

Errata

Title & Document Type: 8111A Pulse/Function Generator Operating & Service Manual

Manual Part Number: 08111-90002

Revision Date: September 1984

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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OPERATING AND SERVICE MANUAL

8111A PULSE/FUNCTION GENERATOR 20 MHz





MANUAL CHANGES

03/94

Manual for Model Number	8111A
Manual printed on	Sept. 1984
Manual Part Number	08111-90002

Make all ERRATA corrections.

Check the following table for your instrument serial prefix/serial number and make the listed changes to your manual.

New Item

Serial Prefix or Serial Number	Manual Changes	Serial Prefix or Serial Number	Manual Changes
ERRATA			
2215G02366			1
2215G02416	and above		1-2
2519G02591	and above		1-3
2519G02716	and above		1-4
2519G02816	and above		1-5
2519G03241	and above		1-6
2519G03661	and above		1-7
2519G03681	and above		1-8
2519G03881	and above		1-9
2519G04021	and above		1-10
2519G04681	and above		1-11
2519G04761	and above		1-12
2519G05041	and above		1-13
2519G05141	and above		1-14
2849G05621	and above		1-15
2849G06201	and above		1-16
2849G06721	and above		1-17
2849G06841	and above		1-18
2849G07601	and above		1-19
2849G08081	and above		1-20
2849G08291	and above		1-21
2849G08471	and above		1-22

INDEX OF MANUAL CHANGES

MANUAL CHANGE	MISCELLANEOUS	FRAME	A1	A2		A4	A5	A6	A7	A8	STANDARD
			A21		A3						
ERRATA	Page 2-1 Page 8-57 Page 6-16 Page 5-4,5-5										
1					C1,3,4,9, C10 thru C13	C13,16,19, C21,22	C20	C2 thru 6, C13,16	C6,7,8	C12,13,15,16, C17,23	
3		MP2,6,13,14, MP15,17,18, MP22						Q1			
4						R35					
5										K 1,2,3	
6	Page 6-12 Page 6-10							R3,13 *R3,13 C10			
7	Page 6-13									MP5,6,7,8,9, MP10,11,12	
8		MP18									
9	Page 6-12							U2			
10	Page 6-15				C4						
11							C8,9,12	C14,18,21	C8,9,11, C14,15	C1,2,5,9, C10	C6,7,21,24,25

MODEL 8111A
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MANUAL CHANGE	MISCELLANEOUS	FRAME	A1	A2	A3	A4	A5	A6	A7	A8	STANDARD
			A21								
12					C4	C2	R49,53, R67,9				
14					U17						
15		MP 20,17, MP23,24, MP25,14, MP15									
16								R51			
17		J1-3									
18						C18		L2			
19			A1,C2	C15,18							
20							U1	U2			
21							R6, R7				
22							U1				

INDEX OF MANUAL CHANGES

MANUAL CHANGE	MISCELLANEOUS	FRAME	A9	A10	A11	A12	A13	STANDARD
			A9	A30	A31			OPTION 001
1				C5,8,9				
2	Page 8-42, Page 8-49		A9,C2, CR1,R11					
11			C1	C2,3				
13							S1	

ERRATA

On Page 2-1, Section II / Installation, change to read:

CAUTION

Do not change the LINE SELECTOR switch settings with the instrument on or with power connected to the rear panel.

2-9 Figure 2-1 provides information for line voltage and fuse selection:

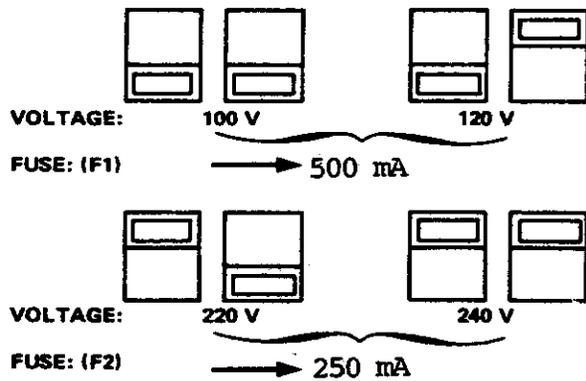
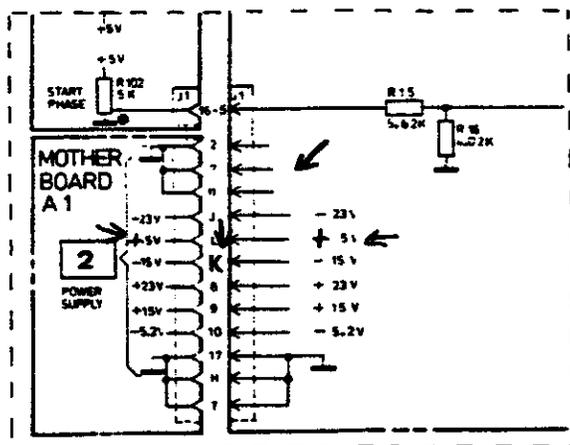


Figure 2-1. Sliding Switches Positions for different Line Voltages

On Page 8-57, VCO Board A5, change to read:



On Page 6-16, Replaceable parts list:

- Delete: Q3,7 1853-0212
- A21Q4,8 1854-0368

MODEL 8111 A

ERRATA (Cont.)

Page 5-4 Shaper Adjustment

change step 6 to read:

Adjust A6R6 for 8V +100mV - ϕ mV

add below step 12

NOTE: Steps 8 to 12 are interdependent and must therefore be repeated until the values are within tolerance.

Page 5-5

change step 14 to read:

Adjust A6R27 for 800mV +10mV - ϕ mV

change the NOTE to read:

NOTE: Readjust steps 1 to 6. Recheck steps 7 to 14 and readjust if necessary.

add to step 30:

Check again steps 1 to 14.

Page 6-12

change the Table of Replaceable Parts to read:

A8	C4	0160-3874	C-FXD 10PF 200V
----	----	-----------	-----------------

ERRATA (Cont.)

On Page 4-8, Performance Tests 4-15, step 4., change to read:

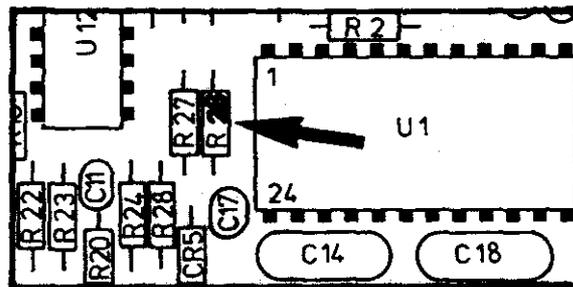
8111A	Counter Reading
10%	4 μ s - 16 μ sec
20%	17 μ s - 23 μ sec
50%	47 μ s - 53 μ sec
---	---
---	---

On Page 4-15, Performance Tests Record, Step 4-15, change to read:

Duty Cycle	Minimum	Actual	Maximum
10%	4 μ s		16 μ s
20%	17 μ s		23 μ s
50%	47 μ s		53 μ s
---	---		---
---	---		---

On Page 8-50 (Component Layout + Ref.Desig.List) change to read:

C25 to C26



On Page 6-15, Table 6-3 Replaceable Parts OPTION 001, add:

MP1 4040-1969 FRONT PANEL, OPTION 001

MODEL 8111A

MANUAL CHANGE 1

On Page 6-10 thru 6-16, change the Table of Replaceable Parts to read:

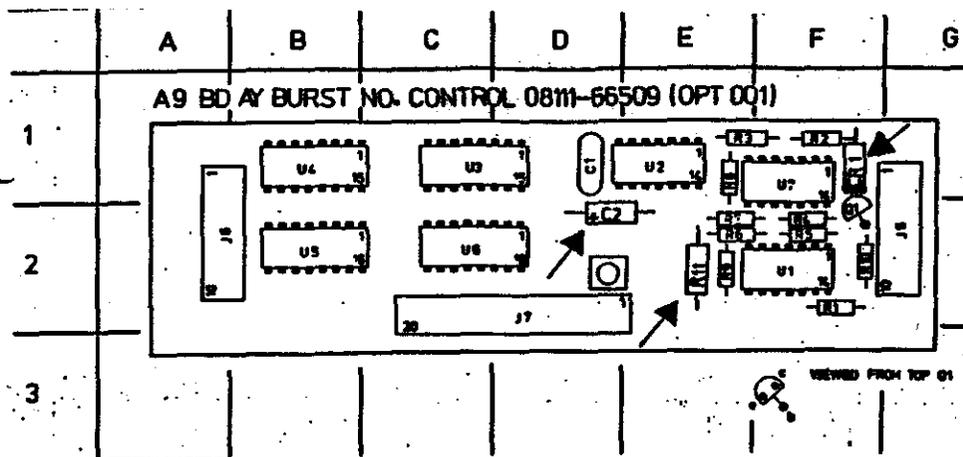
- A3 C1,3,4,
C10 thru 13
- A4 C13,16,19,21,22
- A5 C20
- A6 C2 thru 6 0160-5746 C-FXD 0.1UF 20%
- C13,16
- A7 C6,7,8
- A8 C12,13,15,16,
C17,23
- A10C5,8,9
- A30C5,8,9

MANUAL CHANGE 2

On Page 6-15, change the Table of Replaceable Parts to read:

- | | | | |
|------|-----|-------------|--------------------|
| | A9 | 08111-66519 | PC-BD |
| Add: | C2 | 0180-0116 | C-FXD 6.8UF 35V TA |
| | CR1 | 1901-0033 | DIO 180V .2A |
| | R11 | 0698-4477 | R-FXD 10.5K 1% |

On Page 8-42, change Service Sheet 6 to read:

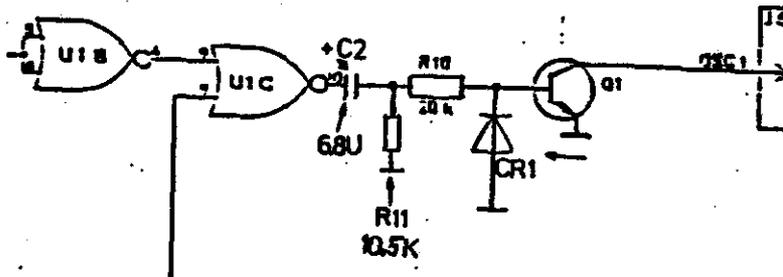


On Ref Des Table and Grid Loc add:

- | | |
|-----|----|
| C2 | D1 |
| CR1 | F1 |
| R11 | E2 |

MANUAL CHANGE 2 (Cont.)

On Page 8-49, change Schematic to read:

MANUAL CHANGE 3

IMPORTANT NOTE: New part numbers assigned to the following items since all threaded holes or screws are now METRIC!

On Page 6-7, change the Table of Replaceable Parts to read:

MP 2	08111-00211	PANEL SUB
MP 6	08111-01211	BRKT FRONT
MP13	08111-02315	HT SNK OUT HLDR
MP14	08111-04111	COVER TOP
MP15	08111-04112	COVER BOTTOM
MP17	5021-5813	FRAME FRONT
MP18	5021-0512	FRAME REAR
MP22	5021-5830	SIDE STRUT

On Page 6-12, change the Table of Replaceable Parts to read:

A6Q1	1853-0589	XSTR MD4260
------	-----------	-------------

MANUAL CHANGE 4

On Page 6-10, change the Table of Replaceable Parts to read:

A4R35	0698-4460	R-FXD 649 1 $\frac{1}{2}$.125W
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MANUAL CHANGE 5

On Page 6-13, change the Table of Replaceable Parts to read:

A 8 K 1,2,3	0490-1527	RELAIS REED
-------------	-----------	-------------

MODEL 8111A

MANUAL CHANGE 6

On Page 6-12, Table 6-3., Replaceable Parts List:

<u>ADD:</u>	A6	*R3	0698-3202	R-FXD 1.74K 1%
	A6	-R3	0757-1094	R-FXD 1.47K 1%
	A6	*R13	0698-3136	R-FXD 17.8K 1%
	A6	-R13	0757-0441	R-FXD 8.25K 1%

DEL: A6 R3,13

On Page 6-10, change the Table of Replaceable Parts to read:

A5	C10	0180-3822	C-FXD 39UF 15V
----	-----	-----------	----------------

MANUAL CHANGE 7

On Page 6-13, change the Table of Replaceable Parts to read:

A8	MP5,6,7,8, MP9,10,11,12	1205-0662	HT SINK SGL
----	----------------------------	-----------	-------------

MANUAL CHANGE 8

On Page 6-7, Replaceable Parts List, change to read:

MP18	5021-5814	FRAME REAR
------	-----------	------------

MANUAL CHANGE 9

On Page 6-12, change the Table of Replaceable Parts to read:

A6	U2	1826-0923	IC 1DC7
----	----	-----------	---------

MANUAL CHANGE 10

On Page 6-15, change the Table of Replaceable Parts to read:

A3	C4	0160-0575	C-FXD 47UF CER
----	----	-----------	----------------

MODEL 8111A

MANUAL CHANGE 11

On Table 6-3, Replaceable Parts List, change to read:

A4	C8,9,12		
A5	C14,18,21		
A6	C8,9,11,14,15	0160-6596	C-FXD .47UF 20%
A7	C1,2,5,9,10		
A8	C6,7,21,24,25		
A9	C1		
A10	C2,3		
A30	C2,3		

MANUAL CHANGE 12

On Page 6-9, change the Table of Replaceable Parts to read:

A4	C2	0160-5739	C-FXD 15PF 5%
----	----	-----------	---------------

On Page 6-11, change the Table of Replaceable Parts to read:

A5	R49	0757-0441	R-FXD 8,25K 1%
	R53,67	0698-0085	R-FXD 2,61K 1%
	R9	0757-0528	R-FXD 1,62K 1%
A3	C4	0160-0574	C-F .022UF 20%

MANUAL CHANGE 13

On Page 6-14, Replaceable Parts List, change to read:

A13	S1	3101-2953	SW-LINE
-----	----	-----------	---------

MANUAL CHANGE 14

On Page 6-14, change the Table of Replaceable Parts to read:

A3	U17	1820-3841	IC 74AS168
----	-----	-----------	------------

MODEL 8111AMANUAL CHANGE 15

On Page 1-2, 1-27. Accessories, change to read:

5061-2001	to	5062-4001
5061-0072	to	5062-3972
5061-0074	to	5062-3974

On Page 6-7, Replaceable Parts List, change to read:

MP20	5001-0538	TRIM STRIP
MP17	5021-8413	FRAME FRONT 1/2M
MP23	5041-8801	FOOT
MP24	5041-8803	TRIM STRIP
MP25	5061-8822	FOOT REAR N-SKID
MP14	08111-04121	COVER TOP
MP15	08111-04122	COVER BOTTOM

MANUAL CHANGE 16

On Page 6-12, Replaceable Parts List, change to read:

A6 R51	0757-0422	R-FXD 909
--------	-----------	-----------

MANUAL CHANGE 17

On Page 6-7, change the Table of Replaceable Parts to read:

J1-3	1250-0083	CONN ENC BLKHD
------	-----------	----------------

MANUAL CHANGE 18

On Page 6-10, change the Table of Replaceable Parts to read:

A4 C18	0160-5736	C-FXD 22PF 5%
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MODEL 8111A

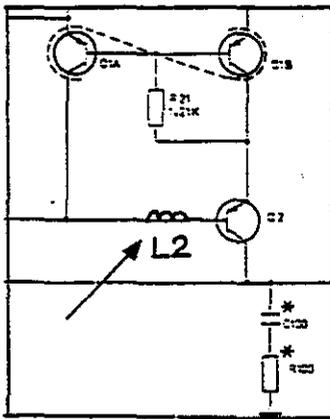
MANUAL CHANGE 18 (Cont.)

On Page 6-11, Replaceable Parts List,

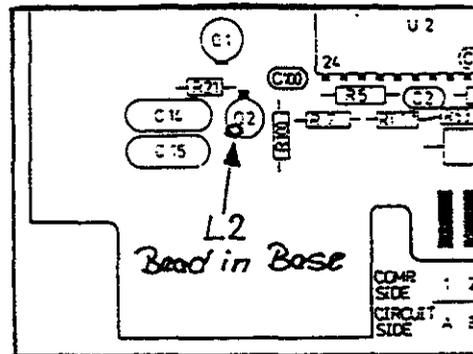
add: A6 L2 9170-0894 BEAD

BEAD MUST BE INSERTED IN BASE-WIRE OF Q2!

Change Schematic, Page 8-71 to read:



Change Component Layout, Page 8-66, to read:



MANUAL CHANGE 19

On Page 6-9, Change the Table of Repl.Parts to read:

A1	C2	0180-3158	C-F 6800UF	(EDC-LBL:A-3217)
A2	C15,18	0180-3157	C-F 47uF 40V	(EDC-LBL:A-3217)

MANUAL CHANGE 20

On Page 6-11, Repl.Parts List, Change to read:

A5	U1	1DB6-0001	IC SNAKE	(EDC-LBL:B-3310)
A6	U2	1DC7-0001	IC BOOSTER	(EDC-LBL:B-3310)

MANUAL CHANGE 21

On Page 6-11, Repl.Parts List, change to read:

A5	R6,7	0757-0274	RES 1.21k 1%	(EDC-LBL:B-3343)
----	------	-----------	--------------	------------------

MODEL 8111A

MANUAL CHANGE 22

On Page 6-11, Repl.Parts List change to read:

A5	U1	1826-0955	IC 1DB6	EDC-LBL: B-3408
----	----	-----------	---------	-----------------



**HEWLETT
PACKARD**

Böblingen Instruments Division

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System

Puls-Generator HP 8111A

in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Meß- und Testgeräte

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that the equipment

Pulse Generator HP 8111A

is in accordance with the Radio Interference Requirements of Directive FTZ 1046/1984. The German Bundespost was notified that this equipment was put into circulation, the right to check the serie for compliance with the requirements was granted.

Additional Information for Test- and Measurement Equipment

If Test- and Measurement Equipment is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still met at the border of his premises.

Hewlett Packard GmbH, 30. Juni 1985

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GENERAL – This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

OPERATION – BEFORE APPLYING POWER comply with the installation section. Additionally, the following shall be observed:

Do not remove instrument covers when operating.

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not install substitute parts or perform any unauthorized modification to the instrument.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

SAFETY SYMBOLS



The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.



Indicates dangerous voltages.



Earth terminal

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.



WARNING



Dangerous voltages, capable of causing serious personal injury, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

OPERATING AND SERVICE MANUAL

8111A PULSE/FUNCTION GENERATOR 20 MHz

(Including Option 001)

SERIAL NUMBERS

This manual applies directly to instrument with serial number 2215G01841 and higher. Any change made in instruments having serial numbers higher than the above number will be found in a "Manual Changes" supplement supplied with this manual. Be sure to examine the supplement for changes which apply to your instrument and record these changes in the manual. Backdating information for instruments with lower serial numbers can be found in Section 7 (yellow pages).

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FEDERAL REPUBLIC OF GERMANY

MANUAL PART No. 08111-90002
MICROFICHE PART No. 08111-95002

PRINTED: SEP 1984

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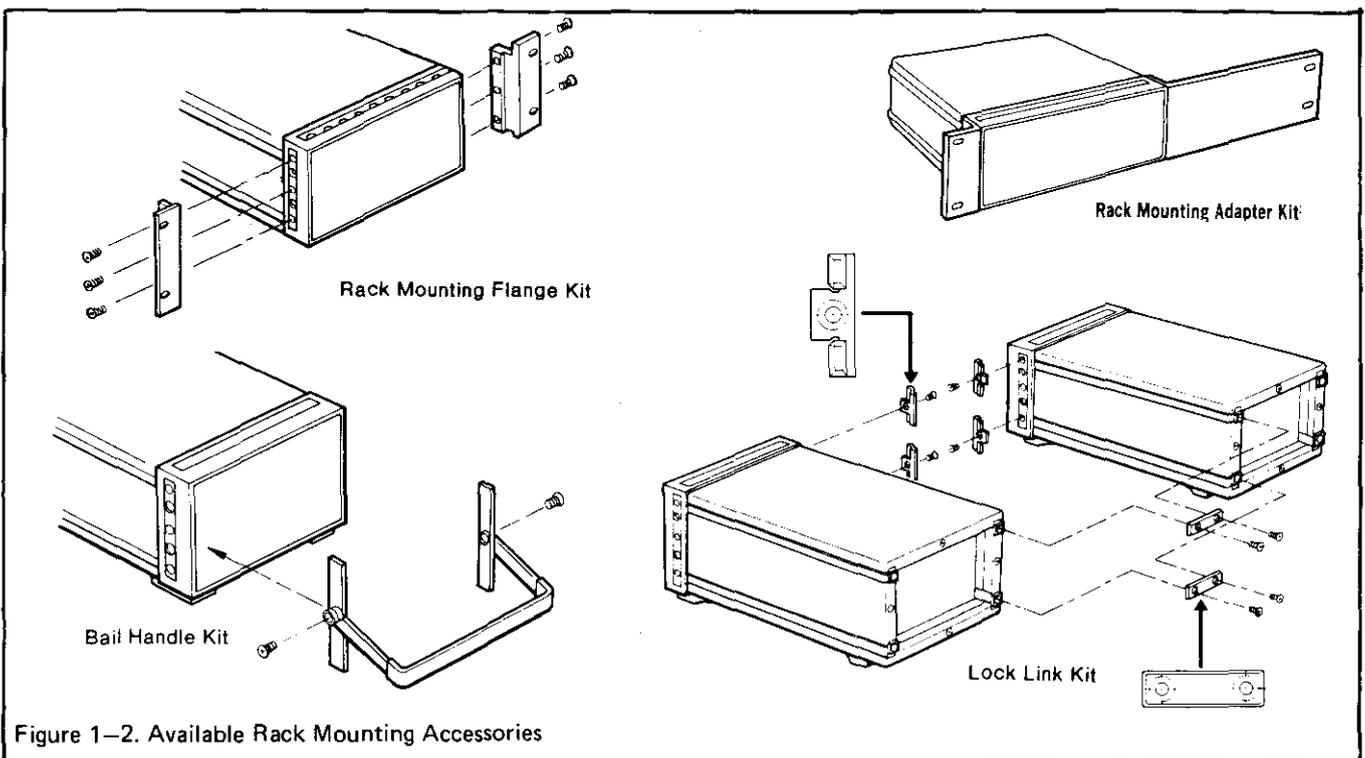
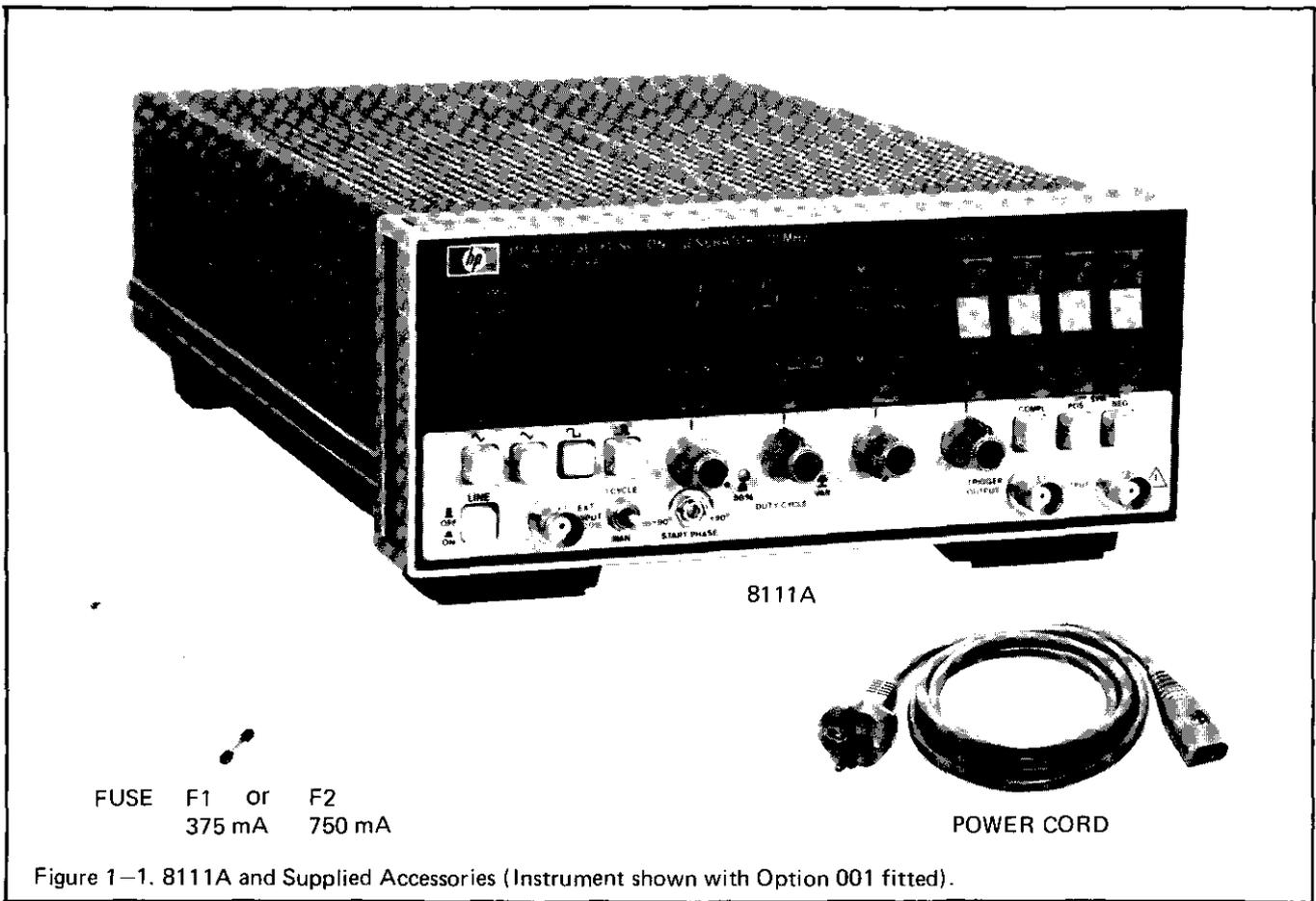
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SECTION I GENERAL INFORMATION

1-1 INTRODUCTION

1-2 This Operating and Service Manual contains information required to install, operate, test, adjust and service the Hewlett-Packard Model 8111A. Figure 1-1 shows the mainframe and accessories supplied. This section covers instrument identification, description, accessories, specifications, and other basic information.

1-3 A Microfiche version of this manual is available on 4 x 6 inch microfilm transparencies (order number on title page). Each microfilm contains up to 60 photoduplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as all pertinent Service Notes.

1-4 SPECIFICATIONS

1-5 Instrument specifications are listed in Table 1-2. These specifications are the performance standards or limits against which the instrument is tested.

1-6 SAFETY CONSIDERATIONS

1-7 The 8111A is a Safety Class 1 instrument (it has an exposed metal chassis that is directly connected to earth via the power supply cable). Before operation, the instrument and manual, including the red safety page, should be reviewed for safety markings and instructions. These must then be followed to ensure safe operation and to maintain the instrument in a safe condition.

1-8 INSTRUMENTS COVERED BY MANUAL

1-9 Attached to the rear of this instrument is a serial number plate (Figure 1-3). The first four digits of the serial number only change when there is a significant change to the instrument. The last five digits are assigned to instruments sequentially. The contents of this manual apply directly to the instrument serial number quoted on the title page. For instruments with lower serial numbers, refer to the backdating information in Section VII of this manual. For instruments with higher serial numbers, refer to the Manual Change sheets at the end of this manual. In addition to change information, the Manual Change sheets may contain information for correct-

ing errors in the manual. To keep this manual as up-to-date and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Change supplement. The supplement for this manual is identified with the manual's print date and part number, both of which appear on this manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard.



Figure 1-3. Serial Number Plate

1-10 DESCRIPTION

1-11 The 8111A is a 20 MHz, pulse/function generator suited to bench, production or service applications. It is available as either a standard instrument or, when fitted with option 001, as a pulse/function generator complete with counted burst mode capability. A carrying handle can be fitted and rackmounting adaptors are available.

1-12 The combination of front panel controls — pushbuttons and verniers — together with the digital display enables quick and easy setting up of complete waveforms with minimum (if any) requirement for additional test equipment.

1-13 8111A OPTIONS

1-14 **Option 001.** The standard 8111A can have its versatility further increased by the addition of option 001 which provides a counted burst mode capability. **Option 910** provides an extra copy of the Operating and Service Manual.

1-15 ACCESSORIES SUPPLIED

1-16 The 8111A is supplied complete with the following items:

ITEM	HP PART NUMBER
375 mA fuse for 220/240 V operation or, 750 mA fuse for 100/120 V operation	2110-0421
Power cable	2110-0360
	See Figure 2-2

1-17 ACCESSORIES AVAILABLE

ITEM	HP PART NUMBER
Carrying handle - Bail Handle Kit	5061-2001
Rack mounting adaptors: Rack mounting flange and filler panel for rack mounting a single 8111A	5061-0072
Rack mounting flange and lock link kit	5061-0074
for rack mounting two 8111As	5061-0094

1-18 RECOMMENDED TEST EQUIPMENT

1-19 Equipment required to maintain the 8111A is listed in Table 1-1. Alternative equipment can be substituted provided that it meets or exceeds the critical specifications listed in the table.

Table 1-1. Recommended Test Equipment

INSTRUMENT	RECOMMENDED MODEL	REQUIRED CHARACTERISTICS	ADEQUATE SUBSTITUTE	USE *
Counter DMM DVM Real Time Scope Sampling Scope	HP 5328A HP3466 HP3455A HP 1740A Tek 7603 with 7T11/7S11 and S-3A	20 MHz, Start/Stop 0.1mA - 10mA, DC 0.1V - 32V, AC, DC 100 MHz Bandwidth Dual channel	HP 5345A HP3465A HP3456A HP 1743A HP 140A/ 1410A	P, A T P,A,T P, A, T P, A, T
Spectrum Analyzer or Distortion Analyzer	HP 3580A HP 339A	1 kHz - 10 kHz 1 kHz - 10 kHz	HP 3585A	P, A P, A
Spectrum Analyzer	HP 181T 8557A	500 kHz - 20 MHz		P
Pulse Generator	HP 8012B	1 Hz - 20 MHz	HP 8011A	P, A
Logic Probe	HP 545A	TTL, CMOS		T
Logic Probe	HP 10525E	ECL		T
BNC 50 Ohm Term.	10100C	50 Ohm, 2 W, 1 % Feedthrough		
Power Supply	HP 6237B	0 - 20 V	HP 6205B	A
Service Accessory				
Extender board	5060-5983	2x18 pin		T
Extender brd	5061-2160	2 x 25 pin		T
Extender cble	5180-2432			T

* P = Performance Test; A = Adjustments; T = Troubleshooting

Table 1-2. Specifications

SPECIFICATIONS

(Specifications describe the instrument's warranted performance)
 The following specifications apply with 50 Ohm load resistance in a temperature range of 0° to 55°C. Output levels double when driving into high impedance (up to 32 Vpp).

WAVEFORMS

Sine, Triangle, Ramp, Square, Pulse, Haversine, Havertriangle

TIMING CHARACTERISTICS

Frequency

Range: 1.00 Hz to 20.0 MHz
 Resolution: 3 digits
 Accuracy: $\pm 5\%$ of setting (10.0 Hz to 20.0 MHz)
 (50% duty cycle) $\pm 10\%$ of setting (1.00 Hz to 9.99 Hz)
 Repeatability: Factor 2.5 better than accuracy
 Jitter: $< 0.1\% + 50$ ps
 Stability: $\pm 0.2\%$ (1 hour)
 $\pm 0.5\%$ (24 hours)

Duty Cycle (sine, triangle, square)
 Range: 10% to 90% (1 Hz to 999 kHz)
 50% fixed (1 Hz to 20 MHz)

Resolution: 1%
 Accuracy (1 Hz to 999 kHz): ± 1 digit, 50% fixed
 ± 3 digits, 20% to 80%
 ± 6 digits, 10% to 20% and 80% to 90%

Pulse Width

Range: 25 ns to 100 ms
 Resolution: 3 digits
 Accuracy: $\pm 5\%$ of setting ± 2 ns
 Repeatability: Factor 2.5 better than accuracy
 Jitter: $< 0.1\% + 50$ ps
 Max. duty cycle: $> 75\%$ (1 Hz to 1 MHz), decreasing to
 $> 50\%$ at 20 MHz

OUTPUT CHARACTERISTICS

Output Impedance: 50 Ohm $\pm 5\%$. Reflection $< 10\%$

Amplitude/Offset

Amplitude and offset are independently variable within the following two level windows.

Level window	± 80.0 mV	$\pm 8.00V$
Ampl. range	160 mVpp to 159.9 mVpp	160 mVpp to 16.00 Vpp
Ampl. resolution	3 1/2 digits	3 1/2 digits
Ampl. accuracy*	$\pm 5\%$ [0.45 dB]	$\pm 5\%$ [0.45 dB]
Ampl. repeatability	Factor 2.5 better than accuracy	
Offset range	0 to ± 80.0 mV	0 to $\pm 8.00V$
Offset resolution	3 digits (best case 10 μV)	3 digits (best case 1 mV)
Offset accuracy	$\pm 5\%$ of setting $\pm 2\%$ of amplitude ± 1 mV	$\pm 5\%$ of setting $\pm 2\%$ of amplitude ± 20 mV
Offset repeatability	Factor 2.5 better than accuracy	

*The amplitude accuracy for sine and triangle is specified at 1 kHz. For other frequencies see the following flatness specifications.

Amplitude Flatness (50% duty cycle)	Sine	Triangle
1.00 Hz to 999 kHz	$\pm 3\%$ [0.26 dB]	$\pm 3\%$
1.00 MHz to 20.0 MHz	$\pm 10\%$ [0.92 dB]	$\pm 10\%$ - 15%

WAVEFORM CHARACTERISTICS

Sine (normal mode, 50% duty cycle, symmetrical mode)
 Total Harmonic Distortion (THD):
 $< 1\%$ [-40 dB], (10 Hz - 99.9 kHz)
 $< 3\%$ [-30 dB], (100 kHz - 999 kHz)
 Harmonic Signals: more than 26 dB below fundamental (1 MHz - 20 MHz) for amplitudes > 10 mVpp

THD and Harmonic Signal Distorsion may increase by 3 dB below 10°C and above 45°C

Triangle, Ramp

Non-linearity: $< \pm 1\%$ (10 Hz to 99.9 kHz)
 $< \pm 3\%$ (1 Hz to 9.9 Hz and 100 kHz to 1 MHz)
 (measured between 10% to 90% of amplitude)

Square, Pulse

Rise/Fall time: < 10 ns (10% to 90% of amplitude)
 Pulse Perturbations: $< \pm 5\%$ of amplitude (≥ 0.16 Vpp)
 $< \pm 10\%$ of amplitude (< 0.16 Vpp)

Output Modes

Switchselectable POSITIVE, NEGATIVE, SYMMETRICAL and NORMAL/COMPLEMENT output signal.

OPERATING MODES

Normal: Continuous waveform is generated
Trigger: Each input cycle generates a single output cycle
Gate: External signal enables oscillator. First output cycle synchronous with active trigger slope. Last cycle always completed.
VCO: External voltage linearly sweeps 2 full frequency decades. The actual frequency is displayed.
 Modulation range: 1:100 with 0.1V to 10V
 Modulation bandwidth: dc to 1kHz
Burst: Each input cycle generates a preprogrammed number (1 to 1999) of periods. Minimum time between bursts is 200 ns. (Option 001)

SUPPLEMENTARY PERFORMANCE CHARACTERISTICS

(Description of non-warranted typical performance parameters)

Ext Input: Threshold Level: 1.4V fixed
 Max input voltage: $\pm 20V$
 Sensitivity: 500 mVpp
 Min pulse width: 25 ns
 Input impedance: 10 kOhm
 Trigger slope: positive

Start Phase: Adjustable from -90° to $+90^\circ$.
 Usable range may decrease to -90° to 0° at 20 MHz.
 Haversine and Havertriangle can be generated.

Trigger Output: TTL compatible output signal.

Man: Simulates external input.

1 Cycle: Provides a single output period in TRIG, GATE and BURST mode.

GENERAL

Warm-up Time: 15 min to meet all specifications.
Environmental: Storage temperature: $-40^\circ C$ to $75^\circ C$
 Operating temperature: $0^\circ C$ to $55^\circ C$
 Humidity range: 95%R.H.,
 $0^\circ C$ to $40^\circ C$
Power: 100/120/220/240 V rms $\pm 5\%$, -10%, 48-440 Hz;
 70 VA max.
Weight: Net 4.6 kg (10 lbs), Shipping 6.6 kg (15 lbs)
Dimensions: 89 mm high, 213 mm wide, 375 mm deep
 (3.5 x 8.4 x 14.8 in)

Options: 001 Counted Burst
 910 Additional Operating & Service Manual

Data subject to change

SECTION II INSTALLATION

2-1 INTRODUCTION

2-2 This section provides installation instructions for the instrument and its accessories. It also includes information about initial inspection and damage claims, preparation for use, and packaging, storage and shipment.

2-3 INITIAL INSPECTION

2-4 Inspect the shipping container for damage. If the container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1 plus any accessories that were ordered with the instrument. Procedures for checking the electrical operation are given in Section 4. If the contents are incomplete, if there is a mechanical damage or defect, or if the instrument does not pass the operator's checks, notify the nearest Hewlett-Packard office. Keep the shipping materials for carrier's inspection. The HP office will arrange for repair or replacement without waiting for settlement.

2-5 PREPARATION FOR USE

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).

2-6 Power Requirements

2-7 The instrument requires a power source of 100/120/220 or 240 Vrms (+5% - 10%) at a frequency of 48-440 Hz single phase. The maximum power consumption is 70 VA.

2-8 Line Voltage Selection

CAUTION

BEFORE SWITCHING ON THIS INSTRUMENT make sure that the instrument is set to the local line voltage. The line voltage selector switches can be seen through the lefthand side of the instrument cover to the rear. The correct setting for the country of destination will have been made at the factory. The instrument power fuse is located behind a metal plate which can also be seen when the switches are viewed. To access the fuse and line selector switches, first DISCONNECT the power cord, then remove instrument top cover by releasing the captive securing screw at rear and sliding cover off. The fuse is accessed by removing the metal cover plate held by two securing screws (non-captive).

CAUTION

Do not change the LINE SELECTOR switch settings with the instrument on or with power connected to the rear panel.

2-9 Figure 2-1 provides information for line voltage and fuse selection:

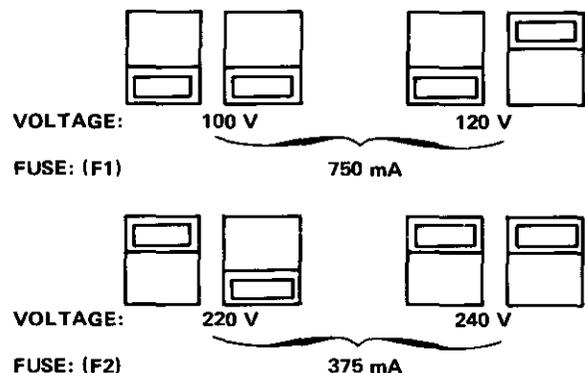


Figure 2-1. Sliding Switches Positions for different Line Voltages

2-10 Power Cable

WARNING

To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on:

- a. If this instrument is to be energized via an autotransformer for voltage reduction, make sure that the common terminal is connected to the grounded pole of the power source.
- b. The power cable plug shall only be inserted into a socket outlet provided with a protective ground contact. The protective action must not be negated by the use of an extension cord without a protective conductor.
- c. Before switching on the instrument, the protective ground terminal of the instrument must be connected to a protective conductor of the power cable. This is verified by checking that the resistance between the instrument chassis and the front panel and the ground pin of the power cable plug is zero ohms.

2-11 In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part number of the power cords available.

2-12 The following work should be carried out by a qualified electrician and all local electrical codes must be observed. If the plug on the cable supplied does not fit your power outlet, or if the cable is to be attached to a terminal block, then cut the cable at the plug end and re-wire it. The colour coding used in the cable will depend on the cable supplied (see Figure 2-2). If a new plug is to be connected, the plug should meet local safety requirements and include the following features:

- adequate load-carrying capacity (see table of specifications in Section 1)
- ground connection
- cable clamp

2-13 Operating Environment

The operating temperature limits are 0°C to 55°C. The specifications also apply over this temperature range.

2-14 CLAIMS AND REPACKAGING

2-15 Claims for Damage

2-16 If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2-17 Storage and Shipment

2-18 The instrument can be stored or shipped at temperatures between -40°C and 75°C. The instrument should be protected from temperature extremes which cause condensation within it.

2-19 If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required. The original shipping carton

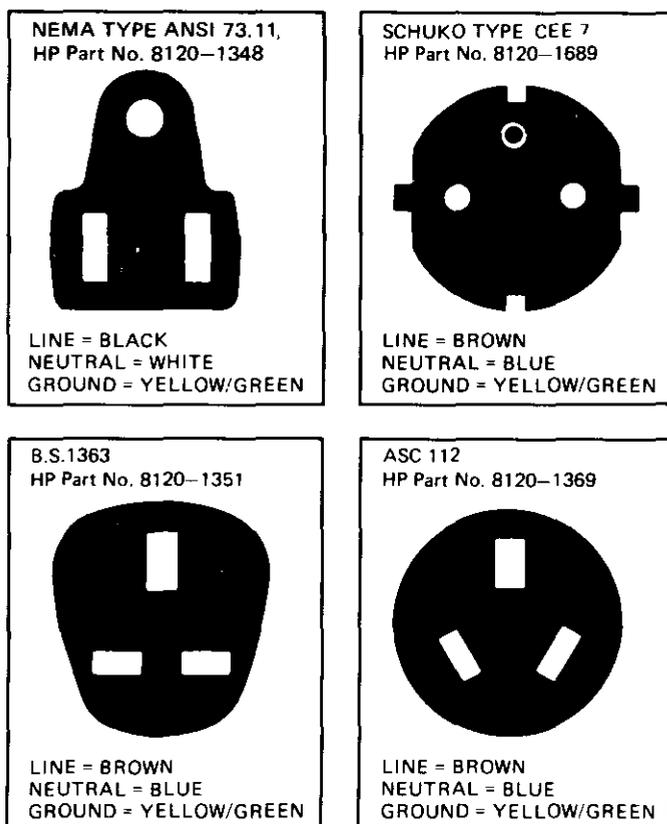
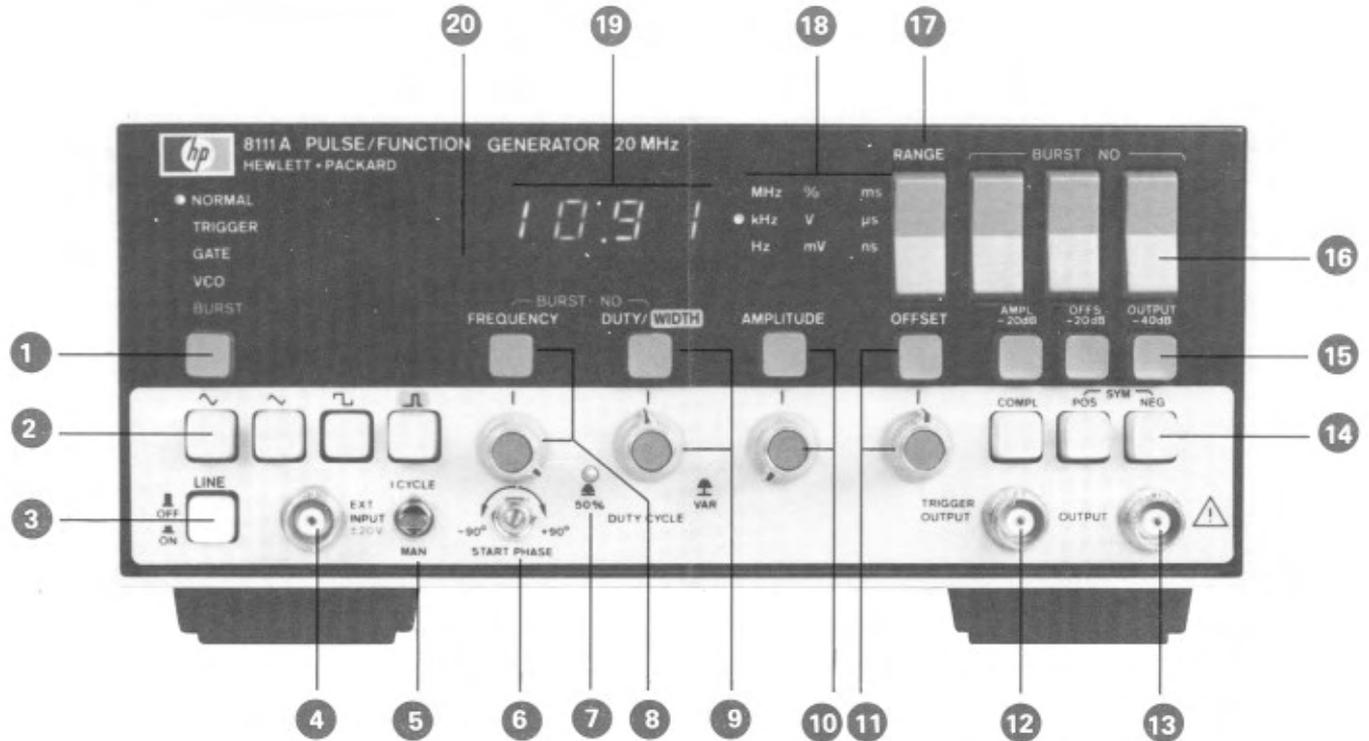


Figure 2-2. Power Cables Available: Plug Identification

and packaging material may be re-usable but the Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing is not available or re-usable. General instructions for re-packing are as follows:

1. Wrap instrument in heavy paper or plastic.
2. Use strong shipping container. A double wall carton made of 200-pound test material is adequate.
3. Use enough shock-absorbing material (3 to 4-inch layer) around all sides of instrument to provide firm cushion and prevent movement inside container. Protect control panel with cardboard.
4. Seal shipping container securely.
5. Mark shipping container FRAGILE to encourage careful handling.
6. In any correspondence, refer to instrument by model number and serial number.

8111A PULSE/FUNCTION GENERATOR
Controls and Connectors (Option 001 fitted)



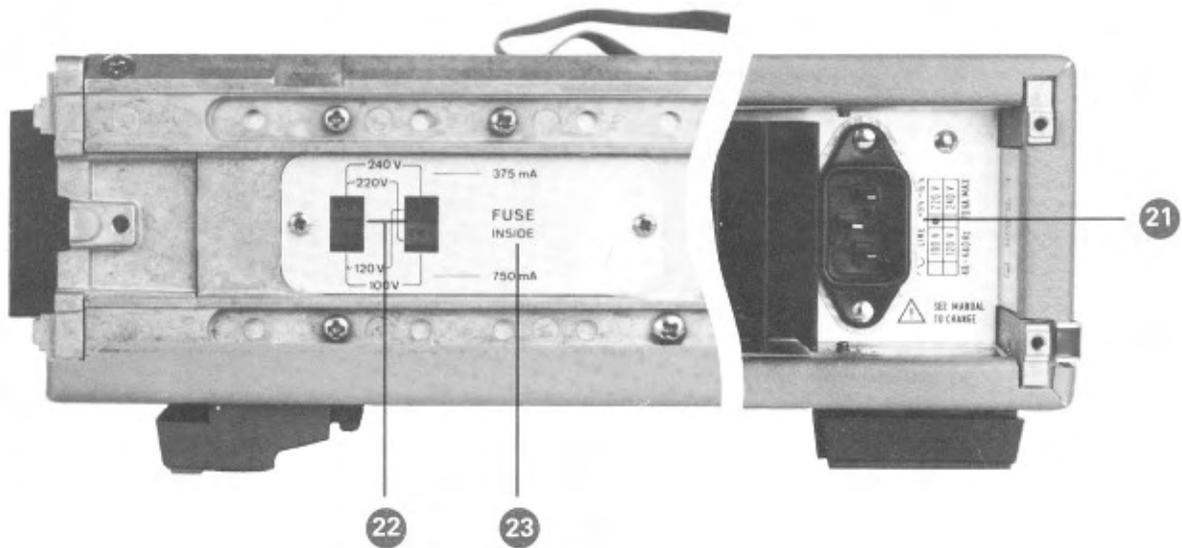
1 The pushbutton on the left-hand side of the front panel selects the operation mode. The selected mode is indicated by an LED. Each successive operation of the pushbutton changes the mode, starting from NORMAL, running through to BURST and back to NORMAL.

The operating modes are:

- NORMAL — 8111A's internal rate generator free running
- TRIGGER — trigger signal, either via EXT INPUT or toggle switch **5** initiates one output cycle
- GATE — gate signal, either via EXT INPUT or toggle switch **5** initiates an output which is maintained as long as gate signal is present
- VCO — signal applied to EXT INPUT determines the output frequency
- BURST — (Option 001 only) a burst trigger either via the EXT INPUT or toggle switch initiates burst of output cycles

- 2** Function pushbuttons select one of 4 possible functions: sine, triangle, square or pulse.
- 3** LINE ON/OFF. Primary ac power switch.
- 4** EXT INPUT. Connector for external signal in TRIGGER, GATE, VCO and BURST (Option 001 only) modes.
- 5** 1 CYCLE/MANUAL switch produces a single trigger pulse when switched to MAN in the TRIGGER, GATE and BURST modes or, initiates a single cycle when switched to 1 CYCLE.
- 6** START PHASE. Vernier control enables variation of output signal start phase with respect to external trigger, gate or burst signal.
- 7** 50 % DUTY CYCLE indicator, either automatically selected when frequency in MHz range or manually by pushing DUTY CYCLE vernier in. Inoperative in pulse mode.

