positioned to the right but the SUPPLY switch can remain at ON to provide a 'standby' condition which maintains the operational levels of the synchronizer.

When TF 2170B is connected to the signal generator it will not be effectively isolated by switching it off. If this procedure is adopted instead of that given in previous paragraph, the performance of the signal generator will be seriously affected.

2.9 MODIFICATIONS TO TF 2002AS TO ACCOMMODATE TF 2170B

Signal Generators TF 2002AS with serial numbers prior to 110905-001 require the following modification to electronically accommodate the synchronizer, using the kit of parts Code No. 46883-137 supplied as an accessory.

The modification kit M.I. code 46883-137 contains :

label, CARRIER	31728-118
label, INPUT FROM TF 2170B	31731-833
tag, printed circuit	34461-712
insulating boot	28488-201
receptacle, BNC	23443-443
tag, solder, 6 BA (2 off)	23231-012
screw, 6 BA x 3/8 in long	21347-070
nut, 6 BA	21382-136
crinkle washer, 6 BA	21177-615
crinkle washer, 3/8 in diameter	21177-623
screened cable	15650-053
capacitor, cer, 100 pF 20% 500 V	26343-167
cap elec 470 μF 25 V	26415-822

1. Remove and discard the metal cover fitted over the power transistor located on the lower rear chassis. Fit the insulating boot using the lower of the two screws holding the power transistor to retain it.

2. Insert the 6 BA x 3/8 in screw in the threaded hole to right of the power transistor. Assemble a solder tag and secure with the 6 BA nut and crinkle washer.

3. Directly below the above hole and directly to right of the power transistor fixing screw, pierce a 'D' shaped hole for the BNC receptacle. (Alternatively drill 0.400 in diameter round hole). Fit receptacle, using 3/8 in crinkle washer.

4. Remove backing from self-adhesive label 'INPUT FROM TF 2170B' and press in position adjacent to receptacle.

5. Locate the regulated power supply and monitor amplifier printed wiring board TM 9056, fitted at the bottom of the left-hand side frame. Gain access to the track side of the board and drill at 1.00 mm (0.039 in) hole, piercing the track at the junction of R8 and R9. Insert the printed circuit tag from the legend side of the board and solder to track. Solder the 100 pF capacitor on the track side of the board between the base track of ~~VT6~~ and the earth track.
VT4

6. Connect the screened cable between the tag described in step 5 and the BNC receptacle (step 3). Solder the screen of the cable at one end only, to the solder tag of step 2.

7. When TF 2170B is installed on top of TF 2002AS the left-hand front fixing bracket of the former obscures the legend 'CARRIER'. The self-adhesive label supplied can be used to restore this when fitted below the bracket.

8. When TF 2170B is used with Signal Generators TF 2002AS with serial numbers commencing 110905-001 the 470 μF -25 V capacitor connected between tag 5 board TM 9056 and earth must be removed.

Note: When TF 2170B is used with TF 2002AS the toggle switch on the rear panel of TF 2170B must be set to the TF 2002AS position.

2.10 MODIFICATIONS TO TF 2002 TO ACCOMMODATE TF 2170B

Signal Generators TF 2002 are required to be modified to electronically accommodate the synchronizer. Using the same kit of parts follow instructions in Section 2.1 (1 to 4 inclusive) then follow instructions given below :

5. Locate printed board TM 7297 on the left-hand side frame.

6. Connect the inner of one end of the screened cable to pin 6 on this board and the other end (inner) to the BNC socket pin. Solder the screen of the cable at one end only, to the solder tag of step 2.

7. Connect the 470 pF 25 V capacitor across the front panel terminals (inside the instrument). Connect the negative end to the FREQ SHIFT terminals and the positive end to the EARTH terminal.

8. When TF 2170B is installed on top of TF 2002 the left-hand front fixing bracket of the former obscures the legend 'CARRIER'. The self-adhesive label supplied can be used to restore this when fitted below the bracket.

Note: When TF 2170B is used with TF 2002 the toggle switch on the rear panel of TF 2170B must be set to the TF 2002 position.

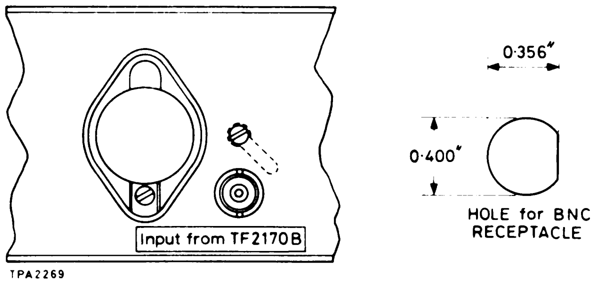


Fig. 2.2 New input socket

Chapter 3

Technical description

3.1 INTRODUCTION

This chapter, which should be read with reference to drawings, illustrations and circuit diagrams contained within this manual, outlines the function of the synchronizer when used with Signal Generators TF 2002, TF 2002AS, TF 2002B and briefly explains the function of the circuits employed.

3.2 MECHANICAL CHARACTERISTICS

Digital Synchronizer TF 2170B is constructed to enable easy access to all components. It consists of front and rear panels supported by side members which also carry an open type chassis and a power unit.

Seven in-line decade frequency setting switches are mounted on the front of the open type chassis which also accommodates two printed circuit boards onto which are constructed the various circuits. Top and bottom cover plates are fitted over the whole r.f. section to provide a completely screened compartment, and overall top and bottom covers are fitted for instrument protection. The power unit which is located behind the r.f. section uses the rear panel of the instrument as a heat sink for the series regulator transistors.

Since the synchronizer is intended to operate in conjunction with series TF 2002 Signal Generators, brackets and clips are fitted to TF 2170B to enable it to be easily attached to the generator.

3.3 SUMMARIZED FUNCTION

When the synchronizer is used with the signal generator as shown in the block functional diagram Fig. 3.1, the configuration is that of a phase locked frequency synthesizer.

Output from the crystal oscillator at a frequency fr is passed to a series of fixed ratio dividers to produce a reference frequency fr/m which is applied to one input of a phase detector. Output from the signal generator at a frequency fo is passed to a series of variable ratio dividers to produce a signal frequency fo/n which is applied to the second input of the phase detector.

When the frequency of the generator is set so that fo/n is correctly related to fr/m the control signal from the phase detector will be held constant. If the frequency of the generator drifts, the two frequencies will not be correctly related, causing the control signal from the phase detector to change in a manner such that the frequency of the signal generator will be corrected.

The circuits are interconnected as shown in the block diagram Fig. 3.2 and the function of each is briefly explained in the following sections.

3.4 INPUT AMPLIFIER

Circuit diagram Fig. 7.1, Board A3

The circuit consists of two amplifying stages with an a.l.c. circuit to maintain a constant output level closely approximating 120 mV p-p. Output

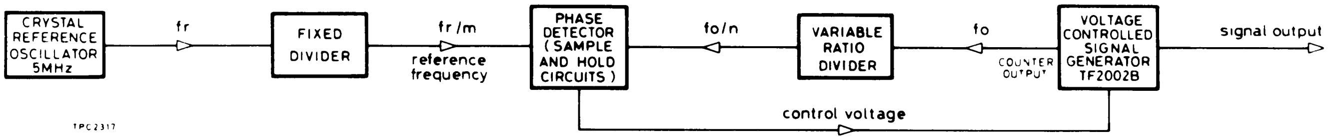


Fig. 3.1 Simplified block diagram

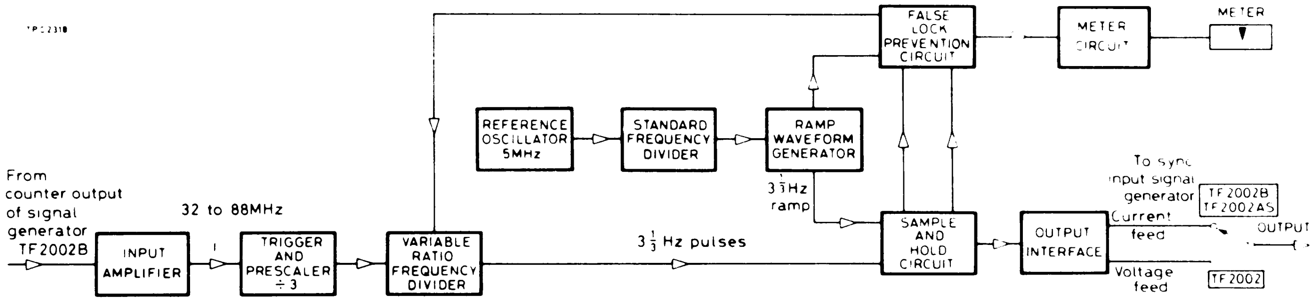


Fig. 3.2 Block diagram

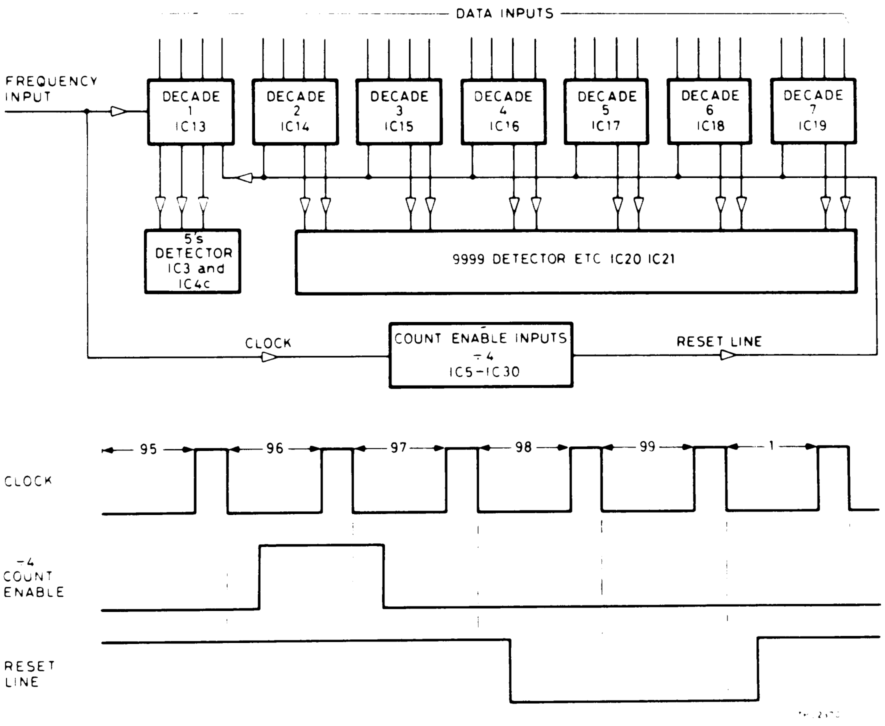


Fig. 3.3 Functional diagram

3.4 *continued*

from TR3 is rectified by D2 and the resulting d. c. level is compared with the d. c. level preset by R20; output from IC1 which is dependent upon the difference between the two d. c. levels, controls the gain of the dual gate f. e. transistor stage, TR1.