Figure 3-1. Controls and Connectors



8 9 10 & 11 Parameter select pushbuttons and corresponding vernier controls which enable display and variation of the required parameter. In BURST mode, both the FREQUENCY and DUTY/WIDTH buttons must be pushed in. In sine, triangle and squarewave modes, the DUTY/WIDTH button and associated vernier (when pulled out) enable duty cycle variation (vernier pushed in and LED on for 50 % duty cycle). In pulse mode, they enable pulse width variation.

12 TRIGGER OUTPUT. BNC connector providing a TTL compatible output signal.

13 OUTPUT. BNC connector providing signal output (50 ohm source impedance).

14 Output mode pushbuttons select POSitive or NEGative polarity, SYMmetrical (both buttons pushed or released) and normal or COMPLEMENT output signal.

15 Amplitude and Offset attenuation controls. Pushbuttons select AMPlitude -20 dB, OFFset -20 dB and OUTPUT -40 dB attenuators.

16 BURST NO. Rocker switches which enable setting up of number of pulses in a burst (Opt. 001).

17 RANGE. Rocker switch enables range change of FREQUENCY or WIDTH parameters.

18 Unit indicator. Indicates unit of currently selected parameter.

19 Display. 3 1/2 digit LED display.

20 ERROR indicator. LED out of limits indicator for incompatible period/width ratio settings or external trigger/8111A frequency setting.

21 Line receptacle. Power Cord to be plugged in here. Chassis ground for operator protection provided through cord.

22 Line voltage select sliding switches to be set to local line voltage.

23 Fuse (under metal plate) protects instrument in case of current overload. 750 mA for 100/120 V operation, 375 mA for 220/240 V operation.

SECTION III OPERATING INSTRUCTIONS

3-1 INTRODUCTION

3-2 The following sections describe the various operating modes and operation of the front panel controls. Pushbutton and/or vernier adjustment is described only where a more detailed description than that accompanying Figure 3-1 is considered necessary.

Numbers within circles — ① — in text are for cross-reference to Figure 3-1.



3-3 SPECIAL OPERATING CONSIDERATIONS

3-4 Read the following sections (a, b, c & d) before applying power to the 8111A.

- a. Read the safety summary (red page) at the front of this manual.
- b. Ensure that the power selector switches are set properly for the power source being used to avoid instrument damage.

CAUTION

Do not change the LINE SELECTOR switch settings with the instrument on or with power connected to the rear panel.

- c. Ensure load is not overdriven (up to 16 Vpp into 50 Ohm or 32 Vpp into high impedance).
- d. Do not apply external voltage to the output connectors.

3-5 OPERATING INSTRUCTIONS

3-6 Mode Selection ①

3-7 NORMAL Mode

3-8 In normal mode, (automatically selected on instrument switch-on), the internal rate generator is free running, the frequency being determined by the FREQUENCY setting and the output is continuous (Figure 3-2).

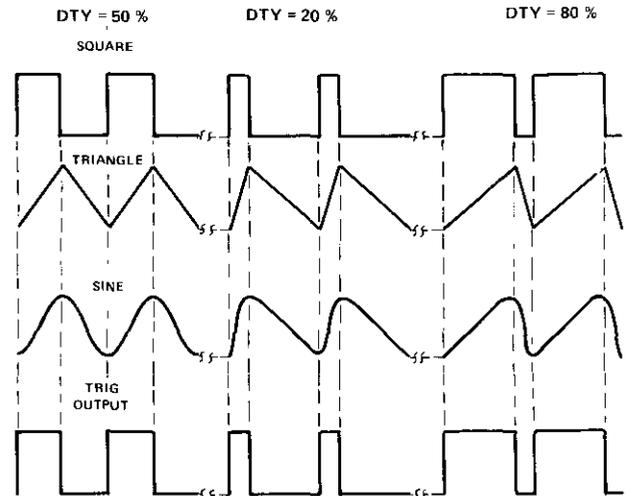


Figure 3-2. Normal Mode—various DUTY CYCLE values

3-9 TRIGGER/GATE/BURST Input Modes ①

3-10 In all three modes you can generate the trigger/gate signal either by applying an external signal to the EXT INPUT BNC connector or by switching the MAN/1 CYCLE switch to MAN. The external trigger signal frequency should not exceed the 8111A's frequency setting. If it does, the ERROR indicator will flash.

NOTE: For all three triggered modes see § 3-30 (first trigger output signal pulse width)

3-11 External Trigger Mode (TRIGGER) ①

3-12 In this mode the trigger signal initiates one complete output cycle (Figure 3-3).

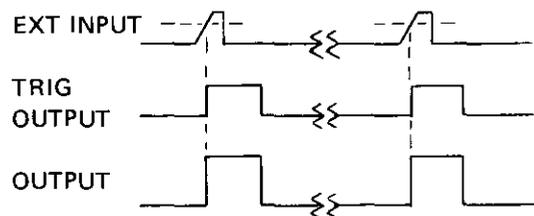


Figure 3-3. Trigger Mode (Squarewave, 50% DUTY CYCLE)

3-13 Gate Mode (GATE) 1

3-14 In gate mode the leading edge of the gate signal enables the 8111A's rate generator and the trailing edge disables it (Figure 3-4). The first and last cycles are always complete.

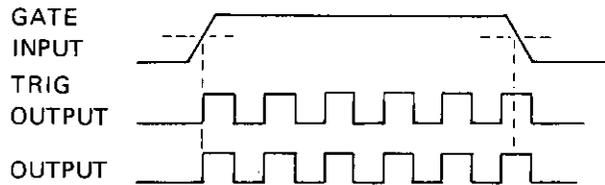


Figure 3-4. Gate Mode (Squarewave, 50 % DUTY CYCLE)

3-15 Burst Mode (BURST) 1

3-16 In burst mode, a preset number of cycles is generated on each leading edge of a positive-going trigger signal applied to EXT INPUT when BURST mode is selected (Figure 3-5). The burst length may be set from 1 to 1999 pulses by pressing both the FREQUENCY and DUTY/WIDTH pushbuttons and operating the BURST NO rocker switches as necessary, (single digit increment by individual pushes or continuous by constant pressure) until the required burst number is displayed.

Frequency and duty cycle/pulse width selection in BURST mode is as described in 3-21—3-25.

NOTE: At the end of a triggered burst length, single pulses can be added by operation of the 1 CYCLE/MAN switch in the 1 CYCLE mode.

See 53-30 for Start Phase variation details if applicable.

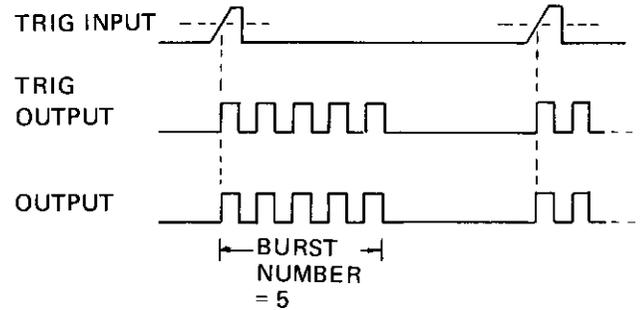


Figure 3-5. Burst Mode (Squarewave, 50 % DUTY CYCLE)

3-17 Voltage-controlled Oscillator Mode (VCO)

3-18 In VCO mode, a signal applied to the EXT INPUT connector determines the output frequency. The working range of input voltage (0.1 V to 10 V or 0.1 V to 2 V for 1.0 to 20 MHz range) sweeps the output frequency linearly over a maximum range of 2 decades. The actual range swept depends, as shown in Table 3-2, on the 8111A's frequency setting. The applied signal may change at up to 1 kHz. An example of the VCO mode is given in Table 3-1:

8111A Frequency range setting: 100 kHz – 1000 kHz

NOTE: Frequency range setting is easier to make in NORMAL mode than VCO mode.

Table 3-1. VCO Mode Example Values

EXT INPUT VOLTAGE	OUTPUT FREQUENCY
0.1 V	10 kHz
1.0 V	100 kHz
10.0 V	1000 kHz

Table 3-2 shows the relationship between external control voltage and output frequency for all ranges.

Table 3-2. Sweepable Bands in VCO Mode

8111A FREQUENCY range setting	Sweepable band			
	From		To	
	V_{in} min	f_{out} min	V_{in} max	f_{out} max
1 Hz – 10 Hz	0.1 V	0.1 Hz	10 V	10 Hz
10 Hz – 100 Hz	0.1 V	1 Hz	10 V	100 Hz
100 Hz – 1000 Hz	0.1 V	10 Hz	10 V	1000 Hz
1 kHz – 10 kHz	0.1 V	0.1 kHz	10 V	10 kHz
10 kHz – 100 kHz	0.1 V	1 kHz	10 V	100 kHz
100 kHz – 1000 kHz	0.1 V	10 kHz	10 V	1000 kHz
1 MHz – 10 MHz	0.1 V	0.1 MHz	10 V	1 MHz
10 MHz – 20 MHz	0.1 V	1 MHz	2 V	20 MHz

3-19 Function, FREQUENCY and DUTY cycle/ WIDTH Selection 2 8 & 9

NOTE: Adjustment of any of the four vernier controls can be made without the corresponding display enable pushbutton being pressed. This allows a waveform which is displayed on an oscilloscope to be quickly and easily varied merely by vernier adjustment at any time.

3-20 Selection of the required function (sine, triangle, square wave or pulse) is by pressing the appropriately labelled front panel pushbutton.

3-21 FREQUENCY display and adjustment 8

NOTE: Frequency controls are non-functional in pulse mode.

3-22 This is enabled by pressing the FREQUENCY pushbutton. Adjustment of the FREQUENCY vernier will change the displayed value, range changing is accomplished by operating the RANGE rocker switch to change either the decimal point position and/or the frequency unit.

NOTE: Selection of a MHz range will cause the 50 % DUTY CYCLE LED to illuminate when sine, triangle or square wave function selected.

3-23 DUTY CYCLE display and adjustment 9

3-24 This is enabled by pressing the DUTY/WIDTH pushbutton. Duty cycle for sine, triangle or square-wave functions can be either a fixed 50 % over the frequency

range 1 Hz to 20 MHz, or 10 % to 90 % variable over 1 Hz to 999 kHz. When the DUTY CYCLE vernier is in the "pushed in" position a constant 50 % duty cycle is obtained (indicated by the 50 % LED). By pulling the vernier out, adjustment of the duty cycle within the limits detailed above is possible.

3-25 WIDTH display and adjustment 9

3-26 This is made (in pulse mode) by first pressing the DUTY/WIDTH pushbutton to display the width value and then adjusting the DUTY/CYCLE/width vernier (now functioning as a width vernier). Variation from 25 ns to 100 ms is possible (see Specification) by vernier adjustment and RANGE rocker switch operation.

3-27 ERROR Signal 20

3-28 In pulse mode, the flashing ERROR signal can be caused by either adjustment of the FREQUENCY or DUTY CYCLE/width verniers or RANGE changing, which results in the FREQUENCY/WIDTH settings being incompatible – width of pulse exceeds period ($WIDTH \geq 1/FREQUENCY$).

3-29 In TRIGGER mode, the ERROR signal will occur if the external trigger frequency is incompatible with the 8111A pulse width setting (internal rate generator disabled in pulse mode) or, if it exceeds the 8111A frequency setting in function mode.

3-30 START PHASE Variation 6

3-31 In sine and triangular functions, the waveform start phase can be varied (with respect to an external trigger, gate or burst signal) by $+90^\circ$ to -90° by the appropriate front panel vernier. (Haversine and Haver-triangle waveforms can be generated).

NOTE: See Specification for usable range details. (At $+90^\circ$ first trigger output signal pulse width is reduced to minimum at high frequencies, this may affect Burst mode)

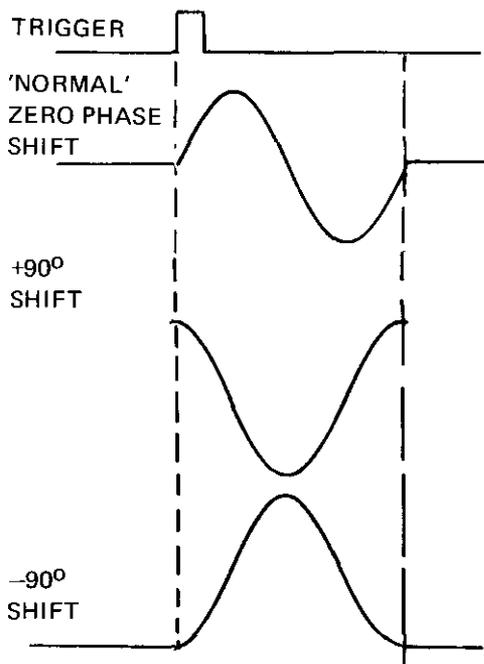


Figure 3-6. Start Phase Variation (Sinewave)

3-32 AMPLITUDE and OFFSET display and adjustment 10 & 11

3-33 Amplitude and offset values are displayed by pressing the AMPLITUDE or OFFSET pushbuttons. To vary either value, adjust the corresponding vernier until the desired figure is displayed. Range changing of either AMPLITUDE or OFFSET is made by pressing one of the three attenuator control pushbuttons as detailed in the following section (the RANGE rocker switch has no control over voltage ranges). Ensure that the maximum amplitude and offset settings do not result in the output signal exceeding the output window levels of ± 8.00 V into 50 Ohm.

3-34 AMPLITUDE, OFFSET and OUTPUT Attenuation 15

3-35 The three pushbutton controlled attenuators (AMPL-20 dB, OFFS-20 dB and OUTPUT-40 dB) can be enabled individually, or if necessary together. The two -20 dB attenuators attenuate either amplitude or offset and the -40 dB one attenuates both, so providing a maximum value of 60 dB attenuation for amplitude and offset.

3-36 OUTPUT MODE Selection 14

3-37 Three output mode pushbuttons enables normal/COMPLEMENTARY, Positive/negative or SYMMETRICAL output waveforms. If none of the buttons are pressed a normal symmetrical waveform will be output.

Examples of output mode differences are shown in Figure 3-7.

NOTE: Positive or negative offset can be added (or subtracted) irrespective of the selected output mode.

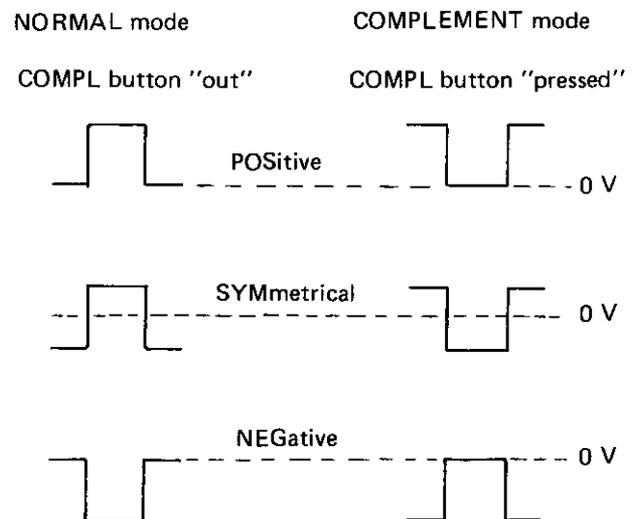


Figure 3-7. Output Mode Differences (no offset applied) (Squarewave, 50 % DUTY CYCLE)

SECTION IV PERFORMANCE TESTS

4-1 INTRODUCTION

4-2 The procedures in this section test the electrical performance of the instrument using the specifications of Table 1-2 as performance standards. All tests can be performed without access to the interior of the instrument.

4-3 EQUIPMENT REQUIRED

4-4 Equipment required for the performance tests is listed in Table 1-1, Recommended Test Equipment. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

4-5 TEST RECORD

4-6 Results of the performance tests may be tabulated on the Test Record at the end of the test procedures. The Test Record lists all of the tested specifications and their acceptable limits. Test results recorded at incoming inspec-

tion can be used for comparison in periodic maintenance, troubleshooting, and after repairs or adjustments.

4-7 PERFORMANCE TESTS

4-8 The performance tests given in this section are suitable for incoming inspection, troubleshooting, or preventive maintenance. During any performance test, all shields and connecting hardware must be in place. The tests are designed to verify the published instrument specifications, perform the tests in the order given and record the data on the Test Record at the end of the test procedures.

4-9 Each test is arranged so that the specification is written as it appears in Table 1-2. Next, when necessary, a description of the test and any special instructions or problem areas are included. Each test that requires test equipment has a setup drawing and a list of the required equipment. The initial steps of each procedure give control settings required for that particular test.

PERFORMANCE TESTS

4-10 FREQUENCY

SPECIFICATION

1.00 Hz – 10 Hz accuracy $\pm 10\%$ of setting
 10 Hz – 20 MHz accuracy $\pm 5\%$ of setting

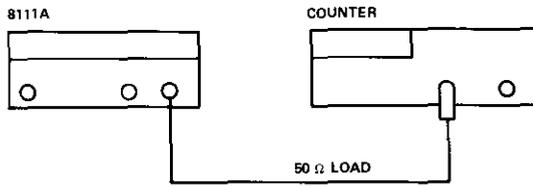


Figure 4-1. Frequency Test Set-up

EQUIPMENT

- Counter
- Cable Assembly BNC
- Feedthrough Termination 50 Ω

PROCEDURE

1. Connect equipment as shown.
2. Set 8111A as follows:

INPUT MODE	.....	NORM
FUNCTION	.....	SQUARE
DUTY CYCLE	.....	50 %
AMPLITUDE	.....	CW
AMPLITUDE ATTENUATION	.....	-20 dB
OFFSET	.....	0 V
OUTPUT MODE	.....	SYM

3. Set counter to frequency measurement.

PERFORMANCE TESTS

4. Set 8111A frequency and verify counter frequency reading as follows:

Table 4-1. Frequency Limits

8111A SETTING	COUNTER READING
1 Hz	0.900 Hz – 1.100 Hz
9.99 Hz	9.000 Hz – 11.000 Hz
10 Hz	9.500 Hz – 10.500 Hz
99.9 Hz	95.000 Hz – 105.00 Hz
100 Hz	95.00 Hz – 105.00 Hz
999 Hz	950.00 Hz – 1050.0 Hz
1 kHz	0.950 kHz – 1.050 kHz
9.99 kHz	9.500 kHz - 10.50 kHz
10 kHz	9.500 kHz - 10.50 kHz
99.9 kHz	95.00 kHz – 105.00 kHz
100 kHz	95.00 kHz – 105.00 kHz
999 kHz	950.0 kHz - 1050 kHz
1 MHz	0.950 MHz – 1.050 MHz
9.99 MHz	9.500 MHz – 10.50 MHz
10 MHz	9.500 MHz – 10.50 MHz
20 MHz	19.00 MHz – 21.00 MHz

PERFORMANCE TESTS

4-12 OFFSET

SPECIFICATION

Offset Range 0 V to ± 8 V (into 50 Ω) accuracy ± 5 % of setting and ± 2 % of amplitude and ± 20 mV

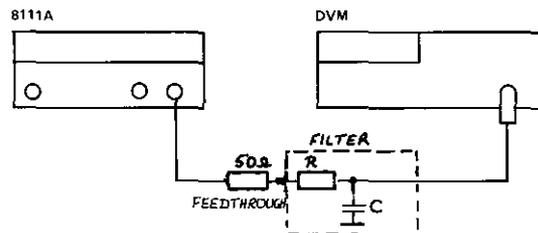


Figure 4-3. Offset Test Set-up

EQUIPMENT

- DVM
- Cable assembly BNC
- Feedthrough Termination 50 Ω
- Filter (suggested values: R = 20 k Ω , C = 2.2 μ F) NOTE: Cut off frequency of the filter should be < 10 Hz

PROCEDURE

1. Connect equipment as shown.
2. Set 8111A as follows:

INPUT MODE	NORM
FUNCTION	SQUARE
DUTY CYCLE	50 %
AMPLITUDE	2 V
OUTPUT MODE	SYM
FREQUENCY	1 kHz
AMPLITUDE ATTENUATION	-20 dB

3. Set 3455A to DC measurement.
4. Set 8111A Offset and verify DVM offset reading as follows:

8111A	DVM READING
8 V	7.576 V - 8.424 V
4 V	3.776 V - 4.224 V
2 V	1.876 V - 2.124 V
0 V	-24 mV 24 mV
-2 V	-1.876 V - -2.124 V
-4 V	-3.776 V - -4.224 V
-8 V	-7.576 V - -8.424 V

PERFORMANCE TESTS

4-13 PULSE CHARACTERISTICS

SPECIFICATION

Transition times (10 % to 90 %): < 10 nsec
 Preshoot, Overshoot, Ringing: $\pm 5\%$ of amplitude (≥ 0.16 Vpp)
 $\pm 10\%$ of amplitude (< 0.16 Vpp)

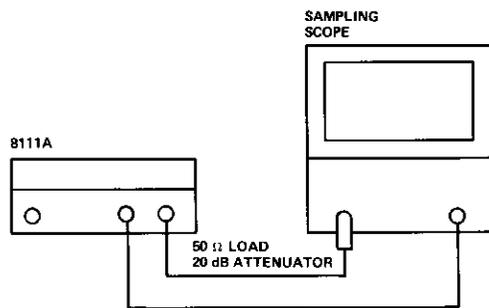


Figure 4-4. Pulse Characteristics Test Set-up

EQUIPMENT

- Sampling oscilloscope
- Cable assembly 2 x BNC
- Feedthrough termination 50 Ω
- Attenuator 20 dB

PROCEDURE

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	.....	NORM
FUNCTION	.....	SQUARE
DUTY CYCLE	.....	50 %
AMPLITUDE	.....	16 Vpp
OUTPUT MODE	.....	SYM
FREQUENCY	.....	2 MHz

3. Set scope so that one cycle fills the display.
 - leading edge ≤ 10 nsec
 - trailing edge ≤ 10 nsec
 - pulse perturbation $\leq \pm 5\%$ of amplitude

PERFORMANCE TESTS

4-14 SINE CHARACTERISTIC

SPECIFICATION

Sine (normal mode, 50 % duty cycle, sym)

THD { < 1 % [-40 dB], (10 Hz - 99.9 kHz) } may increase by 3dB below 10° C and above 45° C.
 { < 3 % [-30 dB], (100 kHz - 999 kHz) }

for > 1 MHz to 20 MHz harmonic signals more than 26 dB below fundamental.

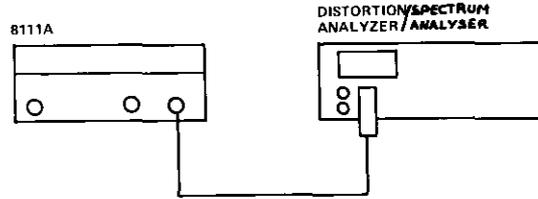


Figure 4-5. Sine Characteristics Test Set-up

EQUIPMENT

- Distortion analyser / Spectrum Analyser
- Cable assembly BNC to Banana
- Feedthrough termination 50 Ω

PROCEDURE

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	.....	NORM
FUNCTION	.....	SINE
DUTY CYCLE	.....	50 %
AMPLITUDE	.....	16 V
FREQUENCY	.....	9.99 kHz
OUTPUT MODE	.....	SYM
OFFSET	.....	0 V

3. Either, set the distortion analyser front panel controls as required (Distortion, Range—dB/%, input range etc.) or, if using a spectrum analyser, tune it for minimum display amplitude and adjust gain so that fundamental corresponds to 0 dB. Verify that the 2nd and 3rd harmonics do not exceed the -42 and -47 dB levels respectively.

4. Verify that THD < 1 %

$$THD = \frac{\sqrt{E_1^2 + E_2^2 + E_3^2 + \dots}}{E_0} \cdot 100 \%$$

where E_0 = fundamental voltage amplitude and E_1, E_2 etc are the 2nd, 3rd etc. harmonic amplitudes.

When the harmonics are expressed in dB the formula becomes:

$$THD = \sqrt{10^{\frac{A_1}{10}} + 10^{\frac{A_2}{10}} + 10^{\frac{A_3}{10}} + \dots} \cdot 100 \%$$

where A_1 = first harmonic in dB etc.

5. Change 8111A frequency setting to 500 kHz.
6. Verify that 2nd and 3rd harmonics do not exceed the -32 dB and -37 dB levels.
7. Verify that THD < 3 % using previously stated formula.
8. Change 8111A frequency setting to 20 MHz.
9. Verify that all harmonics are less than -26 dB.

PERFORMANCE TESTS

4-15 DUTY CYCLE

SPECIFICATION

Variable range: 10 % to 90 % (1 Hz to 999 kHz)
50 % fixed (1 Hz to 20 MHz)

Accuracy: ± 1 digit, 50 % fixed
 ± 3 digit, 20 % to 80 %
 ± 6 digit, 10 % to 20 % and 80 % to 90 %

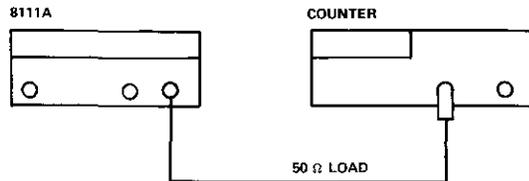


Figure 4-6. Duty Cycle Test Set-up

EQUIPMENT

Counter
Cable assembly BNC
Feedthrough termination 50 Ω

PROCEDURE

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	.....	NORM
FUNCTION	.....	SQUARE
AMPLITUDE	.....	16 V _{pp}
AMPLITUDE ATTENUATION	.....	-20 DB
FREQUENCY	.....	10.000 kHz
VAR DUTY CYCLE	.....	50 %

3. Set counter to TI avg, Slope A+, Slope B- measurement.
4. Set 8111A Duty cycle and verify counter duty cycle reading as follows:

8111A	COUNTER READING
10 %	4 μ sec - 16 μ sec
20 %	17 μ sec - 23 μ sec
50 %	49 μ sec - 51 μ sec
80 %	77 μ sec - 83 μ sec
90 %	84 μ sec - 96 μ sec

PERFORMANCE TESTS

4-16 WIDTH

SPECIFICATION

Range: 25 nsec to 100 msec

Accuracy: $\pm 5\%$ of setting ± 2 nsec

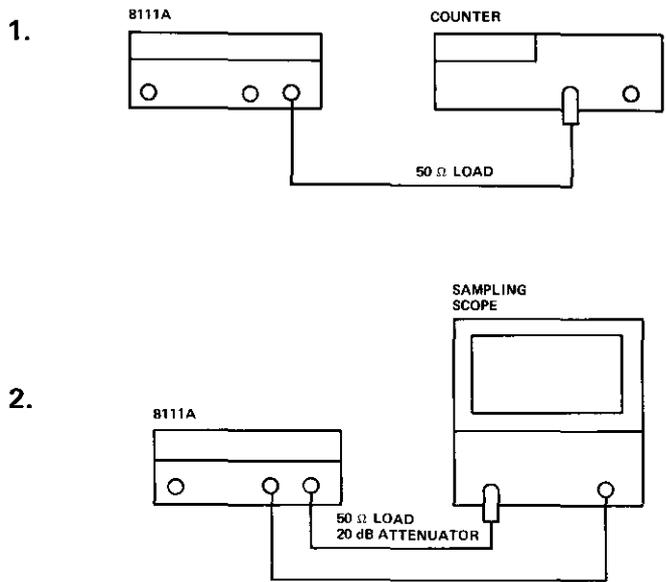


Figure 4-7. Width Test Set-up

EQUIPMENT

- Counter
- Sampling scope
- Cable assembly 2 x BNC
- Attenuator 20 dB
- Feedthrough termination 50 Ω

PROCEDURE

1. Connect the equipment as shown in Figure 4-7-1.
2. Set 8111A as follows:

INPUT MODE.	NORM
FUNCTION.	PULSE
WIDTH	as required
AMPLITUDE	16 Vpp
OUTPUT MODE	SYM

PERFORMANCE TESTS

3. Set Counter to T.1. avg, Slope A+, Slope B– measurement.
4. Set 8111A Width and verify counter T.1 reading as follows:

8111A	COUNTER READING
5 kHz 100 nsec 999 nsec	93 nsec — 107 nsec 948 nsec — 1051 nsec
5 kHz 1 μsec 9.99 μsec	0.948 μsec — 1.052 μsec 9.498 μsec — 10.5 μsec
5 kHz 10 μsec 99.9 μsec	9.50 μsec — 10.5 μsec 94.99 μsec — 104.9 μsec
500 Hz 100 μsec 999 μsec	95 μsec — 105 μsec 949.9 μsec — 1049 μsec
50 Hz 1 msec 9.99 msec	0.95 msec — 1.05 msec 9.499 msec — 10.49 msec
5 Hz 10 msec 99.9 msec	9.5 msec — 10.5 msec 94.9 msec — 104.9 msec

5. Connect the equipment as shown in Figure 4–7–2.
6. Set 8111A as follow:

INPUT MODE	.....	NORM
FUNCTION	.....	PULSE
WIDTH	.....	as required
AMPLITUDE	.....	16 Vpp
OUTPUT MODE	.....	SYM
FREQUENCY	.....	1 MHz
7. Set scope so that one cycle fills the display.
8. Set 8111A Width and verify sampling scope width reading as follows:

8111A	SAMPLING SCOPE
25 nsec 100 nsec	21.75 nsec — 28.25 nsec 93 nsec — 107 nsec

PERFORMANCE TESTS

4-17 TRIGGER, GATE, BURST

SPECIFICATION

Each input cycle generates a single output cycle.

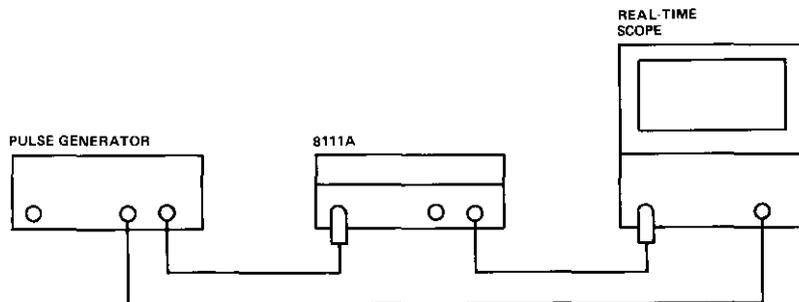


Figure 4-8. Trigger, Gate and Burst Test Set-up

EQUIPMENT

Pulse generator
 Realtime scope
 Cable assembly 3 x BNC
 2 x Feedthrough termination 50 Ω

PROCEDURE (Trigger)

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	TRIGGER
FUNCTION	SINE
DUTY CYCLE	50 %
AMPLITUDE	16 V _{pp}
OUTPUT MODE	SYM
FREQUENCY	10 kHz

3. Set pulse generator to 1 kHz and 100 nsec width.
4. Check on scope for 8111A output signals.

PERFORMANCE TESTS

PROCEDURE (Gate)

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	GATE
FUNCTION	SINE
DUTY CYCLE	50 %
AMPLITUDE	16 Vpp
OUTPUT MODE	SYM
FREQUENCY	10 kHz

3. Set pulse generator to 1.0 kHz and 500 μ sec width.
4. Check on scope for 8111A output signals.

PROCEDURE (Burst)

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	BURST
FUNCTION	SINE
DUTY CYCLE	50 %
AMPLITUDE	16 Vpp
OUTPUT MODE	SYM
FREQUENCY	10 kHz
BURST	3

3. Set pulse generator to 1 kHz and 100 nsec width.
4. Check on scope for 8111A output signals.

PERFORMANCE TESTS

4-18 VCO-MODE

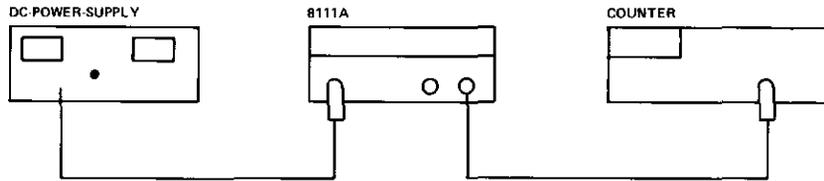


Figure 4-9. VCO-Mode Test Set-up

EQUIPMENT

- DC Power Supply
- Counter
- Cable assembly BNC and BNC-Banana
- 2 x Feedthrough termination 50 Ω

PROCEDURE

1. Connect the equipment as shown.
2. Set 8111A as follows:

INPUT MODE	.....	VCO
FUNCTION	.....	SQUARE
DUTY CYCLE	.....	50 %
AMPLITUDE	.....	16 Vpp
OUTPUT MODE	.....	SYM
FREQUENCY RANGE	.....	1-10 kHz
3. Set counter to frequency.
4. Set DC Supply for .1 to 10 V and verify counter frequency (typical).

DC POWER SUPPLY	8111A	COUNTER
.1 V	.10 kHz	.10 kHz
1 V	1.00 kHz	1.00 kHz
10 V	10.00 kHz	10.00 kHz

PERFORMANCE TESTS RECORD

Hewlett-Packard Company Model 8111A/8111A Option 001 Pulse/Function Generator		Instrument Serial No. _____ Tested by _____ Date _____		
Paragraph No.	Test Description and parameter values	Result		
		Minimum	Actual	Maximum
4-10	Frequency 1 Hz 9.99 Hz 10 Hz 99.9 Hz 100 Hz 999 Hz 1 kHz 9.99 kHz 10 kHz 99.9 kHz 100 kHz 999 kHz 1 MHz 9.99 MHz 10 MHz 20 MHz	0.900 Hz 9.000 Hz 9.500 Hz 95.000 Hz 95.00 Hz 950.00 Hz 0.950 kHz 9.950 kHz 9.950 kHz 95.00 kHz 95.00 kHz 950.00 kHz 0.950 MHz 9.500 MHz 9.500 MHz 19.00 MHz		1.100 Hz 11.000 Hz 10.500 Hz 105.00 Hz 105.00 Hz 1050.0 Hz 1.050 kHz 10.50 kHz 10.50 kHz 105.00 kHz 105.00 kHz 1050.0 kHz 1.050 MHz 10.50 MHz 10.50 MHz 21.00 MHz
4-11 (1)	Amplitude and Attenuation Amplitude Square 16 Vpp 10 Vpp 1.6 Vpp Triangle 16 Vpp 10 Vpp 1.6 Vpp Sine 16 Vpp 10 Vpp 1.6 Vpp	7.600 V 4.750 V 0.760 V 4.388 V 2.742 V 0.439 V 5.374 V 3.359 V 0.537 V		8.40 V 5.25 V 0.84 V 4.85 V 3.031 V 0.485 V 5.940 V 3.712 V 0.594 V

PERFORMANCE TESTS RECORD

Paragraph No.	Test Description and parameter values	Result		
		Minimum	Actual	Maximum
4-11 cont'd	Amplitude and Attenuation Attenuation 10 Vpp -20 dB (1 Vpp) -40 dB (100 mVpp) -60 dB (10 mVpp)	4.750 V 0.475 V 47.5 mV 4.75 mV		5.250 V 0.525 V 52.5 mV 5.25 mV
4-12	Offset 8 V 4 V 2 V 0 V -2 V -4 V -8 V	7.576 V 3.776 V 1.876 V -24 mV -1.876 V -3.776 V -7.576 V		8.424 V 4.224 V 2.124 V 24 mV -2.124 V -4.224 V -8.424 V
4-13	Pulse Characteristics leading edge trailing edge pulse perturbation	≤ 10 nsec ≤ 10 nsec $\leq \pm 5\%$ of amplitude	yes <input type="checkbox"/> yes <input type="checkbox"/> yes <input type="checkbox"/>	no <input type="checkbox"/> no <input type="checkbox"/> no <input type="checkbox"/>
4-14	Sine Characteristics (Harmonic level) Frequency 9.99 kHz (2nd Harmonic) 9.99 kHz (3rd Harmonic) 9.99 kHz (THD) 500 kHz (2nd Harmonic) 500 kHz (3rd Harmonic) 500 kHz (THD) 20 MHz (worst Harmonic)		_____ _____ _____ % _____ _____ _____ % _____	-42 dB -47 dB < 1 % -32 dB -37 dB < 3 % -26 dB
4-15	Duty Cycle 10 % 20 % 50 % 80 % 90 %	4 μ s 17 μ s 49 μ s 77 μ s 84 μ s		16 μ s 23 μ s 51 μ s 83 μ s 96 μ s

PERFORMANCE TESTS RECORD

Paragraph No.	Test Description and parameter values	Result		
		Minimum	Actual	Maximum
4-16	Width			
	5 kHz 100 ns	93 ns		107 ns
	999 ns	948 ns		1051 ns
	5 kHz 1 μs	0.948 μs		1.052 μs
	9.99 μs	9.498 μs		10.5 μs
	5 kHz 10 μs	9.50 μs		10.5 μs
	99.9 μs	94.99 μs		104.9 μs
	500 Hz 100 μs	95 μs		105 μs
	999 μs	949.9 μs		1049 μs
	50 Hz 1 ms	0.95 ms		1.05 ms
9.99 ms	9.499 ms		10.49 ms	
5 Hz	10 ms	9.5 ms		10.5 ms
	99.9 ms	94.9 ms		104.9 ms
	25 ns	21.75 ns		28.25 ns
	100 ns	93 ns		107 ns
4-17	Trigger, Gate, Burst			
	Trigger	Output Signals	yes <input type="checkbox"/>	no <input type="checkbox"/>
	Gate	Output Signals	yes <input type="checkbox"/>	no <input type="checkbox"/>
	Burst	Output Signals	yes <input type="checkbox"/>	no <input type="checkbox"/>
4-18	VCO Mode			
	0.1 V	0.10 kHz	yes <input type="checkbox"/>	no <input type="checkbox"/>
	1.0 V	1.00 kHz	yes <input type="checkbox"/>	no <input type="checkbox"/>
	10 V	10.00 kHz	yes <input type="checkbox"/>	no <input type="checkbox"/>

SECTION V ADJUSTMENT PROCEDURE

5-0 GENERAL

The adjustment procedure is divided into the following sections:

- | | |
|----------------------------------|-----------|
| 1. Power supply regulator | para. 5-1 |
| 2. Pre-adjustment | para. 5-2 |
| 3. Voltage Controlled Oscillator | para. 5-3 |
| 4. Shaper | para. 5-4 |
| 5. Width generator | para. 5-5 |

If the complete instrument needs to be recalibrated, it is recommended that the adjustments are made in the sequence as listed above.

If only a part of the instrument has to be recalibrated, for example after replacement of a faulty component on a board, the procedure should be started at the appropriate paragraph. Subsequent sections must be checked through and adjustments made if necessary. Checking and/or adjustment of values in previous sections is necessary only in the case of the Shaper board since it requires inputs from the VCO which might need to be adjusted for correct Shaper board calibration after repair or replacement.

NOTE the following points:

Allow the instrument a 15 minute warm-up time with closed cover. Keep cover closed between adjustments.

An adjustment points location diagram (Figure 5-4) is given at the end of this section.

All measurements are made at the 8111A output except:

- Power Supply output voltages
 - Control voltage for VCO
- which are made at special testpoints.

All specification of the 8111A apply with 50 Ohms load resistance, so ensure that the 8111A output is terminated with 50 Ohms during amplitude and transition time measurement.

5-1 POWER SUPPLY REGULATOR ADJUSTMENT

EQUIPMENT:
DVM

PROCEDURE

1. Connect DVM low terminal to ground (⏏) test point on board A2 and measure the output voltages at the other A2 test points.
2. Adjust +5V via A2 R5 for +5V ±10mV (TP+5V)
3. Adjust +15V via A2 R37 for +15V ±10mV (TP+15V)
4. Measure -5.2V. It should be -5.2V ±100mV (TP-5.2V)
 Measure -15V. It should be -15V +/- 750mV (TP-15V)
 Measure -23V. It should be -23V +/- 200mV (TP-23V)
 Measure +23V. It should be +23V +/- 200mV (TP+23V)

5-2 PRE-ADJUSTMENT

EQUIPMENT:

Oscilloscope, 50 Ohm feedthrough.

Waveform pre-adjustments

PROCEDURE

1. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM square
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) approx. 2kHz
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) approx. 8V
 AMPL ATTENUATOR released
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

2. Connect 8111A output to Scope. Make sure, that the output is terminated with 50 Ohms.
3. Adjust A6R50 to its mid-position then adjust A6R33 for symmetrical square wave output.
4. Adjust A8 R14 for optimal square wave on scope (minimum distortion).
5. Disconnect Shaper Board A6 from connector. Adjust A8 R55 for 0V ±1mV baseline offset.

Amplitude pre-adjustment

6. Reconnect A6.
7. Set 8111A :
AMPLITUDE (VERNIER) CW
8. Adjust A6 R6 for $16V \pm 500mV$ displayed on scope.
9. Set 8111A:
AMPLITUDE (VERNIER) CCW
Adjust A6R23 for symmetrical output.
10. Turn A6 R27 fully CCW then adjust for $1.6V \pm 100mV$.
11. Set 8111A :
AMPLITUDE (VERNIER) CW
12. If the amplitude is not $16V \pm 500mV$, repeat steps 8 to 11.
13. Set 8111A :
WAVEFORM Triangle
14. Adjust A5 R10 for $16V \pm 500mV$.

The amplitude of the triangle should be the same as the amplitude of the square.

5-3 VCO ADJUSTMENT

EQUIPMENT:

Counter, DVM, Fine adjustable Power Supply, Sampling scope, 20dB Attenuator (2W)

PROCEDURE

1. Set 8111A :

OPERATING MODE NORMAL
 WAVEFORM square
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) CW
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR -20dB
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

Fixed 50% Duty Cycle Adjustment

2. Set Counter: TIME INTERVAL A → B Slope A ↘ Slope B ↗
COM A, Trigger level 0V
If possible use an averaged TI measurement over 100 time intervals.
3. Connect 8111A output to Counter Input A.
4. Note value displayed by counter
5. Set Counter: Slope A ↘ Slope B ↗.
6. Adjust A5 R65 for same value as in 4.) $\pm 10ns$.

NOTE: This adjustment can also be made with the help of a spectrum analyser. For a 50% Duty Cycle the 2nd, 4th, etc., harmonics must disappear. This simplifies the minimizing of the difference between NORM and COMPL mode.

Frequency Adjustment For Variable Duty Cycle

7. Set Counter to PERIOD A. If possible use an averaged period-measurement over 100 periods.
8. Note value displayed by counter.
9. Set 8111A:

DUTY CYCLE MODE variable
 DUTY CYCLE (VERNIER) 40-60%

10. Adjust A5 R50 for same value (as in 8.) $\pm 100 ns$.

VCO Linearity adjustment

11. Set 8111A:

OPERATING MODE VCO
 WAVEFORM square
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) CW
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR -20dB
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

12. Connect DVM between A5 TP3 and TP4. The position of TP3 and TP4 is shown in Figure 5-1.

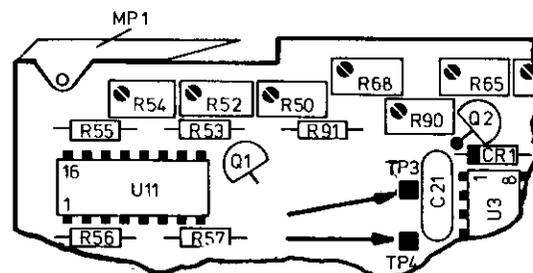


Figure 5-1.

Model 8111A

13. Connect 10V DC $\pm 50\text{mV}$ to EXT INPUT.
14. Note voltage between TP3 and TP4, displayed by the DVM
15. Connect 100mV DC $\pm 0.5\text{mV}$ to EXT INPUT.
16. Adjust A5 R90 for 1/100 of value (from 14.) on DVM.
17. Disconnect DVM from TP3/TP4.

Positive Slope Timing Linearity Adjustment

18. Set Counter: TIME INTERVAL A \rightarrow B Slope A \setminus Slope B \setminus
COM A, Trigger level 0V
19. Adjust A5 R86 for $5000\mu\text{s} \pm 20\mu\text{s}$.

Negative Slope Timing Linearity Adjustment

20. Set Counter: Slope A \setminus Slope B \setminus .
21. Adjust A5 R88 for $5000\mu\text{s} \pm 20\mu\text{s}$.
22. Disconnect the external voltage.

Frequency Adjustment (1Hz-1000kHz)

23. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM square
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) 10.00kHz
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR -20dB
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

24. Set Counter: FREQUENCY A.
Adjust A5 R54 for 10.00 kHz $\pm 0.1\text{kHz}$

Variable Duty Cycle Display Adjustment

25. Set 8111A:

DUTY CYCLE variable
 DUTY CYCLE VERNIER as required

26. Set Counter: TIME INTERVAL A \rightarrow B, Slope A \setminus Slope B \setminus
COM A, Trigger level 0V
If possible, use an averaged time interval measurement over at least 10 time intervals.
27. Adjust 8111A DUTY CYCLE VERNIER for $50\mu\text{s} \pm 0.1\mu\text{s}$ on counter.
28. Adjust A5 R68 for 50% duty cycle displayed by 8111A.

Overshoot & Transition Time

29. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM square
 FREQUENCY RANGE 1-10MHz
 FREQUENCY (VERNIER) approx 2MHz
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR released
 OFFSET (VERNIER) CCW
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE POS,NORM

30. Connect 8111A output to sampling scope as shown in Fig. 5-2

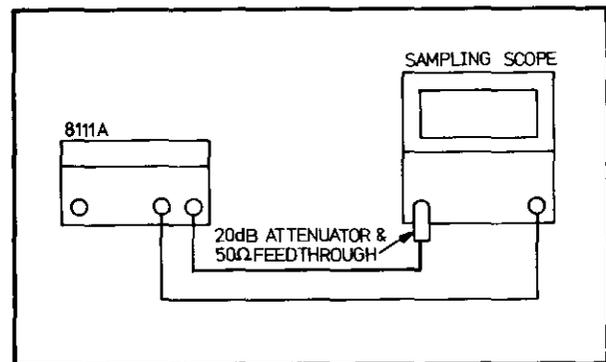


Figure 5-2

31. Adjust A8C14 for overshoot $\leq 5\%$.
32. Set 8111A:

OFFSET (VERNIER) CW
 OUTPUT MODE NEG,NORM

33. Check that overshoot $\leq 5\%$.

34. Set 8111A:

AMPLITUDE (VERNIER) CCW
 OFFSET (VERNIER) -7.2V
 OUTPUT MODE SYM,NORM

35. Check that transition times $\leq 10\text{nS}$.

Flatness

36. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM Triangle
 FREQUENCY RANGE 100-1000kHz
 FREQUENCY (VERNIER) approx 500kHz
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR released
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

37. Adjust Input Vernier of the Sampling scope for a 100% display of the waveform.

38. Set 8111A:

FREQUENCY RANGE 10-20 MHz
 FREQUENCY (VERNIER) CW

39. Adjust A5 R5 for low level -4%.
Adjust A5 R8 for high level -4%.**Frequency Adjustment (10-20MHz)**

40. Set 8111A:

FREQUENCY (VERNIER) 20MHz

41. Set Counter: FREQUENCY A.

42. Connect 8111A output to Counter Input A.

43. Adjust A5 C3 for 20 MHz ± 0.2 MHz.**Frequency Adjustment (1-10 MHz)**

44. Set 8111A:

FREQUENCY RANGE 1-10MHz
 FREQUENCY (VERNIER) 10.00MHz

45. Adjust A5 R52 for 10MHz ± 0.1 MHz.
Repeat 30-45 twice.**5-4 SHAPER ADJUSTMENT****EQUIPMENT:**

DVM, Lowpass filter as shown in Figure 5-3, Scope, Spectrum analyser (Distortion analyser)

PROCEDURE**Square Amplitude Adjustment**

1. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM square
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) CW
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR released
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

2. Set DVM to AC, 10V Range.

3. Connect 8111A output to DVM input.

4. Adjust A6 R24 for maximum amplitude

5. Set 8111A:

AMPLITUDE (VERNIER) 16.00V

Adjust A6 R50 to its center position.

6. Adjust A6 R6 for 8V ± 400 mV.**Square Normal/Complement Error**

7. Set DVM to DC, 10V Range. Use DVM built in filter function, otherwise use set-up as shown in Figure 5-3

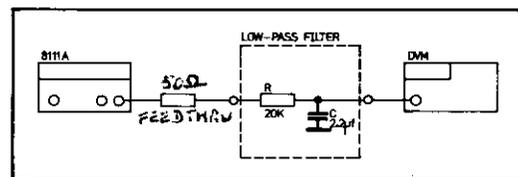


Figure 5-3

8. Change 8111A OUTPUT MODE from NORM to COMPL and back.

9. Check that the difference between NORM and COMPL does not exceed 10mV. If necessary adjust A6 R16 for minimum difference.

Symmetry Adjustment10. Adjust A6 R33 for 0V ± 10 mV.

11. Set 8111A:

AMPLITUDE VERNIER 1.60V

12. Adjust A6 R23 for 0V ± 10 mV.

Model 8111A

Minimum Amplitude Adjustment

- 13. Set DVM to AC, 10V Range.
- 14. Adjust A6 R27 for 825mV ±5mV

NOTE: Steps 6 and 14 are interdependent and must therefore be repeated until the values are within tolerance.

Triangle Amplitude Adjustment

- 15. Set 8111A:

WAVEFORM Triangle
 AMPLITUDE (VERNIER) 16.00V
 AMPL ATTENUATOR released
 OUTPUT MODE SYM,NORM

- 16. Set DVM to AC.
- 17. Adjust A5 R10 for 4.62V ±0.1V.

THD Adjustment

- 18. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM sine
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) 3kHz
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) 16.00V
 AMPL ATTENUATOR released
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM/COMPL
 as required

- 19. Connect 8111A to a spectrum analyser and adjust its input amplifier so that the fundamental equals 0dB on display.
- 20. Adjust A6R10/R17 for THD < 1% for NORM and COMPL modes. Ensure that minimum difference exists between the corresponding harmonic values in each mode, i.e. the 2nd harmonic value in NORM should be as close as possible to the 2nd harmonic in COMPL etc.
 A6 R10 varies the 2nd harmonic. It should be <45dB
 A6 R17 varies the 3rd harmonic. It should be <47dB
 NOTE: For this adjustment, the use of a distortion analyser enables a direct readout of the THD percentage value.

Sine Amplitude Adjustment

- 21. Connect 8111A output to DVM input.
- 22. Set DVM to AC, 10V Range
- 23. Adjust A6 R18 for 5.66V±0.2V.

Triangle Normal/Complement Error

- 24. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM Triangle
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) CW
 DUTY CYCLE fixed 50%
 AMPLITUDE (VERNIER) 16.00V
 AMPL ATTENUATOR released
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

- 25. Set DVM to DC, 10V Range. Use built-in filter or set-up as shown in Figure 5-3•
- 26. Change output mode from NORM to COMPL and back.
- 27. Adjust A6 R15 for minimum difference between NORM and COMPL output mode

Sine Normal/Complement Error

- 28. Set 8111A:

WAVEFORM Sine

- 29. Change output mode from NORM to COMPL and back.
- 30. Adjust A6 R14 for minimum difference between NORM and COMPL output mode.
 If difference >100mV, adjust A6R50 for <40mV difference and repeat the the procedure for Square Normal/Compl Error and Triangle Normal /Compl Error. Check again for minimum (>100mV) difference in Sine Normal/Compl Error.

POS/NEG-Baseline Adjustment

- 31. Set 8111A:

WAVEFORM SQUARE
 AMPLITUDE (VERNIER) CCW
 AMPL ATTENUATOR -20dB
 OUTPUT MODE NORM, POS/NEG as required

- 32. Connect 8111A output to scope input.
- 33. Set Scope to 0.02V/Division.
- 34. Adjust A6 R36 for minimum baseline difference between POS and NEG output mode.

5-5 WIDTH ADJUSTMENT

EQUIPMENT:

Counter

1. Set 8111A:

OPERATING MODE NORMAL
 WAVEFORM Pulse
 FREQUENCY RANGE 1-10kHz
 FREQUENCY (VERNIER) 5kHz
 WIDTH RANGE 10-100 μ s
 WIDTH VERNIER 40.0 μ s
 AMPLITUDE (VERNIER) CW
 AMPL ATTENUATOR -20dB
 OFFSET (VERNIER) 0V
 OFFSET ATTENUATOR released
 OUTPUT ATTENUATOR released
 OUTPUT MODE SYM, NORM

2. Set Counter: TIME INTERVAL A \rightarrow B Slope A \nearrow Slope B \searrow COM A Trigger level 0V

If possible use an averaged TI- measurement over at least 10 time intervals.

3. Set A4 R34 to its mid position.
4. Adjust A4 R41 for 40 μ s \pm 0,4 μ s.
5. Set 8111A:

WIDTH RANGE 100-1000ns
 WIDTH (VERNIER) 400ns

4. Adjust A4 C1 for 400ns \pm 4ns.
7. Set 8111A:

WIDTH RANGE 25-100ns
 WIDTH (VERNIER) 100.0ns

8. Connect 8111 A OUTPUT to a sampling scope
 (use 20dB attenuator)

9. Adjust A4 R34 for 100ns \pm 2ns.

10. Set 8111A:

WIDTH (VERNIER) 25.0ns

11. Check pulse width for 25ns \pm 2ns

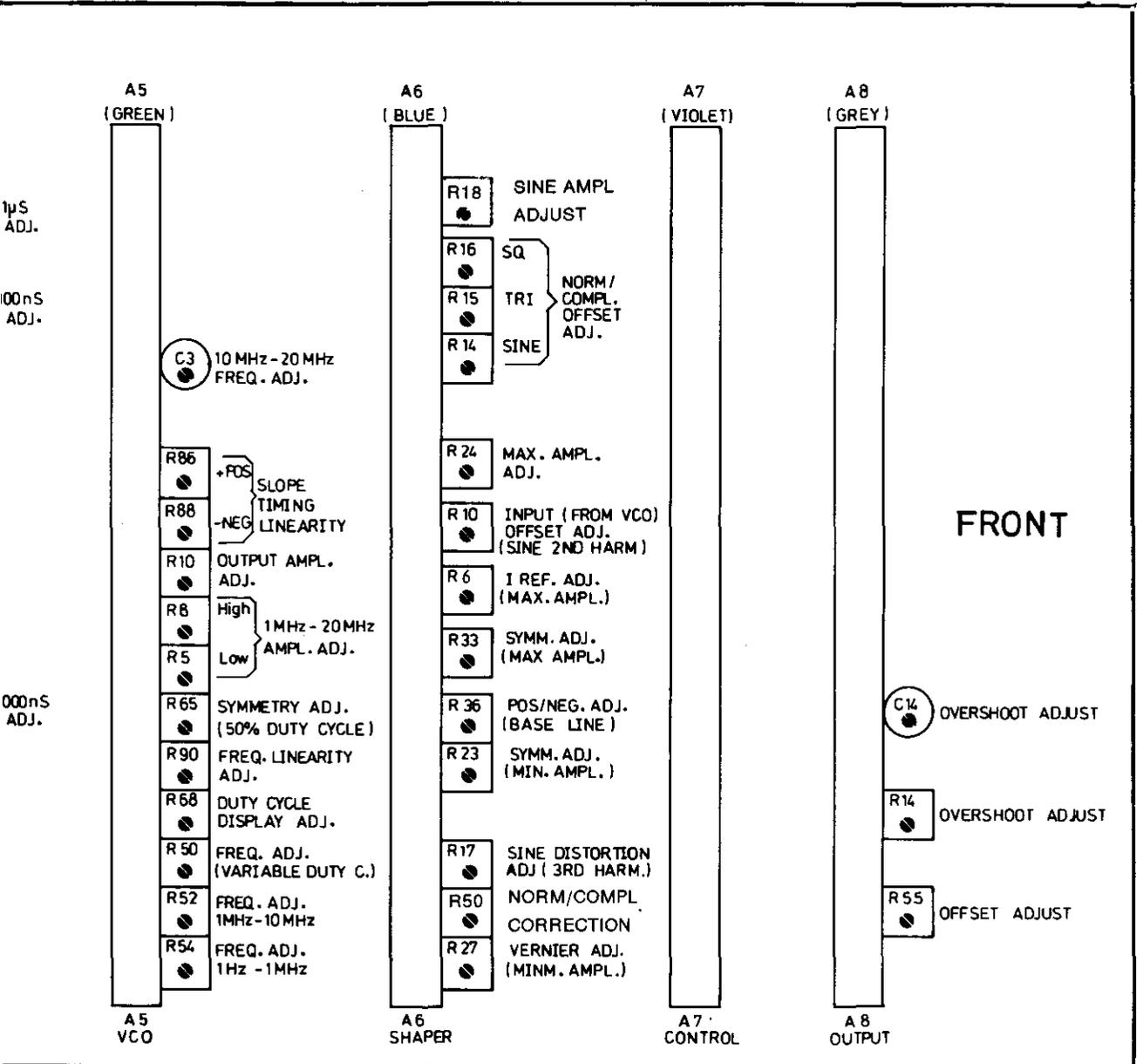
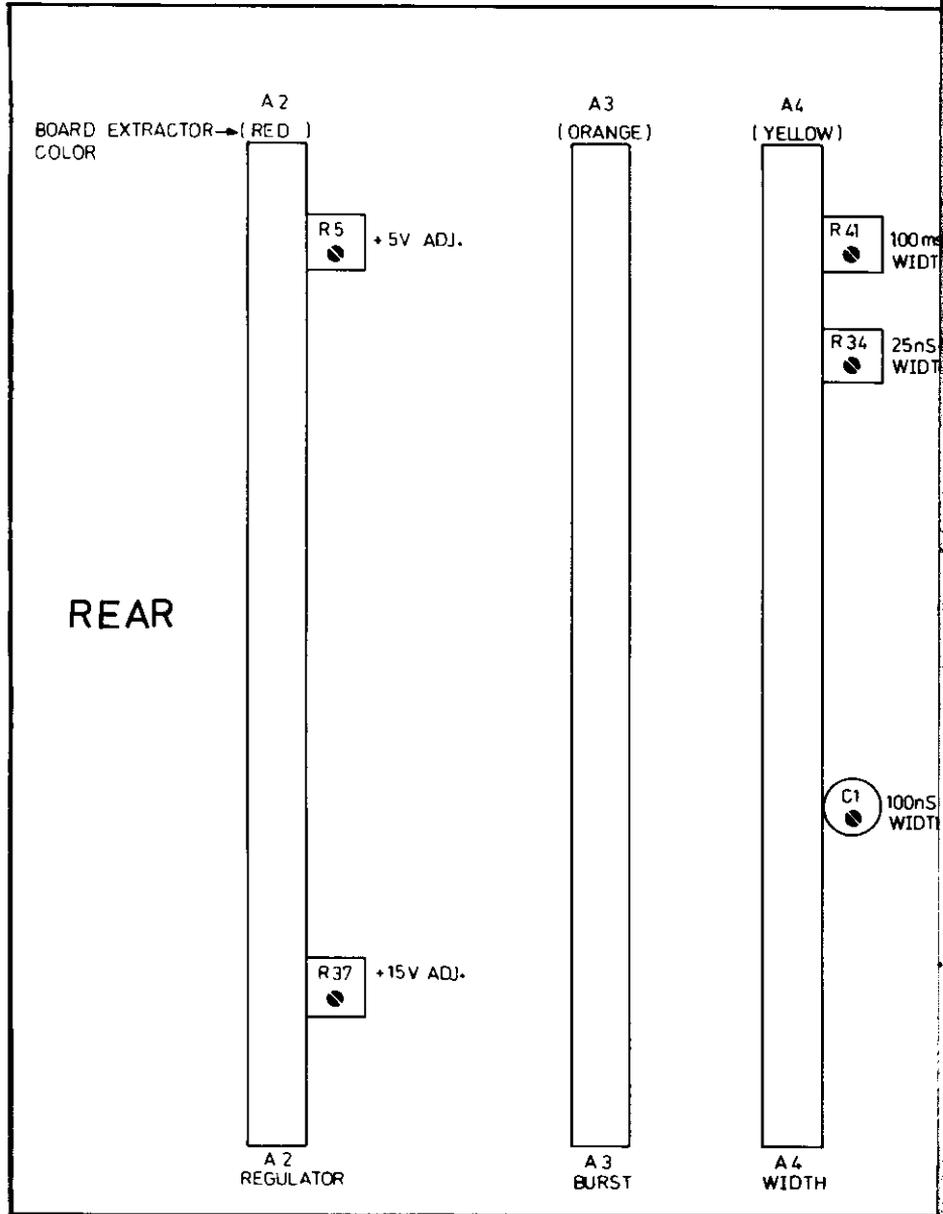


Figure 5-2. Adjustments point location diagram



SECTION VI REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts lists and elsewhere in the manual. Table 6-2 contains the names and addresses that correspond to the manufacturer code numbers. Table 6-3 lists all replaceable parts in reference designator order.

6-3 ABBREVIATIONS

6-4 Table 6-1 lists abbreviations used in the parts lists, schematics and elsewhere in the manual. In some cases two forms of the abbreviations are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts lists are always all capitals. However, in the schematics and other parts of the manual, the same abbreviations may have upper and lower case letters.

6-5 REPLACEABLE PARTS

6-6 Table 6-3 is the list of replaceable parts and is organised as follows:

- a. Mainframe (chassis) parts in alphanumerical order by reference designation.
- b. Electrical assemblies and their components in alpha-numerical order by reference designation.

Reference designators are of the form A5R9 i.e. resistor 9 assembly 5. The blue pages at the end of this section list the parts required for Option 001.

6-7 The information given for each part consists of the following:

- a. The Hewlett-Packard part number.
- b. The description of the part.
- c. Part number check digit (CD).

6-8 ORDERING INFORMATION

6-9 To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number (with check digit), indicate the quantity required, and address the order to the nearest Hewlett-Packard office (list of Sales/Service offices at the rear of this manual). The check digit will ensure accurate and timely processing of your order.

6-10 To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required, address the order to the nearest Hewlett-Packard office.

6-11 DIRECT MAIL ORDER SYSTEM (USA)

6-12 Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are as follows:

- a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.
- b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).
- c. Prepaid transportation (there is a small handling charge for each order).
- d. No invoices — to provide these advantages, a check or money order must accompany each order.

6-13 Mail order forms and specific ordering information is available through your local HP office. Addresses and phone numbers are located at the back of this manual.

Table 6-1. Abbreviations for Replaceable Parts List

REFERENCE DESIGNATIONS

A assembly	E miscellaneous electrical part	P electrical connector (movable portion); plug	VR voltage regulator; breakdown diode
AT attenuator; isolator; termination	F fuse	Q transistor: SCR; triode thyristor	W cable; transmission path; wire
B fan; motor	FL filter	R resistor	X socket
BT battery	H hardware	RT thermistor	Y crystal unit (piezo-electric or quartz)
C capacitor	HY circulator	S switch	Z tuned cavity; tuned circuit
CP coupler	J electrical connector (stationary portion); jack	T transformer	
CR diode; diode thyristor; varactor	K relay	TB terminal board	
DC directional coupler	L coil; inductor	TC thermocouple	
DL delay line	M meter	TP test point	
DS annunciator; signaling device (audible or visual); lamp; LED	MP miscellaneous mechanical part	U integrated circuit; microcircuit	
		V electron tube	

ABBREVIATIONS

A ampere	CW continuous wave	h hour	MET OX metallic oxide
ac alternating current	cw clockwise	HET heterodyne	MF medium frequency; microfarad (used in parts list)
ACCESS accessory	cm centimeter	HEX hexagonal	MFR manufacturer
ADJ adjustment	D/A digital-to-analog	HD head	mg milligram
A/D analog-to-digital	dB decibel	HDW hardware	MHz megahertz
AF audio frequency	dBm decibel referred to 1 mW	HF high frequency	mH millihenry
AFC automatic frequency control	dc direct current	HG mercury	mho mho
AGC automatic gain control	deg degree (temperature interval or difference)	HI high	MIN minimum
AL aluminum	° degree (plane angle)	HP Hewlett-Packard	min minute (time)
ALC automatic level control	°C degree Celsius (centigrade)	HPF high pass filter	. . . . . minute (plane angle)
AM amplitude modulation	°F degree Fahrenheit	HR hour (used in parts list)	MINAT miniature
AMPL amplifier	°K degree Kelvin	HV high voltage	mm millimeter
APC automatic phase control	DEPC deposited carbon	Hz Hertz	MOD modulator
ASSY assembly	DET detector	IC integrated circuit	MOM momentary
AUX auxiliary	diam diameter	ID inside diameter	MOS metal-oxide semiconductor
avg average	DIA diameter (used in parts list)	IF intermediate frequency	ms millisecond
AWG American wire gauge	DIFF AMPL differential amplifier	IMPG impregnated	MTG mounting
BAL balance	div division	IN inch	MTR meter (indicating device)
BCD binary coded decimal	DPDT double-pole, double-throw	INCD incandescent	mV millivolt
BD board	DR drive	INCL include(s)	mVac millivolt, ac
BE CU beryllium copper	DSB double sideband	INP input	mVdc millivolt, dc
BFO beat frequency oscillator	DTL diode transistor logic	INS insulation	mVpk millivolt, peak
BH binder head	DVM digital voltmeter	INT internal	mVp-p millivolt, peak-to-peak
BKDN breakdown	FCL emitter coupled logic	INTE inductance-capacitance	mVrms millivolt, rms
BP bandpass	EMF electromotive force	LED light-emitting diode	mW milliwatt
BPF bandpass filter	EDP electronic data processing	LF low frequency	MUX multiplex
BRS brass	ELECT electrolytic	LG long	MY mylar
BWO backward-wave oscillator	ENCAP encapsulated	LH left hand	μA microampere
CAL calibrate	EXT external	LIM limit	μF microfarad
ccw counter-clockwise	F farad	LIN linear taper (used in parts list)	μH microhenry
CER ceramic	FET field-effect transistor	lin linear	μmho micromho
CHAN channel	F/F flip-flop	LK WASH lock washer	μs microsecond
cm centimeter	FH flatt head	LO low; local oscillator	μV microvolt
CMO cabinet mount only	FIL H fillister head	LOG logarithmic taper (used in parts list)	μVac microvolt, ac
COAX coaxial	FM frequency modulation	log logarithm(ic)	μVdc microvolt, dc
COEF coefficient	FP front panel	LPF low pass filter	μVp-p microvolt, peak-to-peak
COM common	FREQ frequency	LV low voltage	μVrms microvolt, rms
COMP composition	FXD fixed	m meter (distance)	μW microwatt
COMPL complete	g gram	mA milliampere	nA nanoampere
CONN connector	GE germanium	MAX maximum	NC no connection
CP cadmium plate	GHz gigahertz	MΩ megohm	N/C normally closed
CRT cathode-ray tube	GL glass	MEG meg (10 ⁶) (used in parts list)	NE neon
CTL complementary transistor logic	GRD ground(ed)	MET FLM metal film	NEG negative
	H henry		nF nanofarad
			NI PL nickel plate
			N/O normally open
			NOM nominal

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-1. Abbreviations for Replaceable Parts List (cont'd)

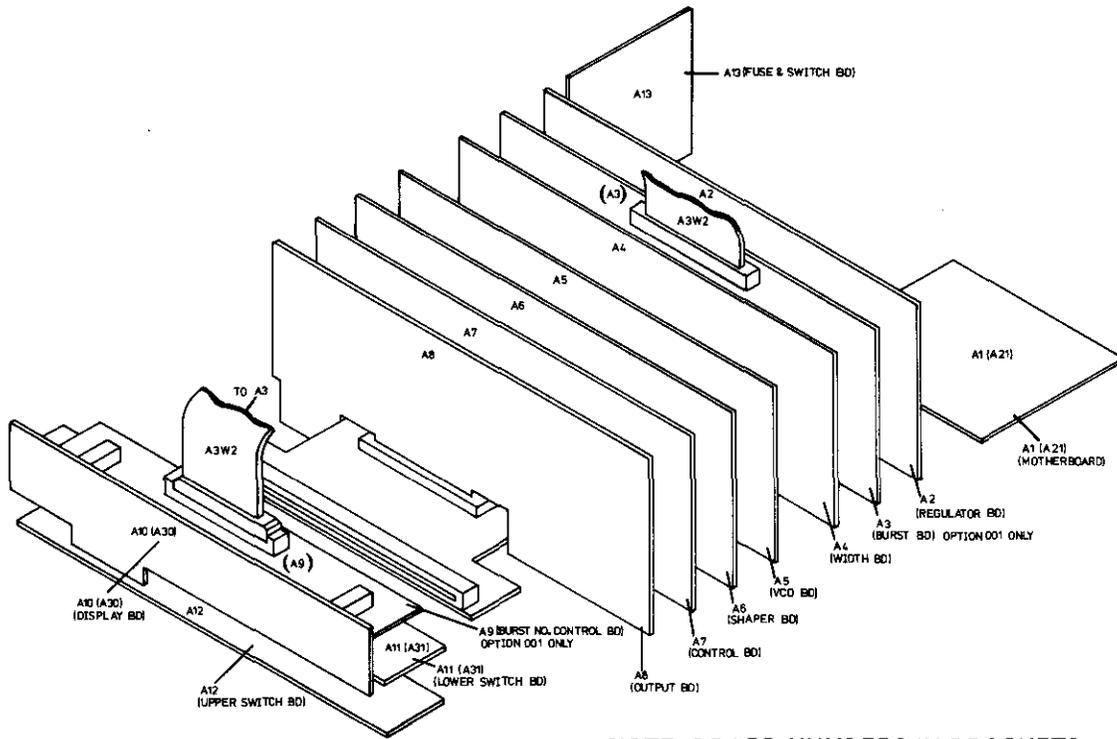
NORM normal	POT potentiometer	SI silicon	VFO variable-frequency oscillator
NPN negative-positive-negative	p-p peak-to-peak	SIL silver	VHF very-high frequency
NPO negative-positive zero (zero temperature coefficient)	PP peak-to-peak (used in parts list)	SL slide	Vpk volts, peak
NRFR not recommended for field replacement	PPM pulse-position modulation	SNR signal-to-noise ratio	Vp-p volts, peak-to-peak
NSR not separately replaceable	PREAMPL preamplifier	SPDT single-pole, double-throw	Vrms volts, rms
ns nanosecond	PRF pulse-repetition frequency	SPG spring	VSWR voltage standing wave ratio
nW nanowatt	PRR pulse repetition rate	SR split ring	VTO voltage-tuned oscillator
OBD order by description	ps picosecond	SPST single-pole, single-throw	VTVM Vacuum-tube voltmeter
OD outside diameter	PT point	SSB single sideband	V(X) volts, switched
OD outside diameter	PTM pulse-time modulation	SST stainless steel	W watt
OH oval head	PWM pulse-width modulation	STL steel	W with
OP AMPL operational amplifier	PWV peak working voltage	SQ square	WIV working inverse voltage
OPT option	RC resistance-capacitance	SWR standing-wave ratio	WW wirewound
OSC oscillator	RECT rectifier	SYNC synchronize	W/O without
OX oxide	REF reference	T timed (slow-blow fuse)	YIG yttrium-iron garnet
oz ounce	REG regulated	TA tantalum	Z ₀ characteristic impedance
Ω ohm	REPL replaceable	TC temperature compensating	
P peak (used in parts list)	RF radio frequency	TD time delay	
PAM pulse-amplitude modulation	RFI radio frequency interference	TERM terminal	
PC printed circuit	RH round head; right hand	TFT thin-film transistor	
PCM pulse-code modulation; pulse-count modulation	RLC resistance-inductance-capacitance	TGL toggle	
PDM pulse duration modulation	RMO rack mount only	THD thread	
pF picofarad	rms root-mean-square	THRU through	
PH BRZ phosphor bronze	RND round	TI titanium	
PHL Phillips	ROM read-only memory	TOL tolerance	
PIN positive-intrinsic-negative	R&P rack and panel	TRIM trimmer	
PIV peak inverse voltage	RWV reverse working voltage	TSTR transistor	
pk peak	S scattering parameter	TTL transistor-transistor logic	
PL phase lock	s second (time)	TV television	
PLO phase lock oscillator	s second (plane angle)	TVI television interference	
PM phase modulation	S-B slow-blow (fuse) (used in parts list)	TWT traveling wave tube	
PNP positive-negative-positive	SCR silicon controlled rectifier; screw	U micro (10 ⁶) (used in parts list)	
P/O part of	SE selenium	UF microfarad (used in parts list)	
POLY polystyrene	SECT sections	UHF ultrahigh frequency	
PORC porcelain	SEMICON semiconductor	UNREG unregulated	
POS positive; position(s) (used in parts list)	SHF superhigh frequency	V volt	
POSN position		VA voltampere	
		Vac volts, ac	
		VAR variable	
		VCO voltage controlled oscillator	
		Vdc volts, dc	
		VDCW volts, dc, working (used in parts list)	
		V(F) volts, filtered	

MULTIPLIERS

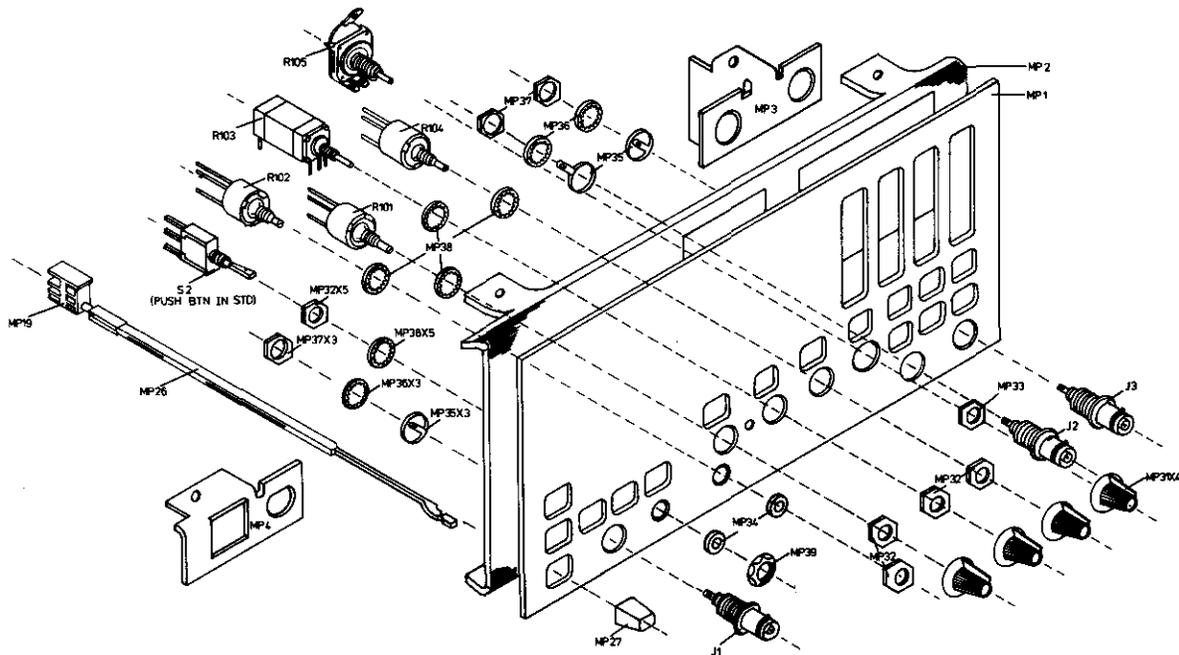
Abbreviation	Prefix	Multiple
T	tera	10 ¹²
G	giga	10 ⁹
M	mega	10 ⁶
k	kilo	10 ³
da	deka	10
d	deci	10 ⁻¹
c	centi	10 ⁻²
m	milli	10 ⁻³
μ	micro	10 ⁻⁶
n	nano	10 ⁻⁹
p	pico	10 ⁻¹²
f	femto	10 ⁻¹⁵
a	atto	10 ⁻¹⁸

NOTE

All abbreviations in the parts list will be in upper-case.



NOTE: BOARD NUMBERS IN BRACKETS e.g. (A30) ARE APPLICABLE TO OPTION 001 ONLY. A10 & A11 (A30 & A31) ARE SUB-ASSEMBLIES OF A40 & A41 RESPECTIVELY.



NOTE: DETAILS ON REMOVAL OF THE COMPLETE FRONT PANEL ASSEMBLY ARE GIVEN IN SERVICE BLOCK 3 (DISPLAY).

Figure 6-1. Frame Parts and Board Identification Diagram (Instrument shown with Option 001 fitted)

Table 6-3. Replaceable Parts

REFERENCE DESIGNATOR	C D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C D	H-P PART NUMBER	DESCRIPTION
FRAME							
A1	0	08111-66501	BD AY-MOTHER	MP40	8	08111-00606	SHIELD FUSE
A2	1	08111-66502	BD AY-REGULATOR	MP42	3	0340-1041	INSULATOR
A4	3	08111-66504	BD AY-WIDTH GEN	MP43	8	3101-0851	CAP PUSH BUTTON
A5	4	08111-66505	BD AY VCO				
A6	5	08111-66506	BD AY SHAPER	Q3	6	1853-0212	XSTR 2N5194 SI
A7	6	08111-66507	BD AY-CONTROL	Q4	5	1854-0368	XSTR 2N5191
A8	7	08111-66508	BD AY-OUTPUT	Q7	6	1853-0212	XSTR 2N5194 SI
A10	1	08111-66510	BD AY-DISPLAY	Q8	5	1854-0368	XSTR 2N5191
A11	2	08111-66511	BD AY-SWITCH UPR	R1	4	0698-8827	R-F 1M 1% .125W
A12	3	08111-66512	BD AY-SWITCH LOW	R101	0	2100-3959	R-VAR 5K 20%
A13	4	08111-66513	BD AY-SW & FUSE	R102	3	2100-3960	R-VAR 5K 20%
C1	8	0160-4323	C-F 0.047UF 20%	R103	8	2100-3981	R-VAR 10K 10%
F1	1	2110-0202	FUSE .5A 250V	R104	9	2100-3958	R-VAR 1K 20%
F2	0	2110-0201	FUSE 250V .25A SB	R105	2	2100-3977	R-VAR 10K 20%
J1	3	1250-0118	CONN BNC BLKHD	S2	6	3101-1261	SW PBTN SPDT
J2	3	1250-0118	CONN BNC BLKHD	T1	6	08111-61101	XFMR-PWR
J3	3	1250-0118	CONN BNC BLKHD	W1	1	08111-61601	CBL AY SIG OUT
L1	5	9170-0013	CORE FERRA .375	W2	2	08111-61602	CBL AY TRIG OUT
L2	5	9170-0013	CORE FERRA .375				
L3	5	9170-0013	CORE FERRA .375				
MP1	1	4040-1968	PANEL FRONT				
MP2	9	08111-00201	PANEL SUB				
MP3	8	08111-01208	BRACKET-SUB-PNL				
MP4	9	08111-01209	BRACKET-SUB PNL				
MP6	1	08111-01201	BRKT-FRONT				
MP7	2	08111-01202	BRKT-BOTTOM				
MP8	4	08111-01204	BRKT-POWER				
MP9	5	08111-01205	BRKT-XFMR				
MP10	6	08111-01206	BRKT-SIDE LEFT				
MP11	7	08111-01207	BRKT-SIDE RIGHT				
MP12	5	08111-02302	HT-SNK-XSTR				
MP13	8	08111-02305	HT-SNK OUT HLDR				
MP14	6	08111-04101	<u>COVER TOP</u>				
MP15	7	08111-04102	COVER BOTTOM				
MP16	2	08111-21101	HEATSINK REAR				
MP17	8	5020-8813	FRAME FRONT				
MP18	9	08116-21103	FRM REAR(MODIFY)				
MP19	5	5040-1135	COUPLER PWR SW				
MP20	7	5001-0438	TRIM STRIP				
MP22	9	5020-8830	SIDE STRUTS				
MP23	8	5040-7201	FOOT				
MP24	0	5040-7203	TRIM STRIP				
MP25	3	5040-7222	RR FEET NON-SKID				
MP26	3	5040-9301	PUSH ROD-SW				
MP27	9	5040-9323	KEY CAP QUARTER				
MP28	7	8120-1689	GERMAN PWR CORD				
MP29	5	1460-1345	TILT STAND				
MP30	0	08111-00202	PANEL REAR				
MP31	2	0370-1005	KNOB BASE PTR				
MP32	3	2950-0072	NUT HEX .25-32				
MP33	7	0535-0036	NUT HEX M7X0.75				
MP34	8	08111-22501	RING				
MP35	5	0360-1190	TERM-LUG SLDR				
MP36	3	2190-0016	WASH-LOCK INT3/8				
MP37	8	2950-0043	NUT-HEX .375-32				
MP38	4	2190-0067	WASH-LOCK .408ID				
MP39	1	0590-0836	NUT 1/4-40				

NOTE: A10 & A11 ARE SUB-ASSEMBLIES OF A40 (08111-66540) AND ARE NOT SEPARATELY AVAILABLE.

dedicated -4111 1984 / wire fuse -4171 1987

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A1			08111-66501	BD AY-MOTHER	A2	Q1	2	1853-0036	XSTR SI 2N3906
A1	C1		0180-3158	C-F ELCO 6800UF	A2	Q2	2	1853-0036	XSTR SI 2N3906
A1	C2		0180-3162	C-F ELCO 4700UF	A2	Q5	1	1854-0215	XSTR SI 2N3904
A1	C3		0180-3161	C-F ELCO 3300VF	A2	Q6	2	1853-0036	XSTR SI 2N3906
A1	C4		0180-3161	C-F ELCO 3300VF	A2	Q9	1	1854-0637	XSTR SI 2219A
A1	CR1	3	1901-0638	DIO AY-SI 100V	A2	Q10	9	1853-0314	XSTR 2N2905A PNP
A1	CR2	7	1906-0096	DIO-FULL WAVE BR	A2	R1	5	0757-0349	R-F 22.6K1%
A1	J1	7	1251-3825	CONNECTOR, 5 PIN	A2	R2	0	0698-4483	R-F 18.7K1%
A1	J2	8	1251-2026	CONN PC 36CONT R	A2	R3	9	0698-4458	R-F 590 1% .125W
A1	J4	8	1251-2026	CONN PC 36CONT R	A2	R4	2	0698-3495	R-F 866 1% .125W
A1	J5	8	1251-2026	CONN PC 36CONT R	A2	R5	2	2100-3349	R-VAR 100 +-10%
A1	J6	8	1251-2026	CONN PC 36CONT R	A2	R6	2	0698-4401	R-F 95.3 1%
A1	J7	8	1251-2026	CONN PC 36CONT R	A2	R7	5	0698-3456	R-F 287K1% .125W
A1	J8	8	1251-2026	CONN PC 36CONT R	A2	R8	7	0757-0200	R-F 5.62K1%
A1	J12		1251-7456	CONN 25 CONT	A2	R9	6	0698-4520	R-F 143K1% .125W
A1	R12	1	0757-0197	R-F 1.5K1% .5W	A2	R10	2	0757-0453	R-F 30.1K1% .125W
A1	R13	1	0757-0197	R-F 1.5K1% .5W	A2	R14	8	0757-0178	R-F 100 1% .25W
A1	R20	6	0812-0045	R-F .15 5% 3W	A2	R15	8	0757-0178	R-F 100 1% .25W
A1	R21	6	0812-0045	R-F .15 5% 3W	A2	R16	2	0757-0411	R-F 332 1% .125W
A1	R25	9	0757-0731	R-F 825 1% .25W	A2	R17	6	0698-3499	R-F 40.2K1%
A1	R28	9	0757-0731	R-F 825 1% .25W	A2	R18	6	0698-3499	R-F 40.2K1%
A1	R31	4	0811-2455	R-F 2 1% 3W	A2	R19		0698-4421	R-F 249 1% .125W
A1	R32	4	0811-2455	R-F 2 1% 3W	A2	R22	9	0698-3153	R-F 3.83K1%
A1	R39	3	0757-0280	R-F 1K1% .125W F	A2	R23	4	0698-4502	R-F 64.9K1%
A1	R40	3	0757-0280	R-F 1K1% .125W F	A2	R24	2	0698-6887	R-F 20.8K 5%
A1	R41	3	0757-0280	R-F 1K1% .125W F	A2	R26	0	0757-0401	R-F 100 1% .125W
A1	R42	3	0757-0280	R-F 1K1% .125W F	A2	R27	0	0757-0401	R-F 100 1% .125W
					A2	R29	7	0698-8961	R-F 909K 1% .125
					A2	R30	6	0698-8704	R-F 665K
					A2	R33	7	0698-4521	R-F 154K1% .125W
					A2	R34	9	0698-8038	R-F 5.9K K%
A2			08111-66502	BD AY-REGULATOR	A2	R35	2	0698-3247	R-F 4.53K.25%
A2	C5	6	0180-0228	C-F 22UF 15V	A2	R36	0	0757-0401	R-F 100 1% .125W
A2	C6	1	0160-3724	C-F .47UF 40V	A2	R37	5	2100-3350	R-VAR 200 10%
A2	C7		0180-3163	C-F 220UF 10V AL	A2	R38	3	0757-0280	R-F 1K1% .125W F
A2	C9	8	0160-4365	C-F 470PF 5%	A2	R40		1810-0567	R-NETWORK 8X20K
A2	C11	3	0160-2306	CAP 27PF 5% 300V	A2	R41	3	1810-0037	R-NETWORK DIP
A2	C12	5	0180-2207	C-F 100UF 10V	A2	U1	7	1826-0161	IC-LM 324N
A2	C14	0	0140-0193	C-F 82PF 300V	A2	U2	7	1826-0161	IC-LM 324N
A2	C15		0180-3156	C-F ELCO 47UF63V	A2	U3	9	1826-0147	IC V RGLTR
A2	C17	3	0140-0196	C-F 150PF 300V	A2	U4	6	1826-0277	IC LM 320 V RGLT
A2	C18		0180-3156	C-F ELCO 47UF63V	A2	VR1	7	1902-0680	DIO 6.2V 5% .25W
A2	C20	3	0180-0291	C-F 1UF 35V	A2	VR2	8	1902-0962	DIODE,ZENER
A2	CR3	1	1901-1098	DIO-SWIT.1N4150	A2	VR3	8	1902-0962	DIODE,ZENER
A2	CR4	1	1901-1098	DIO-SWIT.1N4150					
A2	CR5	1	1901-1098	DIO-SWIT.1N4150	A4			08111-66504	BD AY-WIDTH GEN
A2	CR6	1	1901-1098	DIO-SWIT.1N4150	A4	C1	6	0121-0165	C-VAR 7-25PF
A2	CR7	1	1901-1098	DIO-SWIT.1N4150	A4	C2	3	0160-3875	C-F 22PF 5% 200V
A2	CR8	1	1901-1098	DIO-SWIT.1N4150	A4	C3	2	0160-2454	C-F 620PF 300V
A2	CR9	1	1901-1098	DIO-SWIT.1N4150	A4	C4	7	0160-4348	C-F 6800PF 100V
A2	CR10	1	1901-1098	DIO-SWIT.1N4150	A4	C5	9	0160-4580	C-F .068UF 1%
A2	CR11	1	1901-1098	DIO-SWIT.1N4150	A4	C6	4	0160-4577	C-F .68UF 1% 40V
A2	CR12	1	1901-1098	DIO-SWIT.1N4150	A4	C7	2	0160-4575	C-F 6.8UF 2% 40V
A2	CR13	1	1901-1098	DIO-SWIT.1N4150	A4	C8	9	0160-0174	C-F .47UF 25VCER
A2	CR14	1	1901-1098	DIO-SWIT.1N4150	A4	C9	9	0160-0174	C-F 47UF 25VCER
A2	MP1	3	4040-0748	PC EXTR BD BLK	A4	C10	3	0160-4386	C-F 33PF 5% 200V
A2	MP2	7	4040-0750	PC EXTR BD RED					
A2	MP3		1205-0295	HEAT-SINK					
A2	MP4		1205-0295	HEAT-SINK					

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A4	C11	7	0160-3879	C-F .01UF 100V	A4	R31	5	0698-4123	R-F 499 1% .125W
A4	C12	9	0160-0174	C-F .47UF 25VCER	A4	R32	0	0757-0401	R-F 100 1% .125W
A4	C13	5	0160-0576	C-F .1UF 20% CER	A4	R33	5	0757-0290	R-F 6.19K1%
A4	C14	1	0180-0116	C-F 6.8UF 35V TA	A4	R34	5	2100-3350	R-VAR 200 10%
A4	C15	7	0160-3879	C-F .01UF 100V	A4	R35	9	0757-0418	R-F 619 1% .125W
A4	C16	5	0160-0576	C-F .1UF 20% CER	A4	R36	9	0757-0442	R-F 10K1% .125W
A4	C17	3	0180-0291	C-F 1UF 35V	A4	R37	9	0757-0442	R-F 10K1% .125W
A4	C18	4	0160-4527	C-F 56PF 5% 200V	A4	R39	3	0698-4428	R-F 1.69K1%
A4	C19	5	0160-0576	C-F .1UF 20% CER	A4	R40	0	0698-4433	R-F 2.26K1%
A4	C21	5	0160-0576	C-F .1UF 20% CER	A4	R41	1	2100-3273	R-VAR 2K 10%
A4	C22	5	0160-0576	C-F .1UF 20% CER	A4	R42	5	0757-0274	R-F 1.21K1%
A4	CR2	8	1901-0047	DIO SI 20V 10NS	A4	R43	0	0698-3245	R-F 20.5K1%
A4	CR3	1	1901-1098	DIO-SWIT.1N4150	A4	R44	3	0757-0438	R-F 5.11K1%
A4	CR4	1	1901-1098	DIO-SWIT.1N4150	A4	R45	9	0698-0084	R-F 2.15K 1% .125
A4	CR5	1	1901-1098	DIO-SWIT.1N4150	A4	R47	9	0757-0442	R-F 10K1% .125W
A4	CR8	1	1901-1098	DIO-SWIT.1N4150	A4	R55	7	0698-3432	R-F 26.1 1%
A4	CR9	1	1901-1098	DIO-SWIT.1N4150	A4	R57	3	0698-4014	R-F 787 1% .125W
A4	CR10	1	1901-1098	DIO-SWIT.1N4150	A4	R60	9	0757-0442	R-F 10K1% .125W
A4	CR11	1	1901-1098	DIO-SWIT.1N4150	A4	R62	6	0757-0465	R-F 100K1% .125W
A4	CR12	7	1901-0179	DIO SI 15V .75NS	A4	R63	4	0757-0405	RES 162 1% .125W
A4	L1	0	9100-2251	COIL-CHOKE .22UH	A4	U1	7	1826-0111	IC-DUAL OP AMPL
A4	MP1	3	4040-0748	PC EXTR BD BLK	A4	U2	7	1826-0111	IC-DUAL OP AMPL
A4	MP2	9	4040-0752	PC EXTR BD YEL	A4	U3	7	1826-0161	IC-LM 324N
A4	Q1	2	1854-0795	XSTR MPS-H10	A4	U4	7	1826-0161	IC-LM 324N
A4	Q2	2	1854-0795	XSTR MPS-H10	A4	U5	3	1820-1216	IC-SN74LS138
A4	Q3	2	1854-0795	XSTR MPS-H10	A4	U6	1	1820-0802	IC-ECL 10102
A4	Q4	2	1853-0036	XSTR SI 2N3906	A4	U7	8	1820-0817	IC DGTL MC 10131
A4	Q5	2	1853-0036	XSTR SI 2N3906	A4	U8	3	1826-0026	IC-DGTL LM311H
A4	Q6	2	1853-0036	XSTR SI 2N3906	A4	VR1	6	1902-0944	DIODE-ZENER
A4	Q7	2	1853-0036	XSTR SI 2N3906	A4	VR2	2	1902-0958	DIO ZNR 10V 5%
A4	Q8	2	1853-0036	XSTR SI 2N3906					
A4	Q9	2	1853-0036	XSTR SI 2N3906					
A4	Q10	7	1853-0354	XSTR MPS H81					
A4	Q11	7	1853-0354	XSTR MPS H81	A5			08111-66505	BD AY VCO
A4	Q14	2	1853-0036	XSTR SI 2N3906	A5	C1	0	0160-4383	C-F 6.8PF 200V
A4	Q15	7	1853-0354	XSTR MPS H81	A5	C2	8	0160-4521	C-F 12PF 5% 200V
A4	R1	6	0757-0407	R-F 200 1% .125W	A5	C3	6	0121-0165	C-VAR 7-25PF
A4	R2	9	0698-3442	R-F 237 1% .125W	A5	C4	1	0160-4318	C-F 330PF 1%
A4	R3	8	0757-0417	R-F 562 1% .125W	A5	C5	9	0160-2675	C-F 3900PF 300V
A4	R4	2	0698-3437	R-F 133 1% .125W	A5	C6		0160-5423	C-F .039UF 2%
A4	R5	9	0757-0278	R-F 1.78K1%	A5	C7		0160-5425	C-F .39UF 2% 40V
A4	R6	8	0757-0433	R-F 3.32K1%	A5	C8		0160-5460	C-F 3.9UF 63VDC
A4	R7	0	0698-4425	R-F 1.54K1%	A5	C10	9	0180-0354	C-F 40UF 10V
A4	R8	0	0698-4037	R-F 46.4 1%	A5	C11	2	0160-4492	C-F 18PF 200Y
A4	R9	7	0698-3432	R-F 26.1 1%	A5	C13	4	0160-0575	C-F .047UF CER
A4	R10	6	0698-3431	R-F 23.7 1%	A5	C14	9	0160-0174	C-F .47UF 25VCER
A4	R11	2	0698-3495	R-F 866 1% .125W	A5	C15	1	0160-0572	C-F 2200PF CER
A4	R12	6	0698-3150	R-F 2.37K1%	A5	C16	7	0160-3879	C-F .01UF 100V
A4	R13	0	0698-3443	R-F 287 1% .125W	A5	C17	4	0160-0575	C-F .047UF CER
A4	R14	3	0698-4379	R-F 44.2 1%	A5	C18	9	0160-0174	C-F .47UF 25VCER
A4	R15	5	0699-0070	R-F 3.16M 1%	A5	C20	5	0160-0576	C-F .1UF 20% CER
A4	R16	5	0699-0070	R-F 3.16M 1%	A5	C21	1	0160-3097	C-F .47UF CER
A4	R17	5	0699-0070	R-F 3.16M 1%	A5	C22	7	0160-3879	C-F .01UF 100V
A4	R18	5	0699-0070	R-F 3.16M 1%	A5	C24	7	0160-3879	C-F .01UF 100V
A4	R19	5	0699-0070	R-F 3.16M 1%	A5	CR1	1	1901-1098	DIO-SWIT.1N4150
A4	R20		1810-0337	R-NETWORK 8X4.7K	A5	CR2	1	1901-1098	DIO-SWIT.1N4150
A4	R21	4	0757-0398	R-F 75 1% .125W	A5	CR3	1	1901-1098	DIO-SWIT.1N4150
A4	R22	6	0698-3431	R-F 23.7 1%	A5	CR4	1	1901-1098	DIO-SWIT.1N4150
A4	R25	0	0757-0394	R-F 51.1 1%	A5	CR5	1	1901-1098	DIO-SWIT.1N4150
A4	R26	2	0698-3437	R-F 133 1% .125W	A5	CR6	8	1901-0047	DIO SI 20V 10NS
A4	R27	1	1810-0275	R-NETW 9X1KOHM	A5	L1	9	9100-2250	COIL-CHOKE .18UH
					A5	MP1	3	4040-0748	PC EXTR BD BLK