3.5 TRIGGER AND PRESCALER

Circuit diagram Fig. 7. 1, Board A4

The output signal from the input amplifier is passed to TR1 on board A4 for amplification to a level suitable for driving the Schmitt trigger circuit employing TR2 and TR3. The square wave output from this circuit is of the required amplitude for the divide by three prescaler which consists of two ECL toggles connected with feedback to provide the desired division ratio. Output from the prescaler circuit is passed to the common emitter amplifier TR7 to provide a 5 V swing necessary to drive the TTL circuits in the variable ratio divider.

3.6 VARIABLE RATIO DIVIDER

Circuit diagram Fig. 7. 1, Board A4

Operation of the variable ratio divider is best described with reference to the functional diagram Fig. 3. 3 which identifies the i. c. packages shown in the circuit diagram.

The variable ratio divider (VRD) operating through the prescaler circuit (divide by three) enables any output frequency from the signal generator to be divided to provide sampling pulses with a repetition frequency of about 3. 333 Hz.

A repetition frequency of 3. 333 Hz is produced when the signal generator frequency is locked to the reference frequency. If the signal generator frequency is closely but not accurately set to the reference frequency the pulse repetition frequency will not be 3. 333 Hz. This will cause the control voltage to change in the appropriate direction to correct the signal generator frequency.

Basically, the variable ratio divider consists of seven decade counters which can each be preset to any number from 0 to 9 to provide the desired overall division ratio. When the TF 2170B digital switches are set at the required frequency, the counters will be preset to a number (X) equal to the complement of the desired division ratio (Y) with respect to the maximum content (Z) of the variable ratio divider i. e. division ratio is (Z-X). When input pulses are received from the prescaler the count will commence from X and continue to Z (counter full). The full condition (Z) is then detected and the signal is passed to the phase detector as a sampling pulse and to the variable ratio divider to reset the counters to accept the next count cycle.

Overall function of the prescaler and the variable ratio divider may be more clearly understood by reference to Fig. 3. 4 which assumes an accurate 15 MHz signal from the generator.

Using seven cascaded counters, a limitation occurs because the reset time of the counters is greater than their maximum clock frequencies.

To overcome this, a divide by four circuit, IC5 and IC30, and a 5's detector circuit, IC3 and IC4c is added to the circuit of the first counter, IC13.

When the counters reach 9999995 circuit IC5 is allowed to count the following clock pulses. At 9999997 the output at pin 6, IC30, goes low to produce a reset pulse until the count reaches 9999999 after which the counters are then ready to accept the reset count cycle.

3.7 REFERENCE OSCILLATOR AND AMPLIFIER

Circuit diagram Fig. 7. 2, Board A4

The fundamental reference frequency fr is provided by a 5 MHz temperature controlled crystal oscillator unit.

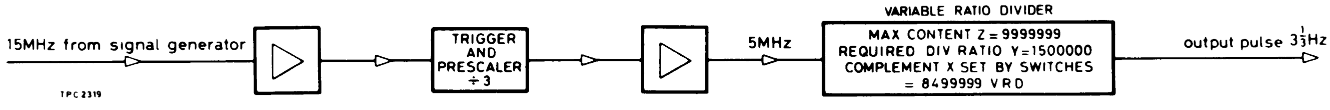


Fig. 3.4 Functional diagram of variable ratio divider

3.7 *continued*

The crystal oscillator circuit incorporates a trimming capacitor to enable the frequency to be very accurately set and compensation for ambient temperature change is included.

Output from the oscillator is passed to a two stage common emitter amplifier TR5-TR6 which produces a signal level suitable for driving the TTL circuits used in the standard divider.

3.8 STANDARD FREQUENCY DIVIDER

Circuit diagram Fig. 7.2, Board A4

This consists of seven integrated circuits IC6 to IC12 inclusive : circuits IC6 and IC7 each divide by ten: circuits IC8, IC9 and IC10 each divide by five whilst IC11 divides by twelve. Output from IC11 is a square wave signal which is converted using NAND gate IC12 to provide a train of narrow negative-going pulses to the ramp generator circuit in the phase detector.

3.9 PHASE DETECTOR

Circuit diagram Fig. 7.2, Board A4

The phase detector consists of a ramp generator and sample and hold circuits which function as described in the following sections.

3.9.1 Ramp generator

During the interval between the 33.333 Hz input pulses, transistor TR8 is non-conducting causing capacitor C33 to charge through the constant current source provided by the circuit TR9 to produce a negative-going linear ramp as shown in Fig. 3.5.

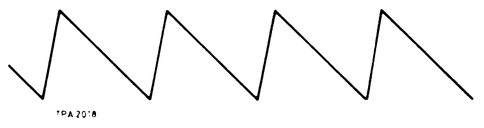


Fig. 3.5 Ramp waveform

Output from the ramp generator circuit is passed to an emitter follower, TR10, which presents the required low impedance to the input of the sample and hold circuit.

3.9.2 Sample and hold circuit

Initially TR12 is ON to allow the output from the ramp generator to charge C44 and TR14 is OFF to isolate the hold capacitor, C49, from the ramp input. When the sampling pulse from the VRD appears, TR12 is switched OFF to isolate C44 which now holds a voltage at a level which has been determined by the position of the sampling pulse on the ramp.

Transistor TR14 is now switched ON for a short period to transfer the voltage on C44 to the hold capacitor, C49. The voltage on C49 is passed to the output amplifier through the high impedance circuit, TR15, which is employed to ensure that the voltage level on C49 is closely maintained.

At the end of the period the cycle is repeated.

3.9.3 Principle of operation

Every tenth ramp waveform, produced by the negative-going pulses derived from the standard divider, is sampled by the narrow pulse from the variable ratio divider. When the signal generator is 'in lock' these pulses will be at a frequency which is precisely 3.333 Hz and sampling will occur at the same position on every tenth ramp and the d.c. voltage on C49 and consequently, the level of the control signal to the generator will remain constant.

If the signal generator frequency is just out of lock the frequency of the sampling pulse will then be above or below 3.333 Hz and sampling will occur at a different position on successive sampled cycles of the ramp. This produces a higher or lower d.c. control voltage which causes the frequency of the signal generator to be corrected to establish the 'in lock' condition - see waveforms Fig. 3.6.

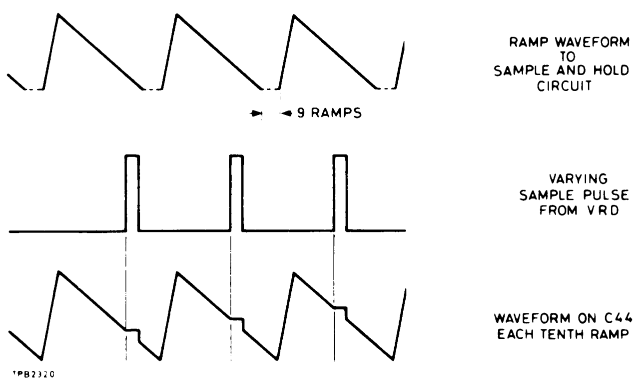


Fig. 3.6 Sampling and ramp waveforms

Fig. 3.6 illustrates the operation of the circuit in the presence of a sampling pulse varying from a p.r.f. of 3.333 Hz. Only every tenth cycle of the ramp waveform is sampled as shown.

3.10 SAMPLE AND HOLD DRIVER CIRCUIT

Circuit diagram Fig. 7.2, Board A4

Operation of the sample and hold circuit is controlled by the sample and hold driver circuit consisting of three monostables, IC24, IC25 and IC28. For sampling it is necessary to switch TR12 OFF just before TR14 is switched ON to ensure that only a pure d.c. voltage is transferred to C49. The output pulse from the VRD is applied to the monostable, IC24, to produce a pulse of the required duration to switch TR11 ON and consequently TR12 OFF during the transfer period.

Monostable IC25 provides a small delay before IC28 supplies a negative-going pulse to switch TR13 OFF and consequently TR14 ON - see output waveforms Fig. 3.7.

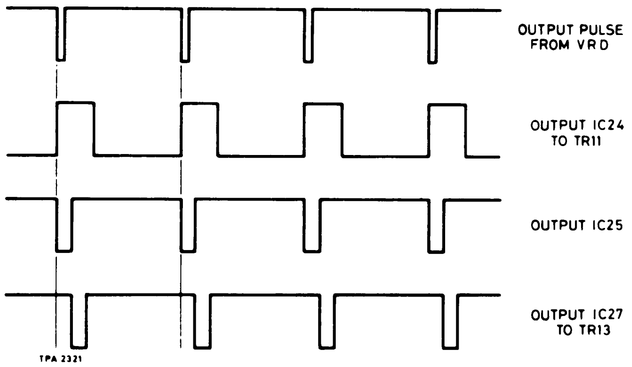


Fig. 3.7 Output waveforms of sample and hold driver circuit

3.11 FALSE LOCK PREVENTION AND DETECTION CIRCUITS

Circuit diagram Fig. 7.2, Board A4

(a) Binary counter and associated decode circuits (IC23, IC22b, IC26a).

(b) Coincidence detector and associated monostable (IC27).

(c) Multivibrator IC26b and IC22c.

(d) Meter circuit.

The binary counter, IC23, and the associated decode circuits, IC22b and IC28a, are employed to convert the 33.333 Hz output from the standard divider to 3.333 Hz and this is applied to one input of the coincidence detector, IC27 with the second input connected to accept the sample pulse from the variable ratio divider. Coincidence is obtained when the lock condition is established and this causes the output from the monostable, IC27, to be low.

When TF 2002AS is not locked to TF 2170B the pulses applied to the respective inputs of the coincidence circuit will be received at different times and this causes the monostable output to be high.

Output levels from the monostable control the operation of the multivibrator, IC26b-IC22c. When the monostable output is low (lock condition established) the multivibrator will be non-oscillatory and since with this condition there will be no output, the pointer of the panel meter will be stationary indicating a true lock condition and the VRD chain will remain as set. When the monostable output is high (non-lock condition) the multivibrator oscillates causing the meter pointer to swing over the scale indicating a non-lock condition. It also causes the VRD divider to be continually reset.