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A5	MP2	0	4040-0753	PC EXTR BD GRN	A5	R65	5	2100-3350	R-VAR 200 10%
A5	Q1	5	1854-0392	XSTR ST 2N 5088	A5	R67	4	0757-0281	R-F 2.74K1%
A5	Q2	2	1853-0086	XSTR SI 2N5087	A5	R68	7	2100-3352	R-VAR 1K .5W
A5	Q3	2	1853-0086	XSTR SI 2N5087	A5	R69	0	0698-3451	RES 133K 1% .125W
A5	Q4	2	1853-0086	XSTR SI 2N5087	A5	R70	4	0698-8827	R-F 1M 1% .125W
A5	Q5	2	1853-0086	XSTR SI 2N5087	A5	R71	4	0698-8827	R-F 1M 1% .125W
A5	Q6	7	1853-0354	XSTR MPS H81	A5	R72	4	0698-8827	R-F 1M 1% .125W
A5	Q7	7	1853-0354	XSTR MPS H81	A5	R73	4	0698-8827	R-F 1M 1% .125W
A5	Q8	1	1854-0215	XSTR SI 2N3904	A5	R74	4	0698-8827	R-F 1M 1% .125W
A5	Q9	1	1854-0215	XSTR SI 2N3904	A5	R75	4	0698-8827	R-F 1M 1% .125W
A5	Q10	1	1854-0215	XSTR SI 2N3904	A5	R76		1810-0470	R-NETWORK 8X2.2K
A5	Q11	1	1854-0215	XSTR SI 2N3904	A5	R82	4	0757-0273	R-F 3.01K1%
A5	Q12	1	1854-0215	XSTR SI 2N3904	A5	R86	0	2100-3355	R-VAR 100K
A5	Q13	1	1854-0215	XSTR SI 2N3904	A5	R87	9	0698-8913	RES.FXD. 1.5MOHM
A5	R1	5	0698-7226	R-F 383 1% .05W	A5	R88	0	2100-3355	R-VAR 100K
A5	R2	4	0698-4453	R-F 402 1% .125W	A5	R89	9	0698-8913	RES.FXD. 1.5MOHM
A5	R3	0	0757-0401	R-F 100 1% .125W	A5	R90	9	2100-3354	R-VAR 50K 10%
A5	R4	8	0757-0384	R-F 20 1% .125W	A5	R91	4	0698-8827	R-F 1M 1% .125W
A5	R5	7	2100-3352	R-VAR 1K .5W	A5	R94	7	0698-7236	R-F 1K 1% .05W
A5	R6	1	0757-0428	RES 1.62K 1% .125	A5	R95	9	0757-0442	R-F 10K1% .125W
A5	R7	1	0757-0428	RES 1.62K 1% .125	A5	R96	9	1810-0207	R-F ARRAY 22K
A5	R8	7	2100-3352	R-VAR 1K .5W	A5	U1		1826-0955	TRIANGLE/SLOPE GEN.
A5	R9	2	0698-4427	R-F 1.55K1%	A5	U2	7	1826-0111	IC-DUAL OP AMPL
A5	R10	6	2100-3351	RES TRMR 500 10%	A5	U3	7	1826-0111	IC-DUAL OP AMPL
A5	R11	4	0698-3439	RES 178 1% .125W	A5	U4	0	1826-0635	IC LIN OP07C
A5	R13	2	0757-0453	R-F 30.1K1% .125W	A5	U6	7	1826-0161	IC 324
A5	R14	6	0757-0449	R-F 20K1% .125W	A5	U7	7	1826-0161	IC 324
A5	R15	7	0757-0200	R-F 5.62K1%	A5	U8	0	1820-0471	IC SN7406 INVERT
A5	R16	8	0698-3558	R-F 4.02K1%	A5	U9	9	1826-0501	IC-CMOS 4053B
A5	R20	7	0698-7236	R-F 1K 1% .05W	A5	U10	9	1826-0501	IC-CMOS 4053B
A5	R21	1	0698-3452	R-F 147K1% .125W	A5	U11	2	1820-1546	IC-4052B
A5	R22	4	0757-0447	R-F 16.2K 1% .125	A5	U12	9	1826-0501	IC-CMOS 4053B
A5	R23	6	0698-3499	R-F 40.2K1%	A5	U14	3	1820-1216	IC-SN74LS138
A5	R24	2	0698-3271	R-F 115K1% .125W	A5	U16	6	1820-1201	IC-SN74LS08N
A5	R26	5	0698-3498	R-F 8.66K1%	A5	U17	6	1820-1201	IC-SN74LS08N
A5	R27	5	0698-3498	R-F 8.66K1%	A5	VR2	7	1902-0961	DIODE-ZENER
A5	R28	3	0698-4501	R-F 59K1% .125W					
A5	R38	9	0698-7238	R-F 1.21K 1% .05	A6			08111-66506	BD AY SHAPER
A5	R39	2	0757-0338	R-F 1K1% .25W F	A6	C1		0180-3155	C-F ELCO 100UF
A5	R40	0	0698-3154	R-F 4.22K 1%	A6	C2	5	0160-0576	C-F .1UF 20% CER
A5	R41	7	0757-0458	R-F 51.1K1%	A6	C3	5	0160-0576	C-F .1UF 20% CER
A5	R42	8	0698-3136	R-F 17.8K1%	A6	C4	5	0160-0576	C-F .1UF 20% CER
A5	R43	4	0757-0124	R-F 39.2K1%	A6	C5	5	0160-0576	C-F .1UF 20% CER
A5	R44	0	0698-0077	R-F 93.1K 1%	A6	C6	6	0160-3878	C-F .001UF 100V
A5	R45	9	0698-3484	R-F 6.65K1%	A6	C7	3	0160-3875	C-F 22PF 5% 200V
A5	R46	1	0698-4492	R-F 32.4K1%	A6	C8	9	0160-0174	C-F .47UF 25V CER
A5	R47	2	0698-4493	R-F 34K1% .125W	A6	C9	9	0160-0174	C-F .47UF 25V CER
A5	R48	9	0757-0442	R-F 10K1% .125W	A6	C10	7	0180-0229	C-F 33UF 10V
A5	R49	6	0698-3259	R-F 7.87K1%	A6	C11	9	0160-0174	C-F .47UF 25V CER
A5	R50	1	2100-3273	R-VAR 2K 10%	A6	C12	4	0160-4527	C-F 56PF 5% 200V
A5	R51	1	0757-0428	RES 1.62K 1% .125	A6	C13	5	0160-0576	C-F .1UF 20% CER
A5	R52	6	2100-3351	RES TRMR 500 10%	A6	C14	9	0160-0174	C-F .47UF 25V CER
A5	R53	4	0757-0281	R-F 2.74K1%	A6	C15	9	0160-0174	C-F .47UF 25V CER
A5	R54	1	2100-3273	R-VAR 2K 10%	A6	C16	5	0160-0576	C-F .1UF 20% CER
A5	R55	3	0757-0438	R-F 5.11K1%	A6	C17	3	0160-3875	C-F 22PF 5% 200V
A5	R56	6	0698-4447	R-F 280 1% .125W	A6	CR1	8	1901-0047	DIO SI 20V 10NS
A5	R57	8	0698-4308	R-F 16.9K 1% 1/8W	A6	CR2	8	1901-0047	DIO SI 20V 10NS
A5	R58	1	0698-4468	R-F 1130 1% 1/8W	A6	CR3	8	1901-0047	DIO SI 20V 10NS
A5	R59	1	0698-4468	R-F 1130 1% 1/8W	A6	CR4	8	1901-0047	DIO SI 20V 10NS
A5	R60	9	0757-0418	R-F 619 1% .125W	A6	L1	4	9100-2247	COIL-CHOKE .10UH
A5	R61	2	0698-3700	R-F 715 1% .125W					
A5	R62	2	0698-3700	R-F 715 1% .125W					
A5	R63	5	0757-0464	R-F 90.9K1%					
A5	R64	7	0698-7195	R-F 19.6 1% .05W					

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A6 MP1	3		4040-0748	EXTR-PC-BD POLYC	A7		08111-66507	BD AY-CONTROL	
A6 MP2	1		4040-0754	PC EXTR BD BLU					
A6 Q1	9		1853-0075	XSTR SI PNP	A7 C1	9	0160-0174	C-F .47UF 25VCER	
A6 Q2	2		1853-0218	XSTR SI PNP	A7 C2	9	0160-0174	C-F .47UF 25VCER	
A6 Q3	2		1853-0036	XSTR SI 2N3906	A7 C3	4	0180-3155	C-F ELCO 100UF	
A6 Q4	7		1854-0477	XSTR NPN 2N2222A	A7 C4	4	0180-3155	C-F ELCO 100UF	
A6 Q5	2		1854-0795	XSTR MPS-H10	A7 C5	9	0160-0174	C-F .47UF 25VCER	
A6 R1	1		1810-0275	R-NETW 9X1KOHM	A7 C6	5	0160-0576	C-F .1UF 20% CER	
A6 R2	3		0757-0280	R-F 1K 1% .125W	A7 C7	5	0160-0576	C-F .1UF 20% CER	
A6 R3	9		0698-3202	R-F 1.74K1%	A7 C8	5	0160-0576	C-F .1UF 20% CER	
A6 R4	9		0757-1094	R-F 1.47K1%	A7 C9	9	0160-0174	C-F .47UF 25VCER	
A6 R5	0		0698-4037	R-F 46.4 1%	A7 C10	9	0160-0174	C-F .47UF 25VCER	
A6 R6	7		2100-3352	R-VAR 1K .5W	A7 CR1	0	1901-0734	DIO-IN5818	
A6 R8	4		0698-3132	3-F 261 1% .125W	A7 MP1	3	4040-0748	EXTR-PC-BD POLYC	
A6 R9	1		0757-0428	3-F 1.62K 1%	A7 MP2	2	4040-0755	PC EXTR BD VIO	
A6 R10	7		2100-3352	R-VAR 1K .5W	A7 R1	8	1810-0280	R-NETWORK 9X10K	
A6 R11	1		0757-0428	R-F 1.62K 1%	A7 R2	5	0698-4123	R-F 499 1% .125W	
A6 R12	4		0698-3132	R-F 261 1% .125W	A7 R3	9	0757-0442	R-F 10K1% .125W	
A6 R13	8		0698-3136	R-F 17.8K1%	A7 R4	9	0757-0442	R-F 10K1% .125W	
A6 R14	0		2100-3355	R-VAR 100K	A7 R7	5	0698-4123	R-F 499 1% .125W	
A6 R15	0		2100-3355	R-VAR 100K	A7 R9	9	0757-0442	R-F 10K1% .125W	
A6 R16	0		2100-3355	R-VAR 100K	A7 U1	5	1820-1416	IC SN74LS14N.	
A6 R17	8		2100-3353	R-VAR 20K .5W	A7 U2	4	1820-1423	IC SN74LS123N	
A6 R18	8		2100-3353	R-VAR 20K .5W	A7 U3	1	1820-1199	IC SN74LS04N	
A6 R19	8		0757-0277	R-F 49.9 1%	A7 U4	1	1820-1199	IC SN74LS04N	
A6 R20	8		0757-0277	R-F 49.9 1%	A7 U5	6	1820-1144	IC SN74LS02N	
A6 R21	9		0698-7238	R-F 1.21K 1%.05	A7 U7	6	1820-1144	IC SN74LS02N	
A6 R22	3		0757-0280	R-F 1K 1% .125W	A7 U8	7	1820-1202	IC SN74LS10N	
A6 R23	8		2100-3353	R-VAR 20K .5W	A7 U9	7	1820-1202	IC SN74LS10N	
A6 R24	1		2100-3273	R-VAR 2K 10%	A7 U10	6	1820-1243	IC SN 74LS15N	
A6 R25	8		0698-3558	R-F 4.02K1%	A7 U11	6	1820-1243	IC SN74LS193N	
A6 R26	8		0757-0433	R-F 3.32K1%	A7 U12	6	1820-1194	IC SN74LS193N	
A6 R27	7		2100-3352	R-VAR 1K .5W	A7 U13	6	1820-1194	IC SN74LS193N	
A6 R28	9		0698-3434	R-F 34.8 1%	A7 U14	1	1820-1470	IC SN74LS157N	
A6 R29	0		0698-4409	R-F 127 1% .125W	A7 U15	3	1820-1216	IC SN74LS138N	
A6 R30	3		0757-0280	R-F 1K 1% .125W	A7 U16	8	1820-1112	IC SN74LS74AN	
A6 R31	3		0757-0280	R-F 1K 1% .125W	A7 U17	6	1820-1508	IC MC14017BCP	
A6 R32	0		0698-4409	R-F 127 1% .125W	A8		08111-66508	BD AY-OUTPUT	
A6 R33	1		2100-3273	R-VAR 2K 10%					
A6 R34	5		0698-3430	R-F 21.5 1%.125W	A8 C1	3	0160-4493	C-F 27PF 5% 200V	
A6 R35	5		0698-3430	R-F 21.5 1%.125W	A8 C2	6	0180-3157	C-F ELCO 47UF40V	
A6 R36	1		2100-3207	R-VAR 5K 10%	A8 C3	6	0180-3157	C-F ELCO 47UF40V	
A6 R37	1		0757-0999	R-F 47.5 1% .5W	A8 C4	0	0160-4383	C-F 6.8PF 200V	
A6 R38	1		0757-0999	R-F 47.5 1% .5W	A8 C5	6	0160-3878	C-F .001UF 100V	
A6 R39	0		0757-0401	R-F 100 1% .125W	A8 C6	1	0160-3097	C-F .47UF CER	
A6 R40	0		0757-0401	R-F 100 1% .125W	A8 C7	1	0160-3097	C-F .47UF CER	
A6 R41	6		0698-4421	R-F 249 1% .125W	A8 C8	3	0160-3875	C-F 22PF 5% 200V	
A6 R42	1		0698-7222	R-F 261 1% .05W	A8 C9	3	0160-3875	C-F 22PF 5% 200V	
A6 R43	5		0698-4123	R-F 499 1% .125W	A8 C10	7	0160-3879	C-F .01UF 100V	
A6 R44	8		0757-0277	R-F 49.9 1%	A8 C11	8	0160-4381	C-F 1.5PF 200V	
A6 R45	0		0757-0401	R-F 100 1% .125W	A8 C12	5	0160-0576	C-F .1UF 20% CER	
A6 R46	8		0757-0277	R-F 49.9 1%	A8 C13	5	0160-0576	C-F .1UF 20% CER	
A6 R47	0		0698-4392	R-F 71.5 1/8W 1%	A8 C14	2	0121-0525	C-VAR 1-3PF NPO	
A6 R48	5		0698-7226	R-F 383 1% .05W	A8 C15	5	0160-0576	C-F .1UF 20% CER	
A6 R49	0		0757-0443	R-F 11K1% .125W	A8 C16	5	0160-0576	C-F .1UF 20% CER	
A6 R50	8		2100-3353	R-VAR 20K .5W	A8 C17	5	0160-0576	C-F .1UF 20% CER	
A6 R51	7		0757-0284	R-F 150 1% .125W	A8 C18	5	0180-0582	C-F 270UF 40V	
A6 R52	9		0757-0442	R-F 10K1% .125W	A8 C19	5	0180-0582	C-F 270UF 40V	
A6 U1	2		1820-1546	ANLG MUXR	A8 C20	2	0160-4492	C-F 18PF 200V	
A6 U2	4		5180-2417	SHAPER SEL TEMP					
A6 U3	1		1820-0802	IC MC10102P					
A6 U4	5		1820-1052	IC MC10125L					
A6 VR1	6		1902-3097	DIO 5.23V 2% .4W					

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A8	C21	1	0160-3097	C-F .47UF CER	A8	R24	6	0757-0407	R-F 200 1% .125W
A8	C22	4	0180-3155	C-F ELCO 100UF	A8	R25	8	0698-3558	R-F 4.02K1%
A8	C23	5	0160-0576	C-F .1UF 20% CER	A8	R26	8	0698-3558	R-F 4.02K1%
A8	C24	1	0160-3097	C-F .47UF CER					
A8	C25	1	0160-3097	C-F .47UF CER	A8	R27	6	0757-0407	R-F 200 1% .125W
A8	C26	0	0160-0571	C-F 470PF20% CER	A8	R29	1	0757-0428	R-F 1.62K 1%
A8	C27	4	0160-4387	C-F 47PF 200V	A8	R30	1	0757-0428	R-F 1.62K 1%
A8	C28	8	0160-4381	C-F 1.5PF 200V	A8	R31	1	0698-4442	R-F 4.42K1%
					A8	R32	1	0698-4442	R-F 4.42K1%
					A8	R33	9	0757-0830	R-F 3.92K1% .5W
A8	CR1	7	1901-0179	DIO SI 15V .75NS					
A8	CR2	7	1901-0179	DIO SI 15V .75NS	A8	R34	7	0698-7195	R-F 19.6 1%.05W
A8	CR3	7	1901-0179	DIO SI 15V .75NS	A8	R35	8	0698-7196	R-F 21.5 2%.05W
A8	CR4	7	1901-0179	DIO SI 15V .75NS	A8	R36	7	0698-7236	R-F 1K 1% .05W
A8	CR5	7	1901-0179	DIO SI 15V .75NS	A8	R37	1	0698-7222	R-F 261 1% .05W
A8	CR6	7	1901-0179	DIO SI 15V .75NS	A8	R38	8	0698-7196	R-F 21.5 2%.05W
A8	K1	5	0490-1137	RELAY-REED 5V	A8	R39	7	0698-7195	R-F 19.6 1%.05W
A8	K2	5	0490-1137	RELAY-REED 5V	A8	R40	8	0698-7188	R-F 10 2% .050W
A8	K3	5	0490-1137	RELAY-REED 5V	A8	R41	8	0698-7188	R-F 10 2% .050W
A8	L1	0	9170-0894	CORE MAGNETIC	A8	R42	1	0757-0428	R-F 1.62K 1%
A8	*L2	0	9170-0894	CORE MAGNETIC	A8	R43	1	0757-0428	R-F 1.62K 1%
A8	MP1	3	4040-0748	EXTR-PC-BD POLYC	A8	R44	2	0757-0346	R-F 10 1% .125W
A8	MP2	2	4040-0747	PC EXTR BD GRA	A8	R45	2	0757-0346	R-F 10 1% .125W
A8	MP3	6	08111-02303	HEATSINK THERMO	A8	R46	2	0757-0346	R-F 10 1% .125W
A8	MP4	7	08111-02304	HEATSINK OUTPUT	A8	R47	2	0757-0346	R-F 10 1% .125W
A8	MP5	3	1205-0329	HT-SINK SGL	A8	R48	3	0766-0025	R-F 101 2% 3W MO
A8	MP6	3	1205-0329	HT-SINK SGL	A8	R49	3	0766-0025	R-F 101 2% 3W MO
A8	MP7	3	1205-0329	HT-SINK SGL	A8	R50	3	0757-0818	R-F 825 1% .5W
A8	MP8	3	1205-0329	HT-SINK SGL	A8	R51	2	0698-3601	R-F 10 5% 2W MO
A8	MP9	3	1205-0329	HT-SINK SGL	A8	R52	2	0698-3601	R-F 10 5% 2W MO
A8	MP10	3	1205-0329	HT-SINK SGL	A8	R53	2	0698-3601	R-F 10 5% 2W MO
A8	MP11	3	1205-0329	HT-SINK SGL	A8	R54	2	0698-3601	R-F 10 5% 2W MO
A8	MP12	3	1205-0329	HT-SINK SGL	A8	R55	8	2100-3353	R-VAR 20K .5W
A8	Q1	9	1854-0354	XSTR SI NPN	A8	U1	0	1826-0635	IC LIN 0P07C
A8	Q2	2	1853-0218	XSTR SI PNP	A8	U2	0	1826-0635	IC LIN 0P07C
A8	Q3	9	1854-0354	XSTR SI NPN	A8	VR1	6	1902-0960	DIO-ZNR 12V 5%
A8	Q4	2	1853-0218	XSTR SI PNP	A8	VR2	6	1902-0960	DIO-ZNR 12V 5%
A8	Q5	9	1853-0314	XSTR 2N2905A PNP	A8	VR3	4	1902-0025	DIO 10V 5% .4W
A8	Q6	9	1854-0784	XSTR NPN 2N3866A					
A8	Q7	7	1854-0477	XSTR NPN 2N2222A	A10			08111-66510	BD AY-DISPLAY
A8	Q8	1	1854-0637	XSTR SI 2N2219A	A10	C1	4	0160-4387	C-F 47PF 200V
A8	Q9	9	1853-0314	XSTR 2N2905A PNP	A10	C2	9	0160-0174	C-F .47UF 25VCER
A8	Q10	1	1854-0637	XSTR SI 2N2219A	A10	C3	9	0160-0174	C-F .47UF 25VCER
A8	Q11	9	1853-0314	XSTR 2N2905A PNP	A10	C4	7	0160-5437	C-F .068UF 160V
A8	Q12	1	1854-0637	XSTR SI 2N2219A	A10	C5	5	0160-0576	C-F .1UF 20% CER
A8	Q13	9	1853-0314	XSTR 2N2905A PNP	A10	C8	5	0160-0576	C-F .1UF 20% CER
A8	Q16	2	1855-0082	XSTR FET P	A10	C9	5	0160-0576	C-F .1UF 20% CER
A8	R1	1	0757-0387	R-F 27.4 1%	A10	DS1	2	1990-0846	DISPLAY SOLID ST
A8	R2	5	0757-0282	R-F 221 1% .125W	A10	DS2	2	1990-0846	DISPLAY SOLID ST
A8	R3	0	0698-4409	R-F 127 1% .125W	A10	DS3	2	1990-0846	DISPLAY SOLID ST
A8	R7	5	0757-0349	R-F 22.6K1% .125W	A10	DS4	2	1990-0846	DISPLAY SOLID ST
A8	R10	8	0698-3516	R-F 6.34K1%	A10	DS5	6	1990-0486	LED-VISIBLE RED
A8	R11	8	0698-3516	R-F 6.34K1%	A10	DS6	6	1990-0486	LED-VISIBLE RED
A8	R12	4	0757-0447	R-F 16.2K 1% .125	A10	DS7	6	1990-0486	LED-VISIBLE RED
A8	R13	8	0698-3178	R-F 487 1% .125W	A10	DS8	6	1990-0486	LED-VISIBLE RED
A8	R14	5	2100-3350	R-VAR 200 10%	A10	DS10	6	1990-0486	LED-VISIBLE RED
A8	R15	0	0757-0443	R-F 11K1% .125W	A10	DS11	6	1990-0486	LED-VISIBLE RED
A8	R16	0	0757-0443	R-F 11K1% .125W	A10	DS12	6	1990-0486	LED-VISIBLE RED
A8	R18	8	0757-0277	R-F 49.9 1%	A10	DS13	6	1990-0486	LED-VISIBLE RED
A8	R19	8	0757-0277	R-F 49.9 1%	A10	DS14	6	1990-0486	LED-VISIBLE RED
A8	R20	3	0757-0280	R-F 1K 1% .125W	A10	DS15	6	1990-0486	LED-VISIBLE RED
A8	R21	3	0757-0280	R-F 1K 1% .125W	A10	DS16	6	1990-0486	LED-VISIBLE RED
A8	R22	3	0757-0280	R-F 1K 1% .125W					
A8	R23	3	0757-0280	R-F 1K 1% .125W					

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A10 DS17	6		1990-0486	LED-VISIBLE RED	A12			08111-66512	BD AY-SWITCH LOW
A10 DS18	6		1990-0486	LED-VISIBLE RED	A12 DS1	5		1990-0485	LED VISIBLE GRN
A10 DS19	0		1990-0696	LED-VISIBLE	A12 MP1	7		5040-9321	KEY CAP QUARTER
A10 R1	9		1810-0330	R-NETWORK 8X470	A12 MP2	7		5040-9321	KEY CAP QUARTER
A10 R2	0		0757-0401	R-F 100 1% .125W	A12 MP3	7		5040-9321	KEY CAP QUARTER
A10 R7	1		0698-7272	R-F 31.6K 1%.05	A12 MP4	7		5040-9321	KEY CAP QUARTER
A10 R8	5		0757-0472	R-F 200K1% .125W	A12 MP5	7		5040-9321	KEY CAP QUARTER
A10 S1	4		3101-2530	SW RKR	A12 MP6	7		5040-9321	KEY CAP QUARTER
A10 U1	1		1826-0876	A/D 3-1/2-DGT	A12 MP7	7		5040-9321	KEY CAP QUARTER
A11			08111-66511	BD AY-SWITCH UPR	A12 R1	9		0757-0442	R-F 10K1% .125W
A11 CR11	1		1901-1098	DIO-1N4150 50V	A12 R2	6		0698-4413	R-F 154 1% .125W
A11 MP1	8		5040-9322	KEY-CAP QUARTER	A12 R3	6		0757-0407	R-F 200 1% .125W
A11 MP2	8		5040-9322	KEY-CAP QUARTER	A12 R4	2		0757-0411	R-F 332 1% .125W
A11 MP3	8		5040-9322	KEY-CAP QUARTER	A12 R5	9		0757-0442	R-F 10K1% .125W
A11 MP4	8		5040-9322	KEY-CAP QUARTER	A12 R6	3		0757-0280	R-F 1K 1% .125W
A11 MP5	8		5040-9322	KEY-CAP QUARTER	A12 R7	0		0757-0401	R-F 100 1% .125W
A11 MP6	8		5040-9322	KEY-CAP QUARTER	A12 S2	3		3101-2513	SW-P-BTN 4STA
A11 MP7	8		5040-9322	KEY-CAP QUARTER	A12 S4	2		3101-2512	SW P-BTN LINE
A11 MP8	8		5040-9322	KEY-CAP QUARTER	A12 W2	2		5180-2407	CBL AY RBN 60MM
A11 Q1	2		1853-0036	XSTR SI 2N3906	A13			08111-66513	BD AY-SW & FUSE
A11 Q2	1		1854-0215	XSTR SI 2N3904	A13 S1	1		3101-2511	SW P-BTN LINE
A11 R11	3		0698-4436	R-F 2.8K1% .125W	A13 S2	6		3101-2300	SWITCH-SLIDE
A11 R12	5		0757-0274	R-F 1.21K1%	A13 S3	6		3101-2300	SWITCH-SLIDE
A11 R13	5		0698-4123	R-F 499 1% .125W					
A11 R14	5		0698-4404	R-F 105 1% .125W					
A11 R15	4		0698-4453	R-F 402 1% .125W					
A11 R16	5		0698-3498	R-F 8.66K1% .125W					
A11 R18	6		0757-0283	R-F 2K1% .125W F					
A11 R20	5		0757-0290	R-F 6.19K1% .125W					
A11 R21	0		0698-3493	R-F 4.12K1%					
A11 R25	9		0757-0442	R-F 10K1% .125W					
A11 R27	9		0757-0442	R-F 10K1% .125W					
A11 R28	9		0757-0442	R-F 10K1% .125W					
A11 R29	0		0698-3154	R-F 4.22K 1%					
A11 R30	6		0757-0465	R-F 100K1% .125W					
A11 R31	9		0757-0442	R-F 10K1% .125W					
A11 R32	8		0757-0441	R-F 8.25K1%					
A11 R33	6		0698-3499	R-F 40.2K1%					
A11 R34	6		0757-0465	R-F 100K1% .125W					
A11 R35	8		0698-4431	R-F 2.05K1%					
A11 R41	0		0698-3279	R-F 4.99K1%					
A11 R42	8		0757-0706	R-F 51.1 1% .25W					
A11 R44	6		0757-0283	R-F 2K1% .125W F					
A11 R45	6		0698-3449	R-F 28.7K1%					
A11 R46	4		0757-0447	R-F 16.2K 1%.125					
A11 S1	2		3101-1762	SW-P-BRN MOM. 45A					
A11 S3	5		3101-2515	SW-P-BTN 4STA					
A11 S5	4		3101-2514	SW-P-BTN 3STA					
A11 U11	3		1820-1745	IC MC14001BCP					
A11 U12	2		1820-1546	ANLG MUXR					
A11 W1	3		08111-61603	CBL AY AMPL OUT					

OPTION 001

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
<p>FRAME</p> <p>A3 08111-66503 BD AY-BURST A9 08111-66509 BD AY BRSTNO.CTL A21 08111-66521 BD AY- MOTHER A30 SEE NOTE 08111-66530 BD AY DISPLAY A31 08111-66531 BD AY-SWITCH UP</p>					<p>A3 U7 6 1820-1144 IC SN74LS02N A3 U8 6 1820-1970 IC DIG 14071B A3 U9 6 1820-1970 IC DIG 14071B A3 U10 9 1820-1486 IC MC14081BCP A3 U11 9 1820-1486 IC MC14081BCP A3 U12 3 1820-1208 IC SN74LS32N A3 U13 7 1820-0931 IC CD4029BE A3 U14 7 1820-0931 IC CD4029BE A3 U15 7 1820-0931 IC CD4029BE A3 U16 1820-1964 IC MC14027BCP A3 U17 1 1820-1454 IC SN745168N A3 U18 6 1820-1277 IC SN74LS 192 N A3 U19 6 1820-1277 IC SN74LS 192 N A3 U20 8 1820-0693 IC SN74S74N TTL A3 U21 4 1820-1423 IC SN74LS123N A3 U22 4 1820-1449 IC 74S32</p>				
<p>S2 3101-1701 SW TOGGLE SPDT</p> <p>NOTE: A30 & A31 ARE SUB-ASSEMBLIES OF A41 (08111-66541) AND ARE NOT SEPARATELY AVAILABLE.</p>					<p>A3 W2 5180-2408 CBL AY RBN 280MM</p>				
<p>A3 08111-66503 BD AY-BURST</p>					<p>A9 08111-66509 BD AY BRSTNO.CTL</p>				
A3	C1	5	0160-0576	C-F .1UF 20% CER	A9	C1	9	0160-0174	C-F .47UF 25VCER
A3	C2	3	0180-0291	C-F 1UF 35V	A9	J5	5	1251-3708	CONN-POST 10F
A3	C3	5	0160-0576	C-F .1UF 20% CER	A9	J6	5	1251-3708	CONN-POST 10F
A3	C4	5	0160-0576	C-F .1UF 20% CER	A9	J7	2	1251-3119	CONN 20PIN RIBN
A3	C5	1	0160-0572	C-F 2200PF CER	A9	Q1	1	1854-0215	XSTR SI 2N3904
A3	C6	6	0160-4040	C-F 1000PF 100V	A9	R1	9	0757-0442	R-F 10K1% .125W
A3	C7	6	0160-4371	C-F 680 PF	A9	R2	7	0757-0200	R-F 5.6K1%
A3	C8	6	0160-4371	C-F 680 PF	A9	R3	6	0698-3499	R-F 40.2K1%
A3	C9	5	0160-0576	C-F .1UF 20% CER	A9	R4	8	0757-0467	R-F 121K 1%
A3	C10	5	0160-0576	C-F .1UF 20% CER	A9	R5	0	0698-3279	R-F 4.99K1%
A3	C11	5	0160-0576	C-F .1UF 20% CER	A9	R6	8	0698-4431	R-F 2.05K1%
A3	C12	5	0160-0576	C-F .1UF 20% CER	A9	R7	0	0698-3162	R-F 46.4K1%
A3	C13	5	0160-0576	C-F .1UF 20% CER	A9	R8	2	0757-0453	R-F 30.1K1% .125W
A3	C14	5	0180-2207	C-F 100UF 10V	A9	R9	2	0698-4435	R-F 2.49K1%
A3	C15	2	0160-3874	C-F 10PF 200V	A9	R10	6	0757-0449	R-F 20K1% .125W
A3	C16	6	0160-4040	C-F 1000PF 100V	A9	U1	3	1820-1745	IC MC14001BCP
A3	CR1	1	1901-1098	DIO-SWIT .1N4150	A9	U2	8	1820-1112	IC DGTL SN74LS74
A3	CR2	1	1901-1098	DIO-SWIT .1N4150	A9	U3	6	1820-1277	IC SN74LS 192 N
A3	CR3	1	1901-1098	DIO-SWIT .1N4150	A9	U4	6	1820-1277	IC SN74LS 192 N
A3	CR4	1	1901-1098	DIO-SWIT .1N4150	A9	U5	6	1820-1277	IC SN74LS 192 N
A3	MP1	3	4040-0748	PC EXTR BD BLK	A9	U6	6	1820-1277	IC SN74LS 192 N
A3	MP2	8	4040-0751	PC EXTR BD ORN	A9	U7	3	1826-0175	IC DUAL 14-DIP
A3	R1	5	0757-0472	R-F 200K1% .125W	<p>A21 08111-66521 BD AY- MOTHER</p>				
A3	R2	4	0698-4479	R-F 14K1% .125W	A21	C1		0180-3158	C-F ELCO 6800UF
A3	R3	4	0698-8827	R-F 1M 1% .125W	A21	C2		0180-3162	C-F ELCO 4700UF
A3	R4	1	0698-8345	R-F 634K 1% .125	A21	C3		0180-3161	C-F ELCO 3300VF
A3	R5	5	0757-0472	R-F 200K1% .125W	A21	C4		0180-3161	C-F ELCO 3300VF
A3	R6	7	0698-4125	R-F 953 1% .125W	A21	CR1	3	1901-0638	DIO AY-SI 100V
A3	R7	8	1810-0208	R-NETWORK 7X10K	A21	CR2	7	1906-0096	DIO-FULL WAVE BR
A3	R8	8	1810-0280	R-NETWORK 9X10K	A21	J1	7	1251-3825	CONNECTOR 5 PIN
A3	R9		0698-4421	R-F 249 1% .125W	A21	J2	8	1251-2026	CONN PC 36CONT R
A3	R10		0698-4421	R-F 249 1% .125W	A21	J3	8	1251-2026	CONN PC 36CONT R
A3	R11	6	0757-0465	R-F 100K1% .125W	A21	J4	8	1251-2026	CONN PC 36CONT R
A3	R12	9	0757-0442	R-F 10K1% .125W	A21	J5	8	1251-2026	CONN PC 36CONT R
A3	R13	9	0757-0442	R-F 10K1% .125W	A21	J6	8	1251-2026	CONN PC 36CONT R
A3	R14	5	0698-3498	R-F 8.66K1%	A21	J7	8	1251-2026	CONN PC 36CONT R
A3	R15	5	0698-4412	R-F 143 1% .125W	A21	J8	8	1251-2026	CONN PC 36CONT R
A3	R16	6	0757-0449	R-F 20K1% .125W	A21	J12		1251-7456	CONN 25 CONT
A3	U1	3	1820-1208	IC-SN74LS32	<p>A3 1820-1486 IC MC14081BCP</p>				
A3	U2	5	1820-1200	IC SN74LS05					
A3	U3	1	1820-2014	IC DGT MC14069BC					
A3	U4	6	1820-1201	IC-SN74LS08N					
A3	U5	5	1820-1961	IC MC14023BCP					

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	D	H-P PART NUMBER	DESCRIPTION
A21	Q3	6	1853-0212	XSTR 2N5194 SI	A31		08111-66531	BD AY-SWITCH UP	
A21	Q4	5	1854-0368	XSTR 2N5191					
A21	Q7	6	1853-0212	XSTR 2N5194 SI					
A21	Q8	5	1854-0368	XSTR 2N5191					
A21	R12	1	0757-0197	R-F 1.5K1% .5W	A31	CR11	1	1901-1098	DIO-SWIT.1N4150
A21	R13	1	0757-0197	R-F 1.5K1% .5W	A31	J5	2	1251-4084	CONN POST 10MALE
A21	R20	6	0812-0045	R-F .15 5% 3W	A31	J6	2	1251-4084	CONN POST 10MALE
A21	R21	6	0812-0045	R-F .15 5% 3W	A31	MP1-8	8	5040-9322	KEY CAP QUARTER
A21	R25	9	0757-0731	R-F 825 1% .25W	A31	Q1	2	1853-0036	XSTR SI 2N3906
A21	R28	9	0757-0731	R-F 825 1% .25W	A31	Q2	1	1854-0215	XSTR SI 2N3904
A21	R31	4	0811-2455	R-F 2 1% 3W	A31	R11	3	0698-4436	R-F 2.8K1% .125W
A21	R32	4	0811-2455	R-F 2 1% 3W	A31	R12	5	0757-0274	R-F 1.21K1%
A21	R39	3	0757-0280	R-F 1K1% .125W F	A31	R13	5	0698-4123	R-F 499 1% .125W
A21	R40	3	0757-0280	R-F 1K1% .125W F	A31	R14	5	0698-4404	R-F 105 1% .125W
A21	R41	3	0757-0280	R-F 1K1% .125W F	A31	R15	4	0698-4453	R-F 402 1% .125W
A21	R42	3	0757-0280	R-F 1K1% .125W F	A31	R16	5	0698-3498	R-F 8.66K1%
					A31	R18	6	0757-0283	R-F 2K1% .125W F
					A31	R20	5	0757-0290	R-F 6.19K1%
					A31	R21	0	0698-3493	R-F 4.12K1%
					A31	R26	9	0757-0442	R-F 10K1% .125W
A30			08111-66530	BD AY DISPLAY	A31	R27	9	0757-0442	R-F 10K1% .125W
A30	C1	4	0160-4494	C-F 39PF 200V	A31	R28	9	0757-0442	R-F 10K1% .125W
A30	C2	9	0160-0174	C-F .47UF 25VCER	A31	R29	0	0698-3154	R-F 4.22K 1%
A30	C3	9	0160-0174	C-F .47UF 25VCER	A31	R30	6	0757-0465	R-F 100K1% .125W
A30	C4		0160-5437	C-F .068UF 160V	A31	R31	9	0757-0442	R-F 10K1% .125W
A30	C5	5	0160-0576	C-F .1UF 20% CER	A31	R32	8	0757-0441	R-F 8.25K1%
A30	C8	5	0160-0576	C-F .1UF 20% CER	A31	R33	6	0698-3499	R-F 40.2K1%
A30	C9	5	0160-0576	C-F .1UF 20% CER	A31	R34	6	0757-0465	R-F 100K1% .125W
A30	DS1		1990-0846	DISPLAY SOLID ST	A31	R35	8	0698-4431	R-F 2.05K1%
A30	DS2		1990-0846	DISPLAY SOLID ST	A31	R41	0	0698-3279	R-F 4.99K1%
A30	DS3		1990-0846	DISPLAY SOLID ST	A31	R42	8	0757-0706	R-F 51.1 1% .25W
A30	DS4		1990-0846	DISPLAY SOLID ST	A31	R44	6	0757-0283	R-F 2K1% .125W F
A30	DS5	6	1990-0486	LED-VISIBLE RED	A31	R45	6	0698-3449	R-F 28.7K1%
A30	DS6	6	1990-0486	LED-VISIBLE RED	A31	R46	4	0757-0447	R-F 16.2K 1% .125
A30	DS7	6	1990-0486	LED-VISIBLE RED	A31	S1	2	3101-1762	SW-P-BRN MOM.45A
A30	DS8	6	1990-0486	LED-VISIBLE RED	A31	S3		3101-2515	SW-P-BTN 4STA
A30	DS9	6	1990-0486	LED-VISIBLE RED	A31	S5		3101-2514	SW-P-BTN 3STA
A30	DS10	6	1990-0486	LED-VISIBLE RED	A31	U11	3	1820-1745	IC MC14001BCP
A30	DS11	6	1990-0486	LED-VISIBLE RED	A31	U12	2	1820-1546	IC-4052B
A30	DS12	6	1990-0486	LED-VISIBLE RED					
A30	DS13	6	1990-0486	LED-VISIBLE RED					
A30	DS14	6	1990-0486	LED-VISIBLE RED					
A30	DS15	6	1990-0486	LED-VISIBLE RED					
A30	DS16	6	1990-0486	LED-VISIBLE RED					
A30	DS17	6	1990-0486	LED-VISIBLE RED					
A30	DS18	6	1990-0486	LED-VISIBLE RED					
A30	DS19	0	1990-0696	LED-VISIBLE					
A30	R1	9	1810-0330	R-NETWORK 8X470					
A30	R2	0	0757-0401	R-F 100 1% .125W					
A30	R7	1	0698-7272	R-F 31.6K 1% .05					
A30	R8	5	0757-0472	R-F 200K1% .125W					
A30	S1		3101-2530	SW RKR					
A30	S2		3101-2530	SW RKR					
A30	S3		3101-2530	SW RKR					
A30	S4		3101-2530	SW RKR					
A30	U1		1826-0876	AD-CONV ICL7107					

SECTION VII BACKDATING

7-1 INTRODUCTION

7-2 This section contains backdating information which adapts this manual to instrument with serial numbers lower than that shown on the title page.

7-3 CHANGE SEQUENCE

7-4 Changes are listed in the serial number order that they occurred in the manufacture of the instrument. However, in adapting this manual to an instrument with a particular serial number, apply the changes in reverse order. That is, begin with the latest change and progress to the earliest change that applies to the serial number in question. Table 7-1 lists the serial numbers to which each change applies.

Table 7-1. Manual Backdating Changes

Instrument Serial Number	Make Manual Changes
2123G00100 and lower	1 to 14
2123G00150 and lower	2 to 14
2123G00165 and lower	3 to 14
2123G00235 and lower	4 to 14
2123G00285 and lower	5 to 14
2123G00435 and lower	6 to 14
2215G00485 and lower	7 to 14
2215G00535 and lower	8 to 14
2215G00715 and lower	9 to 14
2215G00835 and lower	10 to 14
2215G01075 and lower	11 to 14
2215G01540 and lower	12 to 14
2215G01590 and lower	13 to 14
2215G01840 and lower	14

CHANGE 1 For serial numbers 2123G00100 and lower.

In Table 6-3. Replaceable Parts, make the following changes to the parts lists stated:
 Frame list: Delete MP34
 A12 list: Delete A12R7

Change associated schematic and component layout diagrams as necessary.

CHANGE 2 For serial numbers 2123G00150 and lower.

In Table 6-3. Replaceable Parts, make the following changes to the parts lists stated:
 Frame list: Delete MP5, MP6 and MP7
 A3 list: Delete A3C16

Change associated schematic and component layout diagrams as necessary.

CHANGE 3 For serial numbers 2123G00165 and lower.

In Table 6-3. Replaceable Parts, make the following changes to the parts lists stated:
 A 5 list: Add: A5C9 0160-3725 C-F 0.68 μ F 100 V
 Change A5C8 to: 0160-3376 C-F 3.3 μ F 63 V

Change associated schematic and component layout diagrams as necessary.
 C9 is connected in parallel to C8.

Backdating

CHANGE 4 For serial numbers 2123G00235 and lower.

In Table 6-3, Replaceable Parts, make the following changes to the parts lists stated:
Frame list: Change MP42 to MP42 (X4) 0340-0451 INS WASHER

CHANGE 5 For serial numbers 2123G00285 and lower.

In Table 6-3, Replaceable Parts, make the following changes to the parts lists stated:
A3 list: Change A3R15 to: 0698-4411 R-F 140 1 % .125 W
Frame list: Delete R1

Change the associated schematic and component layout diagrams as necessary.

CHANGE 6 For serial numbers 2123G00435 and lower

Delete the following from Table 6-3, Replaceable Parts, and from the A6 component layout:

A6R49, A6R50, A6R51, A6R52 and A6Q3

Add the following to Table 6-3, Replaceable Parts, and to the A6 component layout:

A6R7 0698-7260 R-F 10K

On the A6 component layout, A7 is located directly below R5.

Change the associated schematic as shown in the Figure 7-1.

Delete any reference to A6R50 in the Adjustment Procedure (page 5-1, para 5-2, step 3; page 5-4, para 5-4, step 5; page 5-5, step 30)

CHANGE 7 For serial numbers 2215G00485 and lower

Delete A8L2 from parts list, component layout and schematic.

CHANGE 8 For serial numbers 2215G00535 and lower

Change Table 6-3, Replaceable Parts to read:

A8C8,C9	0160-3878	C-F .001UF 100V
A8L1	9170-0894	CORE MAGNETIC

CHANGE 9 For serial numbers 2215G00715 and lower

Change Table 6-3, Replaceable Parts to read:

A8Q6	1854-0637	XSTR SI 2219A
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8111A

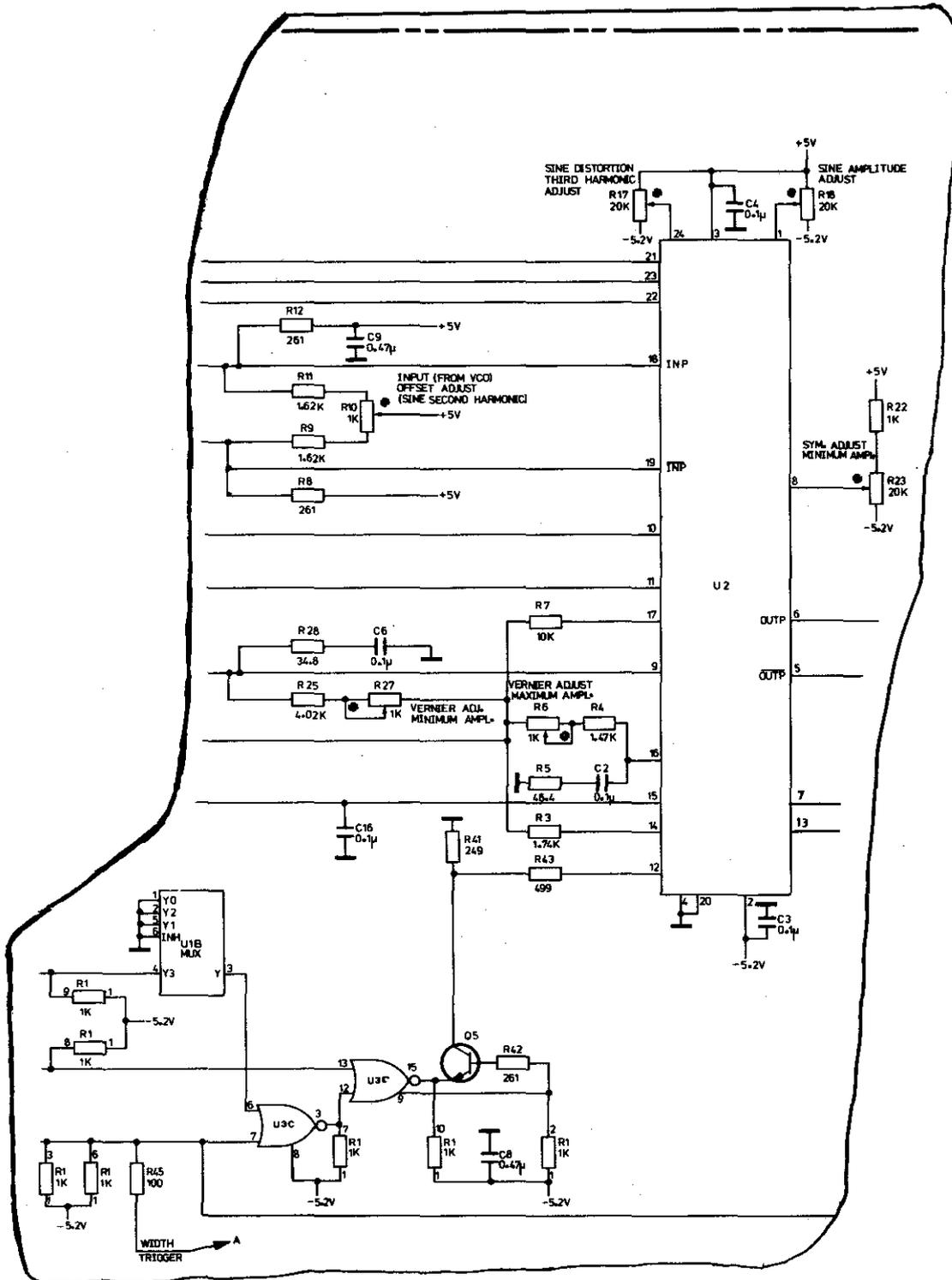


Figure 7-1

Backdating

8111A

CHANGE 10 For serial numbers 2215G00835 and lower

Change Table 6-3, Replaceable Parts to read:

A6Q1 5180-2409 XSTR SEL PAIR

Delete the following components from the parts list, component layout and schematic:

A6R53*, A6RT1*

CHANGE 11 For serial numbers 2215G01075 and lower

Delete the following components from the parts list, component layout and schematic:

A7C9, A7C10, A7R3, A7R4 and A7U2

On Service Sheet 4, U1E pin1 is connected to U8C/U9C pin 10, and U1D pin 8 is connected to U8A/U9A pin 13

CHANGE 12 For serial numbers 2215G01540 and lower

Change Table 6-3, Replaceable Parts to read:

A6C10 0160-0174 C-F 0.47UF 25VCER

CHANGE 13 For serial numbers 2215G01590 and lower

Change Table 6-3, Replaceable Parts to read:

A5R9 0757-0278 R-F 1.78K

CHANGE 14 For serial numbers 2215G01840 and lower

Change Table 6-3, Replaceable Parts to read:

A7CR1 1901-0731 DIO-PWR 400V 1A

SECTION VIII SERVICE

8-1 INTRODUCTION

8-2 This section contains the information to service the HP Model 8111A. The information includes theory of operation, troubleshooting, schematics, component layouts and block diagram.

8-3 The schematics and component layouts are organized as 'Service Sheets' which are identified by a large number within a square in the lower corners. A table relating these Service Sheets to board assemblies is given in Table 8-1. Schematic diagram symbols are given in Table 8-3.

Table 8-1. Index of Assemblies

Assembly	Service Sheet
A1 (A21) Mother Board	1
A2 Regulator Board	2
A3 Burst Board (Opt. 001)	6
A4 Width Generator Board	9
A5 VCO Board	8
A6 Shaper Board	10
A7 Control Board	4
A8 Output Board	11
A9 Burst No. Control Board (Opt. 001)	7
A10 (A30) Display Board	5
A11 (A31) Upper Switch Board	3
A12 Lower Switch Board	3
A13 Switch and Fuse Board	2

NOTE: The numbers given in brackets e.g. (A21) refer to the boards as used in Option 001 (Burst) instruments where they differ from the standard type.

8-4 SAFETY CONSIDERATIONS

8-5 This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment:

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the

hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

When servicing is complete, the After Service Safety Check must be performed.

8-6 AFTER SERVICE SAFETY CHECK

8-7 Execute the following checks when servicing is completed.

8-8 Disconnect power cord from line. Visually inspect interior of instrument for any sign of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine cause and remedy.

8-9 Check cabinet/ground pin continuity in accordance with IEC/VDE. Flex the power cord while making the measurement to detect any intermittent discontinuity. Check internal ground connections on boards and frame. Also check resistance of any front or rear panel ground terminals marked $\frac{1}{\text{E}}$.

8-10 Check cabinet/line isolation in accordance with IEC/VDE. Replace any component which results in a failure or refer to production Memo or Service Note issued by product division for alternate action.

8-11 Check line fuse to verify that the proper value is installed.

8-12 Check that safety covers are installed.

8-13 Check that the coaxial and flat cables are properly connected. Check that all boards are properly fitted and the heatsink connections between the Output board A8 and front frame member are secure.

8-14 Inform Hewlett-Packard (internally, the responsible product division) of any repeated failures in the above tests or any other safety features.

8-15 SERVICE BLOCKS (THEORY/TROUBLESHOOTING)

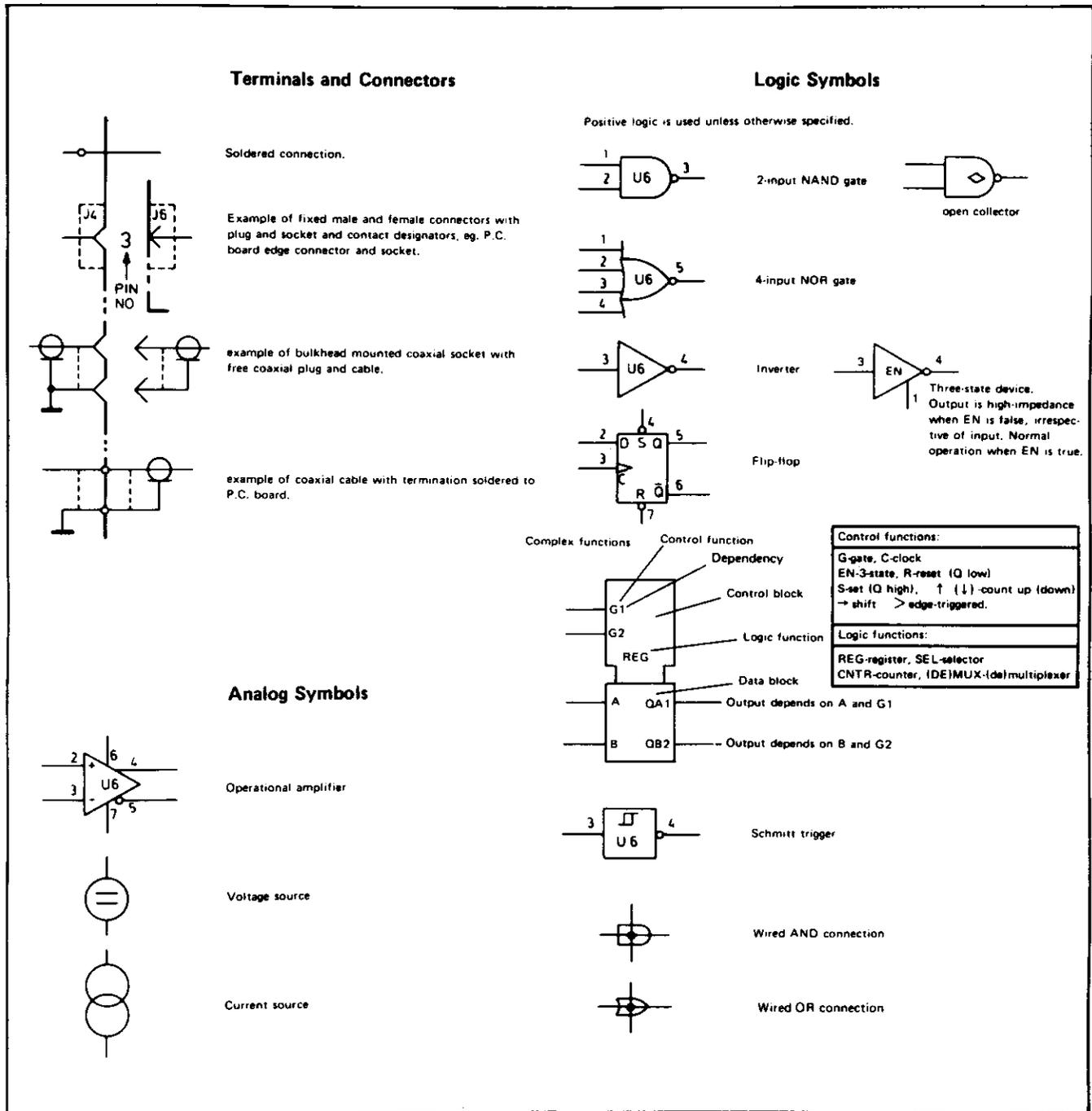
8-16 The theory of operation and troubleshooting

Table 8-3. Schematic Diagram Notes (1 of 2)

The following symbols conform, as far as possible, with ANSI Y 32.2, IEEE No. 315 and ANSI Y32.14 (for the logic symbols). These standards should be consulted when further informations is required.

General		Components	
Units	Resistance values are in ohms, capacitance values in microfarads and inductance values in microhenries unless otherwise noted !		Normally open toggle switch. Circles (O) are used for the contacts to indicate a locking type switch.
P/O	Part of		Spring return, 2-position transfer switch. Triangle (▲) are used for the contacts to indicate a non-locking type switch.
*	Asterisk denotes a factory selected value. The value shown is the nominal value.		2-position, 2-pole slide switch.
	Encloses front panel nomenclature.		Air cored inductor.
	Encloses rear panel nomenclature.		Air cored transformer. The dot (●) is used, when necessary, to indicate instantaneous polarity.
	Heavy line indicates signal path.		Iron core
	Heavy dashed line indicates primary feedback path.		Ferrite core
	Wire colour code. Same as resistor colour code. First number is wire body colour.		Ferrite bead
	Wire or plug used as link.		Varactor diode
	Test point in a circuit. Point may/may not be identified on P.C. board.		Multi-junction diode
	Used with trimmer potentiometers or capacitors to indicate screwdriver adjustment.		Diode
	Direct connection to earth.		Zener diode
	Ground connection to instrument chassis or frame.		Schottky diode
	Used when a number of common-return connections are at the same potential. If there is more than one such system in the same circuit, numbers are written in the triangles so that all connections with the same potential have the same number.		Light Emitting Diode (LED)
	Specific potential difference with respect to a potential reference level, eg. +10 V		Photodiode
Schematic Referencing			Fuse
			Neon
<p>These references on a signal leaving a schematic diagram indicate the signal destination. The circle contains the signal number and the square contains the number of the schematic to which that signal goes.</p>			Filament lamp
<p>These references on a signal entering a schematic diagram indicate the signal origin. The circle contains the signal number and the square contains the number of the schematic to which that signal originates.</p>			

Table 8-3. Schematic Diagram Notes (2 of 2)

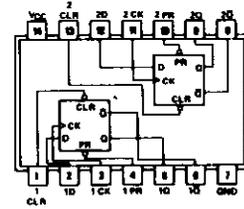


1820-0693

DUAL D-TYPE POSITIVE-EDGE-TRIGGERED
FLIP-FLOPS WITH PRESET AND CLEAR (S74)

FUNCTION TABLE

INPUTS				OUTPUTS	
PRESET	CLEAR	CLOCK	D	Q	\bar{Q}
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	1	H	H	L
H	H	1	L	L	H
H	H	L	X	Q_0	\bar{Q}_0

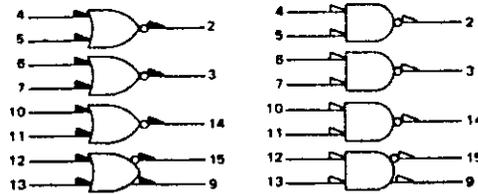


1820-0802

QUAD 2-INPUT NOR GATE (ECL)

POSITIVE LOGIC

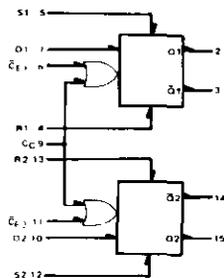
NEGATIVE LOGIC



VCC1 = Pin 1
VCC2 = Pin 16
VEE = Pin 8

1820-0817

DUAL TYPE D MASTER-SLAVE FLIP-FLOP (ECL)



CLOCKED TRUTH TABLE

C	D	Q_{n+1}
L	0	Q_n
H	L	L
H	H	H

0 - Don't Care
C - $C_1 = C_2$
A clock H is a clock transition from a low to a high state

R S TRUTH TABLE

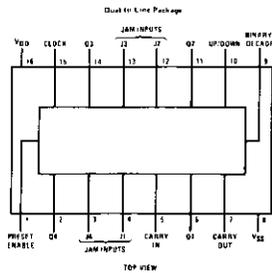
R	S	Q_{n+1}
L	L	Q_n
L	H	H
H	L	L
H	H	N/D

N/D - Not Defined

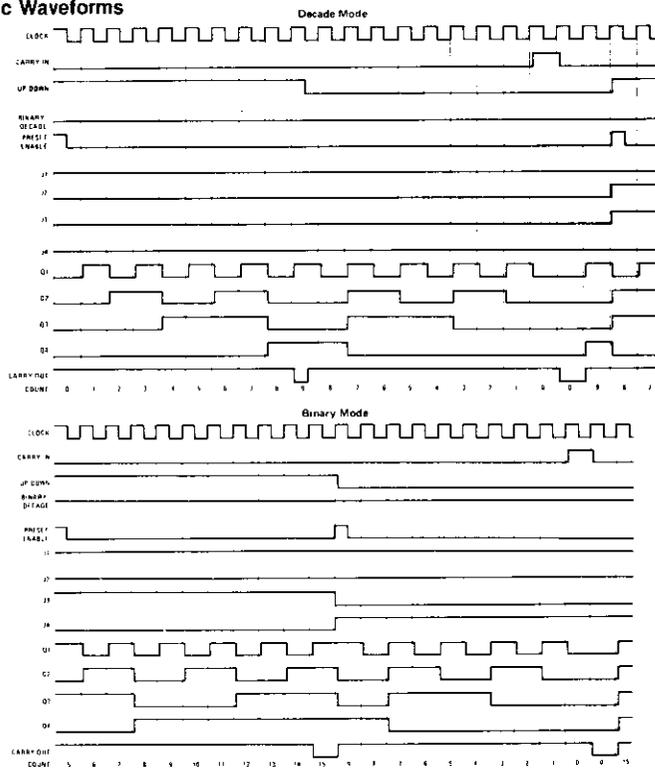
VCC1 = Pin 1
VCC2 = Pin 16
VEE = Pin 8

1820-0931

PRESETTABLE BINARY/DECADE UP/DOWN COUNTER

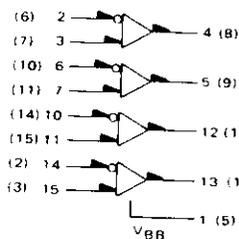


Logic Waveforms



1820-1052

QUAD ECL TO TTL CONVERTER



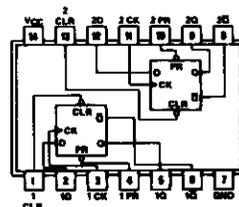
Gnd = Pin 16 (4)
 V_{CC} (+5.0 Vdc) = Pin 9 (13)
 V_{EE} (-5.2 Vdc) = Pin 8 (12)

1820-1112

DUAL D-TYPE POSITIVE-EDGE-TRIGGERED FLIP-FLOPS WITH PRESET AND CLEAR (LS74)

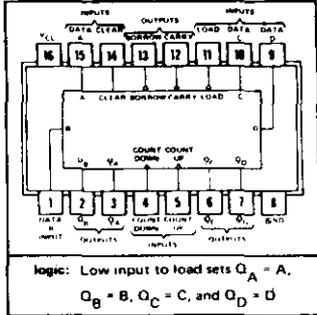
FUNCTION TABLE

INPUTS				OUTPUTS	
PRESET	CLEAR	CLOCK	D	Q	\bar{Q}
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H*	H*
H	H	1	H	H	L
H	H	1	L	L	H
H	H	L	X	Q_0	\bar{Q}_0



1820-1194

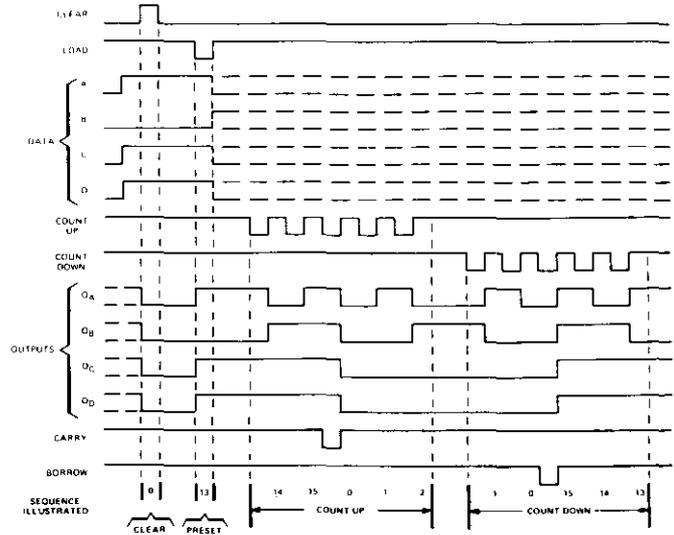
SYNCHRONOUS 4 BIT UP/DOWN COUNTER
(DUAL CLOCK WITH CLEAR)



typical clear, load, and count sequences

Illustrated below is the following sequence:

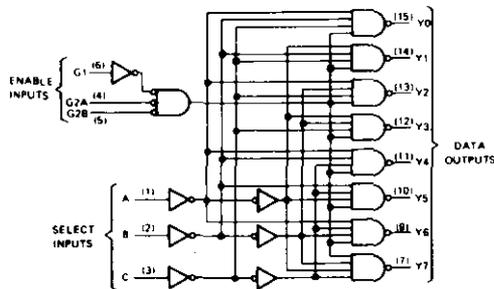
1. Clear outputs to zero.
2. Load (preset) to binary thirteen.
3. Count up to fourteen, fifteen, carry, zero, one, and two.
4. Count down to one, zero, borrow, fifteen, fourteen, and thirteen.



NOTES: A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high, when counting down, count-up input must be high.

1820-1216

3-BIT BINARY DECODER/DEMULTIPLEXER

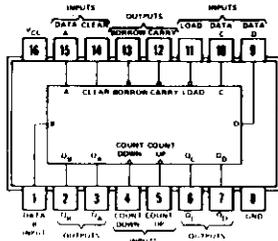


FUNCTION TABLE

ENABLE		SELECT			OUTPUTS							
G1	G2*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	L	H	H	H	L	H	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H	H
H	L	L	L	H	H	H	H	H	L	H	H	H
H	L	L	L	H	H	H	H	H	H	L	H	H
H	L	L	L	H	H	H	H	H	H	H	L	H
H	L	L	L	H	H	H	H	H	H	H	H	L

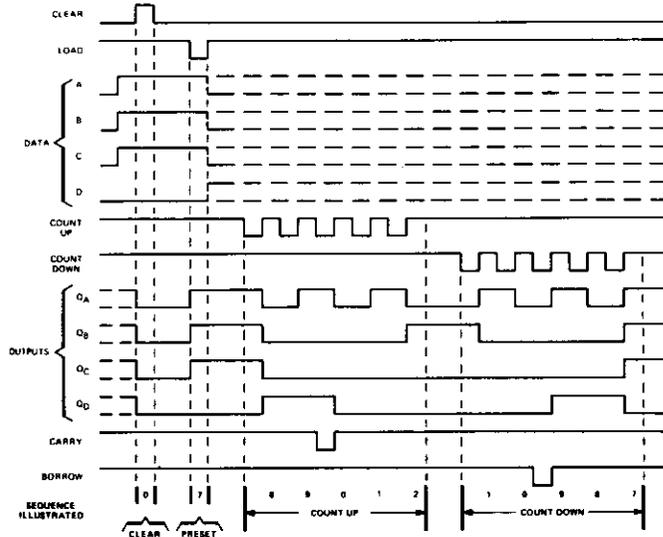
*G2 = G2A + G2B
H = high level, L = low level, X = irrelevant

1820-1277 SYNCHRONOUS 4-BIT DECADE UP/DOWN COUNTERS
(DUAL CLOCK WITH CLEAR)



Illustrated below is the following sequence:

1. Clear outputs to zero.
2. Load (preset) to BCD seven.
3. Count up to eight, nine, carry, zero, one, and two.
4. Count down to one, zero, borrow, nine, eight, and seven.

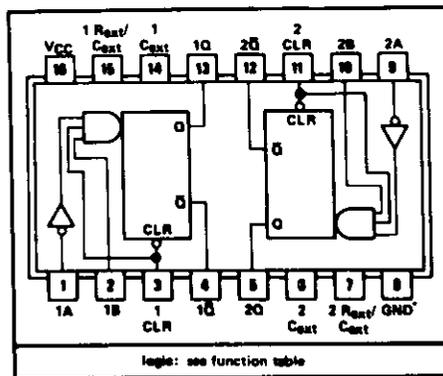


NOTES: A. Clear overrides load, data, and count inputs.
B. When counting up, count-down input must be high; when counting down, count-up input must be high.

1820-1423 DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATORS
WITH CLEAR

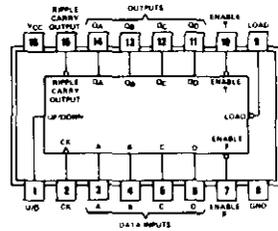
FUNCTION TABLE

CLEAR	INPUTS		OUTPUTS	
	A	B	Q	\bar{Q}
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑	↓	↑
H	J	H	↓	↑
↑	L	H	↓	↑



1820-1454

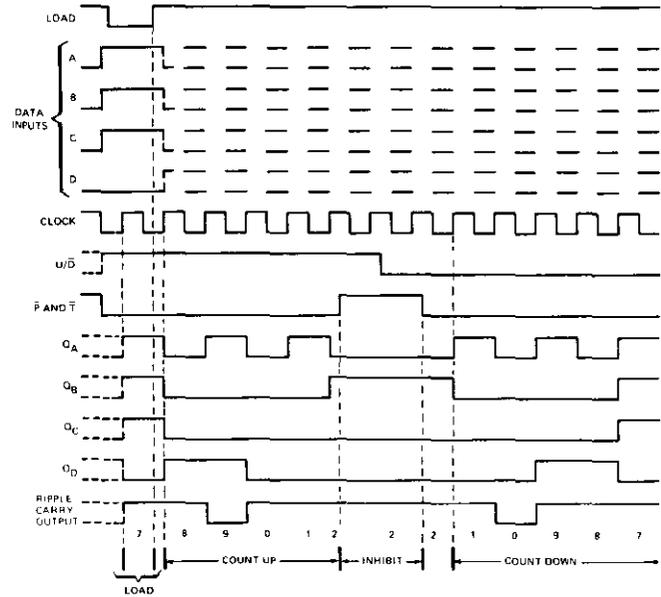
SYNCHRONOUS DECADE UP/DOWN COUNTER



typical load, count, and inhibit sequences

Illustrated below is the following sequence.

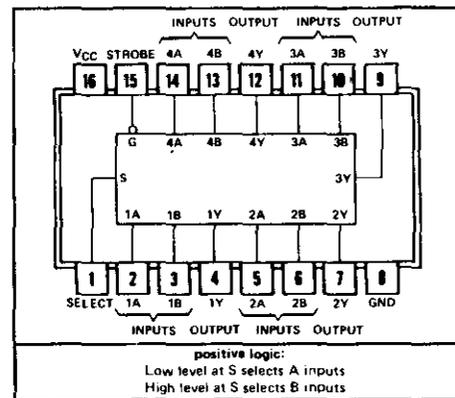
1. Load (preset) to BCD seven
2. Count up to eight, nine (maximum), zero, one, and two
3. Inhibit
4. Count down to one, zero (minimum), nine, eight, and seven



1820-1470

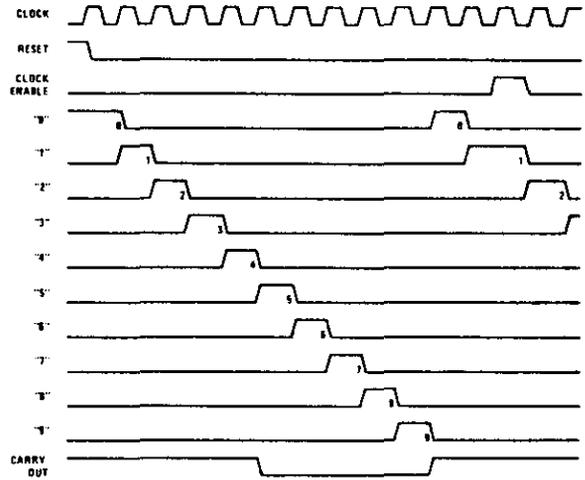
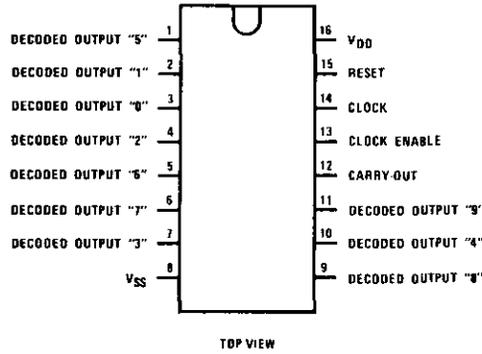
QUAD 2 TO 1-LINE DATA SELECTORS/MULTIPLEXERS

Inputs		Output		
Strobe	Select	A	B	Y
H	X	X	X	L
L	L	L	X	L
L	L	H	X	H
L	H	X	H	L
L	H	X	H	H



1820-1508

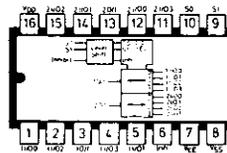
DECADE COUNTER/DIVIDER WITH 10 DECODED OUTPUTS



1820-1546

DUAL 4 TO 1-LINE ANALOG MULTIPLEXERS

Inputs			Channel turned on
INH	S1	S0	
H	X	X	None
L	L	L	0
L	L	H	1
L	H	L	2
L	H	H	3



1820-1964

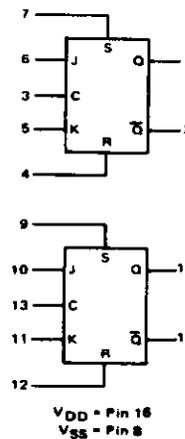
DUAL JK FLIP-FLOP

TRUTH TABLE

C†	INPUTS				OUTPUTS*		
	J	K	S	R	Q _n ‡	Q _{n+1}	Q̄ _{n+1}
↑	1	X	0	0	0	1	0
↓	X	0	0	0	1	1	0
↑	0	X	0	0	0	0	1
↓	X	1	0	0	1	0	1
↑	X	X	0	0	X	Q _n	Q̄ _n
X	X	X	1	0	X	1	0
X	X	X	0	1	X	0	1
X	X	X	1	1	X	1	1

X = Don't Care
 † = Level Change
 ‡ = Present State
 * = Next State

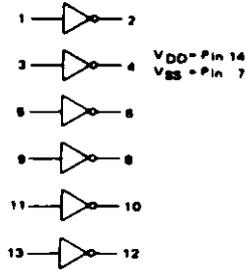
No Change



VDD = Pin 16
 VSS = Pin 8

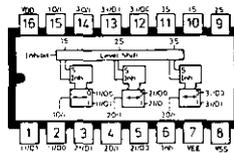
1820-2014 HEX INVERTER

LOGIC DIAGRAM



1826-0501 TRIPLE 2 TO 1-LINE ANALOG MULTIPLEXER

Inputs		Channel turned on
INH	S	
H	X	None
L	L	0
L	H	1

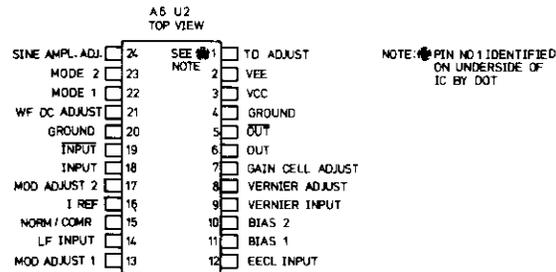


1826-0876 3 1/2DIGIT A/D CONVERTER

(+) SUPPLY	1	40	OSC. 1
D (UNITS)	2	39	OSC. 2
C (UNITS)	3	38	OSC. 3
B (UNITS)	4	37	TEST
A (UNITS)	5	36	+ REF
F (UNITS)	6	35	- REF
G (UNITS)	7	34	+ REF CAR
E (UNITS)	8	33	- REF CAR
D (TENS)	9	32	COMMON
C (TENS)	10	31	INPUT HI
B (TENS)	11	30	INPUT LO
A (TENS)	12	29	AUTO-ZERO
F (TENS)	13	28	BUFFER
E (TENS)	14	27	INTEGRATOR
D (100%)	15	26	(-) SUPPLY
B (100%)	16	25	G (TENS)
F (100%)	17	24	C (100%)
E (100%)	18	23	A (100%)
AB (100%)	19	22	G (100%)
POLARITY (TENS)	20	21	DIGITAL GND

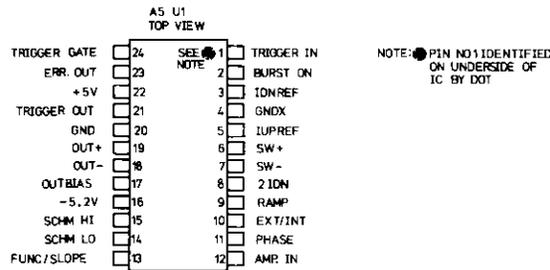
1826-0923

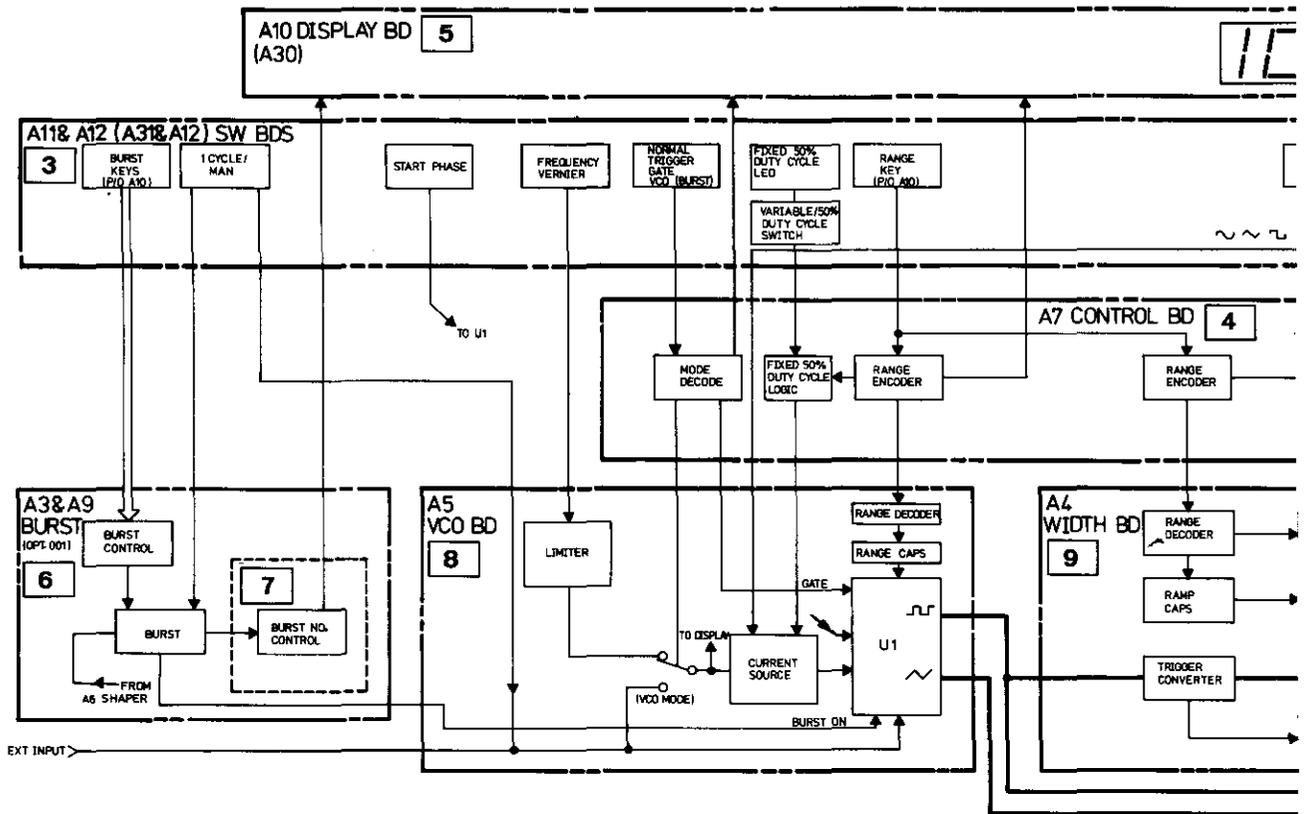
SHAPER/VERNIER IC



1826-0955

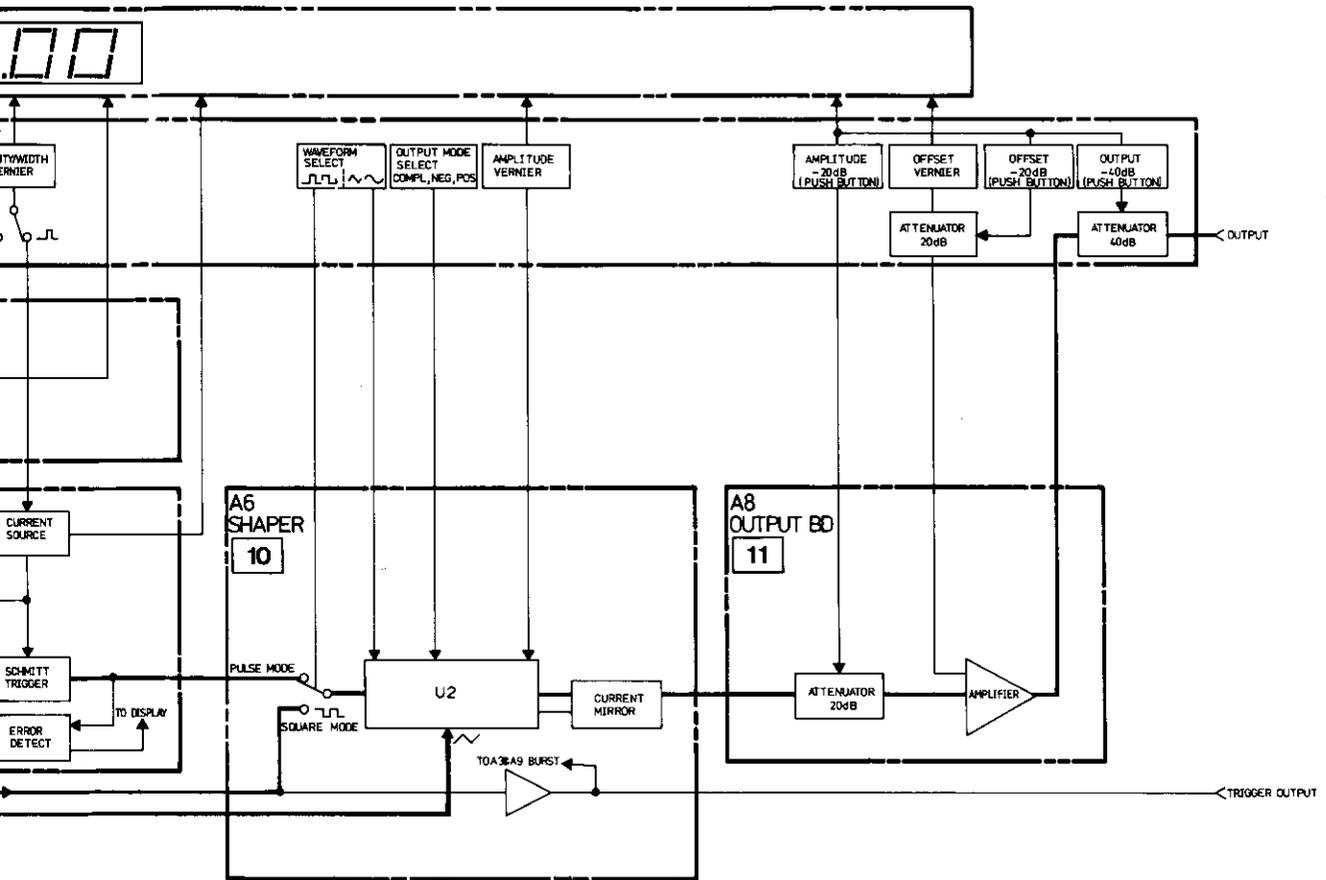
TRIANGLE/SLOPE GENERATOR IC





NOTE: BOARD NUMBERS IN BRACKETS
eg: (A30) INDICATE DIFFERENCES
FOR OPTION 001 (BURST) INSTRUMENTS.
NUMBERS WITHIN RECTANGLES eg: [6]
ARE SCHEMATIC IDENTIFIERS

Figure 8-1-1. 8111A Block Diagram, Option 001 (Burst) Details Included



Model 8111A

SERVICE BLOCK 1 PROBLEM AREA IDENTIFICATION

General

The purpose of this Service Block is to present a brief overview of the instrument circuits operation which, when combined with the Troubleshooting Tree (Figure 8-1-3), will assist in quickly identifying which Service Block(s) should be referred to. Once the actual board or circuit at fault has been identified, reference to the appropriate Service Block will provide detailed circuit operational theory and comprehensive troubleshooting data. Details of the overall 811A circuits operation and the function of individual boards follows, reference should also be made as necessary to Figure 8-1-1 and the condensed block diagram – Figure 8-1-2. Where possible, the board descriptions are given in the same order as they appear in the two block diagrams i.e. in their logical priority.

Board/Signal Flow Description (Standard 8111A)

In all operating and waveform modes except External Trigger/Pulse, board A5 (VCO) functions as a rate generator with the rate (or frequency) being determined either by front panel settings or by an externally applied control voltage. For the one exception stated, A5 serves only as a Schmitt trigger to ensure that the incoming trigger signal is compatible with level shifter of A6 (Shaper) and the trigger converter circuit of A4 (Width).

Two output signals are produced by A5 U1 – triangular and square waveforms, the triangular waveform is input to A6 (Shaper) where it is further processed by A6 U2 to form a sinusoidal function if necessary and also given the required ("front panel") output mode and amplitude settings. If a squarewave is required then the "square output" from A5 U1 is utilized and processed by A6 U2. In pulse mode, the "square output" from A5 U1 is input to A4, given the required width characteristics (determined by front panel settings) and then output to A6 where it is processed as necessary. In all cases, the output from A6 is input to A8 (Output) for offset control and amplitude, output and offset attenuation.

A7 (Control) serves basically as an interface between A11, A12, A5 and A4. A3, A9, A6 and A8 interface directly with the front panel controls and A11, A12.

Parameter and error display is by board A10 with parameter display being via an A-D converter (analogue voltages derived from vernier control settings) and application of appropriate scaling factors via A12U12 depending on the chosen parameter.

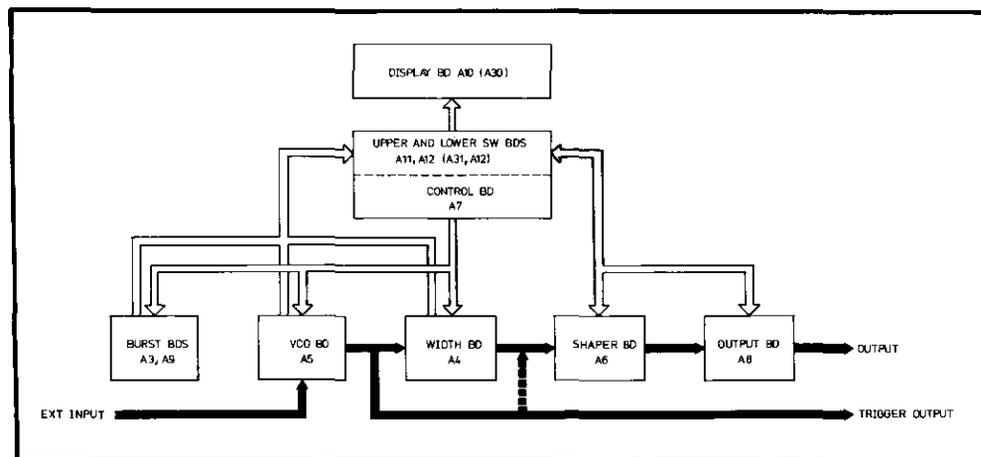


Figure 8-1-2. 8111A Condensed Block Diagram

Differences for Option 001 - Burst instruments

In Option 001 (Burst) instruments a trigger signal, either externally generated or via the Manual/1 Cycle switch, is required to initially activate A5U1. It is then maintained active by a signal (BURST ON) from A3. The operating frequency and all other settings are made as for the standard 8111A, (via front panel settings and A11, A12 and A7 Control). The output is disabled by the BURST ON signal going low. The burst number, set by the Burst rocker switches, keeps the signal active high until the required output count is reached, it is also used by A9 to control the display value of A10.

TROUBLESHOOTING

The Troubleshooting Tree, Figure 8-1-3, should be referred to when necessary since it shows the connection between possible faults and related boards. While it will be found to be correct for all the basic fault conditions or symptoms, it cannot cover all possible situations.

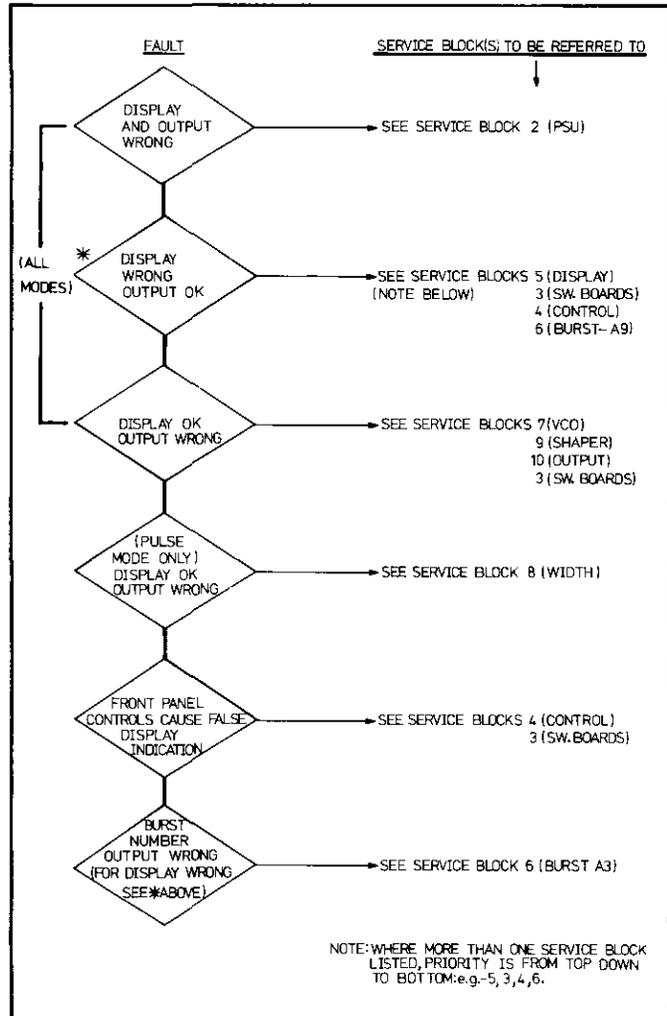
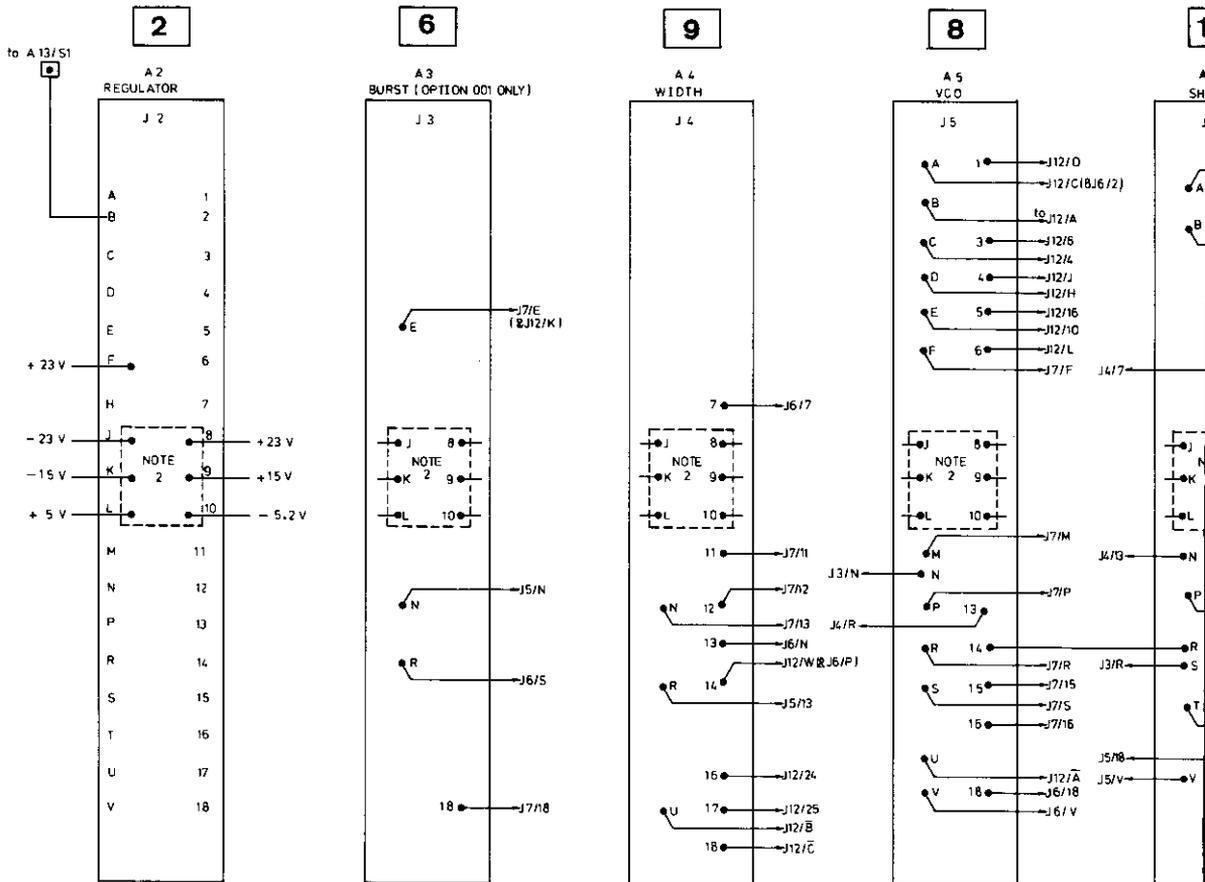


Figure 8-1-3. Troubleshooting Tree

A1 BD AY MOTHERBOARD 08111-66501 STANDARD
 A21 ■ ■ ■ ■ 08111-66521 OPTION 001



5	4	3	2	1
		J1		

NOTE : 1- BOARD VIEWED FROM UNDERSIDE
 2- POWER RAIL CONNECTIONS FOR J
 3- NUMBERS SHOWN AS [NO] INDIC
 4- DETAILS IN BRACKETS - () AR

1

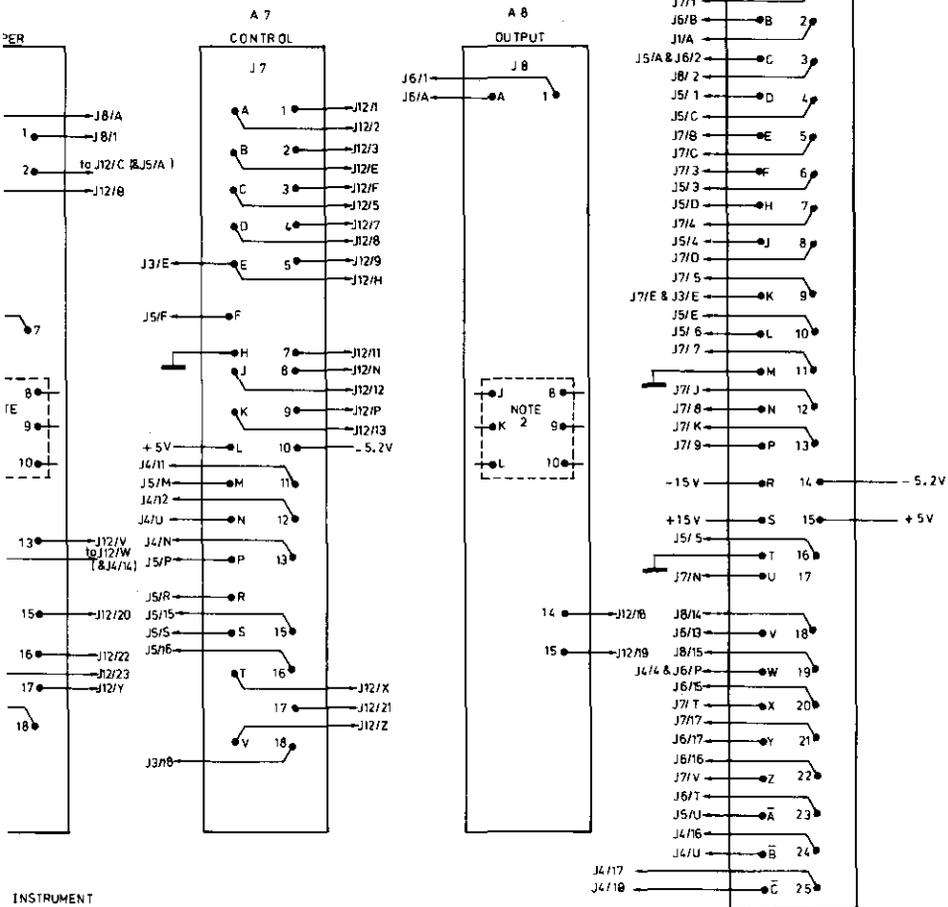
—FRONT— →

0

4

11

3



INSTRUMENT
AND J8 IDENTICAL WITH J2.
E CORRESPONDING SERVICE SHEET NUMBER.
ADDITIONAL CONNECTION POINTS

—FRONT— →

SERVICE BLOCK 2 POWER SUPPLY A1, A2, A13 2

THEORY OF OPERATION

General

The 8111A power supply comprises basically a step down transformer, bridge rectifiers, smoothing capacitors and various regulators. The components are distributed over boards – A1, A2 and A13.

The instrument may be operated from 100/120/220 or 240 Vrms single phase supplies. Two line voltage selector switches, A2, S2 and S3, are provided to enable the appropriate local voltage to be used. Operation of these switches causes the correct combination of transformer T1 primary windings to be selected so that the required secondary voltages are produced. These voltages are then rectified, smoothed and regulated to produce the following regulated supplies:

$$\pm 23 \text{ V}, \pm 15 \text{ V}, +5 \text{ V}, -5.2 \text{ V}$$

The unregulated $\pm 23 \text{ V}$ rails are used to generate auxiliary $\pm 15 \text{ V}$ supplies and regulated $\pm 23 \text{ V}$ and $\pm 15 \text{ V}$. The auxiliary supplies ($\pm 15 \text{ VR}$) are derived via zener diodes

and are the power source for PSU (Power Supply Unit) regulators and protection circuits. In the event of a PSU shut-down, due to a short circuit for example, the auxiliary supplies ensure that the protection circuits maintain their integrity.

NOTE: References to components in the following paragraphs are always for board A2 unless otherwise indicated.

Reference Voltage

All voltage regulators in this PSU use the same reference voltage (-5.2 V) which is generated by zener diode VR1 and a potential divider.

At instrument switch on the zener diode supply current for the -5.2 V supply comes from the rectified transformer output via CR10, R3, Q2. During normal operation the zener current comes from the regulated -15 V supply via CR9, CR10 is then nonconducting. R2/C5 provides a slow ramp-like rise of the reference voltage and therefore also of the regulated supplies.

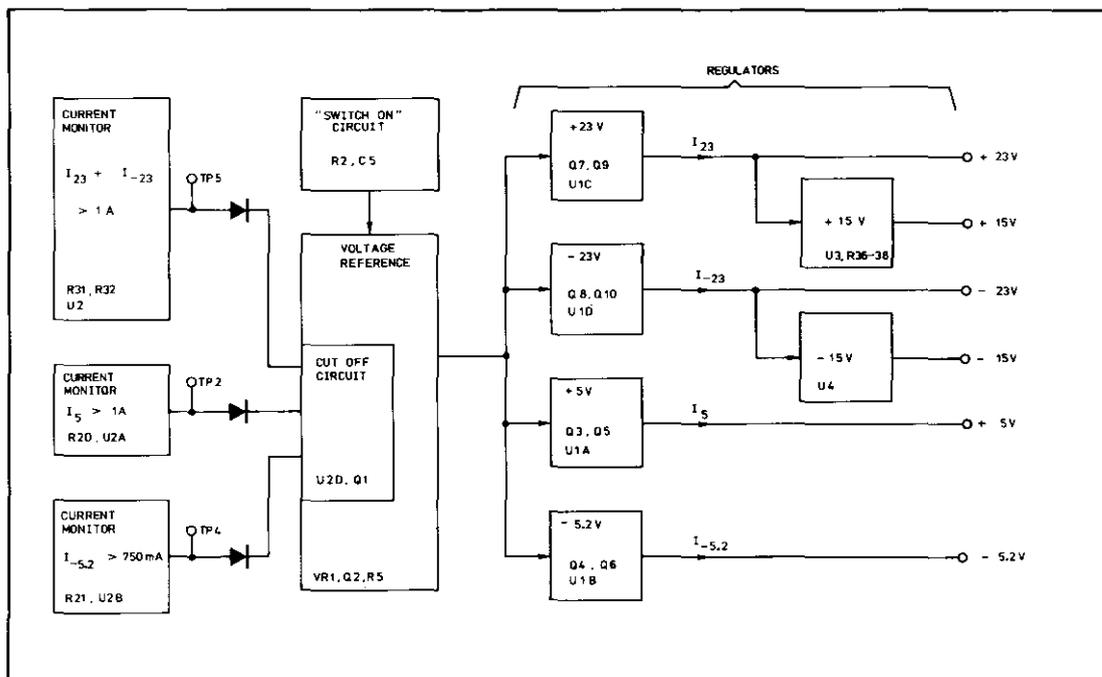


Figure 8-2-1. Simplified Voltage/Current Regulating/Limiting Circuits

± 23 V Supplies

A simplified functional diagram illustrating the operating principle of a positive voltage regulator is shown in Figure 8-2-2. The circuit functions as an inverting amplifier with a high current output. The operating principle of the negative voltage regulator is shown in Figure 8-2-3. The error amplifier compares V_{reg} with V_{ref} and drives the regulator transistor to zero difference. Excessive output current is detected by R31 and R32 as shown in Figure 8-2-5. The output of the overload amplifier U2C goes high if the voltage drops over R31 and R32 exceed a set level.

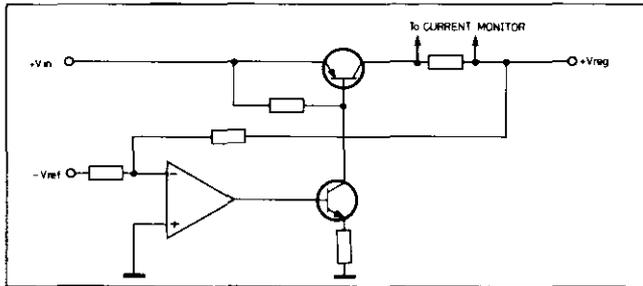


Figure 8-2-2. Principle of Fixed Positive Voltage Regulator

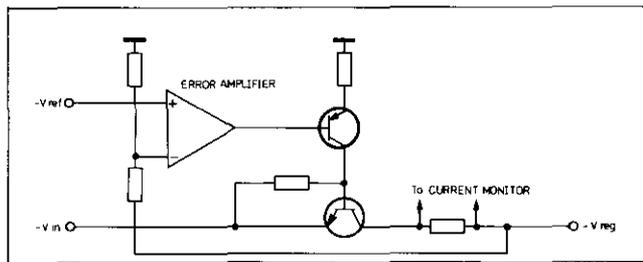


Figure 8-2-3. Principle of Fixed Negative Voltage Regulator

± 15 V Supplies

The ± 15 V supplies are derived from the regulated ± 23 V supplies by using "standard 3 pin" voltage regulators. Excessive current is detected by R31 and R32.