The time constant of the multivibrator has been made equal to several sample pulse periods to enable the lock condition to be established when it is near the set frequency.

3.12 OUTPUT AMPLIFIER

Circuit diagram Fig. 7.2, Board A4

This consists of two different systems, (a) the voltage amplifier, IC29, which is used for signal generators TF 2002 and (b) a current amplifier, TR16, TR17 and TR18, which is used for signal generators TF 2002AS and TF 2002B.

Circuit IC19 forms a strapped voltage follower whilst TR16 and TR18 form a current long tailed pair, the current source being obtained from the collectors of TR17-TR18. To increase the gain on ranges above 3.2 MHz, resistor R71 is switched out of circuit.

3.13 METER CIRCUIT

Circuit diagram Fig. 7.2

The panel meter indicates the signal level present at the output of IC29 and this is routed to the meter through a low-pass filter.

3.14 POWER SUPPLY

Circuit diagram Fig. 7.3, Board A2

The power supply which is located at the rear of the instrument operates by switch selection from a.c. supplies of 95 to 130 V or 190 to 264 V - 45 to 500 Hz, to provide stabilized d.c. outputs of :

+5 V at 750 mA
-18 V at 35 mA
with common 0 V

The mains transformer has three secondary windings connected to independent full-wave rectifier circuits which, together with their associated capacitors, provide smoothed unregulated d.c. to the respective regulator circuits.

A three pin connector is used to connect the a.c. supply to the instrument and the input circuit includes the on/off switch and a suitable fuse.

Chapter 4 Maintenance

4.1 INTRODUCTION

This chapter contains information to enable the performance of the instrument to be maintained. It should be read with reference to Chapter 3 and the drawings and circuit diagrams contained within this manual.

CAUTION

The instrument uses semiconductor devices which, although having inherent long term reliability, can be damaged by overloads, reverse polarity and excessive heat or radiation. Care should be exercised to ensure that d.c. supplies are not reversed, avoid prolonged soldering, and strong r.f. fields. Before applying continuity or insulation tests or before shorting or breaking a circuit refer to the circuit diagram to establish the effect on the bias arrangement of the devices employed.

4.2 SCREW FASTENERS

Screw threads used in this instrument are mainly metric but some BA sizes are used.

Ensure that screws removed are refitted in original positions.

4.3 ACCESS AND LAYOUT

The sectional layout of TF 2170B is shown in Fig. 4.1 and the location of sub-assemblies, printed circuit boards and certain components is detailed in Fig. 4.2 and Fig. 4.3. All components on printed circuit boards are individually identified. Applied d.c. voltages are as given on the appropriate circuit diagram. Access to all assemblies and components is obtained by removing the top and bottom protection covers and screening plates.

4.4 PRELIMINARY CHECKS

1. Check to ensure that all switches are undamaged and operating correctly and verify that connectors are securely mated.

2. Check that the fuse is of the correct rating and type, not open circuit, and fits correctly in the holder.

3. Check using the multimeter on low ohms range that electrical connections to chassis and earth points have low contact resistance.

4.5 TEST EQUIPMENT

The test equipment listed in Table 4.1 is required to perform the checks described for maintenance and repair.

4.6 OVERALL PERFORMANCE TESTS

With the signal generator and TF 2170B connected together and switched on, correct performance can be quickly ascertained by performing the following overall test :

1. Connect the frequency counter to the OUTPUT socket of the signal generator.

2. Set the synchronizer at 15 MHz (1 5 0 0 0 0 0).

3. Set the signal generator frequency at 15 MHz and carefully tune to set the pointer of the TF 2170B panel meter at the centre mark on the scale and check that the counter displays 15 MHz.

4. Set only the synchronizer at 15 MHz + 10 kHz (1 5 0 1 0 0 0). The counter should now display this frequency and the meter pointer should be on scale (not centrally positioned) and stationary.

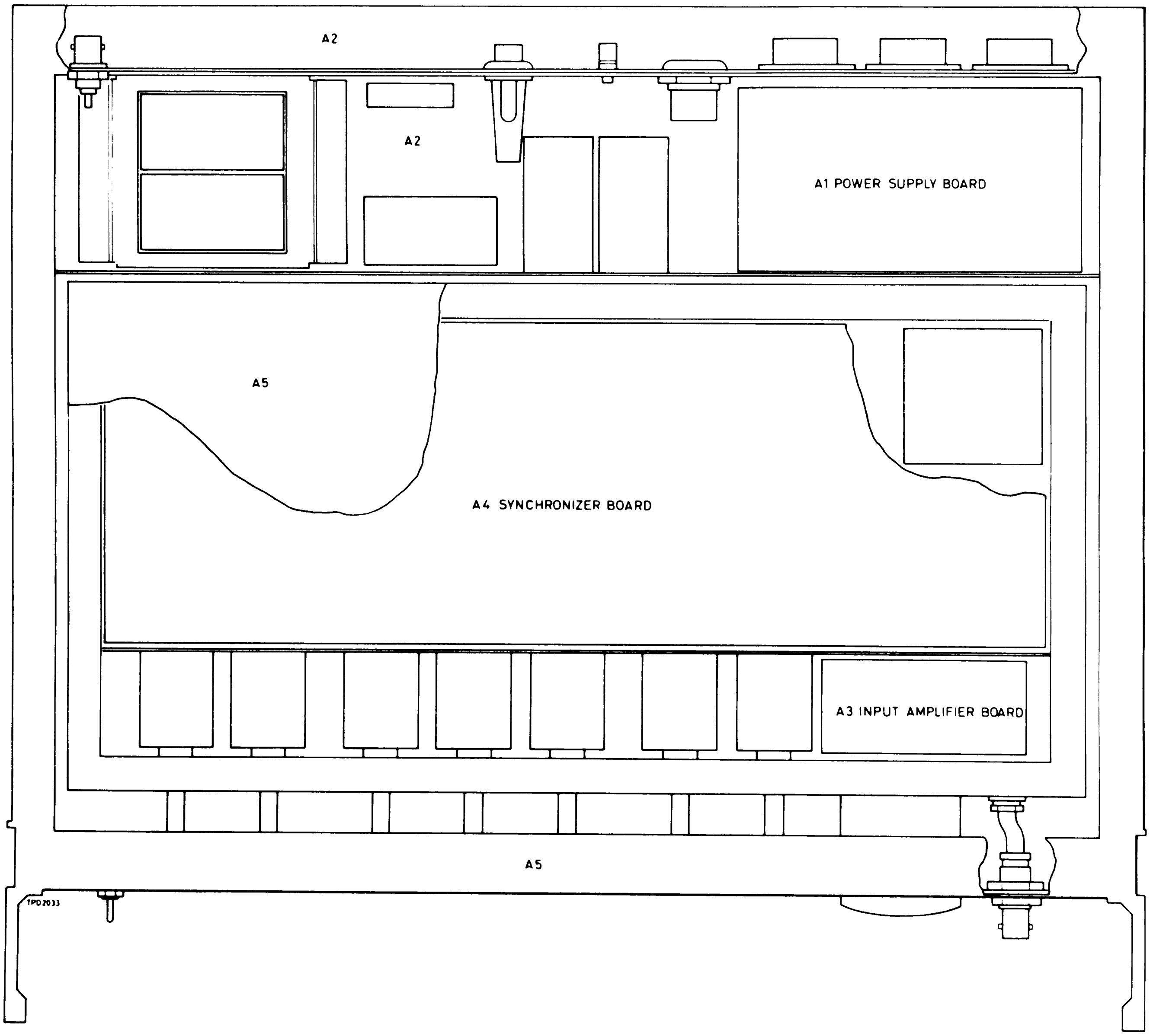


Fig. 4.1 Location of sub-assemblies

Table 4.1

Item	*Description*	*Recommended model*
(1)	Multimeter	Avometer Model 8 or equivalent.
(2)	Oscilloscope	Minimum requirements : (a) Double beam (b) Time base : 10 ns to 100 ms (c) Rise time : 2 ns (d) Amplitude measurement : 0 to 25 V
	Input probes (2 off)	Suitable for above.
(3)	Frequency counter	Range up to 100 MHz.