± 5 V/-5.2 V Supplies

The voltage regulator operating principles are the same as those which have been described in the previous paragraphs. Principles of excessive current detection of the +5 V regulator is shown in Figure 8-2-4. For the -5.2 V regulator the same principle applies with changed polarities.

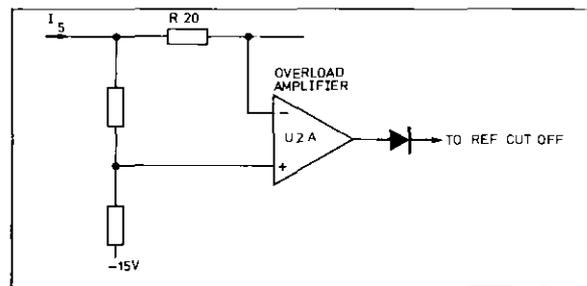


Figure 8-2-4. Current Monitor

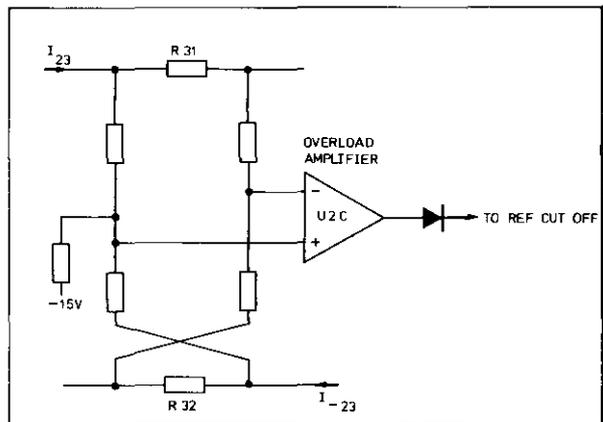


Figure 8-2-5. Summing Current Monitor

Switch-off Circuit

An overload signal from one of the current monitoring amplifiers will cause C6 to charge up via R8. When the threshold level of the Schmitt trigger U2D, R9, R10 is reached, its negative going output turns Q1 on, the current for Vref is turned off, so Vref goes to zero causing all regulated voltages to be reduced to zero. After a time (determined by the time constant of R7 and C6) the threshold level of the Schmitt trigger (now negative) is reached, Q1 turns off, C5 begins to charge up, thus ensuring a slow ramp-like rise of the reference voltage at R5. If the overload still exists, then the whole procedure is repeated continuously.

TROUBLESHOOTING

Two basic faults can occur in the PSU:

- a. no voltage or over-voltage caused by a faulty supply.
- b. excessive current consumption (due to a short circuit or faulty component) on one of the boards which is recognizable by all supplies being repeatedly switched on and off.

Faulty Supply

If one supply is at fault, troubleshoot it as necessary to locate the faulty or failed components.

Excessive Current

Note that an excessive current taken from only one supply will cause all supplies to be switched on and off repeatedly. A short circuit across one of the supplies will cause all voltage rails to be narrow pulsed, thus the 8111A display will remain dark (LEDs under-energized). Excessive current, but no short circuit causes wider pulses and the display may flash.

To determine which is the overloaded supply, measure at TP2, TP4 and TP5 and note which current monitor is active, (see Figure 8-2-6).

Having determined the overloaded supply, locate the faulty board by pulling out each in turn starting with the output amplifier and finishing with the complete front panel assembly.

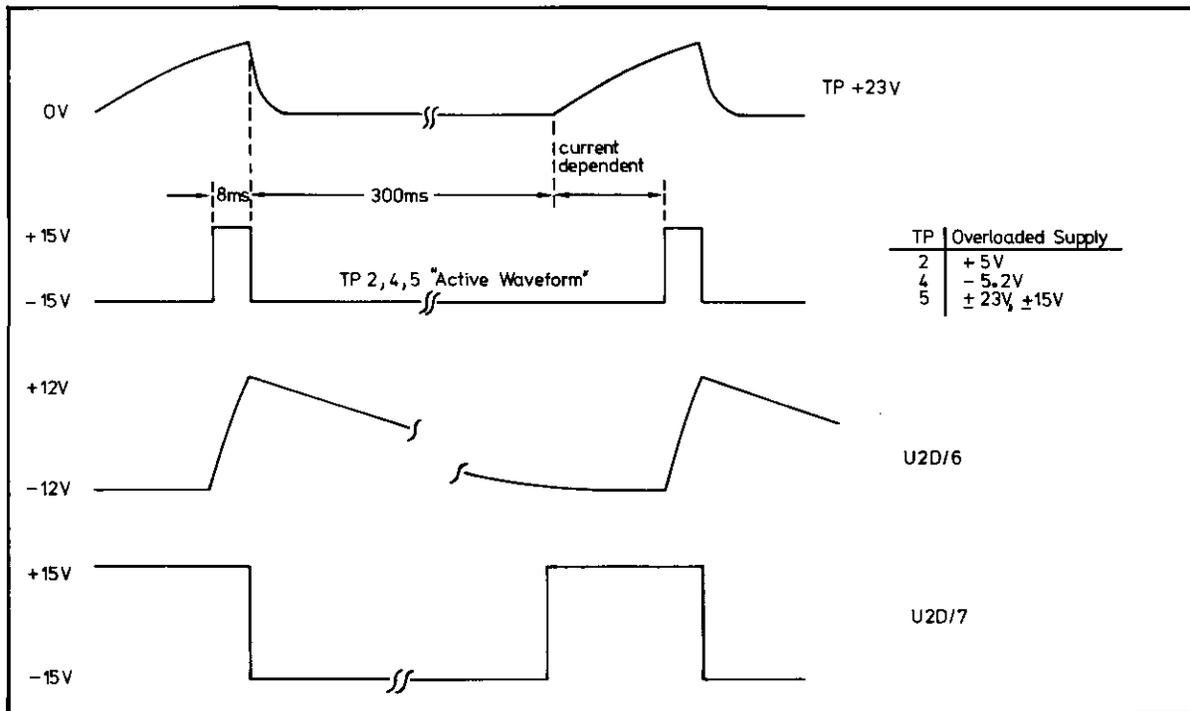
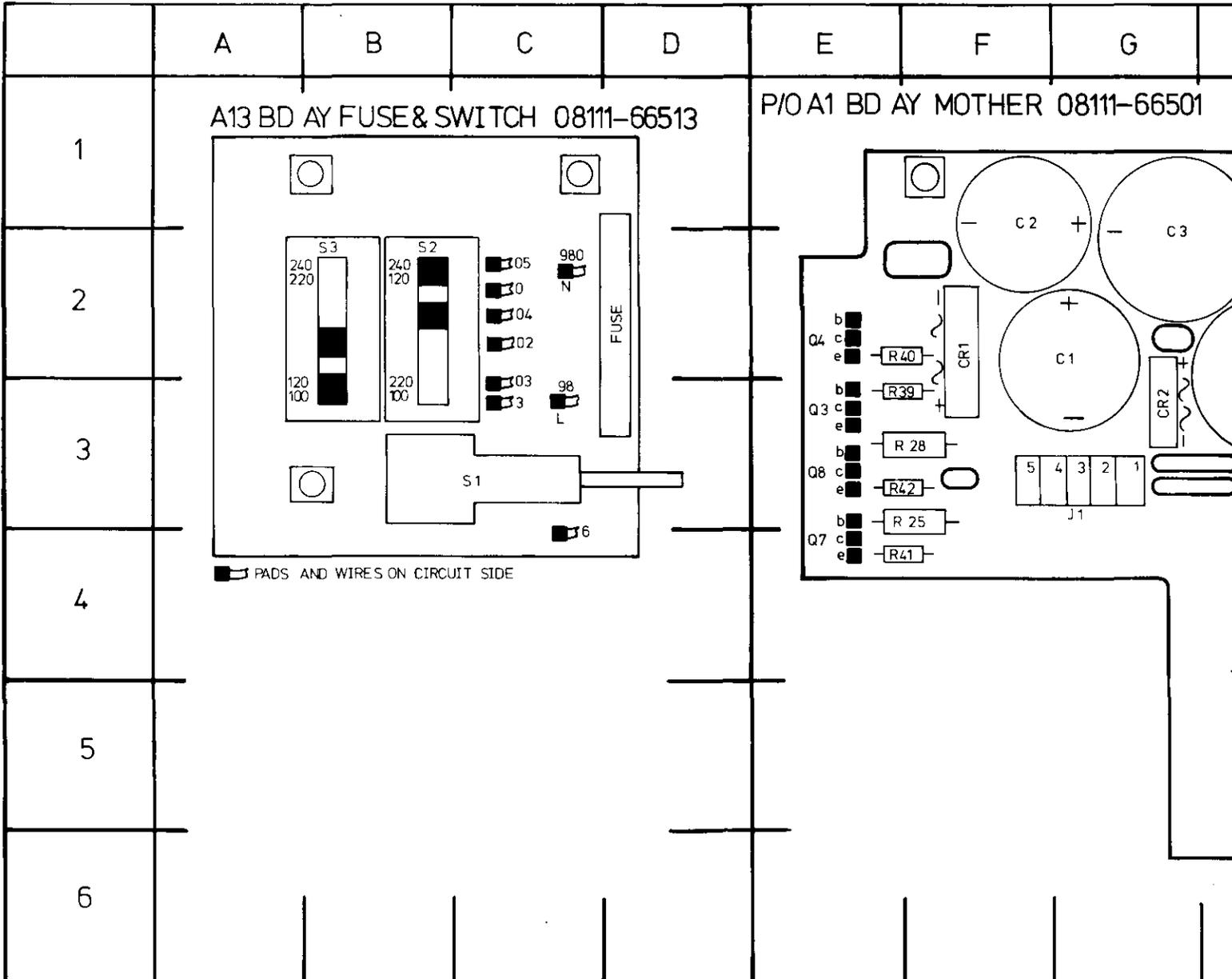


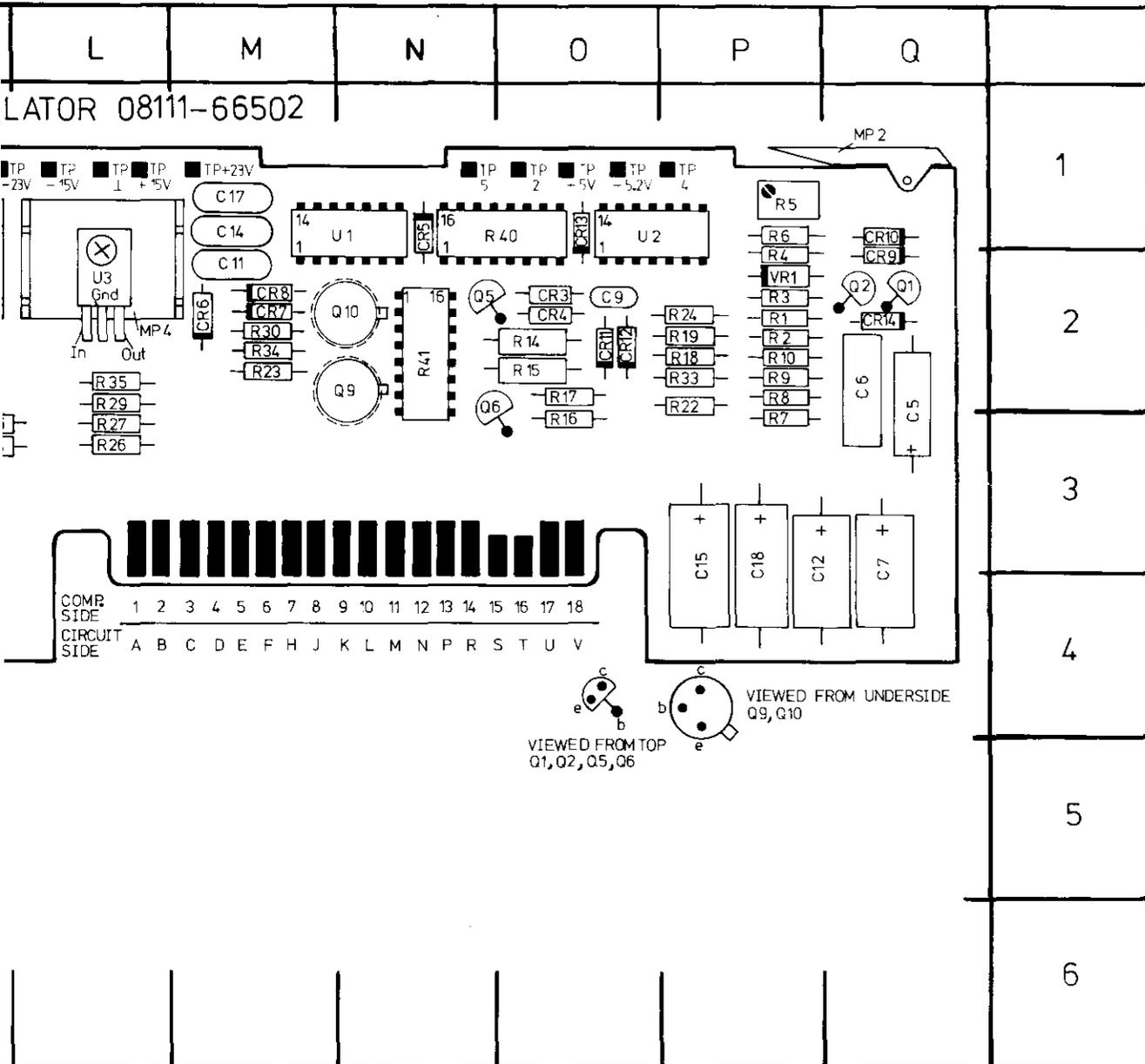
Figure 8-2-6. Fault Condition Output Waveforms



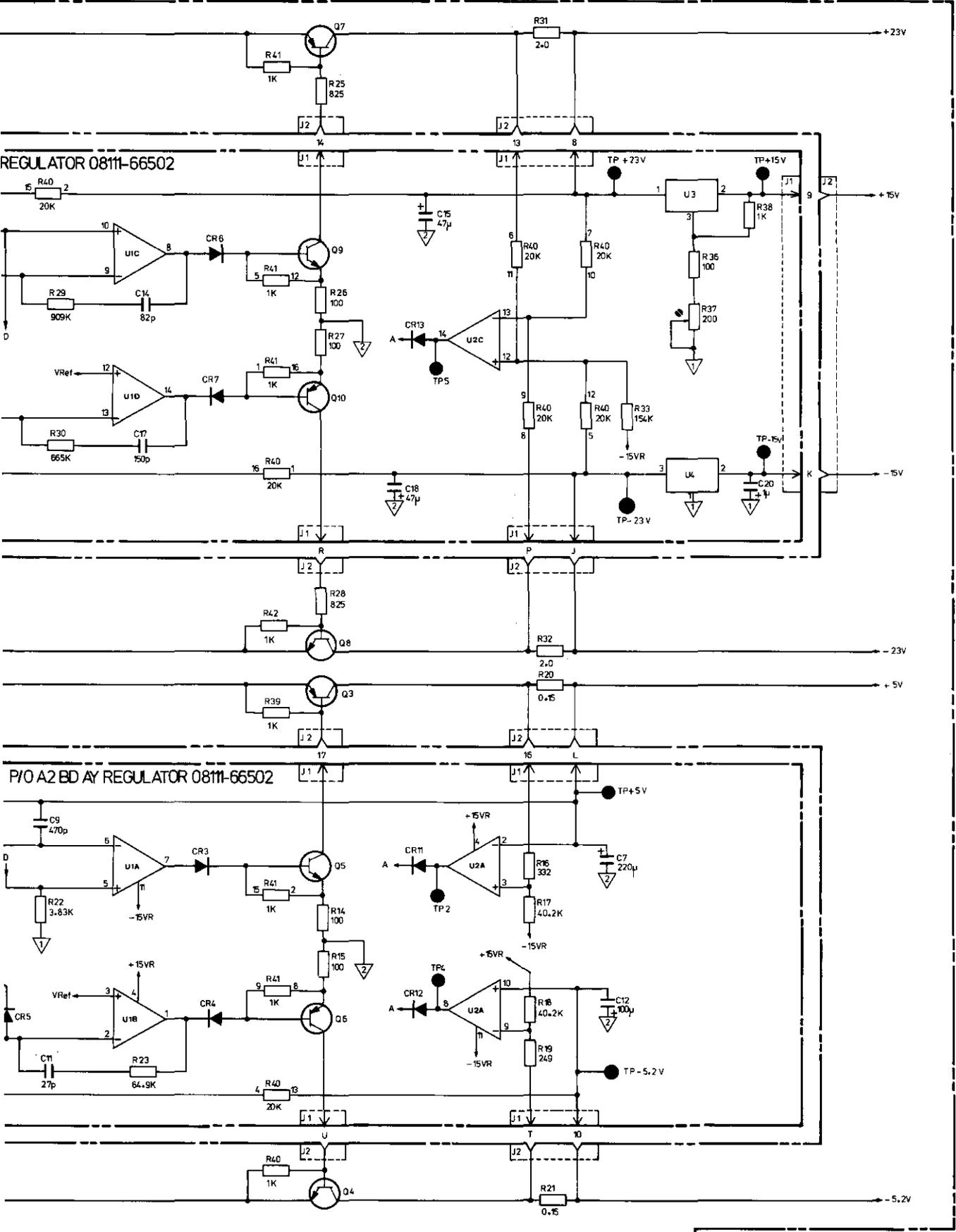
REF DESIG	GRID LOC
S1	B/C3
S2	B2
S3	B2

REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	G2	R39	E3
C2	F2	R40	E2
C3	G2	R41	E4
C4	H2	R42	E3
CR1	F2	Q3	E3
CR2	G3	Q4	E2
J1	G3	Q7	E4
R12	H4	Q8	E3
R13	H4		
R20	H5		
R21	H4		
R25	E3		
R28	E3		
R31	H5		
R32	H5		

2



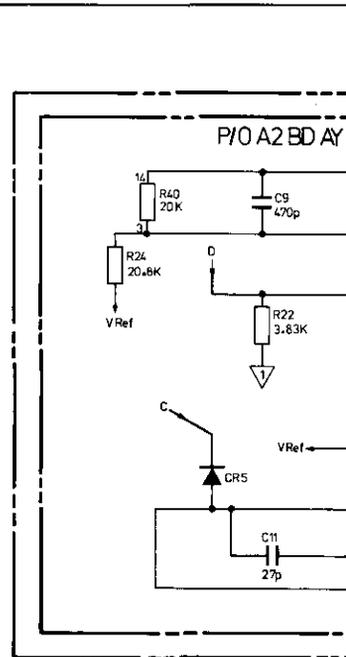
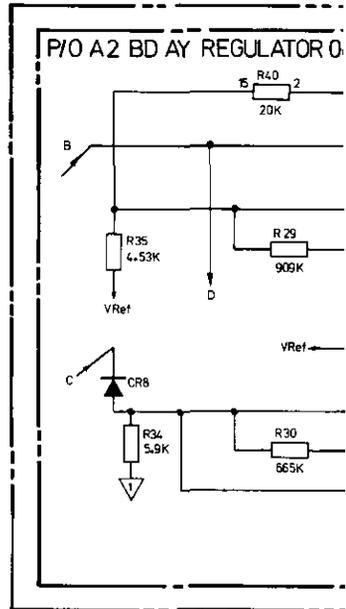
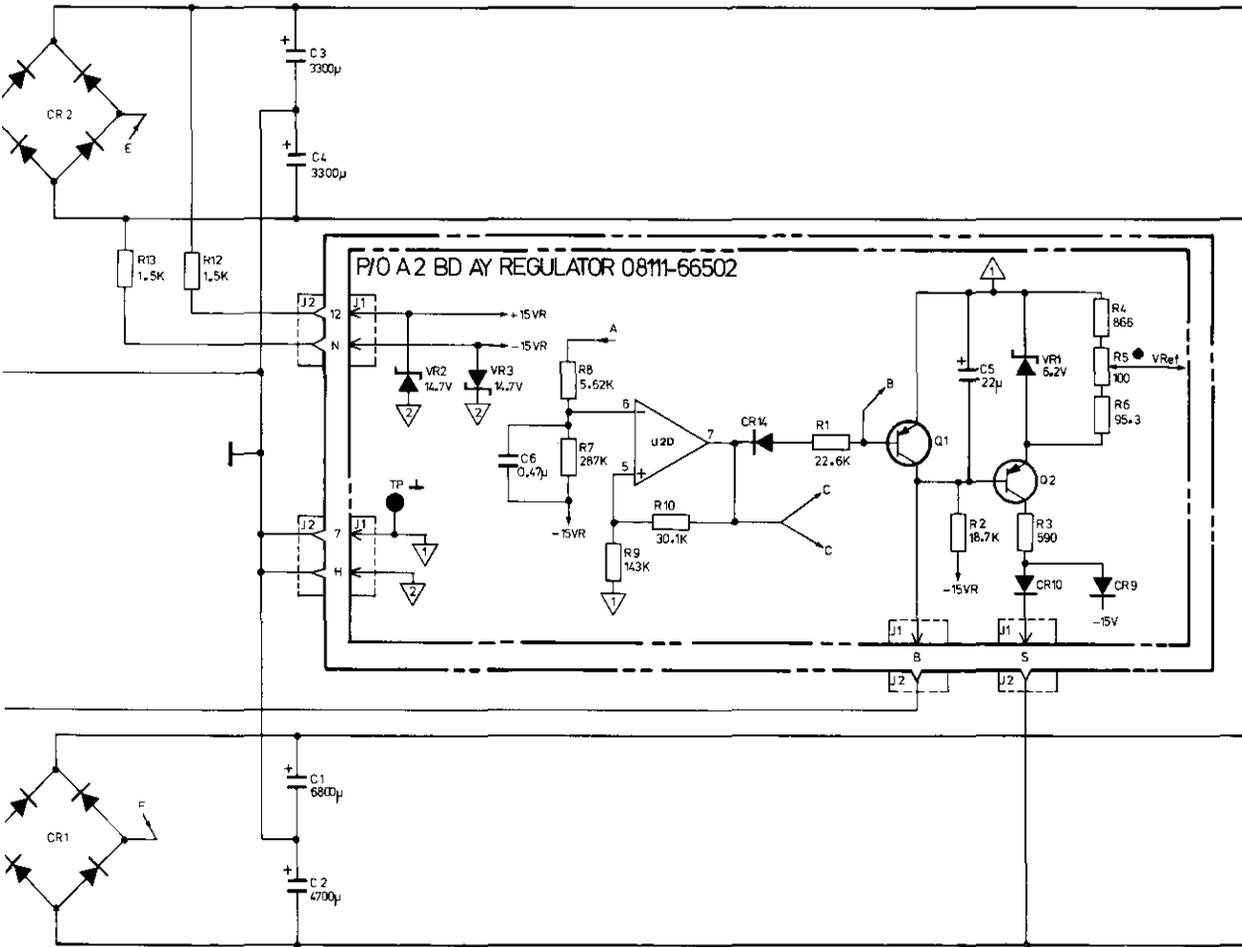
REF DESIG	GRID LOC								
R7	M2	R2	P2	R22	P2	TP2	O1	VR2	P2
R8	M2	R3	P2	R23	M2	TP4	P1	VR3	J2
R9	Q2	R4	P2	R24	P2	TP5	M1		
R10	Q1	R5	P1	R26	L3	TP+5V	O1		
R11	O2	R6	P1	R27	L3	TP-5, 2V	O1		
R12	O2	R7	P3	R29	L2	TPGND	L1		
R13	O1	R8	P2	R30	M2	TP-23V	L1		
R14	Q2	R9	P2	R33	P2	TP+23V	M1		
1	Q2	R10	P2	R34	M2	TP-15V	L1		
2	Q2	R14	O2	R35	L2	TP+15V	L1		
5	N2	R15	O2	R36	K2	U1	N1		
5	N2/3	R16	O2	R37	K2	U2	O1		
9	N2	R17	O2	R38	K2	U3	L2		
10	N2	R18	P2	R40	N1	U4	K2		
1	P2	R19	P2	R41	N2	VR1	P2		



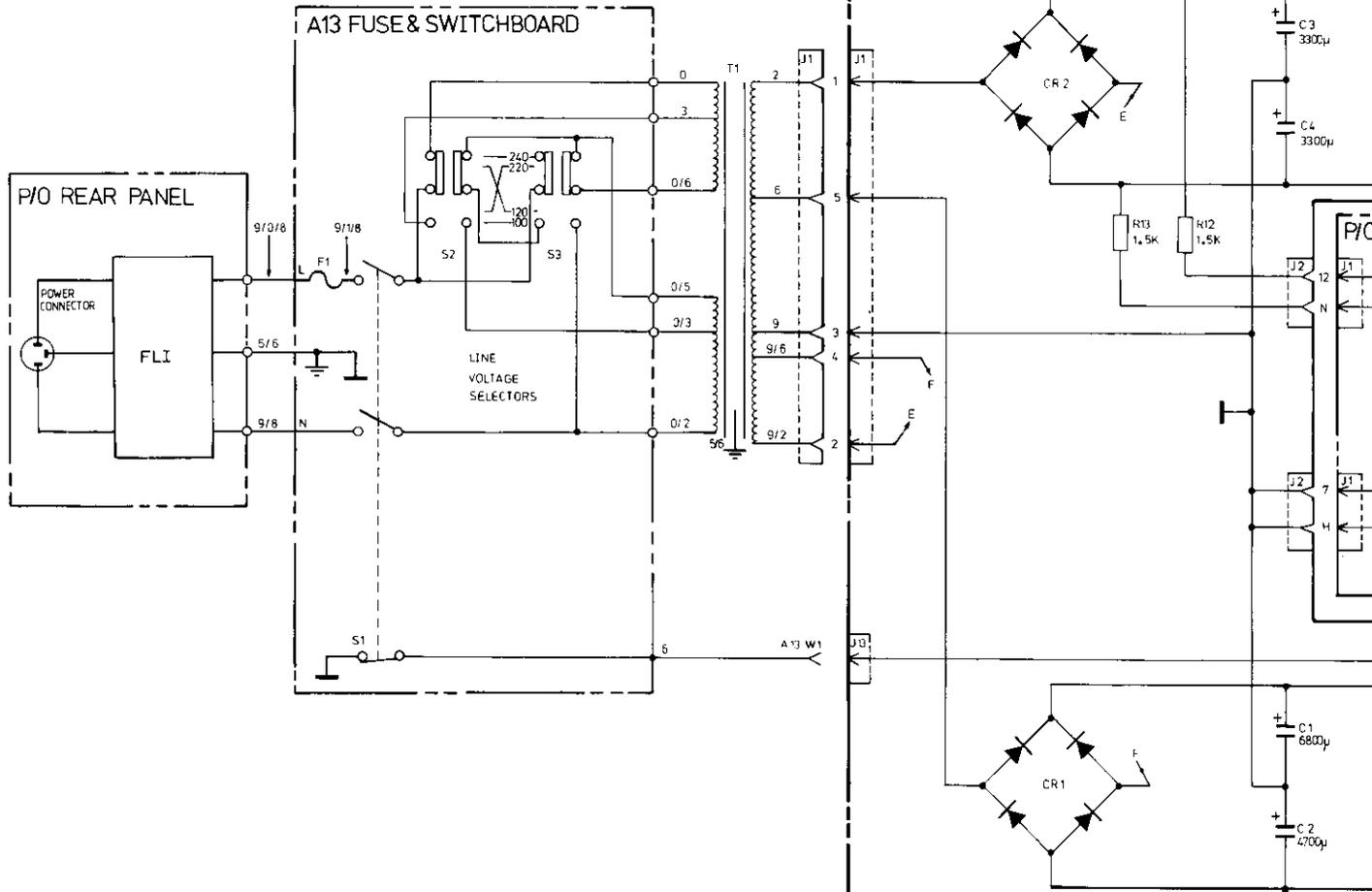
POWER SUPPLY A1, A2, A13

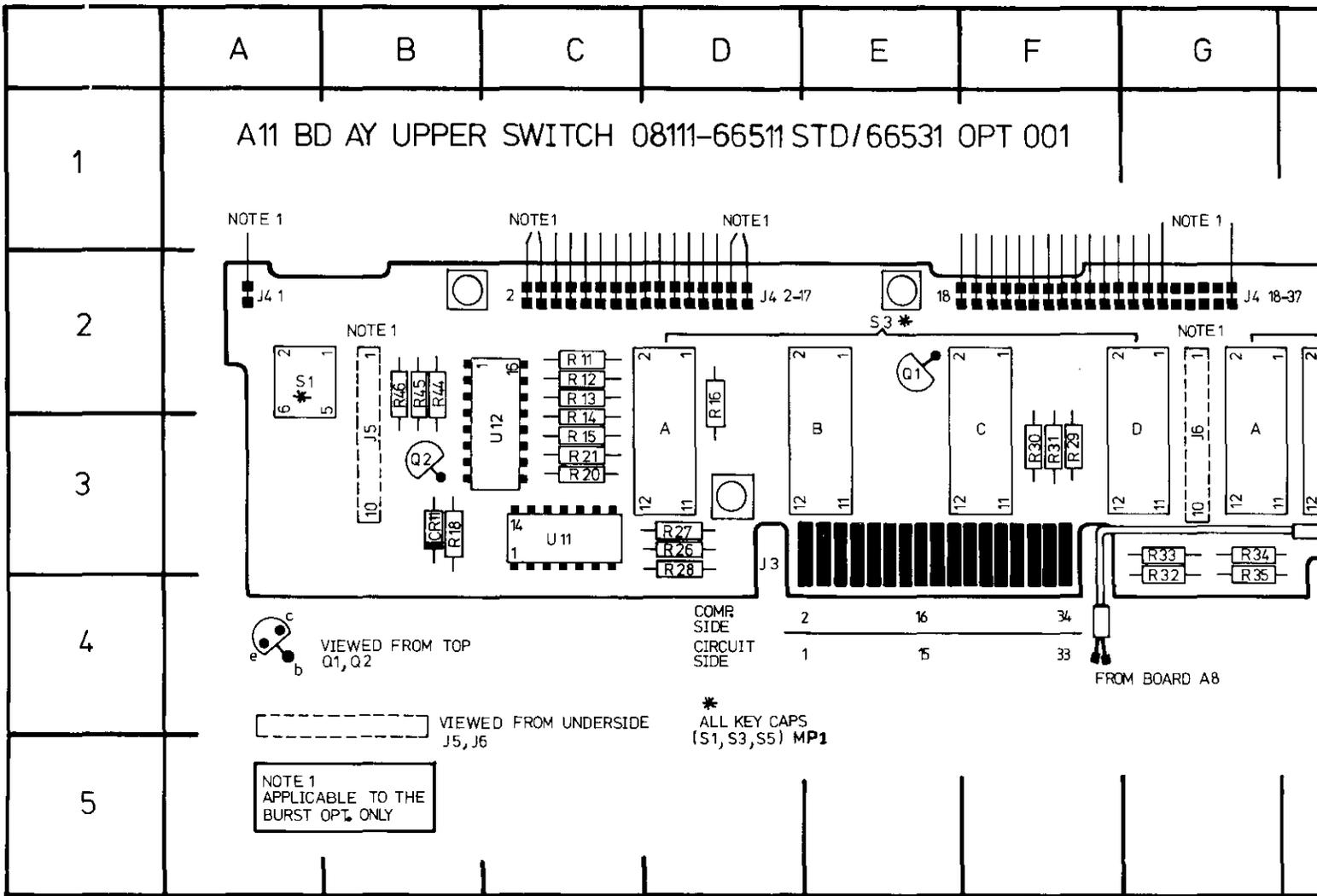
2

Y MOTHERBOARD 08111-66501 (STANDARD)
 Y MOTHERBOARD 08111-66521 (OPTION 001)



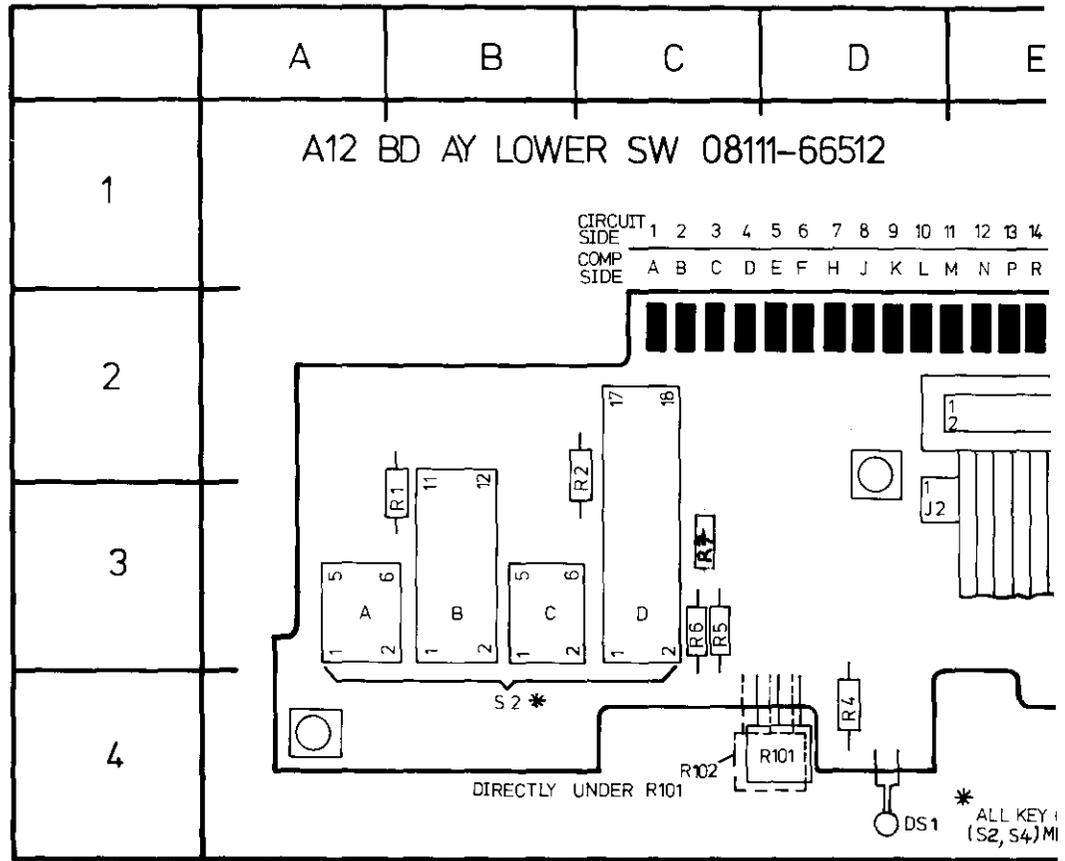
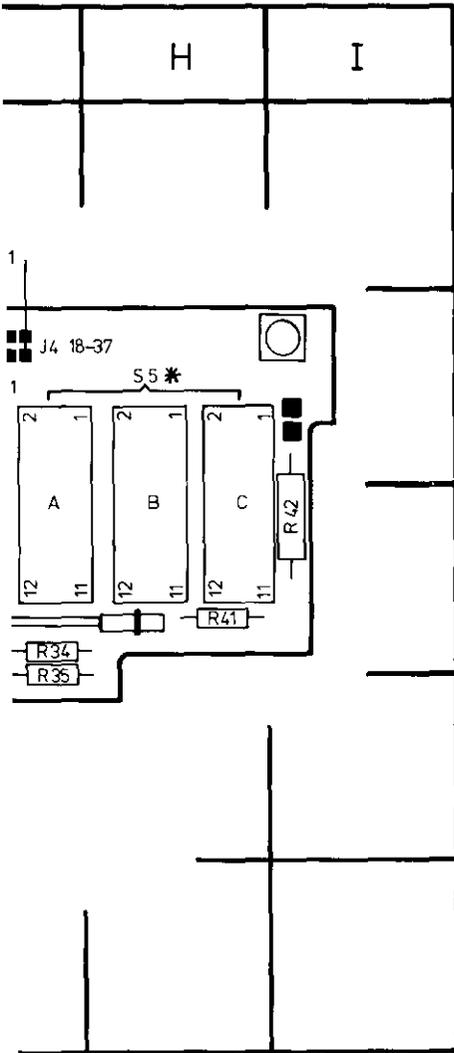
P/O A1 BD AY MOTHERBOARD 08111-66501 (STA
A21BD AY MOTHERBOARD 08111-66521 (OP



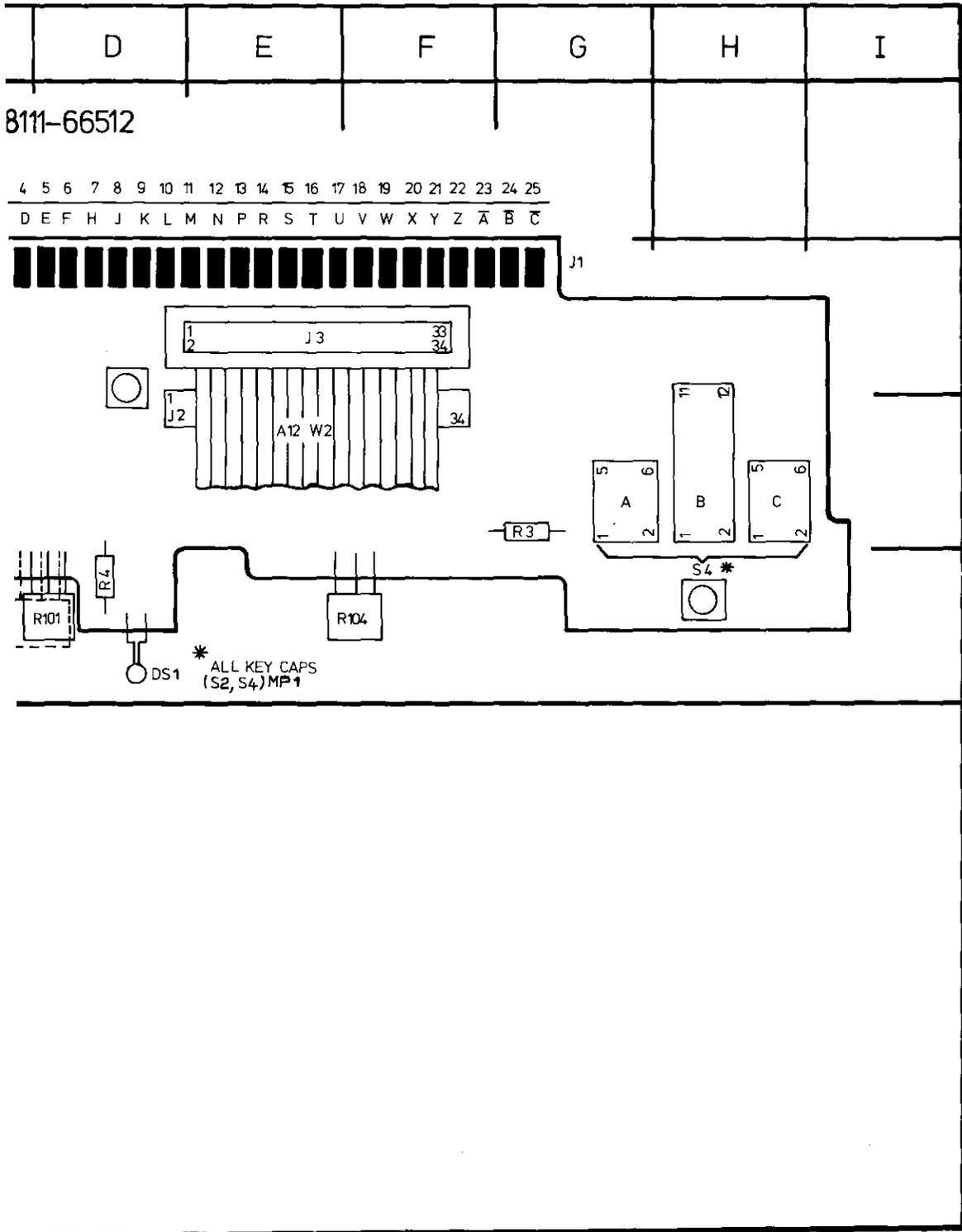


REF DESIG	GRID LOC	REF DESIG	GRID LOC
CR11	B3	R30	F3
Q1	E2	R31	F3
Q2	B3	R32	G4
R11	C2	R33	G3
R12	C2	R34	G3
R13	C2	R35	G4
R14	C3	R41	H3
R15	C3	R42	F3
R16	D2	R44	B2
R18	B3	R45	B2
R20	C3	R46	B2
R21	C3	S1	A2
R26	D3	S3	C/G3
R27	D3	S5	D/G3
R28	D3	U11	C3
R29	F3	U12	C3

3



REF DESIG	GRID LOC
DS1	D4
J2	D/F2
R1	B3
R2	B3
R3	G3
R4	D4
R5	C3
R6	C3
R101	D4
R102	D4
R104	F4
S2	A/C3
S4	G/H3
R7	C3



SERVICE BLOCK 3 SWITCH BOARDS A11 (A31), A12 3

THEORY OF OPERATION

The Switch boards contain the switches and interconnections required for selection of the appropriate circuit elements involved in the various 8111A operating modes and functions. An additional feature of A11 (A31) is that it includes the voltage reference, and parameter signal control circuitry for the Display board A-D converter. The reference selection and signal switching is achieved by multiplexer A11 U12 under the control of A11 U11.

TROUBLESHOOTING

NOTE: FRONT PANEL ASSEMBLY REMOVAL:

To troubleshoot either of the switch boards (or Display or Burst Number Control board) it is usually necessary to separate the complete Front Panel Assembly from the instrument frame and motherboard connector (J12) and reconnect it via an extender board. To remove the front Panel Assembly refer to Figure 3-1 to identify the securing screws to be removed. Access to the two upper screws is by removing MP24 - the plastic trim strip which can be levered out with the aid of a screwdriver.

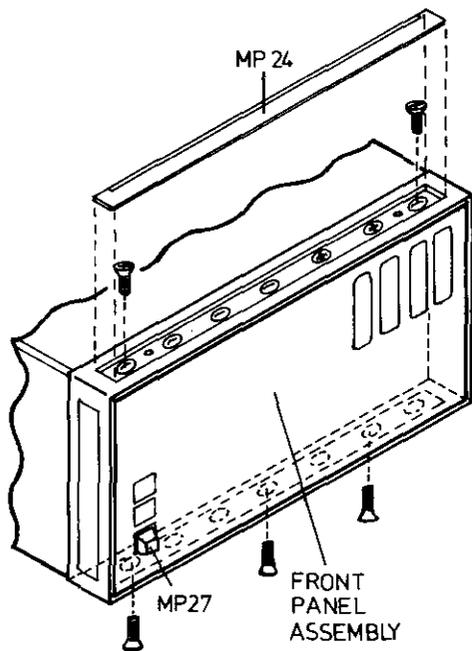


Figure 3-1.

After removal of the five screws the complete Front Panel assembly can be gently pushed forward out of the instrument frame away from the motherboard connector and over MP27.

NOTE: There are two interconnecting co-axial cables between the Front Panel assembly and boards A6 and A8, complete removal of the assembly from the instrument requires that they are disconnected at the two boards. The same applies (Option 001 instruments only) to the ribbon cable between A3 and A9, this should be disconnected at board A9.

REMEMBER to reconnect all of these cables when re-fitting the Front Panel Assembly in the instrument.

When refitting the assembly, MP27 should be guided through the appropriate front panel hole otherwise it can jam.

Since the switch boards comprise mostly passive components, no troubleshooting information is included for these. The only data is the following: If the displayed value is incorrect, then, as mentioned in Service Block 5 (Display), A11 U11 and A11 U12 may be faulty. The following truth table conditions should be checked and it should be noted that U11 pin 9 is high only when the Duty/Width and Frequency pushbuttons are both pressed.

Table 8-3-1. U11 Truth Table

Selected Waveform	U11 pin 8
  	L
	H

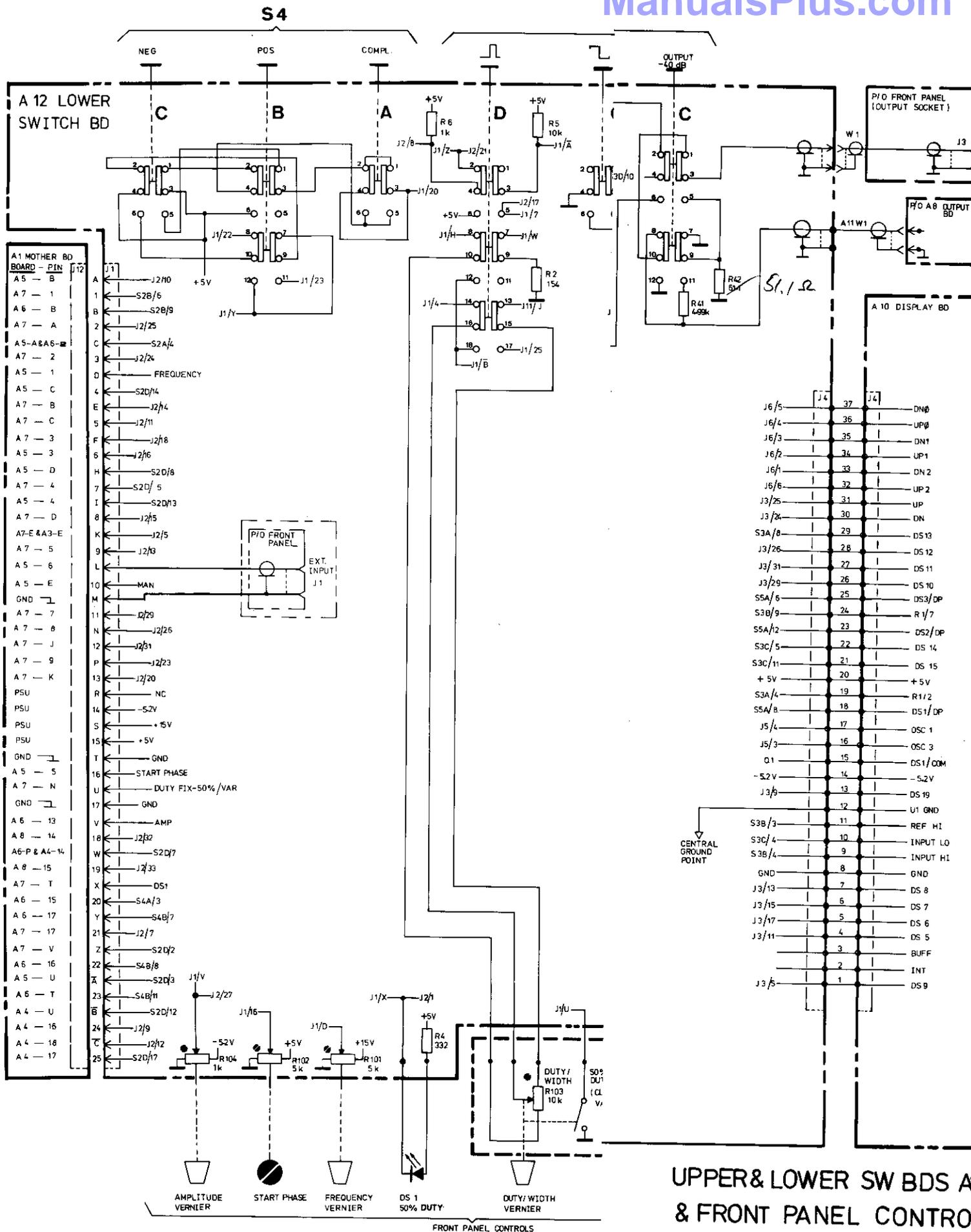
Table 8-3-2. U11 Truth Table

Duty/Width Mode	U11 pin 5/6
variable	H
fixed 50 %	L
	H

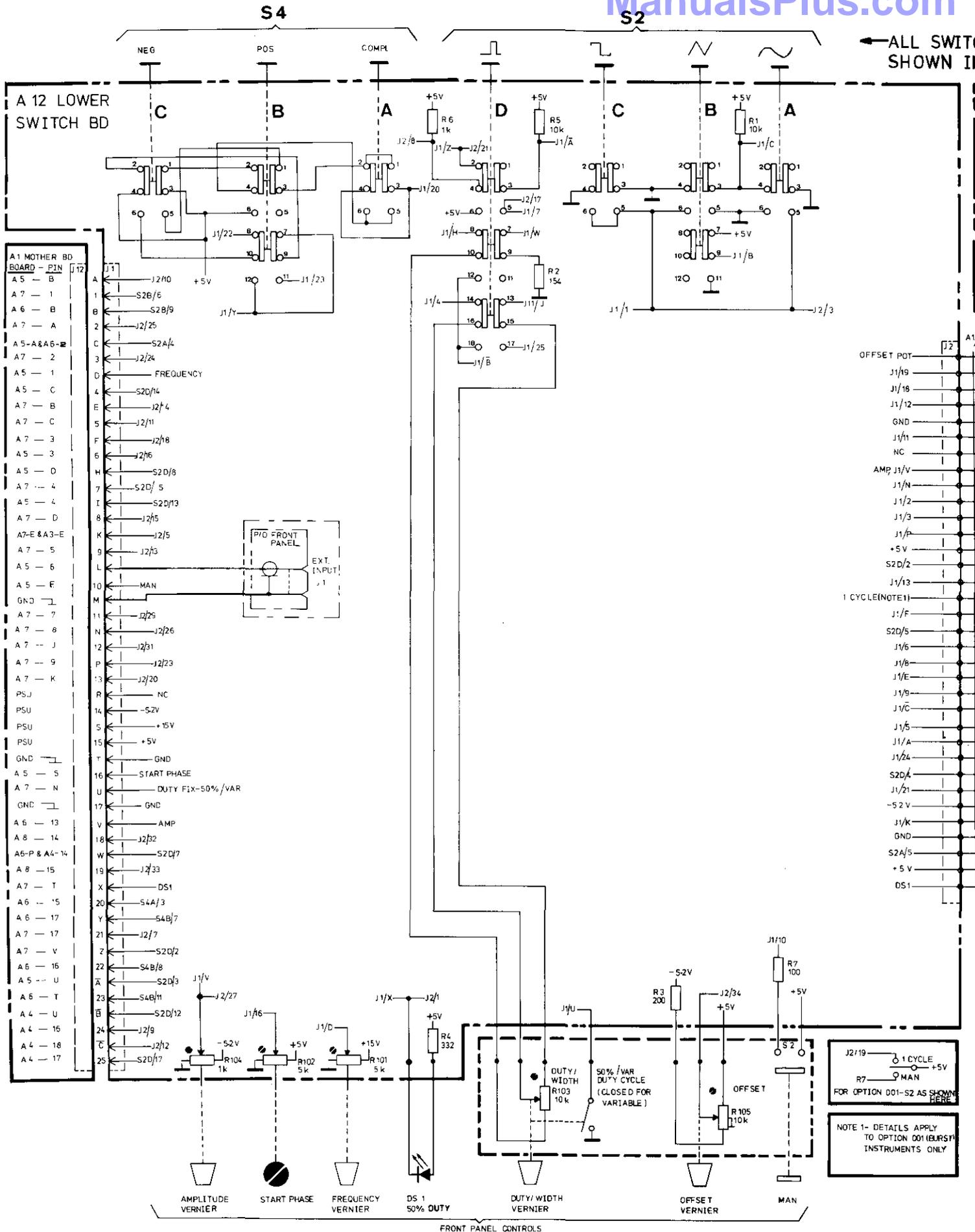
To check that the correct voltages are output from A11, refer to Service Block 5, Table 8-5-1 and A11 J4 pins 9, 10 and 11 (instead of A10 U1 pins 31, 30 and 36 respectively).