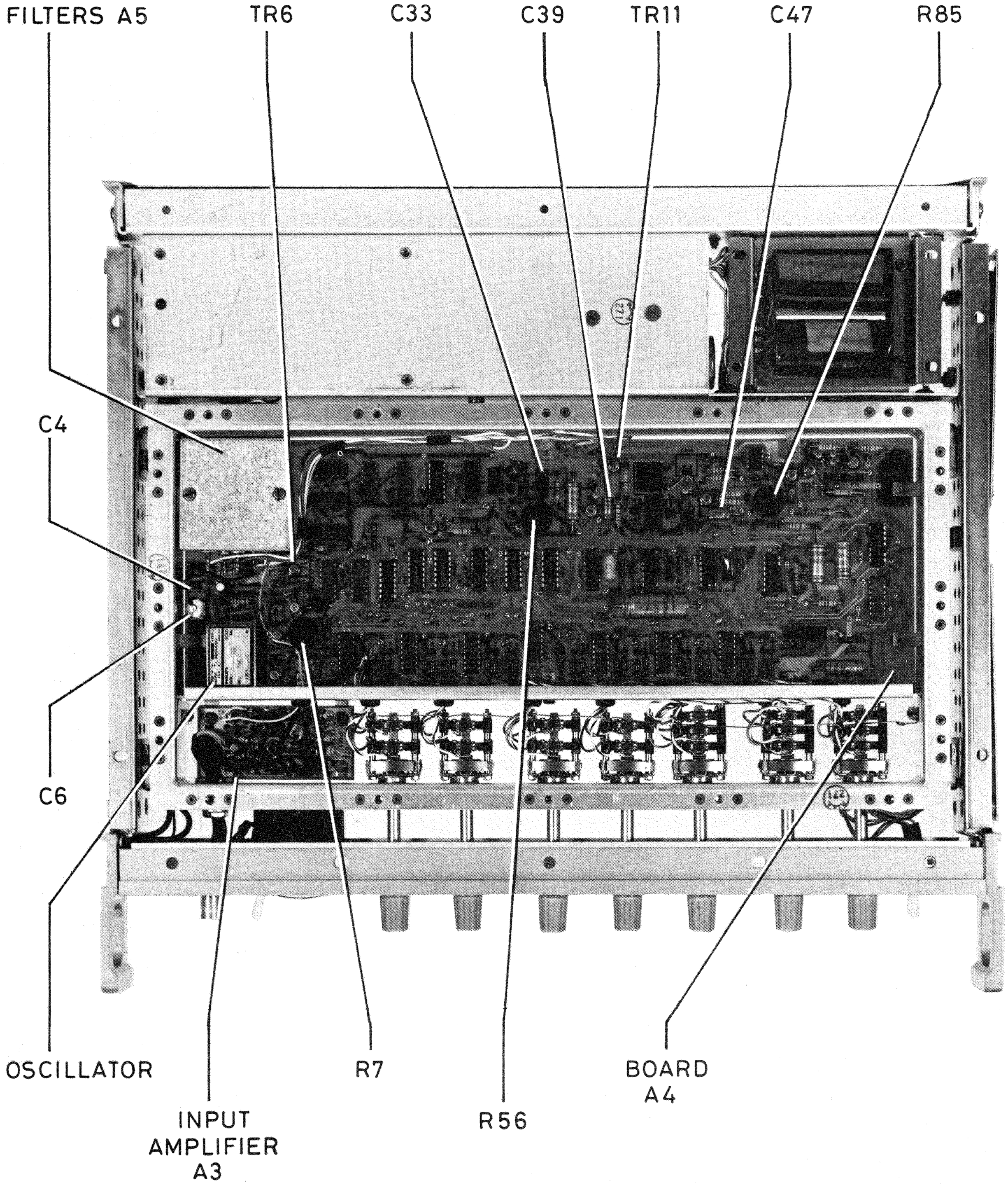


Fig. 4.2 View from above with covers and screening removed

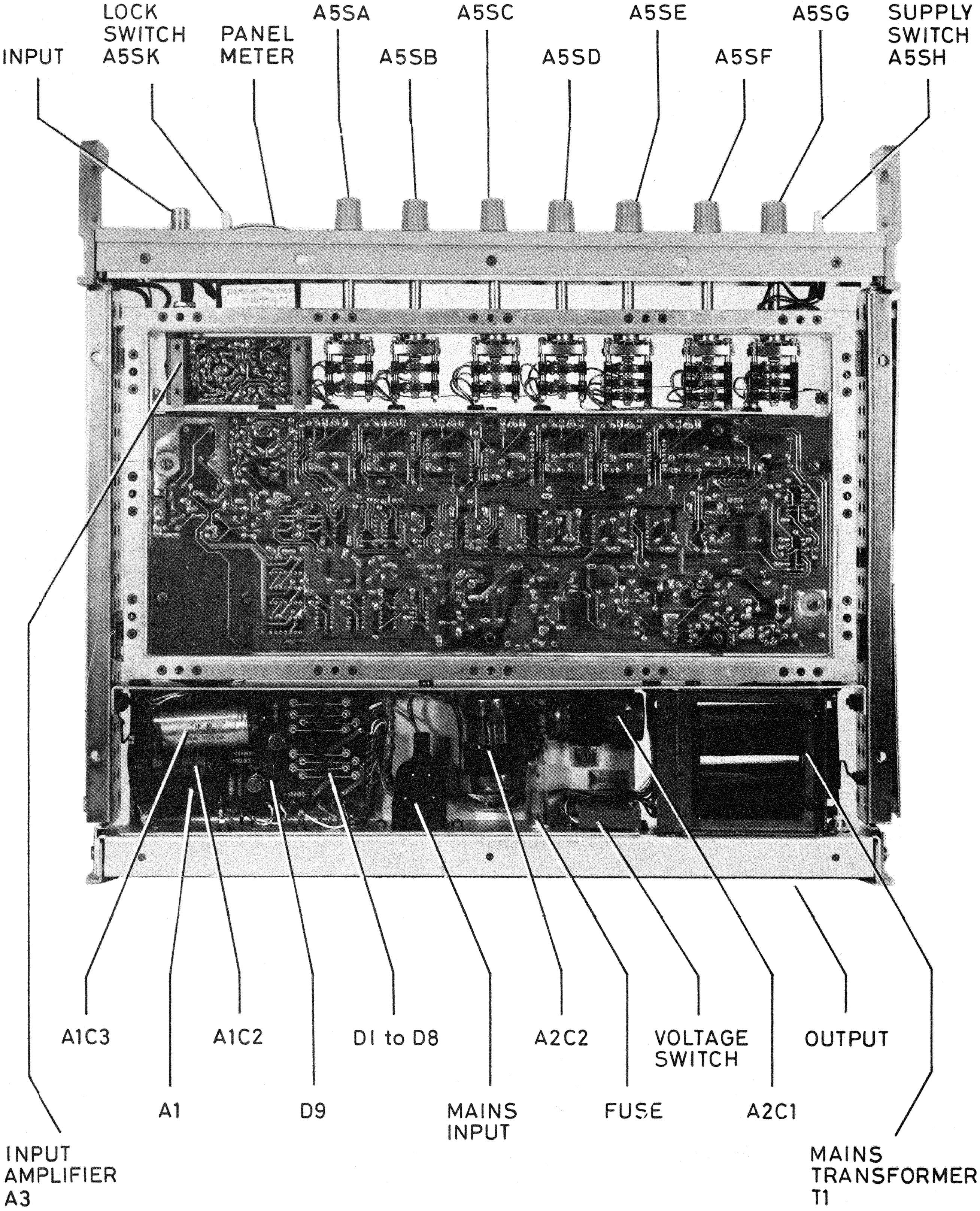


Fig. 4.3 View from below with covers and screening removed

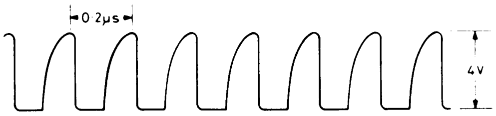


Fig. 4.4 Collector TR6, standard divider

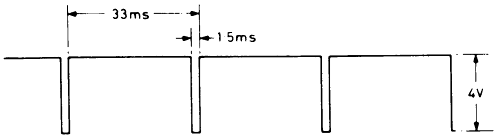


Fig. 4.5 TP1, standard divider

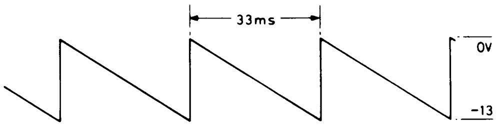


Fig. 4.6 TP2, ramp generator

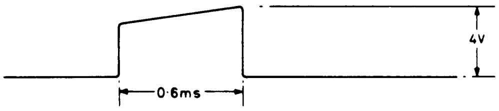


Fig. 4.7 Positive end C39, sample and hold circuit

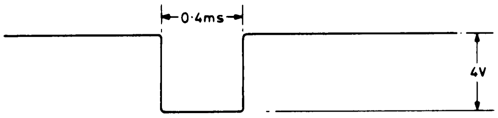


Fig. 4.8 Positive end C47, sample and hold circuit

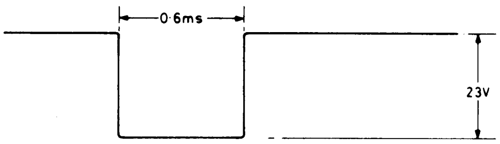


Fig. 4.9 Collector TR11, sample and hold circuit

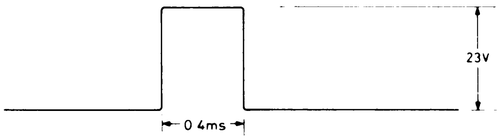


Fig. 4.10 Collector TR13, sample and hold circuit

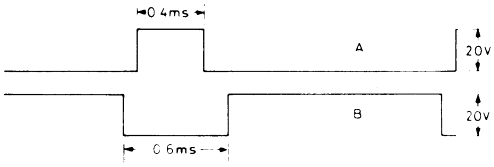


Fig. 4.11 Collectors TR13 and TR11, sample and hold circuit

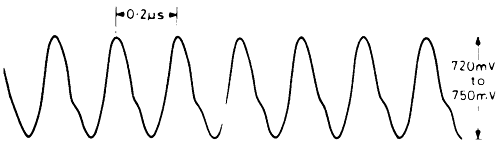


Fig. 4.12 Collector TR1 Schmitt trigger circuit

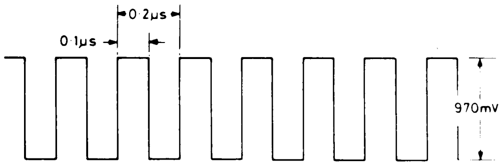


Fig. 4.13 Collector TR3, Schmitt trigger circuit

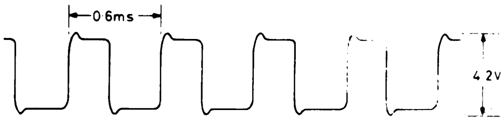


Fig. 4.14 Collector TR7, prescaler circuit

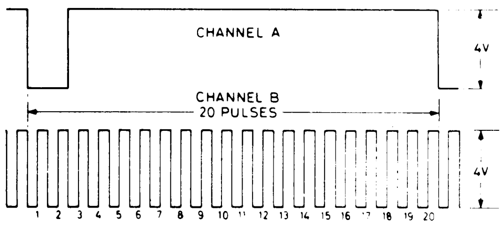


Fig. 4.15 Pin 1, IC24 and pin 2, IC13 variable ratio divider

4.7 CIRCUIT CHECKS AND ADJUSTMENTS

To ensure that the performance of TF 2170B is fully maintained, it is recommended that periodic checks be made to prove correct operation of certain circuits employed in the instrument and, if necessary, adjustments should be made to obtain the required result.

NOTE. Test waveforms may vary slightly from the typical waveforms in Figs 4.4 to 4.15.

4.8 DC SUPPLY CHECKS

Board A1 - Fig. 4.3

1. Before proceeding with functional checks verify, using the multimeter, that the d.c. outputs from the power unit are within the following limits :

+5 V supply

Tag 18 (+) and tag 19 (-) 5.2 V to 5.4 V.

-18 V supply

Tag 19 (+) and tag 20 (-) 18 V to 18.4 V.

If the measured voltages are outside the limits select the highest value for R6 to satisfy these requirements.

Connect the oscilloscope in turn to the +5 V and -18 V supply and check that the ripple is not greater than 5 mV p-p respectively.

2. Check that voltage levels on the A4 board tags (see circuit diagram) are as given in (1) for +5 V and -18 V respectively allowing for a small voltage drop across the filters.

4.9 REFERENCE OSCILLATOR

Board A4 - Fig. 4.2

Connect the counter to the collector of TR6. Check and if necessary adjust C6 to set the frequency of the oscillator at 5 MHz ±1 Hz.

4.10 STANDARD DIVIDER

Board A4 - Fig. 4.2.

1. Connect the oscilloscope to collector of TR6, the waveform should be as Fig. 4.4.

2. Connect the oscilloscope to TP1, the waveform should be as Fig. 4.5.

4.11 RAMP GENERATOR

Board A4 - Fig. 4.2

Connect the oscilloscope to TP2, the waveform should be as Fig. 4.6. If necessary, adjust R56 to obtain the required amplitude.

4.12 SAMPLE AND HOLD CIRCUIT

Board A4 - Fig. 4.2

1. Set both instruments at 5 MHz, and the signal generator output at 14 mV.

2. Connect the oscilloscope in turn to :

Positive end C39, waveform should be as Fig. 4.7.
Positive end C47, waveform should be as Fig. 4.8.
Collector TR11, waveform should be as Fig. 4.9.
Collector TR13, waveform should be as Fig. 4.10.

3. Connect the Channel A input of oscilloscope to collector of TR13 and the Channel B input and trigger input of the oscilloscope to collector of TR11.

The waveforms on Channels A and B should be as Fig. 4.11. Ensure that the A waveform is within that of B.

4.13 FALSE LOCK PREVENTION CIRCUIT

Board A4 - Fig. 4.2

1. Set both instruments at 5 MHz and the signal generator output at 14 mV.

2. Check that 33.333 Hz pulses are present at pin 2 on IC22a3 and that 3.333 Hz pulses are present at pins 1 and 3 on IC27.

4.14 INPUT AMPLIFIER

Board A3 - Fig. 4.2

1. Set both instruments at 5 MHz and the signal generator output at 14 mV.

2. Connect the oscilloscope to collector of TR1 on board A4 and check that the waveform is as Fig. 4.12. If necessary adjust R20 to obtain the required amplitude.

4.14 *continued*

3. Self oscillation of the amplifier can occur and this will be detected when performing the above waveform check. To confirm this disconnect the input to SKA and replace with a 2 ft (nominal) length of coaxial cable. If oscillation waveforms are displayed on the oscilloscope the amplifier is suspect - see Section 5.9.

4.15 SCHMITT TRIGGER CIRCUIT

Board A4 - Fig. 4.2

1. Set both instruments at 5 MHz and the signal generator output at 14 mV.

2. Connect the oscilloscope to collector of TR3. The waveform which is required to have a mark-space ratio closely approximating 1:1 should be as Fig. 4.13. If necessary adjust R7 to obtain the required mark-space ratio.

4.16 PRESCALER CIRCUIT

Board A4 - Fig. 4.2

With both instruments at 5 MHz and signal generator output at 14 mV, connect the oscilloscope to the collector of TR7 and check that the waveform is as Fig. 4.14.

4.17 VARIABLE RATIO DIVIDER

Board A4 - Fig. 4.2

1. Set LOCK switch to the right, i.e. not towards lock.

2. Set TF 2170B switches at 0000020.

3. Connect the Channel A input of the oscilloscope to pin 1 on IC24 and the Channel B input to pin 8 on IC13.

Waveforms A and B should be as Fig. 4.15.

Ensure that 20 pulses occur on trace B between 2 pulses on trace A.

4.18 CHECKING OUTPUT LEVELS AND LOCKING

For signal generators TF 2002AS and TF 2002B.

With both instruments at 5 MHz and signal generator output at 14 mV :

1. Connect the signal generator output to TF 2170B input.

2. Set the signal generator selector switch (rear panel) to the appropriate position, i.e. at TF 2002AS/TF 2002B.

3. Connect the TF 2170B output to the test circuit shown in Fig. 4.16.

4. Set the TF 2170B FREQUENCY switches at 0320000 (3.2 MHz), the LOCK switch at LOCK and the variable d.c. supply at 11 V.

5. Set the signal generator frequency at 3.2 MHz then adjust the frequency slightly above or below 3.2 MHz to obtain a slowly varying multimeter reading.

The pointer of the multimeter should swing between -0.3 mA ±0.05 mA and +0.3 mA ±0.05 mA.

6. Check that the same results are obtained with the a.c. supply at 19 V.

7. Disconnect the test circuit.

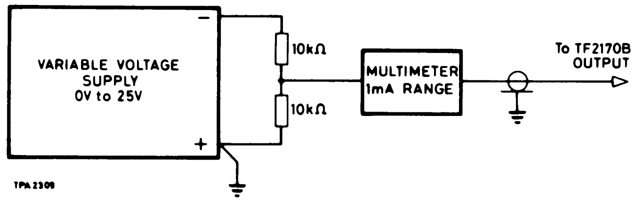


Fig. 4.16 Test Circuit

4.18 *continued*

For signal generator TF 2002

1. Connect the multimeter set at 25 V d.c. range to output of TF 2170B, positive voltmeter terminal to earth.

2. Set the signal generator selector switch on TF 2170B at TF 2002, the LOCK switch at LOCK, the FREQUENCY switches at 0 3 1 0 0 0 0 (3.1 MHz).

3. Set the signal generator frequency at 3.1 MHz then adjust the frequency slightly above or below 3.1 MHz to obtain a slowly varying voltmeter reading.

The pointer of the multimeter should swing between -1.5 V ±0.5 V and -11.5 V ±0.5 V.

4. Set the LOCK switch on TF 2170B at LOCK and the FREQUENCY switches at 0 5 0 0 0 0 0 then, using the internal crystal calibrator, tune the signal generator to 5 MHz precisely. The pointer of the meter should be at the centre mark on the scale and stationary. If the pointer is swinging over the scale, locking has not been obtained and a check should be made for faults.

4.19 METER ADJUSTMENT

If the pointer of the panel meter is stationary but not at the centre mark, adjust R85 to position the pointer correctly.

4.20 FINAL CHECKS

If adjustments have been necessary, repeat the overall performance test given in Section 4.6.

4.21 CLEANING ROTARY SWITCHES

These should be cleaned two or three times a year depending upon the use. Only benzine or white spirit (not carbon tetrachloride) should be used. After cleaning, wipe the contacts with a lubricant of 1% solution petroleum jelly in white spirit.

Chapter 5 Repair

5.1 INTRODUCTION

Since the performance checks given in Chapter 4 serve to localize any malfunction of the instrument, the cause can usually be quickly ascertained by extended testing of the suspected stage.

Extended testing of a particular stage is primarily concerned with proving the presence of d.c. supplies, input and output signals and correct operation of the components. Typical procedures are outlined below.

5.2 POWER SUPPLY

(a) Symptom - fuse blows when instrument is switched on.

(i) Fuse not of required rating.

(ii) Check a.c. input circuit.

(iii) Check A2C1, A2C2, C2, C3, A5C17 and A5C16 for short or partial short circuit.

(iv) Check for short or partial short circuit at +5 V and -18 V supply points.

(b) Symptom - no d.c. outputs or low +5 V or -18 V.

(i) Check fuse FS1, SUPPLY switch SH and VOLTAGE switch SJ.

(ii) Check for excessive current drain at +5 V or -18 V supply points. (Nominal currents are 670 mA and 70 mA respectively).

(iii) Check transistors TR1, TR2, diodes D5 to D8 and related i.c. regulators.

5.3 REFERENCE OSCILLATOR AND DIVIDER

(a) Symptom - no output from TR6.

(i) Check for +5 V to TR6 and TR5.

(ii) Check transistor TR5, TR6 and associated components.

(b) Symptom - inability to accurately set frequency of crystal oscillator by adjusting C6.

(i) Replace C4.

5.4 STANDARD DIVIDER

(a) Symptom - output from TR6 but no 33.333 Hz pulses at TR1.

(i) Check for +5 V at tag 5 on IC6 to IC9 inclusive and all tags 2, 3, 5 and 14 on IC12.

(ii) Check in turn for outputs from dividers, i.e. at tags 12 on IC6, IC7, tags 11 on IC8, IC9, IC10 and tag 9 on IC11.

Expected outputs are : 500 kHz, 50 kHz, 10 kHz, 2 kHz, 400 Hz and 33.333 Hz respectively.

5.5 RAMP GENERATOR CIRCUIT

(a) Symptom - output at TP1 but no output or incorrect waveform TP2.

(i) Check for d.c. volts on transistors TR8, TR9 and TR10.

(ii) Check capacitor C33 and other components in ramp generator circuit.

5.6 SAMPLE AND HOLD CIRCUIT

(a) Symptom - no input to C39 or waveform has incorrect mark-space ratio.

(i) Check IC24 circuit, i.e. d.c. supplies and input signal from variable ratio divider to pin 1.

(b) Symptom - no input to C47 or waveform has incorrect mark-space ratio.

(i) Check IC25 and IC30 circuits, i.e. d.c. supplies and input and output signals.

5.6 *continued*

(c) Symptom - correct inputs to C39 and C47 but no outputs from TR11 or TR12.

(i) Check for d. c. volts at collectors TR11, TR13.

(ii) Check appropriate transistor.

(d) Symptom - output waveform from collector TR13 not within waveform from collector TR11 (double beam display).

(i) Re-check inputs C39 and C47 for correct mark-space ratio.

5.7 INPUT AMPLIFIER

(a) Symptom - with input to SKA (tag 1 board A3) no output or output much greater or less than 120 mV.

(i) Check that -18 V is present at tag 3 and d. c. is present at various points throughout the circuit.

(ii) Check for an input to TR3, if no input check TR1 and TR2 and the a. l. c. circuit IC1 and associated components.

5.8 TRIGGER AND PRESCALER

(a) Symptom - with input to TR1 no output at collector TR7.

(i) Check that d. c. volts are present on transistors and integrated circuits.

(ii) Check for output signals at collectors of TR1, TR2, TR3, IC1, IC2 and collector TR7.

5.9 VARIABLE RATIO DIVIDER

(a) Symptom - unsatisfactory operation.

(i) Check that d. c. volts are present at tags 4, 10, 13 and 11 on IC13 to IC19 inclusive.

(b) Check d. c. supplies to associated integrated circuits and check inputs and outputs of these circuits.

5.10 ADDITIONAL INFORMATION

If further information is required please write or telephone Marconi Instruments Limited, Service Division - see address on back cover - or contact nearest representative, quoting the type and serial number on the data plate on rear of instrument.

If the instrument is being returned for repair please indicate clearly the nature of the fault or the work you require to be done.

Chapter 6

Replaceable parts

Introduction

Each sub-assembly or printed circuit board in this instrument has been allocated a unit identification in the sequence A1 to A5.

The complete component reference carrier its unit number as a prefix e.g. A1C1 but for convenience in the text and on circuit diagrams the prefix is not used.