Table 8-3-3 U11, U12 Truth Table for various 8111A settings

8111A Setting			U11			U12	
Selected Waveform	Freq & Duty/Width pressed for Burst No Display?	Duty Cycle Mode	pin 8	9	5/6	9	10
 or  or 	no	fixed 50 %	L	L	L	L	L
 or  or 	no	variable	L	L	H	L	H
 or  or 	yes	fixed 50 %	L	H	L	H	L
 or  or 	yes	variable	L	H	H	H	L
	yes	X	H	H	H	H	L
	no	X	H	L	H	H	H



UPPER & LOWER SW BDS A & B
& FRONT PANEL CONTROLS



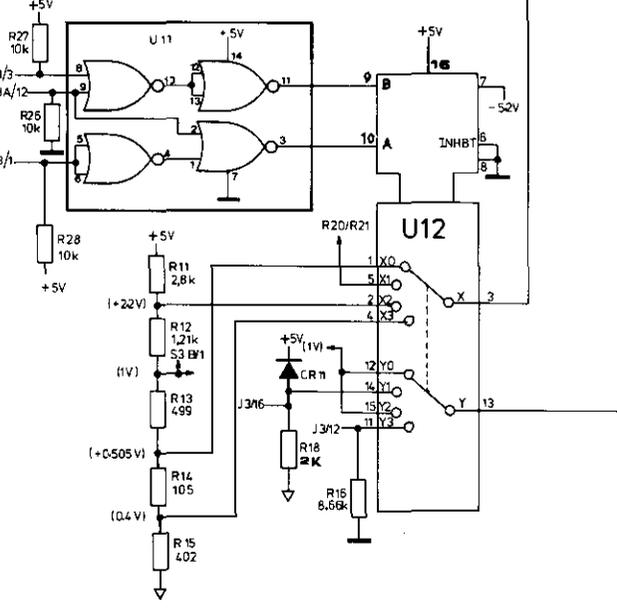
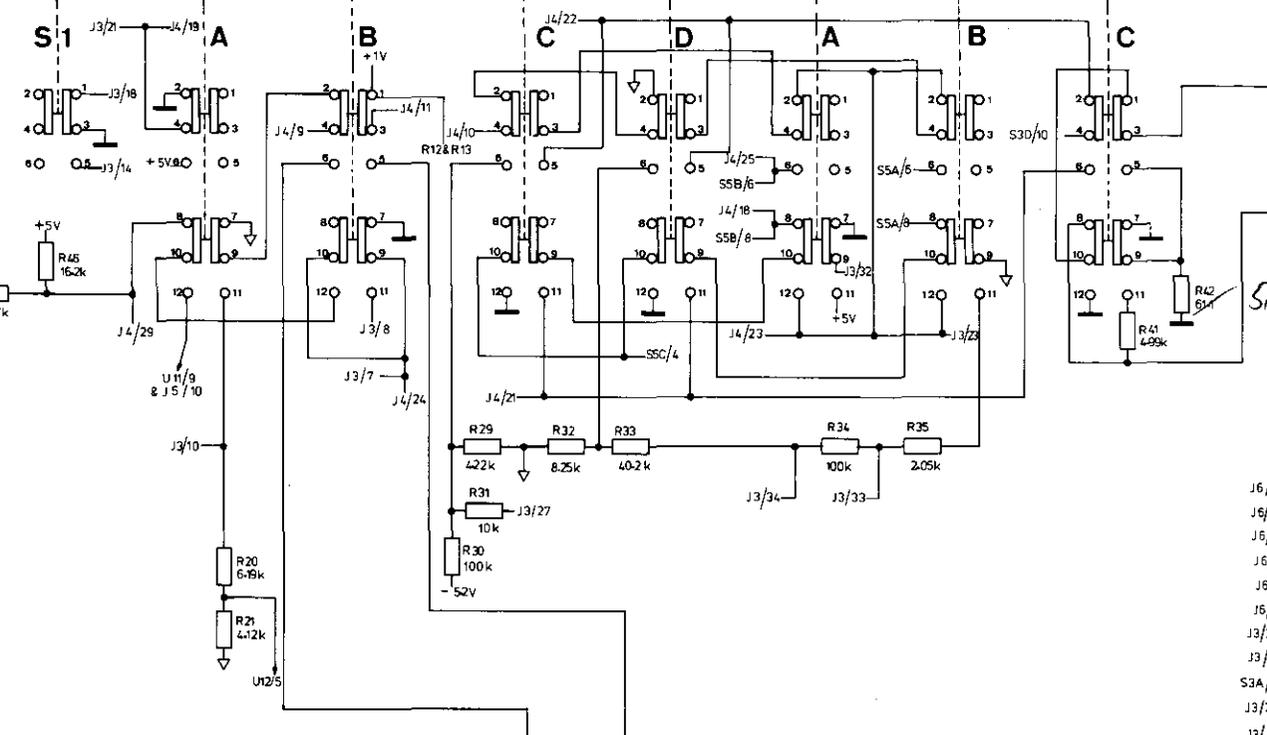
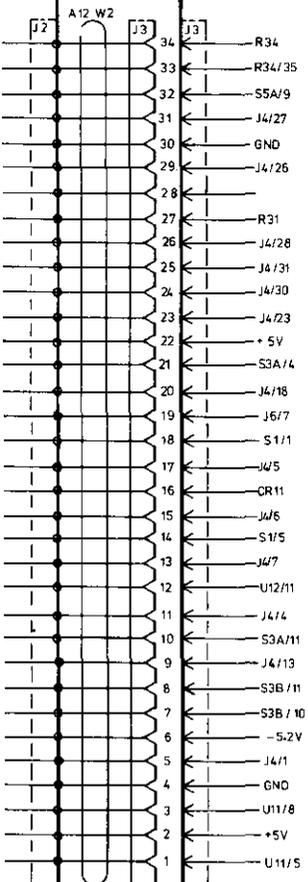
SWITCHES S1-S5 →
PWN IN*OUT POSITION

S1
NORMAL
TRIGGER
GATE
VCO
BURST (NOTE 1)

S3

S5

A 11 UPPER
SWITCH BD
(A31 OPT 001)

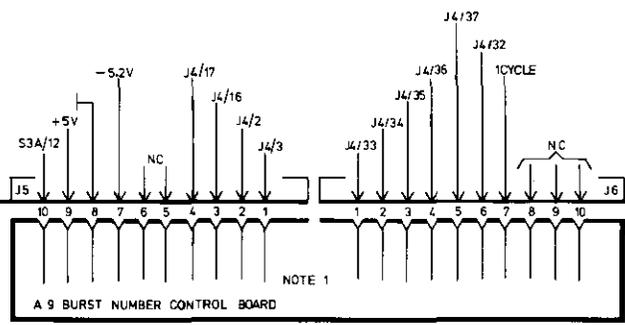


U12 TRUTH TABLE

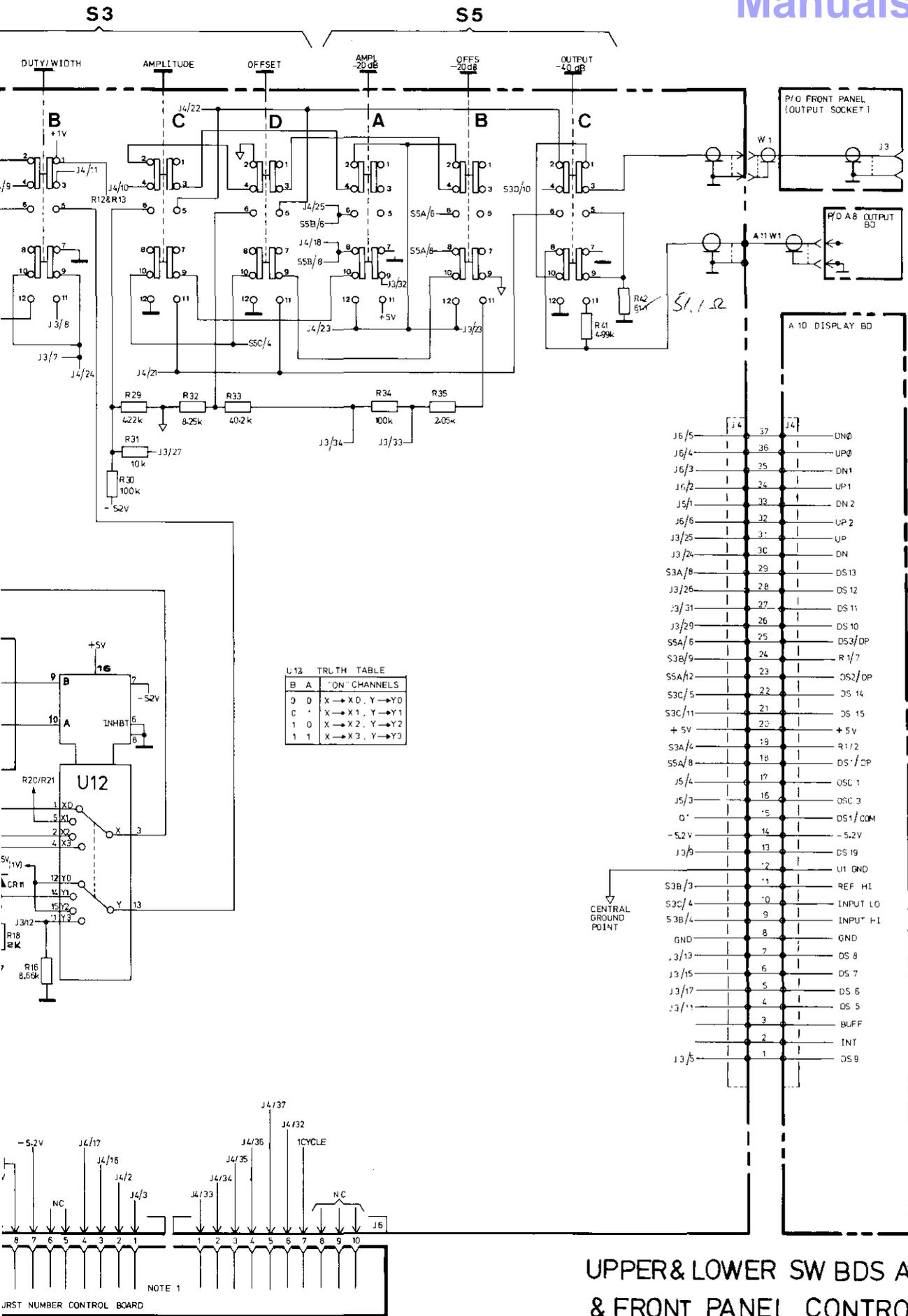
B	A	"ON" CHANNELS
0	0	X → X0, Y → Y0
0	1	X → X1, Y → Y1
1	0	X → X2, Y → Y2
1	1	X → X3, Y → Y3

- 16/5
- 16/4
- 16/3
- 16/2
- 16/1
- 16/6
- 13/25
- 13/24
- S3A/8
- 13/26
- 13/31
- 13/29
- S5A/6
- S3B/9
- S5A/2
- S3C/5
- S3C/11
- +5V
- S3A/4
- S5A/8
- 15/4
- 15/3
- 01
- 5.2V
- 13/5
- S3B/3
- S3C/4
- S3B/4
- GND
- 13/13
- 13/15
- 13/17
- 13/11
- 13/5

E
- +5V
: SHOW
HERE
PLY
(BURST)
ONLY



UPPER & L
& FRONT

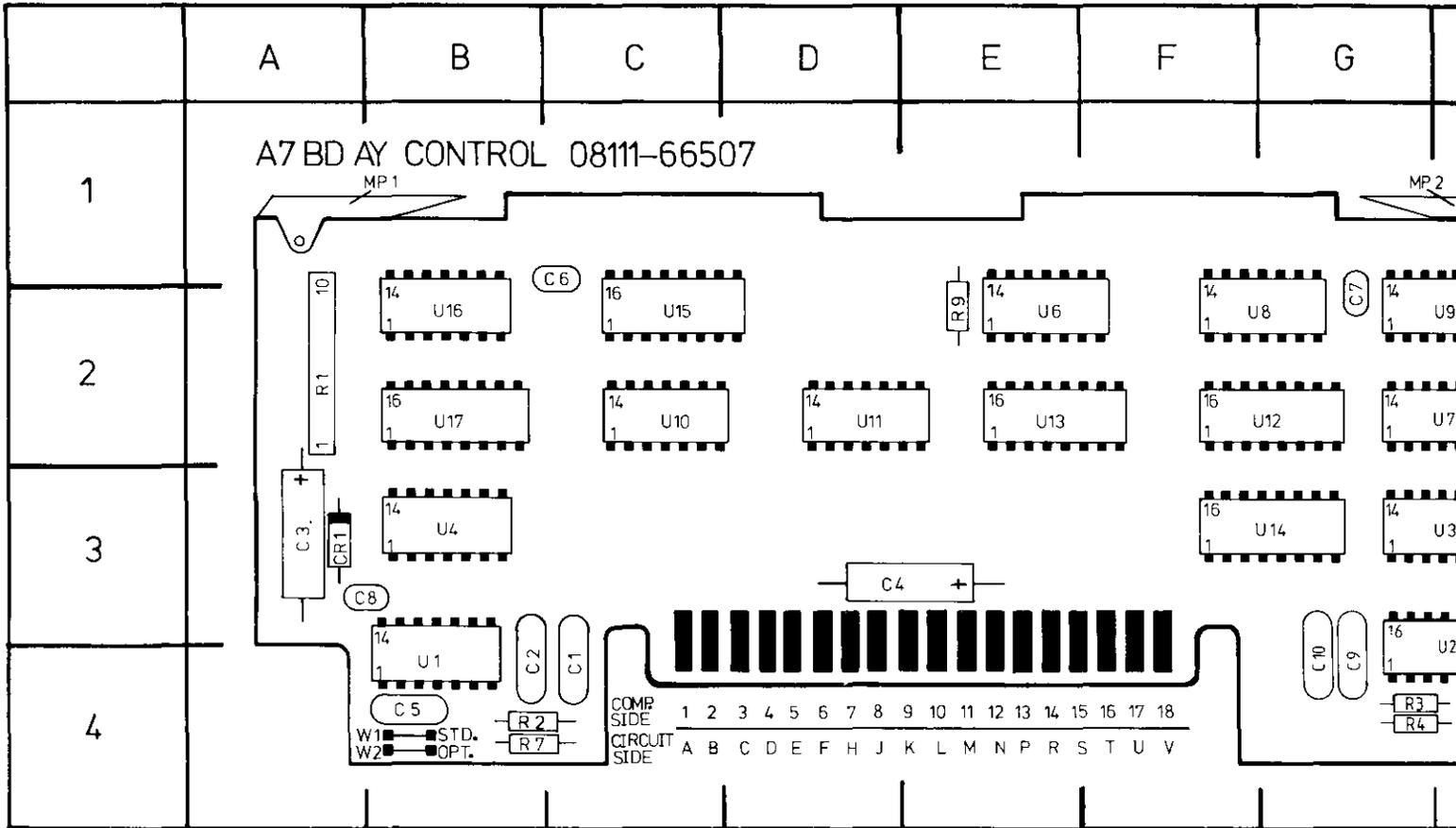


U12 TRUTH TABLE

B	A	"ON" CHANNELS
0	0	X → X0, Y → Y0
0	1	X → X1, Y → Y1
1	0	X → X2, Y → Y2
1	1	X → X3, Y → Y3

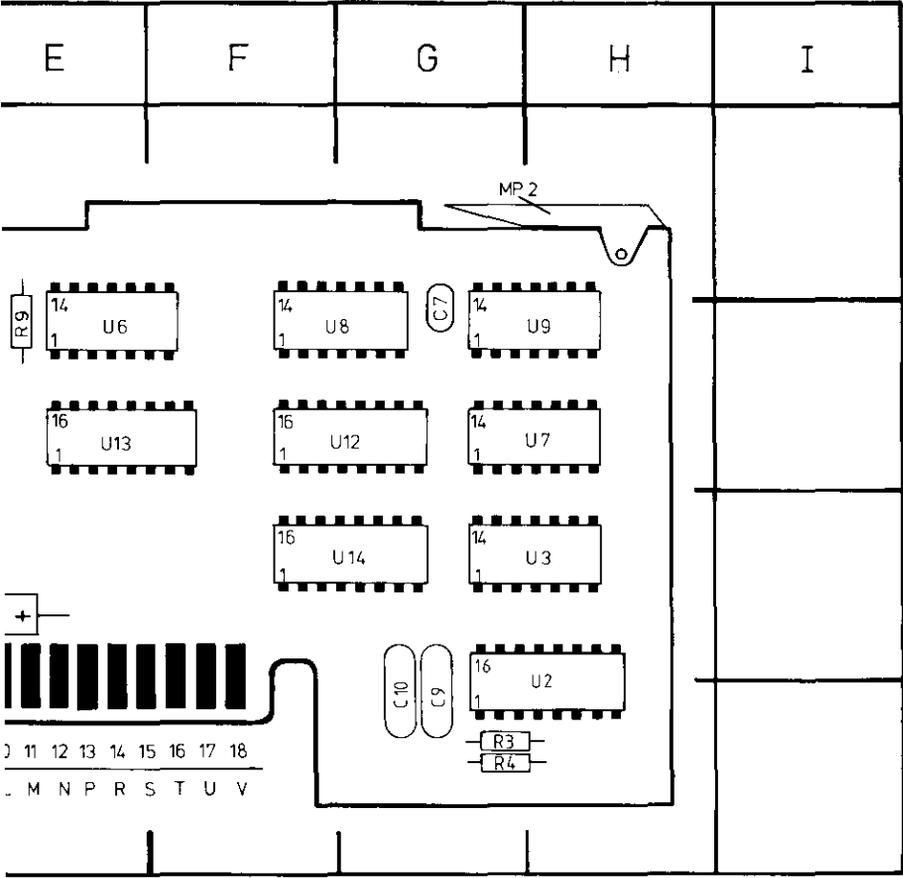
J6/5	37	DN0
J6/4	36	UP0
J6/3	35	DN1
J6/2	34	UP1
J5/1	33	DN2
J6/6	32	UP2
J3/25	31	UP
J3/24	30	DN
S3A/8	29	DS13
J3/26	28	DS12
J3/31	27	DS11
J3/29	26	DS10
SSA/6	25	DS3/DP
S3B/9	24	R1/?
SSA/12	23	DS2/DP
SSC/5	22	DS14
SSC/11	21	DS15
+5V		+5V
S3A/4	19	R1/2
SSA/8	18	DS1/2P
J5/4	17	OSC1
J5/3	16	OSC3
0	15	DS1/COM
-5.2V	14	-5.2V
J3/8	13	DS19
	12	U1 GND
S3B/3	11	REF HI
S3C/4	10	INPUT LO
S3B/4	9	INPUT HI
GND	8	GND
J3/13	7	DS8
J3/15	6	DS7
J3/17	5	DS6
J3/11	4	DS5
	3	BUFF
	2	INT
J3/5	1	DS9

UPPER & LOWER SW BDS A11 & A12 & FRONT PANEL CONTROLS



REF DESIG	GRID LOC	REF DESIG	GRID LOC
		U1	B4
C1	B4	U2	G/H3
C2	B4	U3	G3
C3	A3	U4	B3
C4	E3	U6	E2
C5	B4	U7	G2
C6	C1	U8	F2
C7	G2	U9	G2
C8	A3	U10	C2
C9	G3/4	U11	D2
C10	G3/4	U12	F2
CR1	A3	U13	G3
R1	A2	U14	F3
R2	B4	U15	C2
R3	G/H4	U16	B2
R4	G/H4	U17	B2
R7	B4	W1	B4
R9	E2	W2	B4

4



SERVICE BLOCK 4 CONTROL BOARD A7 4

THEORY OF OPERATION

General

The Control Board is the interface between the Switch boards A11, A12 and VCO and Width boards. It also directly controls the following Display board LEDs: operating mode, numeric display decimal point position, and the width and frequency unit indicators. An additional feature of A7 is to provide 8111A "power on" initial condition settings via the preset circuitry.

OPERATION

Referring to the block diagram Figure 8-4-1, the board operation is as follows: The two up/down counters U12 and U13 are clocked by the range rocker switch and output their data to either the VCO or Width boards. They also output, via U14/U15, the appropriate range unit and decimal point data to the Display board A10. The range rocker switch data is input to either U12 or

U13 via multiplexers U8A, C and U9A, C depending on whether the FREQUENCY or DUTY/WIDTH front panel pushbuttons are depressed.

The mode select pushbutton signal clocks a counter U17 whose outputs are fed to the VCO board A5 and sets the operating mode of the Triangle/Slope Generator IC A5U1. A7U17 outputs are also fed to the Display board and control the operating mode LEDs. In Option 001 (Burst) instruments A7U17 outputs enable the Burst function and associated mode LED.

On 8111A switch on the preset circuit sets the instrument to NORMAL mode, 1-10kHz frequency range and 1-10 μ s pulse width range. In option 001 models the burst counter is preset to one.

Depending on whether a waveform function (instead of PULSE) is selected, the operative frequency range and/or the position of the DUTY CYCLE vernier/switch, the "50 % LED" will be energised and the VCO board current source suitably controlled via the circuit elements shown.

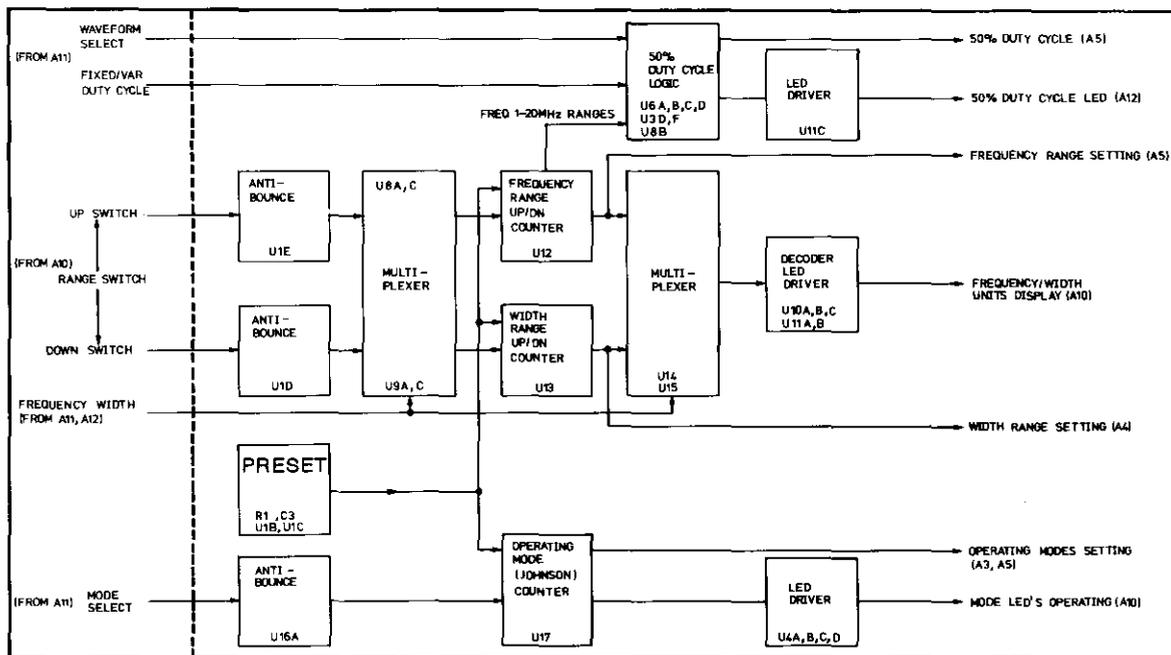


Figure 8-4-1. Simplified Control Board Block Diagram

TROUBLESHOOTING

The board can be considered as three separate functions for troubleshooting purposes. These are:

- Fixed 50 % Duty Cycle Logic
- Frequency/Width Up and Down Ranging
- Operating Mode Selection.

Since the three functions are all very different it is quite easy to link a failure or fault to the appropriate one.

All logic levels are TTL and can be measured with a suitable logic probe, it can be either externally energised or the 8111A +15 V supply may be used.

To isolate a fault check the circuit operation with the aid of the following truth tables.

Table 8-4-1. U6, U11 Truth Table

8111A Setting	U6 pin 13	U11 pin 8
-Mode	H	H
Mode, fixed 50 % DTY	H	L
Mode, variable DTY, 1 MHz-20 MHz	H	L
Mode, variable DTY, 1 Hz-1000 kHz	L	H

Table 8-4-2. U8 Truth Table

8111A Setting	down ranging				up ranging				
	U8 pin	1	2	13	12	11	9	10	8
Frequency pushbutton pressed									
10 - 20 MHz		H	H			H	L		H
1 - 10 MHz		H	H			H	H		
100 - 1000 kHz		H	H			H	H		
10 - 100 kHz		H	H			H	H		
1 - 10 kHz		H	H			H	H		
100 - 1000 Hz		H	H			H	H		
10 - 100 Hz		H	H			H	H		
1 - 10 Hz		H	L		H	H	H		
Frequency pushbutton released		L	X		H	L	X		H

Table 8-4-3. U9 Truth Table

8111A Setting	down ranging				up-ranging			
	U9 pin 1	2	13	12	11	9	10	8
Width and \square -Mode pushbuttons pressed								
10 – 100 ms	H	H	\surd	\surd	H	L	\surd	H
1 – 10 ms	H	H	\surd	\surd	H	H	\surd	\surd
100 – 1000 μ s	H	H	\surd	\surd	H	H	\surd	\surd
10 – 100 μ s	H	H	\surd	\surd	H	H	\surd	\surd
1 – 10 μ s	H	H	\surd	\surd	H	H	\surd	\surd
100 – 1000 ns	H	H	\surd	\surd	H	H	\surd	\surd
25 – 100 ns	H	L	\surd	H	H	H	\surd	\surd
Width or \square -Mode pushbutton released	L	X	\surd	H	L	X	\surd	H

Fixed 50 % Duty Cycle Logic

Table 8-4-4. U12 Truth Table

8111A Frequency Range Setting	Range Data U12 pin	C 6	B 2	A 3
10 – 20 MHz		L	L	L
1 – 10 MHz		L	L	H
100 – 1000 KHz		L	H	L
10 – 100 KHz		L	H	H
1 – 10 KHz	(Status at 8111A Switch on) \rightarrow	H	L	L
100 – 1000 Hz		H	L	H
10 – 100 Hz		H	H	L
1 – 10 Hz		H	H	H

Frequency/Width Up/Down Ranging

Table 8-4-5. U13 Truth Table

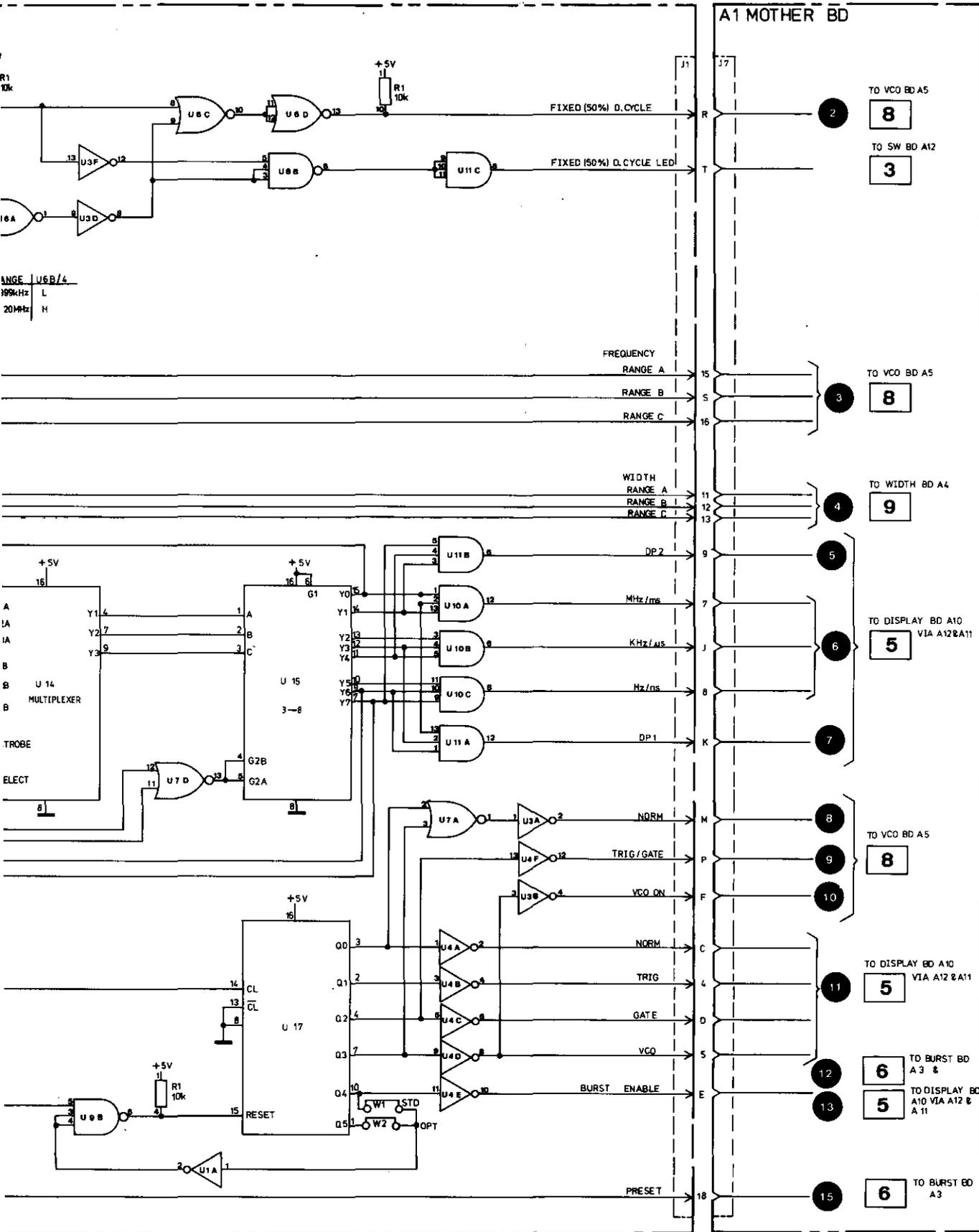
8111A Width Range Setting	Range Data U13 pin	C 6	B 2	A 3
10 – 100 ms		L	L	L
1 – 10 ms		L	L	H
100 – 1000 μ s		L	H	L
10 – 100 μ s		L	H	H
1 – 10 μ s	(Switch on Status) \rightarrow	H	L	L
100 – 1000 ns		H	L	H
25 – 100 ns		H	H	L

Operating Mode Selection

Table 8-4-6. U17 Truth Table

8111A Setting U17 pin	Q ₀ 3	Q ₁ 2	Q ₂ 4	Q ₃ 7	Q ₄ 10
NORMAL	H	L	L	L	L
TRIGGER	L	H	L	L	L
GATE	L	L	H	L	L
VCO	L	L	L	H	L
BURST (Option 001 only)	L	L	L	L	H

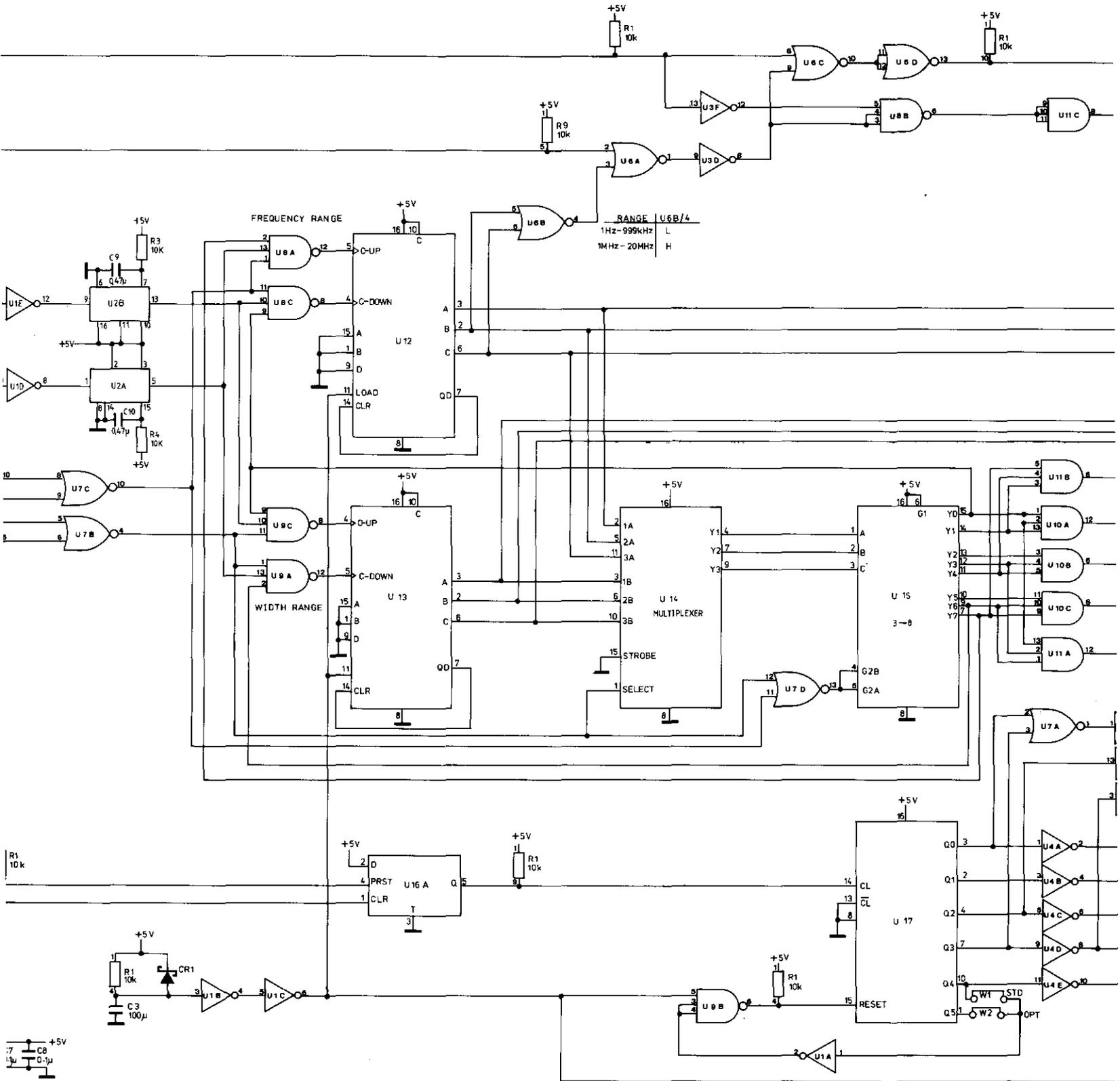
The counter is reset when Q₄ (Q₅ in Option 001) goes to high level.



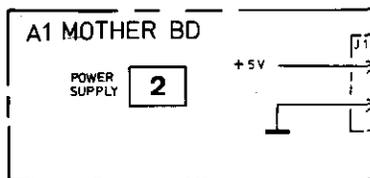
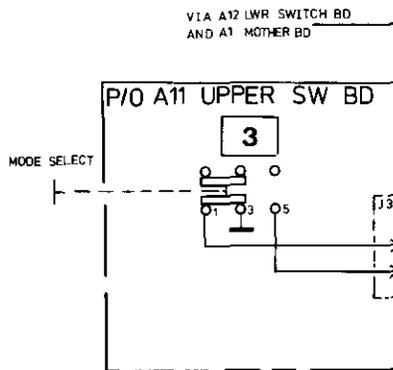
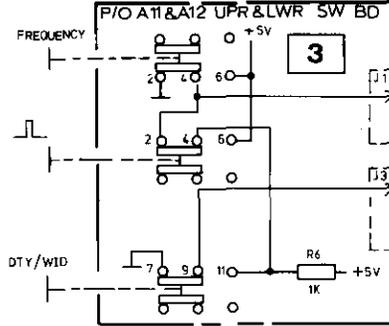
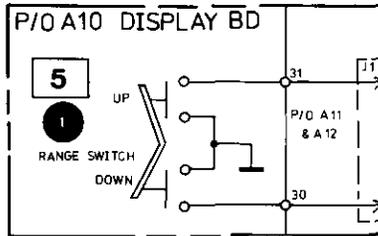
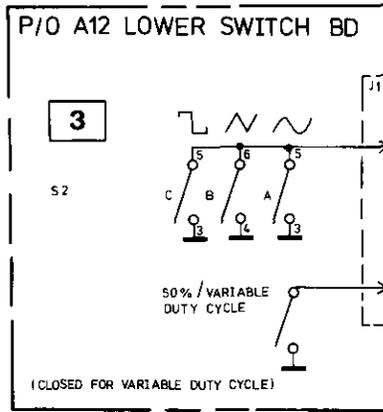
CONTROL BOARD A7

4

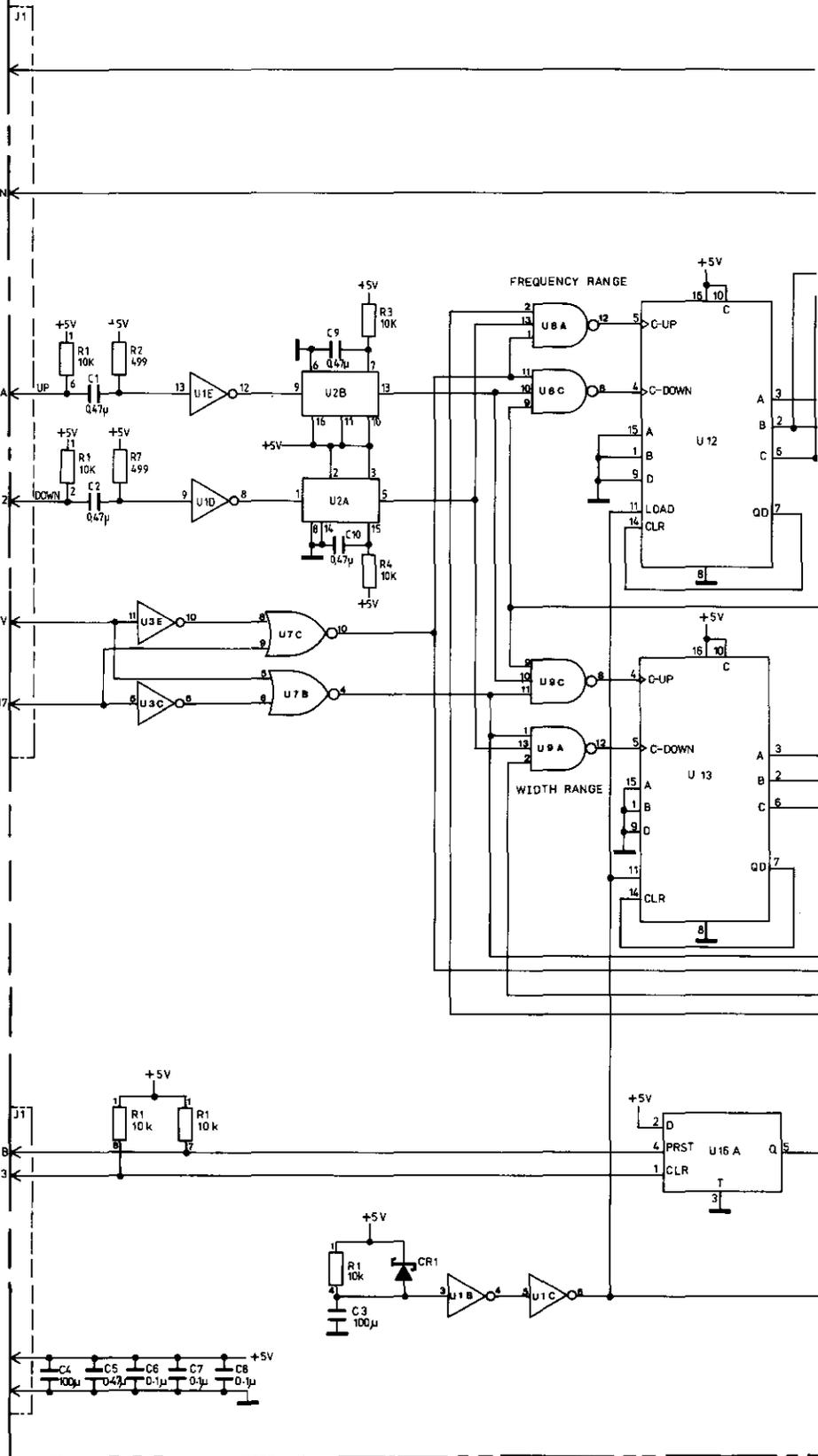
CONTROL 08111-66507



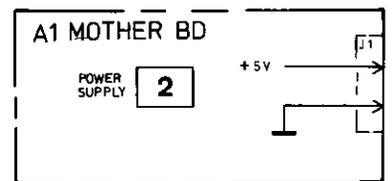
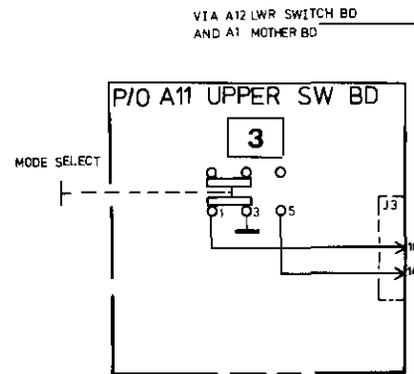
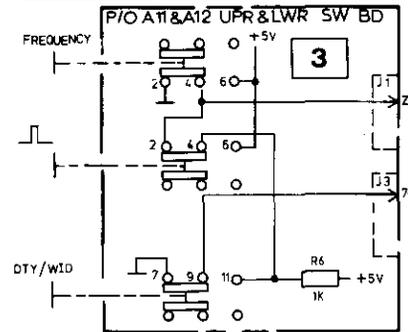
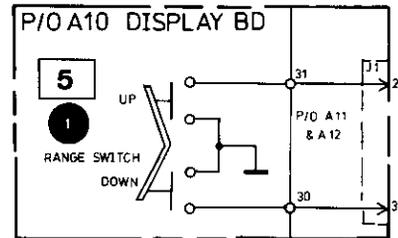
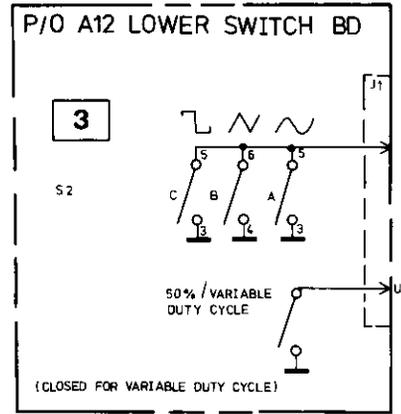
BETWEEN BOARDS
UNLESS OTHERWISE INDICATED

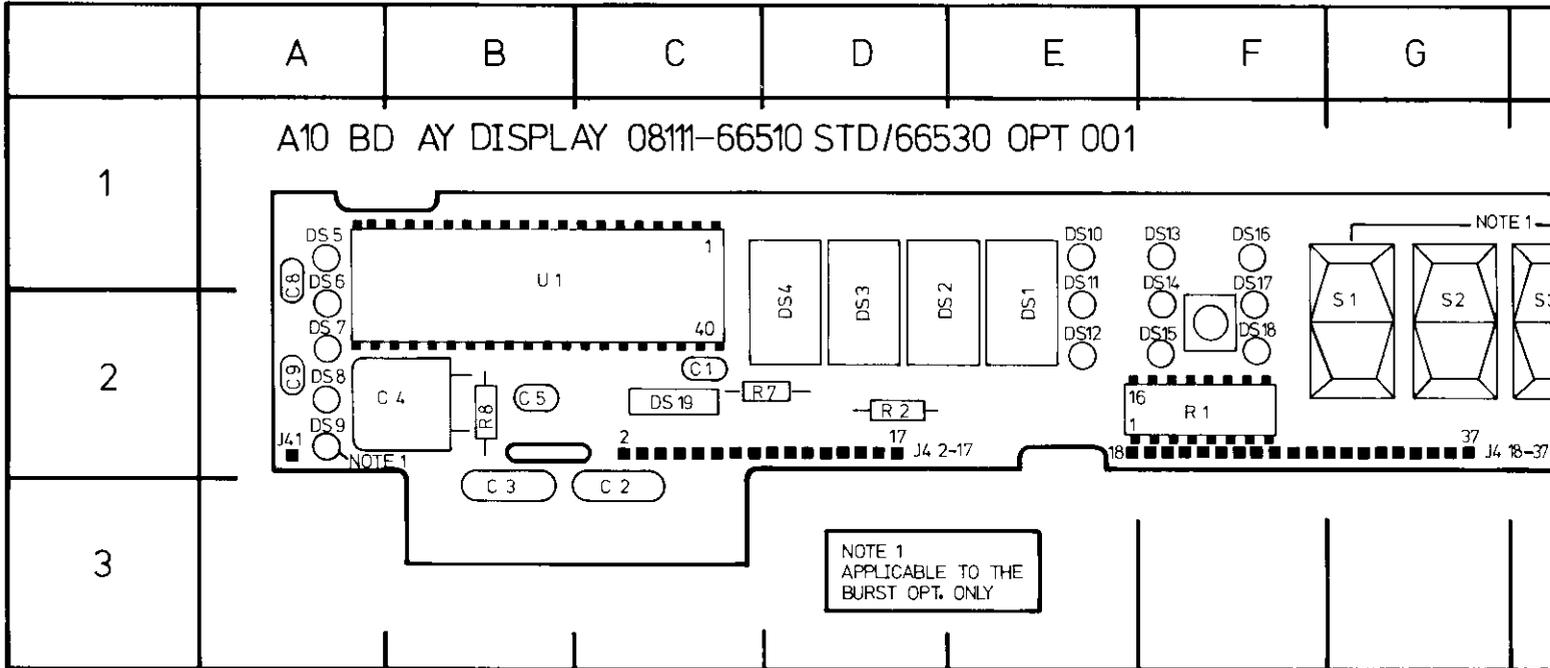


A 7 BD AY CONTROL 08111-66507

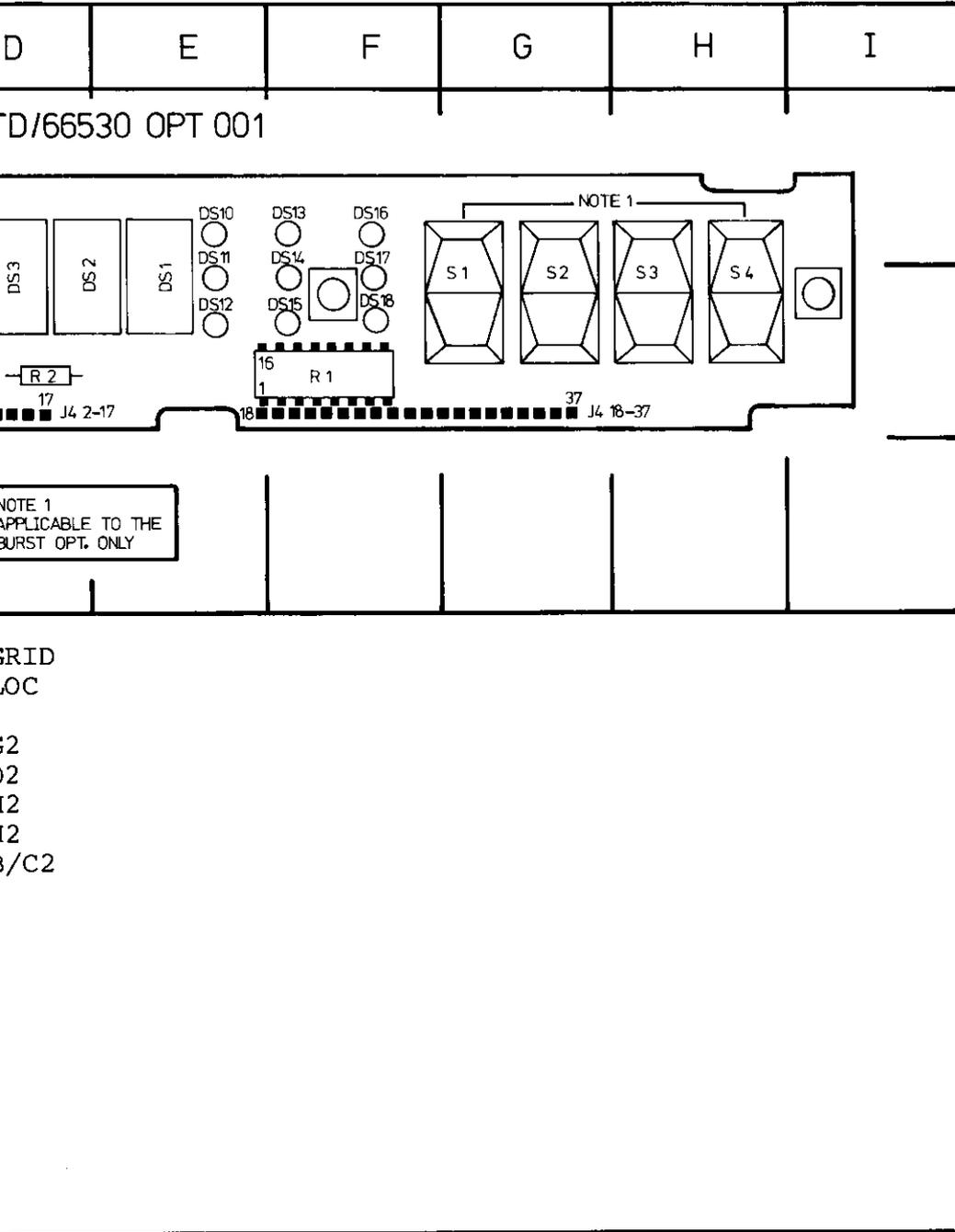


NOTE: ALL INTERCONNECTIONS BETWEEN BOARDS VIA A1 MOTHERBOARD UNLESS OTHERWISE INDICATED





REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	C2	DS9	A2	S1	G2
C2	C3	DS10	E1	S2	D2
C3	B3	DS11	E2	S3	H2
C4	B2	DS12	E2	S4	H2
C5	B2	DS13	F1	U1	B/C2
C8	A1	DS14	F2		
C9	A2	DS15	F2		
DS1	E2	DS16	F1		
DS2	E2	DS17	F2		
DS3	D2	DS18	F2		
DS4	D2	DS19	C2		
DS5	A1	R1	F2		
DS6	A2	R2	D2		
DS7	A2	R7	C2		
DS8	A2	R8	B2		



SERVICE BLOCK 5 DISPLAY BOARD A10 (A30) 5

THEORY OF OPERATION

All parameters of the 8111A except the burst number are voltage controlled via the front panel settings. The resulting control voltages are measured by a DVM based on an A-D converter IC-U1. This "DVM" uses the dual slope integration method of A-D conversion and the operating principle is shown in Figure 8-5-1.