However, when ordering replacements or in correspondence the complete component reference must be quoted.

One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons:

(a) Components indicated by '†' have their value selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

Ordering

When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required.

(1) Type and serial number of instrument

(2) Complete circuit reference

(3) Description

(4) M.I. code number

Component references

The components are listed in alpha-numerical order and the following abbreviations are used.

C	:	capacitor
Carb	:	carbon
Cer	:	ceramic
D	:	semiconductor diode
Elec	:	electrolytic
FS	:	fuse
IC	:	integrated circuit (package)
L	:	Inductor
ME	:	meter
Met	:	metal
Min	:	minimum value
Ox	:	oxide
PL	:	plug
Plas	:	plastic dielectric
R	:	resistor
S	:	switch
SK	:	socket
T	:	transformer
TP	:	terminal
TR	:	transistor
WW	:	wirewound
X	:	crystal oscillator
†	:	value selected during test; nominal value listed
ϕ	:	feed-through component
W	:	watts at 70°C
W*	:	watts at 55°C
W**	:	watts at 40°C
W***	:	watts at 20°C
W°	:	watts at unspecified temperature

Circuit reference	Description	M.I. code

Power supply board A1

(circuit diagram Fig. 7.3)

When ordering, prefix circuit reference with A1.

	Complete board	44827-077
C1	Cer 0.001μF -20+80% 500V	26383-242
C2	Elec 100μF -20+100%	26415-824
C3	Elec 1000μF -20+100% 25V	26415-826
C4	Elec 47μF -20+100% 40V	26415-810

Circuit reference	Description	M.I. code
D1	1N4004	28357-028
D2	1N4004	28357-028
D3	1N4004	28357-028
D4	1N4004	28357-028
D5	1N4004	28357-028
D6	1N4004	28357-028
D7	1N4004	28357-028
D8	1N4004	28357-028
D9	Zener Z5B6.2V	28371-483
D10	1S920	28336-138
D11	1S920	28336-138
IC1	µA741	28461-304
IC2	µA723	28461-701
R1	Met ox 3.3kΩ 2% $\frac{1}{2}$W	24573-085
R2	Met ox 3.3kΩ 2% $\frac{1}{2}$W	24573-085
R3	Met ox 2.2kΩ 2% $\frac{1}{2}$W	24573-081
R4	Met ox 12kΩ 2% $\frac{1}{2}$W	24573-099
R5	Met ox 3.9kΩ 2% $\frac{1}{2}$W	24573-087
R6 †	Met ox 12kΩ 2% $\frac{1}{2}$W	24573-099
R7	Met ox 5.1kΩ 2% $\frac{1}{2}$W	24573-090
R8	Met ox 18kΩ 2% $\frac{1}{2}$W	24573-103
R9	Met ox 180Ω 2% $\frac{1}{2}$W	24573-055

Power supply unit A2

(circuit diagram Fig. 7.3)

When ordering, prefix circuit reference with A2.

Circuit reference	Description	M.I. code
C1	Elec 4700µF +50-20% 16V	26426-091
C2	Elec 2200µF +50-10% 40V	26426-086
FS1	Fuse 160mA	23411-033
	Fuse holder	23416-191
PLC	Fixed plug CEE22	23423-159
SJ	DPCO switch	23467-155
T1	Mains transformer	43466-021
TR1	2N3055	28456-567
TR2	NKT403	28423-924

Input amplifier board A3

(circuit diagram Fig. 7.1)

When ordering, prefix circuit reference with A3.

Circuit reference	Description	M.I. code
	Complete board	44827-078
C1	Elec 4.7µF 20% 35V	26486-219
C2	Cer 0.01µF -20 +80% 100V	26383-055
C3	Cer 0.001µF -20+80%	26383-242
C4	Elec 4.7µF 20% 35V	26486-219
C5	Cer 0.01µF -20+80% 100V	26383-055
C6	Cer 0.01µF -20+80% 100V	26383-055
C7	Elec 4.7µF 20% 35V	26486-219
C8	Cer 0.01µF -20+80% 100V	26383-055
C9	Cer 0.01µF -20+80% 100V	26383-055
C10	Cer 330pF 20% 500V	26383-136
C11	Elec 4.7µF 20% 35V	26486-219
D1	1N4148	28336-676
D2	1N4148	28336-676
IC1	µA741	28461-304
R1	Met film 51Ω 2% $\frac{1}{4}$W	24773-242
R2	Carb 1MΩ 5% 1/8W	24311-945
R3	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R4	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R5	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R6	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R7	Met film 220Ω 2% $\frac{1}{4}$W	24773-257
R8	Met film 10Ω 2% $\frac{1}{4}$W	24773-225
R9	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R10	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R11	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R12	Met film 430Ω 2% $\frac{1}{4}$W	24773-264
R13	Met film 22Ω 2% $\frac{1}{4}$W	24773-233
R14	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R15	Carb 470kΩ 5% 1/8W	24311-957
R16	Carb 470kΩ 5% 1/8W	24311-937
R17	Met film 150Ω 2% $\frac{1}{4}$W	24773-253
R18	Met film 150Ω 2% $\frac{1}{4}$W	24773-253
R19	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R20	Var carb 500Ω 20% 0.21W	25541-315
R21	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
TR1	MFE3007	28459-019
TR2	BCY71	28435-235
TR3	BFY90	28452-157

Synchronizer board A4

(circuit diagram Figs. 7.1 & 7.2)

When ordering, prefix circuit reference with A4.

Circuit reference	Description	M.I. code
	Complete board	44827-076
C1	Cer 0.1μF -25+50% 30V	26383-031
C2	Cer 0.1μF -25+50% 30V	26383-031
C3	Cer 47pF 20% 500V	26343-160
C4	Cer 10pF ±0.25pF 750V	26324-709
C5	Cer 0.1μF -25+50% 30V	26383-031
C6	Var air 3.5 to 23.5pF	26816-238
C7	Cer 0.1μF -25+50% 30V	26383-031
C8	Cer 0.1μF -25+50% 30V	26383-031
C9	Cer 0.1μF -25+50% 30V	26383-031
C10	Cer 0.1μF -25+50% 30V	26383-031
C11	Cer 0.1μF -25+50% 30V	26383-031
C12	Cer 0.1μF -25+50% 30V	26383-031
C13	Cer 0.01μF -20+80% 100V	26383-055
C14	Cer 0.01μF -20+80% 100V	26383-055
C15	Cer 0.01μF -20+80% 100V	26383-055
C16	Cer 0.01μF -20+80% 100V	26383-055
C17	Cer 0.01μF -20+80% 100V	26383-055
C18	Cer 82pF 10% 500V	26343-165
C19	Cer 0.01μF -20+80% 100V	26383-055
C20	Plas 0.22μF 10% 63V	26582-406
C21	Cer 0.01μF -20+80% 100V	26383-055
C22	Cer 0.01μF -20+80% 100V	26383-055
C23	Cer 0.01μF -20+80% 100V	26383-055
C24	Elec 1000μF -20+100% 10V	26415-824
C25	Cer 0.01μF -20+80% 100V	26383-055
C26	Cer 0.01μF -20+80% 100V	26383-055
C27	Cer 0.01μF -20+80% 100V	26383-055
C28	Cer 0.01μF -20+80% 100V	26383-055
C29	Cer 0.01μF -20+80% 100V	26383-055
C30	Cer 0.001μF -20+80% 100V	26383-242
C31	Plas 0.47μF 10% 63V	26582-410
C32	Cer 0.01μF -20+80% 100V	26383-055
C33	Plas 0.47μF 10% 63V	26582-410
C34	Cer 0.01μF -20+80% 100V	26383-055
C35	Elec 100μF -20+100% 25V	26415-813
C36	Plas 0.1μF 10% 250V	26582-208
C37	Cer 0.01μF -20+80% 100V	26383-055
C38	Cer 0.01μF -20+80% 100V	26383-055
C39	Elec 4.7μF -20+100% 63V	26415-801
C40	Cer 0.01μF -20+80% 100V	26383-055
C41	Cer 0.01μF -20+80% 100V	26383-055
C42	Plas 0.01μF 10% 400V	26582-232
C43	Cer 0.01μF -20+80% 100V	26383-055
C44	Plas 2.2μF 10% 63V	26582-418
C45	Cer 0.01μF -20+80% 100V	26383-055
C46	Cer 0.01μF -20+80% 100V	26383-055
C47	Elec 4.7μF -20+100% 63V	26415-801
C48	Cer 0.01μF -20+80% 100V	26383-055
C49	Plas 0.68μF 10% 63V	26582-412
C50	Elec 100μF -20+100% 25V	26415-813
C51	Plas 0.068μF 10% 400V	26582-207
C52	Plas 0.22μF 10% 63V	26582-406
C53	Cer 0.01μF -20+80% 100V	26383-055
C54	Cer 0.01μF -20+80% 100V	26383-055
C55	Cer 0.01μF -20+80% 100V	26383-055
C56	Cer 0.1μF -25+50% 30V	26383-031
C57	Elec 220μF -20+100% 10V	26415-817
C58	Cer 0.01μF -20+80% 100V	26383-055
C59	Elec 220μF -20+100% 10V	26415-817
C60	Elec 2.2μF 20% 20V	26486-540
D1	1N4148	28336-676
D2	1N4148	28336-676
D3	EB383	28336-245
D4	1N4148	28336-676
D5	EB383	28336-245
D6	1N4148	28336-676
D7	Zener 6.8V 5%	28371-553
IC1	J.K. flip flop 120MHz (MC1027P)	28462-006
IC2	J.K. flip flop 120MHz (MC1027P)	28462-006
IC3	3 input NAND gate (SN74H11N)	28466-005

For symbols and abbreviations see introduction to this chapter

Circuit reference	*Description*	*M.I. code*
IC4	Quad 2 input NAND gate (74S00N)	28466-331
IC5	J.K. flip flop (74H102N)	28462-014
IC6	Divider 4 bit 2-5-10 (SN7490N)	28464-002
IC7	Divider 4bit 2.5.10 (SN7490N)	28464-002
IC8	Divider 4 bit 2-5-10 (SN7490N)	28464-002
IC9	Divider 4 bit 2-5-10 (SN7490N)	28464-002
IC10	Divider 4 bit 2-5-10 (SN7490N)	28464-002
IC11	Divider 4 bit 2-6-12 (SN7492N)	28464-104
IC12	8 input NAND gate (SN7430N)	28466-325
IC13	Decade counter (N8290A)	28464-004
IC14	Decade counter (N8290A)	28464-004
IC15	Decade counter (N8290A)	28464-004
IC16	Decade counter (N8290A)	28464-004
IC17	Decade counter (N8290A)	28464-004
IC18	Decade counter (N8290A)	28464-004
IC19	Decade counter (N8290A)	28464-004
IC20	Single input NAND gate (SN74H30N)	28466-330
IC21	Single input NAND gate (SN74H30N)	28466-330
IC22	Quad 2 input NAND gate (SN74H00N)	28466-327
IC23	Binary counter (N8291A)	28464-103
IC24	Monostable TTμL (9601)	28468-301
IC25	Monostable TTμL (9601)	28468-301
IC26	Dual 4 input NAND gate (SN74H20N)	28466-329
IC27	Monostable TTμL (9601)	28468-301
IC28	Monostable TTμL (9601)	28468-301
IC29	Operational amplifier (μA741)	28461-304
IC30	J.K. flip flop (74H102N)	28462-014
R1	Met ox 1kΩ 2% ½W	24573-073
R2	Met ox 3.3kΩ 2% ½W	24573-085
R3	Met ox 1kΩ 2% ½W	24573-073
R4	Met ox 150Ω 2% ½W	24573-053
R5	Met ox 22Ω 2% ½W	24573-033
R6	Met ox 220Ω 2% ½W	24573-057
R7	Var carb 470Ω 20% ¼W*	25611-070
R8	Met ox 820Ω 2% ½W	24573-071
R9	Met ox 47Ω 2% ½W	24573-041
R10	Met ox 220Ω 2% ½W	24573-057
R11	Met ox 6.8kΩ 2% ½W	24573-093
R12	Met ox 2.2kΩ 2% ½W	24573-081
R13	Met ox 1.5kΩ 2% ½W	24573-077
R14	Met ox 330Ω 2% ½W	24573-061
R15	Met ox 2.2kΩ 2% ½W	24573-081
R16	Met ox 68Ω 2% ½W	24573-045
R17	Met ox 3.3kΩ 2% ½W	24573-085
R18	Met ox 680Ω 2% ½W	24573-069
R19	Met ox 470Ω 2% ½W	24573-065
R20	Met ox 470Ω 2% ½W	24573-065
R21	Met ox 68Ω 2% ½W	24573-045
R22	Met ox 220Ω 2% ½W	24573-057
R23	Met ox 6.8kΩ 2% ½W	24573-093
R24	Met ox 430Ω 2% ½W	24573-064
R25	Met ox 10kΩ 2% ½W	24573-097
R26	Met ox 10kΩ 2% ½W	24573-097
R27	Met ox 10kΩ 2% ½W	24573-097
R28	Met ox 10kΩ 2% ½W	24573-097
R29	Met ox 10kΩ 2% ½W	24573-097
R30	Met ox 10kΩ 2% ½W	24573-097
R31	Met ox 10kΩ 2% ½W	24573-097
R32	Met ox 10kΩ 2% ½W	24573-097
R33	Met ox 10kΩ 2% ½W	24573-097
R34	Met ox 10kΩ 2% ½W	24573-097
R35	Met ox 10kΩ 2% ½W	24573-097
R36	Met ox 10kΩ 2% ½W	24573-097
R37	Met ox 10kΩ 2% ½W	24573-097
R38	Met ox 10kΩ 2% ½W	24573-097
R39	Met ox 10kΩ 2% ½W	24573-097
R40	Met ox 10kΩ 2% ½W	24573-097
R41	Met ox 10kΩ 2% ½W	24573-097
R42	Met ox 10kΩ 2% ½W	24573-097
R43	Met ox 10kΩ 2% ½W	24573-097
R44	Met ox 10kΩ 2% ½W	24573-097
R45	Met ox 10kΩ 2% ½W	24573-097

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R46	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R47	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R48	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R49	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R50	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R51	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R52	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R53	Met ox 100kΩ 2% $\frac{1}{2}$W	24573-121
R54	Met ox 9.1kΩ 2% $\frac{1}{2}$W	24573-096
R55	Met ox 1kΩ 2% $\frac{1}{2}$W	24573-073
R56	Var carb 3.3kΩ 20% $\frac{1}{4}$W*	25611-075
R57	Met ox 3.3kΩ 2% $\frac{1}{2}$W	24573-085
R58	Met ox 22kΩ 2% $\frac{1}{2}$W	24573-105
R59	Met ox 120Ω 2% $\frac{1}{2}$W	24573-051
R60	Met ox 3.3kΩ 2% $\frac{1}{2}$W	24573-085
R61	Met ox 2.2kΩ 2% $\frac{1}{2}$W	24573-081
R62	Met ox 560kΩ 2% $\frac{1}{2}$W	24573-139
R63	Met ox 22kΩ 2% $\frac{1}{2}$W	24573-105
R64	Met ox 3.3kΩ 2% $\frac{1}{2}$W	24573-085
R65	Met ox 2.2kΩ 2% $\frac{1}{2}$W	24573-081
R66	Met ox 560kΩ 2% $\frac{1}{2}$W	24573-139
R67	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R68	Met ox 22kΩ 2% $\frac{1}{2}$W	24573-105
R69	Met ox 1.5kΩ 2% $\frac{1}{2}$W	24573-077
R70	Met ox 1.5kΩ 2% $\frac{1}{2}$W	24573-077
R71	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R72	Met ox 1.5kΩ 2% $\frac{1}{2}$W	24573-077
R73	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R74	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R75 †	Met ox 680kΩ 2% $\frac{1}{2}$W	24573-141
R76 †	Met ox 680kΩ 2% $\frac{1}{2}$W	24573-141
R77	Met ox 22kΩ 2% $\frac{1}{2}$W	24573-105
R78	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R79	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R80	Met ox 2.2kΩ 2% $\frac{1}{2}$W	24573-081
R81	Met ox 2.2kΩ 2% $\frac{1}{2}$W	24573-081
R82	Met ox 4.7kΩ 2% $\frac{1}{2}$W	24573-089
R83	Met ox 1.5kΩ 2% $\frac{1}{2}$W	24573-077
R84	Met ox 1.5kΩ 2% $\frac{1}{2}$W	24573-077
R85	Var carb 10kΩ 20% $\frac{1}{4}$W*	25611-078

Circuit reference	Description	M.I. code
R86	Met ox 10kΩ 2% $\frac{1}{2}$W	24573-097
R87	Met ox 24kΩ 2% $\frac{1}{2}$W	24573-106
R88	Met ox 150Ω 2% $\frac{1}{2}$W	24573-053
TR1	2N709	28451-327
TR2	2N709	28451-327
TR3	2N709	28451-327
TR5	BSX20	28452-197
TR6	BSX20	28452-197
TR7	2N709	28451-327
TR8	BCY71	28435-235
TR9	BF244B	28459-011
TR10	BC107	28455-437
TR11	BC107	28455-437
TR12	BF244B	28459-011
TR13	BC107	28455-437
TR14	BF244B	28459-011
TR15	BF244B	28459-011
TR16	BC109	28452-777
TR17	BCY71	28435-235
TR18	BC109	28452-777
X1	5 MHz crystal oscillator unit	28313-863

Synchronizer unit A5

(circuit diagram Fig. 7.2)

When ordering, prefix circuit reference with A5.

Circuit reference	Description	M.I. code
C1	Cer Ø 4700pF -20+80% 500V	26373-665
C2	Cer Ø 4700pF -20+80% 500V	26373-665
C3	Cer Ø 4700pF -20+80% 500V	26373-665
C4	Cer Ø 4700pF -20+80% 500V	26373-665
C5	Cer Ø 4700pF -20+80% 500V	26373-665
C6	Cer Ø 4700pF -20+80% 500V	26373-665
C7	Cer Ø 4700pF -20+80% 500V	26373-665
C8	Cer Ø 4700pF -20+80% 500V	26373-665
C9	Cer Ø 4700pF -20+80% 500V	26373-665
C10	Cer Ø 4700pF -20+80% 500V	26373-665
C11	Cer 0.1μF -25+50% 30V	26383-031

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C12	Cer 0.1μF -25+50% 30V	26383-031
C13	Cer 0.1μF -25+50% 30V	26383-031
C14	Cer 0.1μF -25+50% 30V	26383-031
C15	Cer 0.1μF -25+50% 30V	26383-031
C16	Cer 0.1μF -25+50% 30V	26383-031
C17	Cer 0.1μF -25+50% 30V	26383-031
C18	Cer 0.1μF -25+50% 30V	26383-031
C19	Cer 0.1μF -25+50% 30V	26383-031
C20	Cer 0.1μF -25+50% 30V	26383-031
L1	Filter coil 18μH	44247-012
L2	Filter coil 18μH	44247-012
L3	Filter coil 18μH	44247-012
L4	Filter coil 18μH	44247-012
L5	Filter coil 18μH	44247-012
ME1	100μA-0-100μA	44555-002
SA	Frequency selection Hz+10	44326-035
SB	Frequency selection Hz+100	44326-035
SC	Frequency selection kHz+1	44326-035
SD	Frequency selection kHz+10	44326-035
SE	Frequency selection kHz+100	44340-025
SF	Frequency selection MHz+1	44340-025
SG	Frequency selection MHz+10	44340-025
SH	Select signal generator	23462-258
SK	LOCK on/off	23462-252
SKA	Fixed input connector	23443-443

Miscellaneous items

	Description	M.I. code
	Switch control knobs	
	Elma knob 70-14-1 Grey	22318-333
	Elma cap 1450-14 Grey	22318-334
	Elma figure dial 1452-14/1	22318-335
	Elma stator 1453-14/1	22318-336
	Fixing brackets	
	Right hand	35354-119
	Left hand	35354-120

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

CIRCUIT NOTES

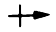
1. COMPONENT VALUES

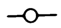
Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.

2. VOLTAGES

Shown in italics adjacent to the point to which the measurement refers.

3. SYMBOLS

 arrow indicates clockwise rotation of knob.

 tag on printed board.

point marked with this symbol is connected to and receives power from

point marked with this symbol.

4. CIRCUIT REFERENCES

These are, in general, given in abbreviated form.
See also introduction to Chap. 6.

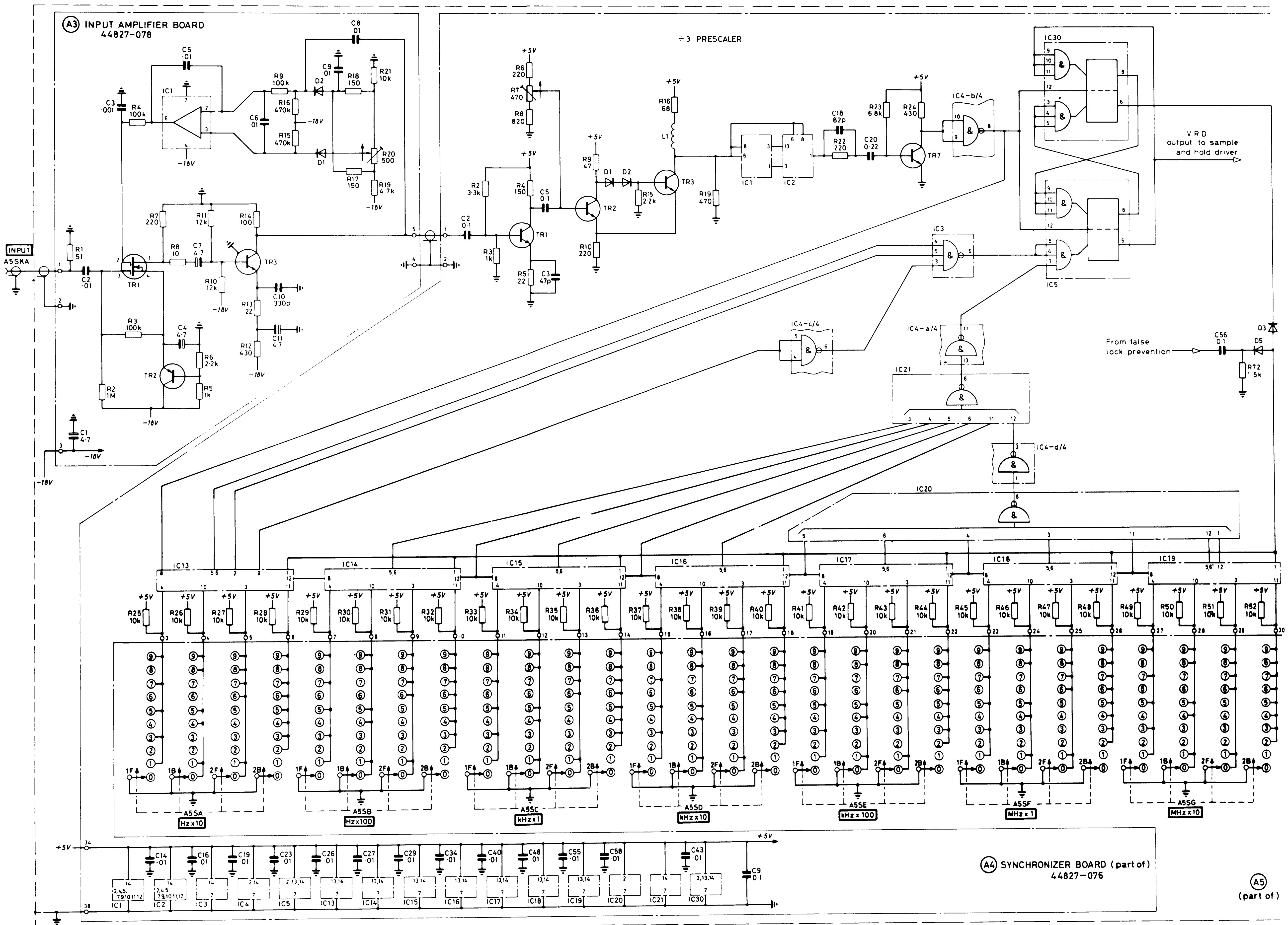


Fig. 7.1 Input amplifier and part of synchronizer

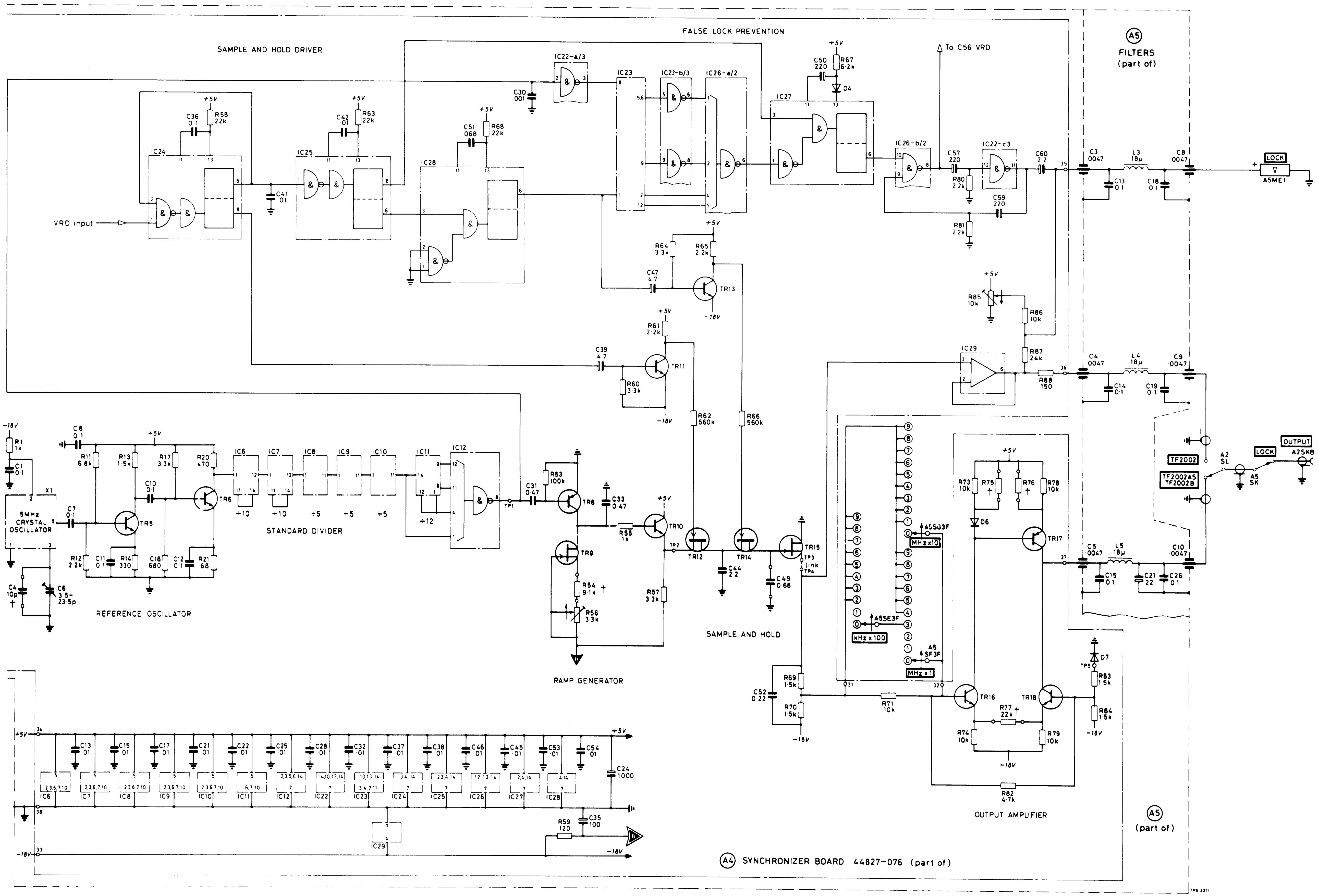


Fig. 7.2 Part of synchronizer

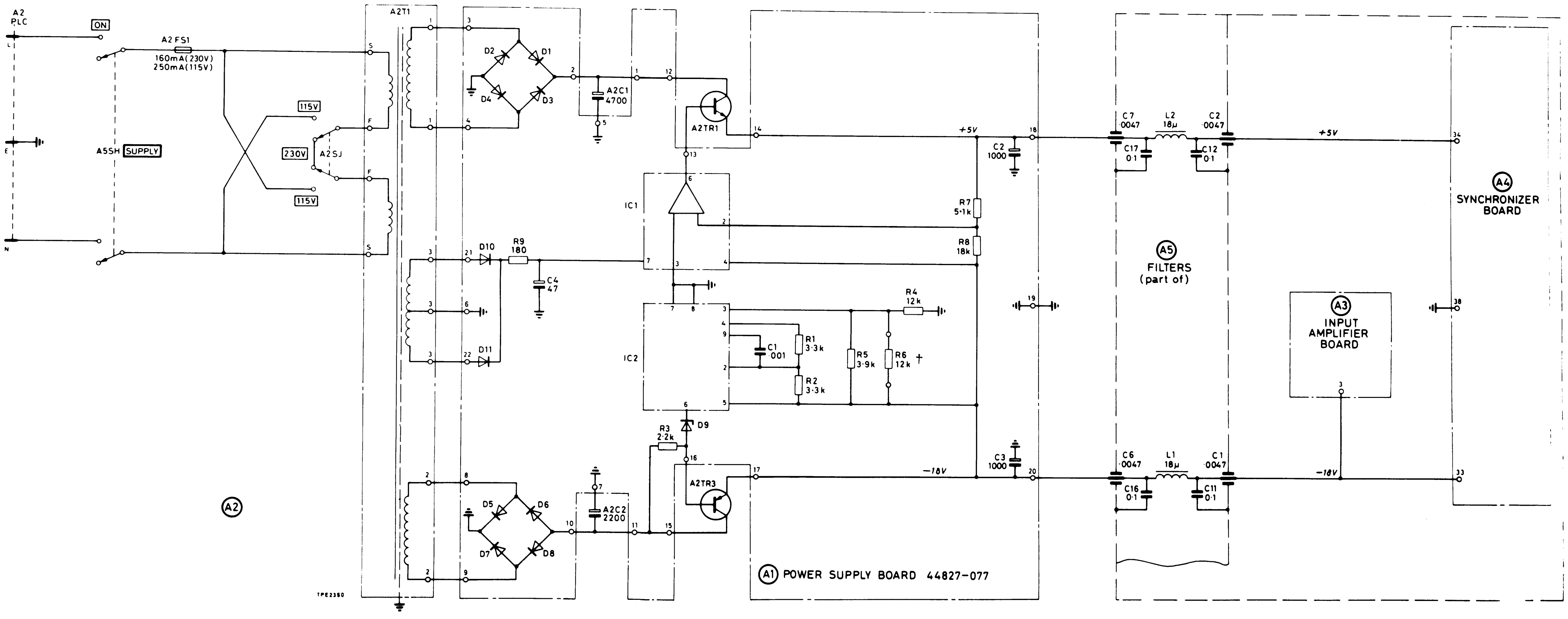


Fig. 7.3 Power unit