The operation is as follows: The signal input voltage is connected to the integrator for a time period of 1000 oscillator cycles, this is therefore the integration time T_I . During this time, C_{int} is charged up linearly starting from 0 volts. At the end of T_I C_{int} will have been charged to a value proportional to the input voltage. The second phase of the dual slope integration involves connecting a fixed reference voltage V_{ref} to the integrator input, this voltage is of opposite polarity to the signal input and results in C_{int} being linearly discharged. At the beginning of this discharge the output from the oscillator is gated into a counter, the gate is disabled when C_{int} has discharged to zero.

Referring to Figure 8-5-2, when the input voltage is equal to the reference the time to discharge C_{int} will be the period for 1000 oscillator cycles and the displayed value will be 1000. When the input voltage = $2 \times V_{ref}$ then the discharge time will be 2000 cycles and the corresponding display will be 2000 etc.

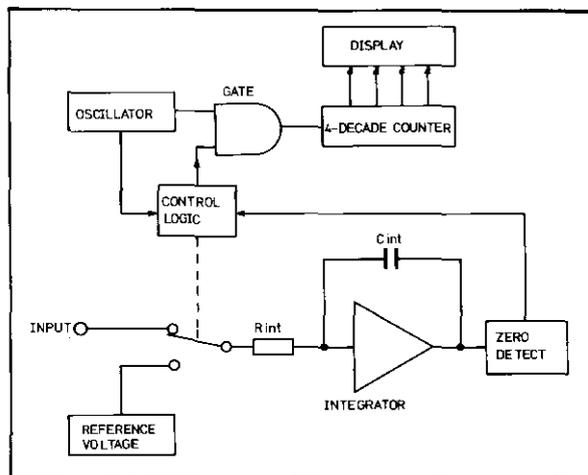


Figure 8-5-1. Simplified Dual Slope Integrating DVM

The DVM IC has differential inputs for both the input and the reference voltages. The Ref. low input is always connected to ground and therefore the displayed value is expressed by:

$$\text{Displayed Value} = \frac{V_{in Hi} - V_{in Lo}}{V_{ref Hi}} \cdot 1000$$

Since various parameters have to be displayed it is necessary to vary the value of V_{ref} and/or interchange it with the V_{in} . The following paragraphs detail how this is done for all parameter display requirements.

Amplitude, Offset and Frequency

To display these parameters the DVM IC is used in its normal application i.e. $V_{ref} = 1 \text{ V}$, the parameter control voltages are fed to the differential inputs of IC and are displayed in their "Oscillator cycle count" equivalent. The decimal point position is controlled by the Control board A7.

Width

The width control voltage is inversely proportional to the width value, therefore, to achieve the correct display value the input signal (control voltage) and the reference voltage for the DVM IC U1 are interchanged.

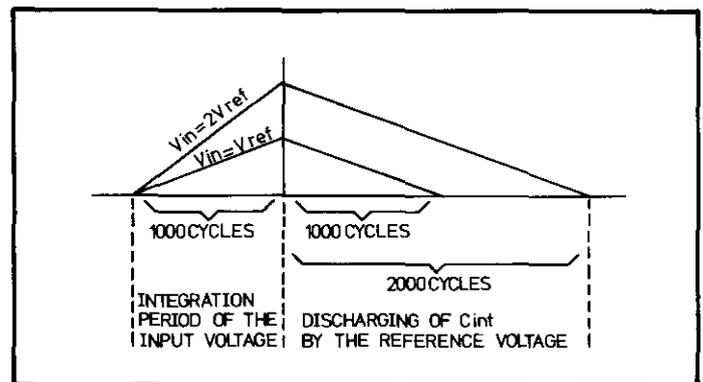


Figure 8-5-2. Dual Slope Integration Measurement Sequence

Duty Cycle

The Duty Cycle is determined by the ratio between the control voltage for the frequency and the voltage V_{UP} which controls the I_{UP} current source on the VCO board. To display this ratio, V_{UP} is used as a variable reference voltage and the frequency control voltage is connected to the input pins of U1.

In fixed duty cycle (50 %) mode a constant 0.505 V voltage is connected to the DVM IC input with a reference voltage of 1 V, this therefore results in 50 being displayed (the last digit is blanked). See Table 8-5-1 for clarification.

Burst (Option 001 only)

The display method for the burst number is a totally digital procedure unlike that for all other parameters and is controlled from the Burst No Control board A9. The theory of operation including the display technique is described in Service Block 6. Table 8-5-1 shows the input conditions at the DVM IC U1 for all parameter displays.

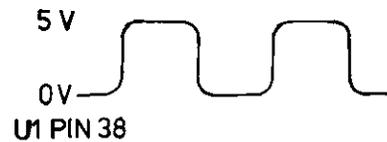
TROUBLESHOOTING

General

Since all switching and changing of the reference and input signals for the DVM is done on switch board A11 by A11U12, most cases of incorrect display value are likely to be related to the A11, A12 assembly. A12 is mentioned since the vernier control outputs go via A12 to A11. If the fault concerns the operating mode, decimal point, width or frequency unit indicating LEDs and not the numeric displays then the Control Board A7 should be suspected.

DVM IC U1

If the fault is that the display readout remains fixed when any vernier control is varied but the decimal point position and unit indicators may be varied then A10 U1 oscillator is suspect. The correct oscillator output should be as shown below with a frequency of approximately 190 kHz. If there is no output verify that U1 pin 40 is not shorted to ground since this disables the oscillator.

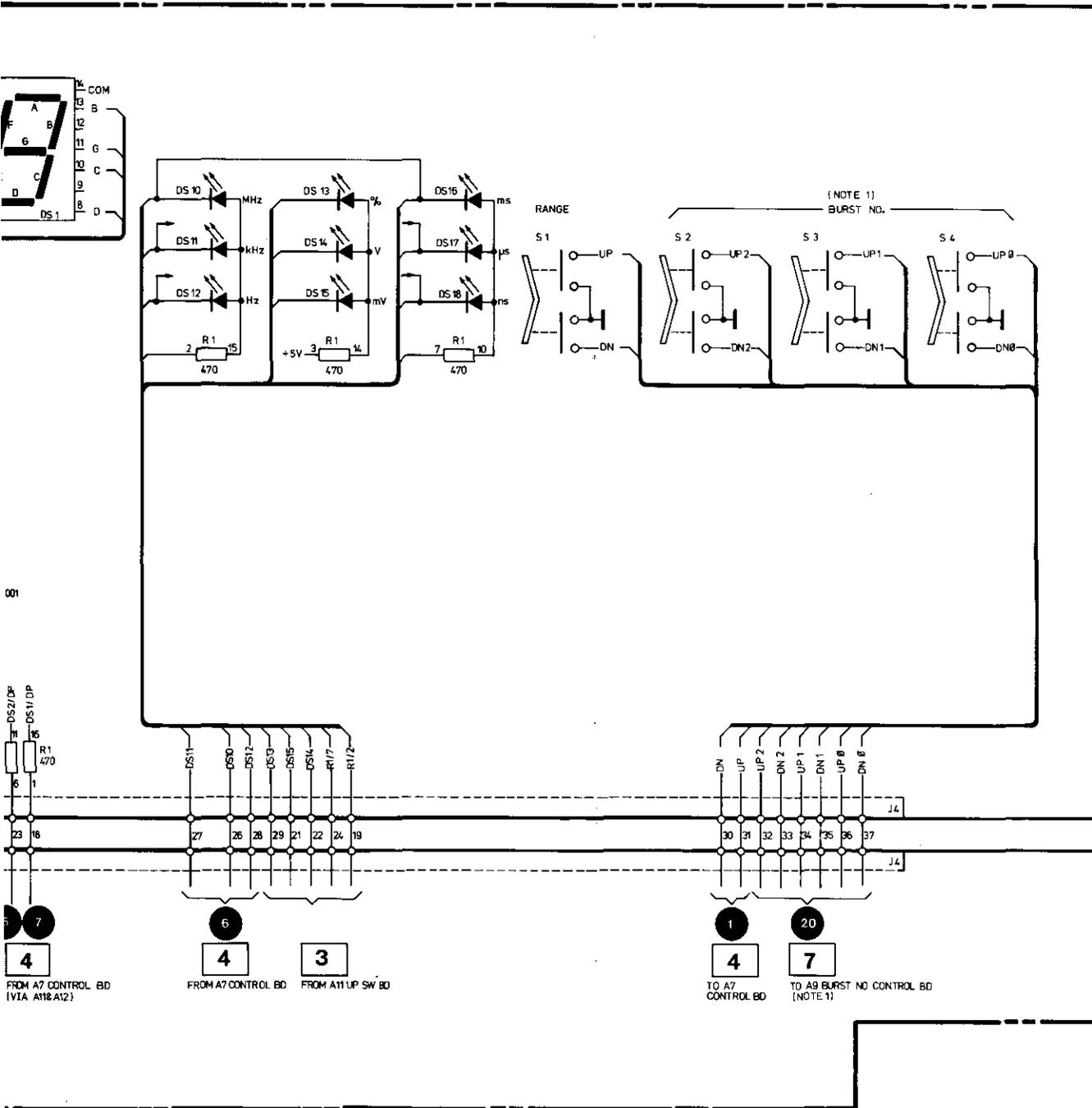


Numeric Display

The display can be checked for correct operation — all segments operatable — by connecting U1 pin 37 to +5 V, all numeric displays should then be illuminated to give a readout of -1888.

Table 8-5-1. Display Required/DVM Input Voltages

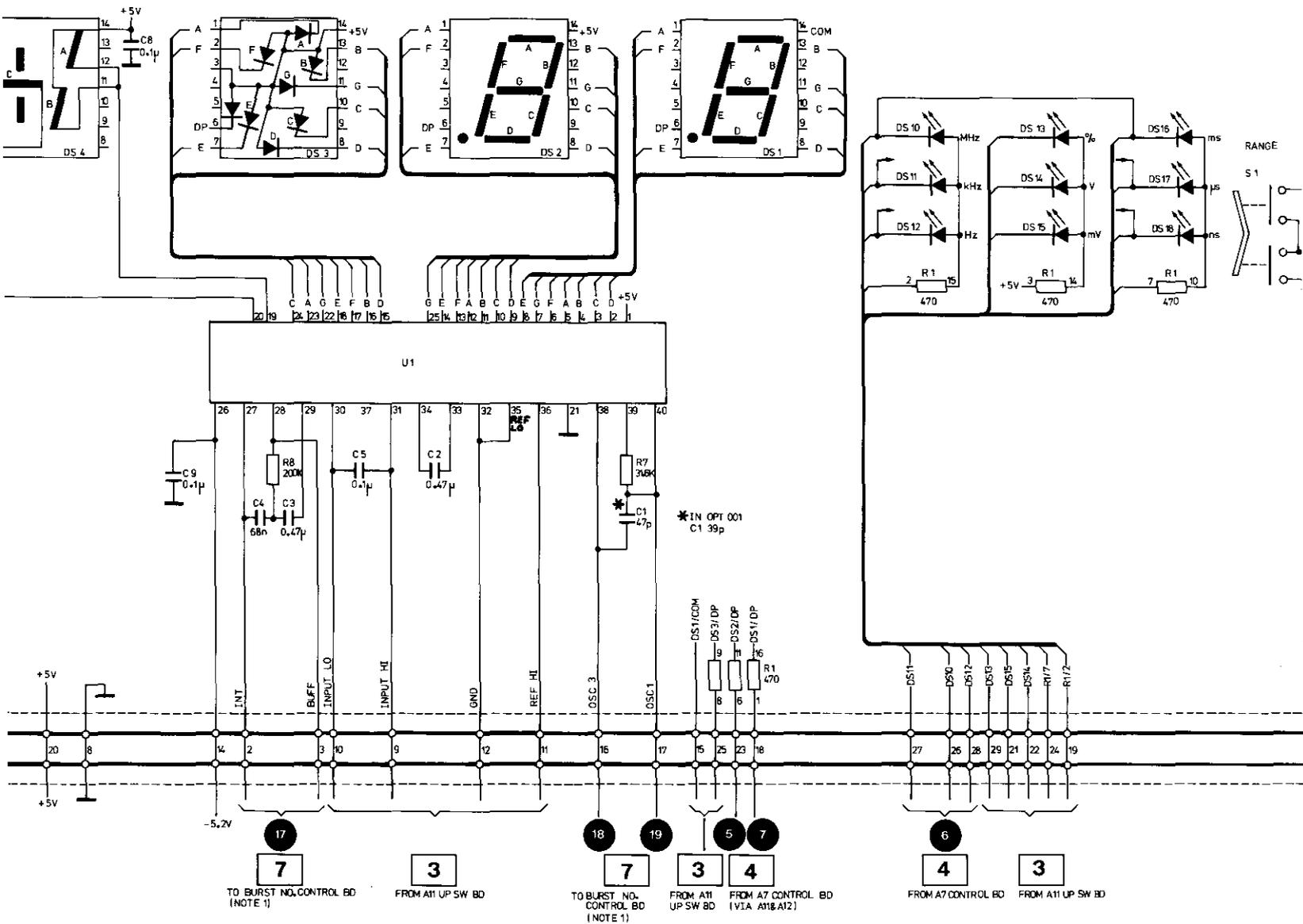
Displayed Parameter	DVM Input Voltages			Values shown on the Display = $\frac{V_{HI}-V_{LO}}{V_{REF}} \cdot 1000$
	INPUT HI pin 31	INPUT LO pin 30	REF HI pin 36	
FREQUENCY	V_{Freq} 0.1 V ... 1 V	gnd	+1 V	10.0 ... 100.0
FIXED 50 % DUTY CYCLE	0.505 V	gnd	+1 V	50
VARIABLE DUTY CYCLE	V_{Freq} 40 mV...0.4 V	gnd	V_{up} 40 mV...0.4 V	10 ... 90 } last digit switched off
WIDTH	+0.4 V	gnd	V_{Width} 4 V ... 0.4 V	10.0 ... 100.0
AMPLITUDE	gnd	V_{Ampl} -0.16 V ... -1.6 V	+1 V	1.60 ... 16.00
OFFSET	gnd	V_{offs} +0.8 V ... -0.8 V	+1 V	-8.00 ... 8.00
BURST	2.2 V	gnd	+1 V	1...1999



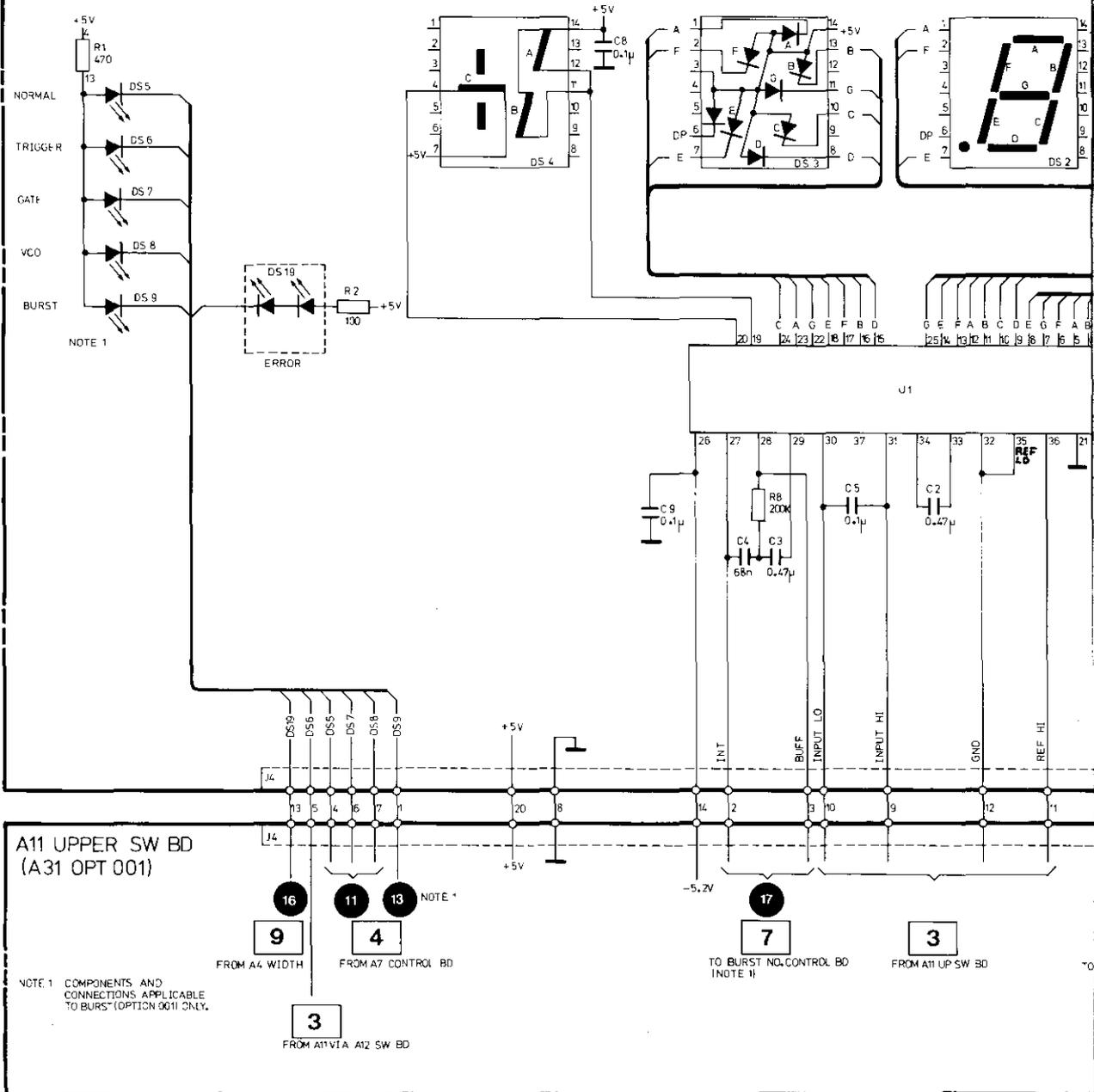
DISPLAY BD A10 (OPT 001 A30)

5

01)

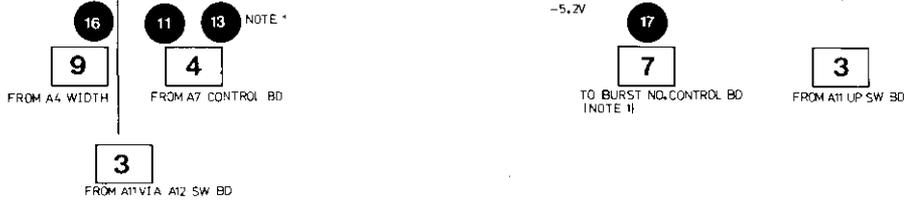


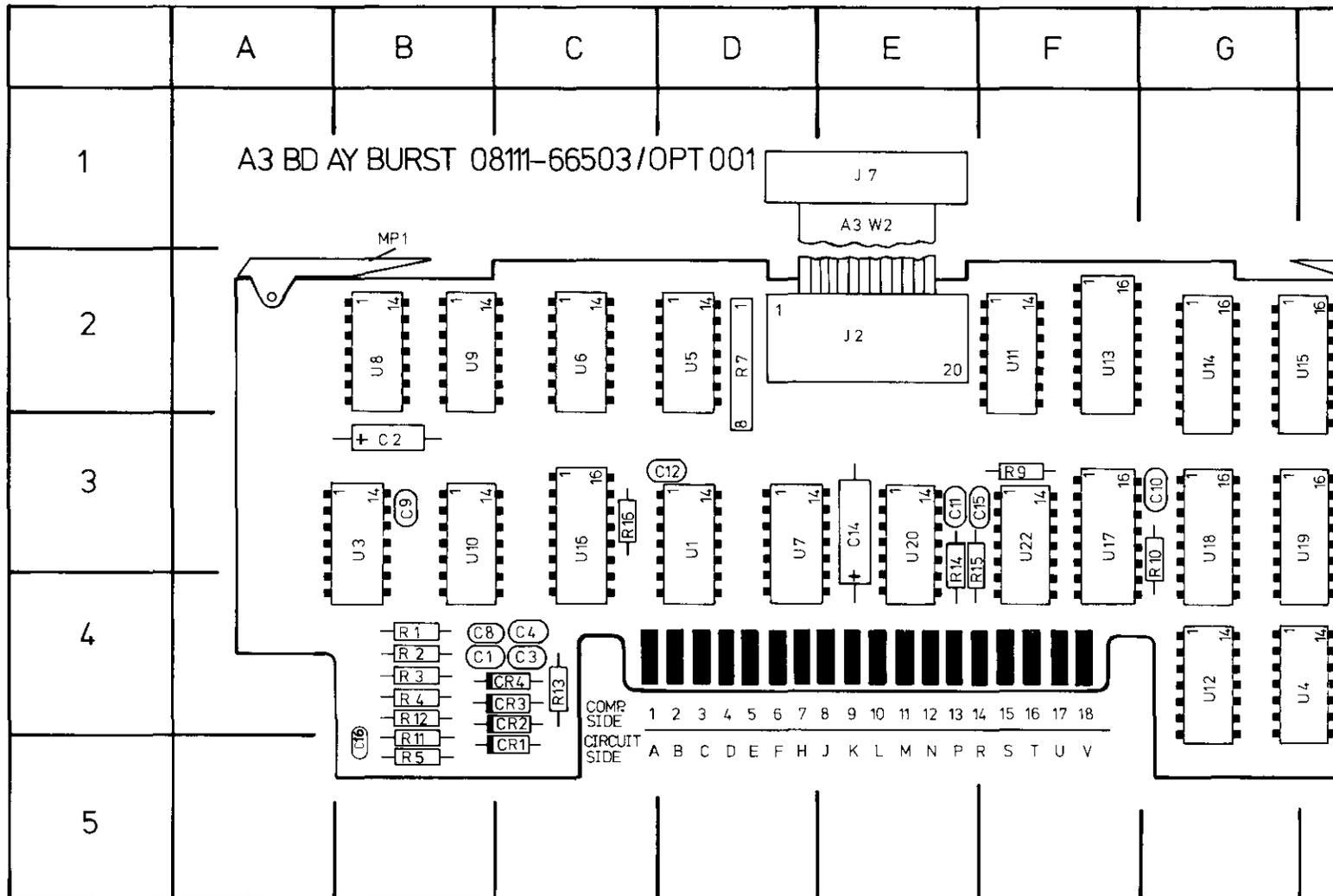
A 10 BD AY DISPLAY 08111-66510 (STANDARD)
 A 30 BD AY DISPLAY 08111-66530 (OPTION 001)



A11 UPPER SW BD
 (A31 OPT 001)

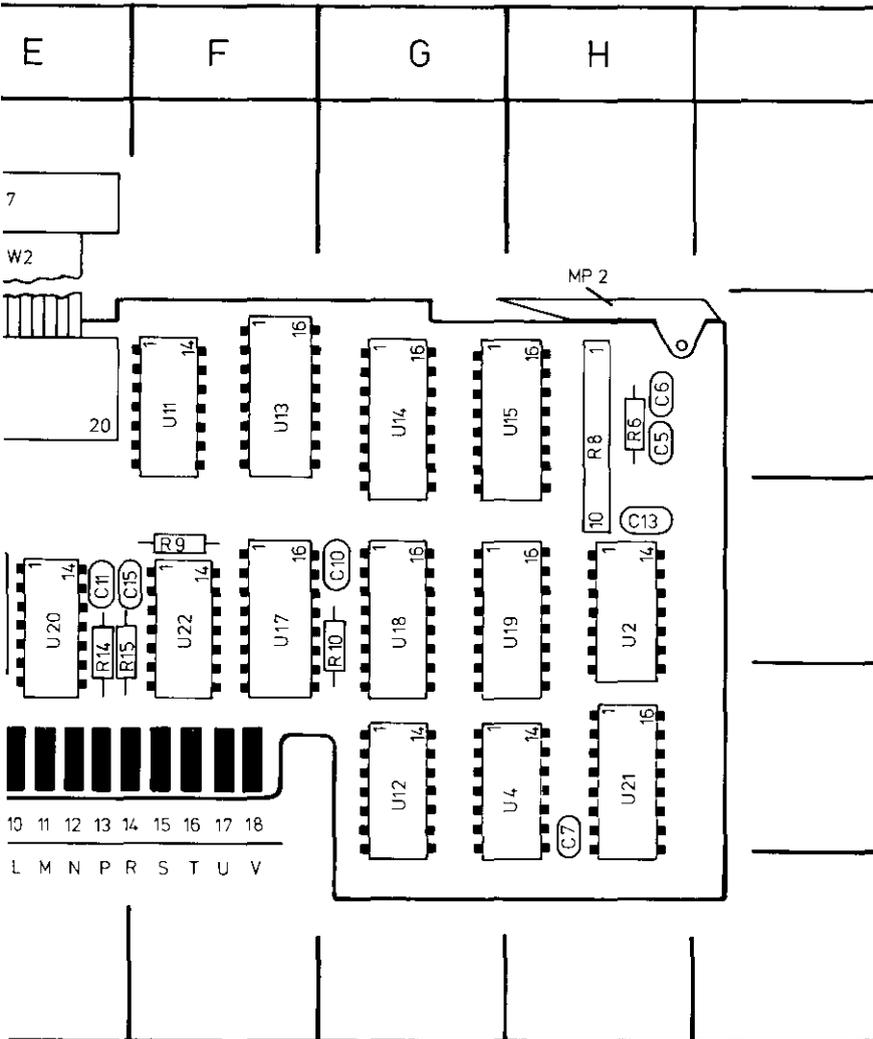
NOTE 1 COMPONENTS AND CONNECTIONS APPLICABLE TO BURST (OPTION 001) ONLY.



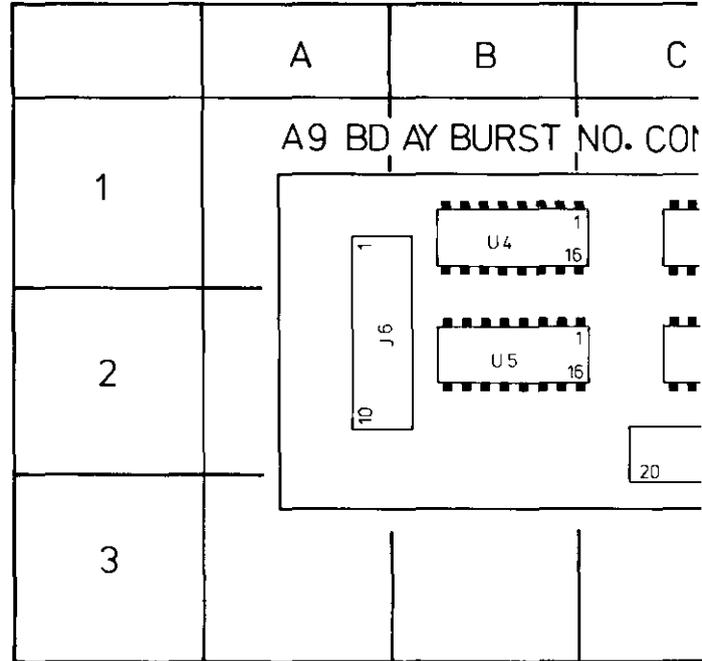


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	B4	CR1	C5	R12	B4	U11	F2
C2	B3	CR2	C4	R13	C4	U12	G4
C3	C4	CR3	C4	R14	E3	U13	F2
C4	C4	CR4	C4	R15	E3	U14	G2
C5	H2	R1	B4	R16	C3	U15	H2
C6	H2	R2	B4	U1	D3	U16	C3
C7	H4	R3	B4	U2	H3	U17	F3
C8	B4	R4	B4	U3	B3	U18	G3
C9	B3	R5	B5	U4	H4	U19	H3
C10	G3	R6	H2	U5	D2	U20	E3
C11	E3	R7	D2	U6	C2	U21	H4
C12	D3	R8	H2	U7	D3	U22	F3
C13	H3	R9	F3	U8	B2	C16	B5
C14	E3	R10	G3	U9	B2		
C15	E3	R11	B5	U10	B3		

6

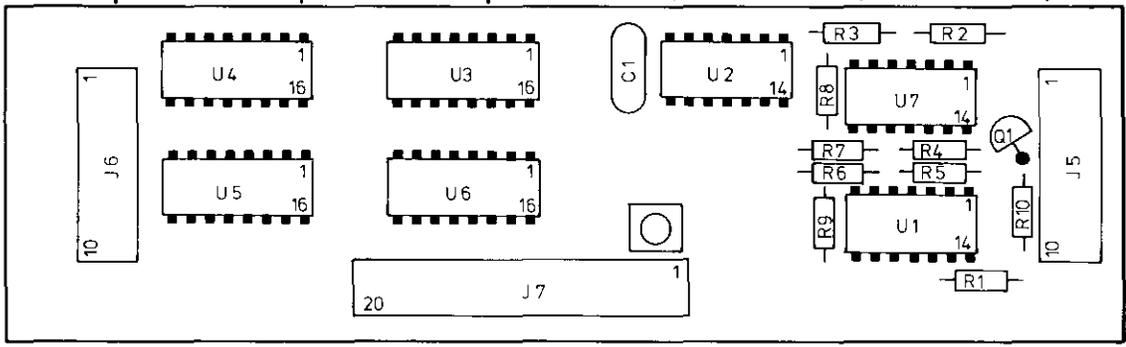


IG	GRID LOC
	F2
	G4
	F2
	G2
	H2
	C3
	F3
	G3
	H3
	E3
	H4
	F3
	B5



REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D1	U4	B1
Q1	F2	U5	B2
R1	F2	U6	C2
R2	F1	U7	F1
R3	E1		
R4	F2		
R5	F2		
R6	E2		
R7	E2		
R8	E1		
R9	E2		
R10	F2		
U1	F2		
U2	E1		
U3	C1		

A9 BD AY BURST NO. CONTROL 08111-66509 (OPT 001)



VIEWED FROM TOP Q1

REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D1	U4	B1
Q1	F2	U5	B2
R1	F2	U6	C2
R2	F1	U7	F1
R3	E1		
R4	F2		
R5	F2		
R6	E2		
R7	E2		
R8	E1		
R9	E2		
R10	F2		
U1	F2		
U2	E1		
U3	C1		

SERVICE BLOCK 6
BURST BOARD A3 6
BURST NO. CONTROL A9 7

THEORY OF OPERATION

General

Refer to Figure 8-6-1, in BURST mode, a preset number of cycles is output by the 8111A, this requires a store or CONTROL COUNTER for the set "BURST NO" and a BURST COUNTER which is loaded with the same number and then counted down (or decremented) by pulses from the VCO (A5) after commencement of the burst.

At the start of a burst sequence, following a trigger signal, the VCO is enabled and outputs cycles as in other modes, pulses (BURST CLOCK) are also fed back to the burst counter to decrement the count to one. A "BURST OFF" signal is produced after this condition is detected and this disables the VCO after completion of the final cycle. During this final cycle the burst counter is re-loaded with the burst number from the control counter.

Board A9, the Burst Number Control, has no significance in the actual burst sequence, it serves to interface the burst number data with the Display board and the rocker switches to A3, it will be described later.

OPERATION

The following operational description of the BURST BOARD A3 is in four sections:

1. The Control Counter
2. Loading the Burst Counter
3. Burst on
4. End of count down – Burst off

Figure 8-6-2 should be referred to as necessary to aid understanding of the descriptions.

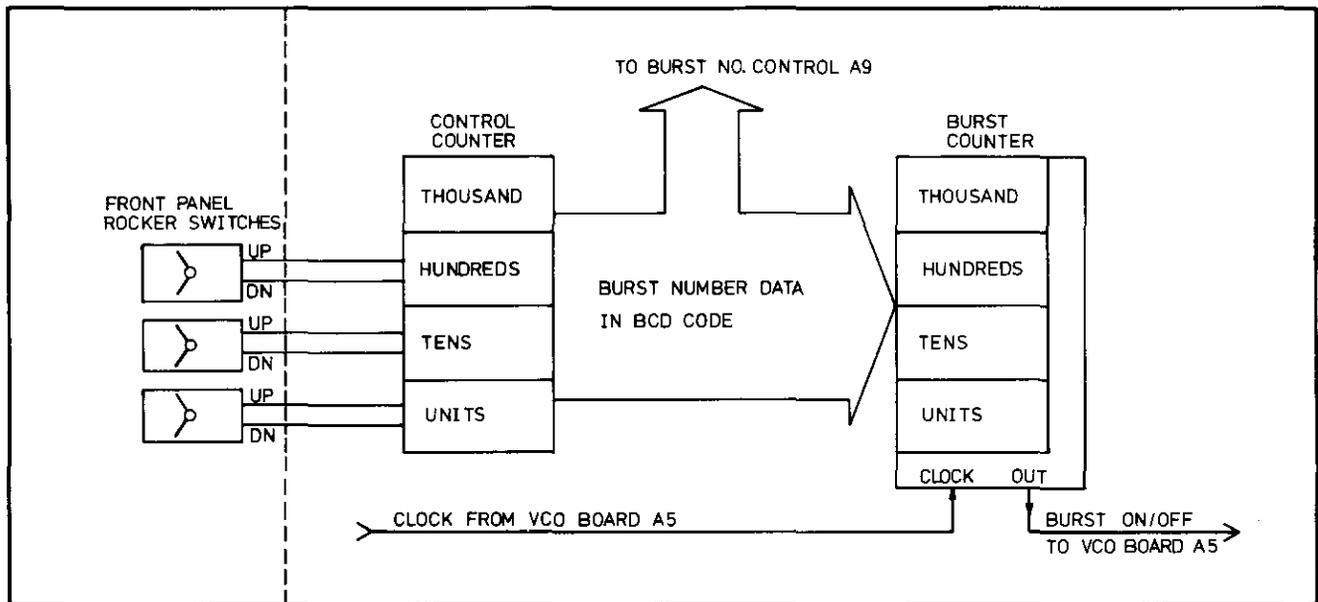


Figure 8-6-1. Burst Block Diagram

1. The Control Counter

This consists of a four stage counter — three cascaded BCD counters U13, U14 and 15 for the "units, tens and hundreds" and a flip-flop U16A for the thousand. At instrument switch on the counter is preset to one (001 displayed when BURST NO buttons pressed) via a signal "PRESET" from the Control board. Operation of the BURST NO rocker switches causes the output of U9C to go high for each "push", the signal is debounced via U10D etc and input, via U6C, to the enabled control counter device. This is done by using the operated rocker switch output (via U6A, B or D) and/or a CARRY output signal to enable, via U4C (units), U10A (tens) or U11D (hundreds), the required counter stage. The output from U6C (control counter clock) will be disabled from clocking the stages (via U11C, B and A) if an unallowed count would result e.g. — if present displayed count is 1985 and the hundreds rocker switch is operated in the 'UP' mode, then only one increment — to 1995 — is possible since the next would be 2005 which is not allowed. The circuit comprising U8D, U9A and B and U10B etc. performs the counter status monitoring and prevents unallowed carry up or down action.

The normal carry up or down function is enabled by U10A, U11D and U4C, C7 and R8 ensure that the counter is set to 001 and not 000 when the "tens" or hundreds count is decremented from 010 or 100 respectively. U8C prevents a 000 setting of the counter by enabling a preset signal for the whole counter to be produced whenever the units switch is pressed to the down position at the 001 counter setting.

The output of U5B enables either an up or down count sequence, in a rocker switch "down" position U5B output is low for DN enable and an "up" position enables UP.

The oscillator is enabled and outputs a pulse train when a rocker switch is pressed either "up or down" for longer than the time constant determined by R3 and C2.

2. Loading the Burst Counter

This is done whenever the existing burst number is changed or a burst has been completed and the number needs to be reloaded for a further one. The Burst Counter contents are automatically decremented to zero during the cycle. Since there are two different loading/reloading situations they will be separately described as:

2-1 Loading a new Burst Number

2-2 Reloading after burst completion

2-1 Loading a new Burst Number

The negative going edge of the Control Counter clock pulse triggers U21B (pin 9) and its Q output enables the load function of U17 (active low). Delay — R6, C5 and U2D, U22 generate the required clock pulse for U17 which then loads the "units data" into U17. The load enable signal for the "tens", "hundreds" and "thousands" data is U21B \bar{Q} .

2-2 Reloading after burst completion

At the end of a burst cycle, when the count has reached 001, the ONE DETECT circuit output (U22C pin 8) goes low and enables the LOAD of U17. On receipt of next positive going clock transition U17 will be reloaded with the units data.

The other counters are reloaded by a pulse via U21A after U20BQ changes from high to low at burst completion.

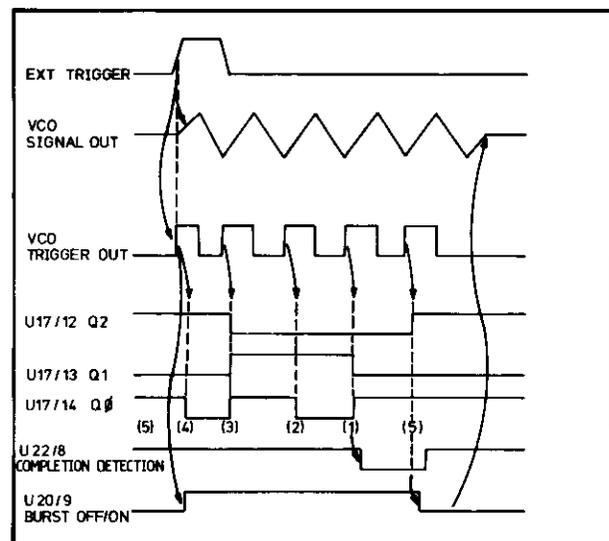


Figure 8-6-2. Burst Timing Diagram (Burst Number = 5)

3. Burst on

On receipt of an trigger signal the VCO (board A5) outputs a signal, this is fed to A6 for ECL to TTL conversion and then input as "BURST CLOCK" to A3U20 and U22C. If the Burst Counter is not set to 001 and no rocker switch is being operated, then U20B D-input is high and the first clock pulse will cause the Q output to go high. The signal BURST ON/OFF is fed back to the VCO and enables the free running mode of A5U1. Also, the burst clock signal now starts to decrement the counter via U22C.

4. End of count down – Burst off

The One Detector circuit output, U22C pin 8, is changed from its normal high to a low level when the stored burst count reaches one (001). Until this point, U22C pin 8 at high has maintain the BURST ON/OFF signal at high (Burst on). At the receipt of the next clock pulse, which initiales the last burst cycle, the level at U22C 'D' is transferred to the Q output so disabling burst via the VCO BURST ON input. This is illustrated by Figure 8-6-2.

Since the oscillator has been disabled the normal "end of ramp down" detector circuit within the IC cannot be used (the digital control logic is effectively at standstill without a control clock) and an external circuit, U7B etc., is used instead. U7B functions as a Schmitt trigger and causes Q1 to be switched off, so reabling the oscillator, when the DVM IC integrator output (signal "INT") euqals the threshold level of about 0.1 V. The burst number is now displayed and the count and display sequence repeated as illustrated by Figure 8-6-3.

BURST NUMBER CONTROL BOARD A9

OPERATION

The function of this board is to control the display of the burst number as set in the control counter of A3. It does this basically by counting the number of cycles output by the Display board DVM oscillator and disabling it when the number equals the set burst number. To help understand how this is achieved it is necessary to understand the basic theory of dual slope integration, and its application in the Display board operation, this is given in Service Block 5.

Devices U2A and B provide a divide by 4 function which is necessary since the DVM IC clock signal is normally divided by 4 internally and the burst number display counter must therefore be supplied with the same frequency.

TROUBLESHOOTING (A3 and A9)

For the purpose of troubleshooting, the complete burst circuitry can be considered as three functional sections:

The timing diagram, Figure 8-6-3 should be referred to when reading the following explanation. The principle of operation is that the DVM IC integrator is first supplied with a fixed input (2.2 V) voltage to enable it to ramp up in the normal manner for 1000 cycles time period. The discharge phase is now started and the oscillator disabled via Q1 when the number of cycles output equals the burst count number.

1. Burst number setting circuitry (rocker switches, oscillator, control counter, carry/borrow logic).
2. Burst Counter, burst completion detection.
3. Burst number control (A9).

To isolate the faulty components the following general troubleshooting information links various possible fault conditions to the most likely cause:

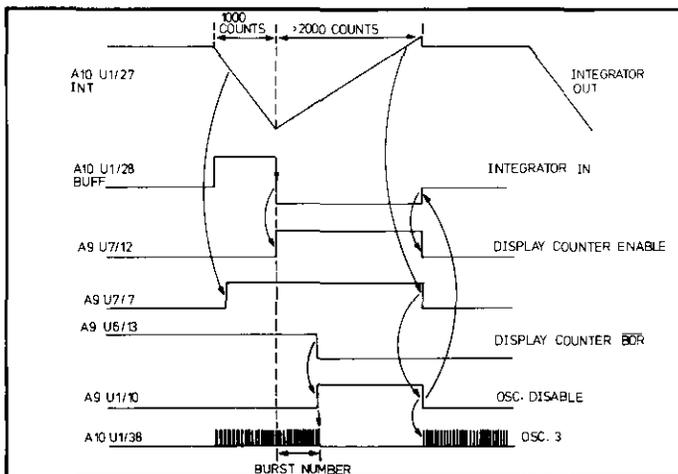


Figure 8-6-3. Burst No. Display Timing Diagram

If it is not possible to set the required burst number on the display and at the 8111A output by operating the appropriate rocker switches, then, a fault in the burst number setting circuitry of A3 is the most likely cause. If however, either the display or the output is wrong but not both, then a check on the operation of A3 Control Counter will assist in identifying the likely fault area. This is done by checking whether the outputs of U13 to U16 have the same decimal value as the display readout. If the values differ and the 8111A burst output is correct then suspect board A9, if they are identical but the output burst number is incorrect then the Burst Counter or completion detector are suspect.

Burst Counter

The correct operation of the Burst Counter can be verified with the following test procedure, refer to Figure 8-6-4 for the waveform and timing data.

1. Disconnect A3R10.
2. Set 8111A:

OPERATING MODENORMAL
 WAVEFORMSquare
 FREQUENCY RANGE100-1000 kHz
 FREQUENCY (VERNIER) 1000 kHz

3. Confirm that the waveforms and timing data as given in Figure 8-6-4 are correct. Use oscilloscope internal trigger on positive slope setting.

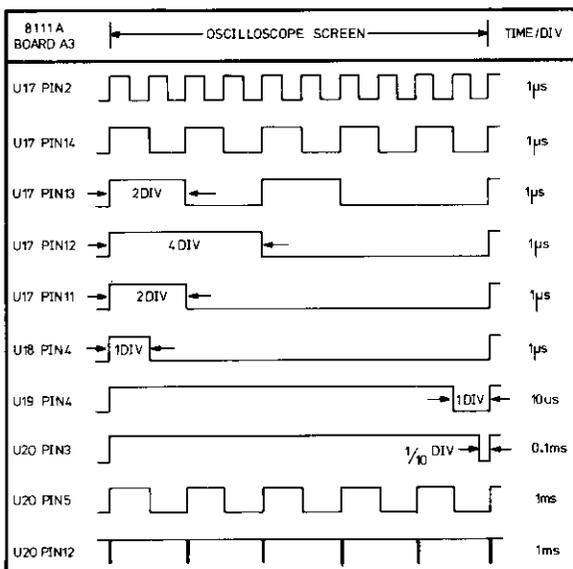


Figure 8-6-4. A3 Troubleshooting Data

Burst No. Control A9

The special "short" extender board should be used when troubleshooting A9, and A9R10 must be disconnected to leave A9Q1 open base. This enables "free run" operation of the Burst No. Control Counter. Frequency and Duty/Width pushbuttons pressed.

The Schmitt triggers U7A and U7B can be checked for correct operation with the aid of Figure 8-6-5 waveforms.

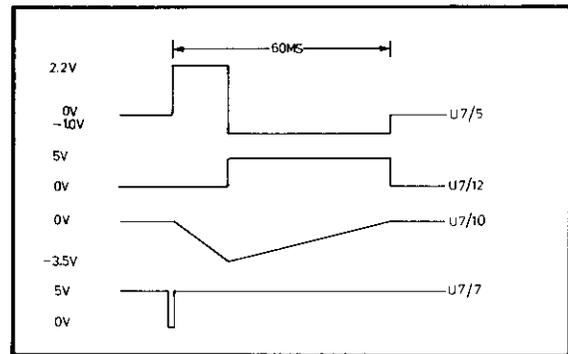


Figure 8-6-5. Burst No. Control A9 Troubleshooting Waveforms

The Burst Number Display Counter operation can be checked with the following test procedure.

1. Connect U7 pin 4 to +5 V. Confirm that U7 pin 12 goes to +5 V.
2. Connect U7 pin 9 to +5 V. Confirm that U7 pin 7 goes to +5 V.
3. Check that the waveform and timing data as given in Figure 8-6-6 is correct. Use oscilloscope internal trigger on positive slope setting.

NOTE: The "spikes" (U6 pin 4 etc.) might need to be verified with the aid of a TTL probe if difficult to see on the oscilloscope screen.

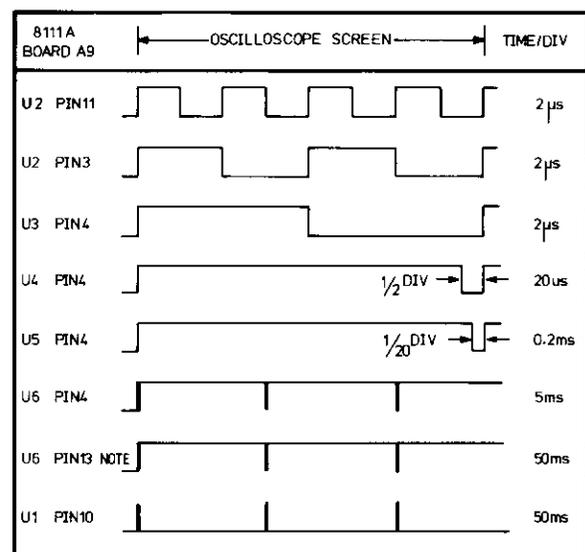
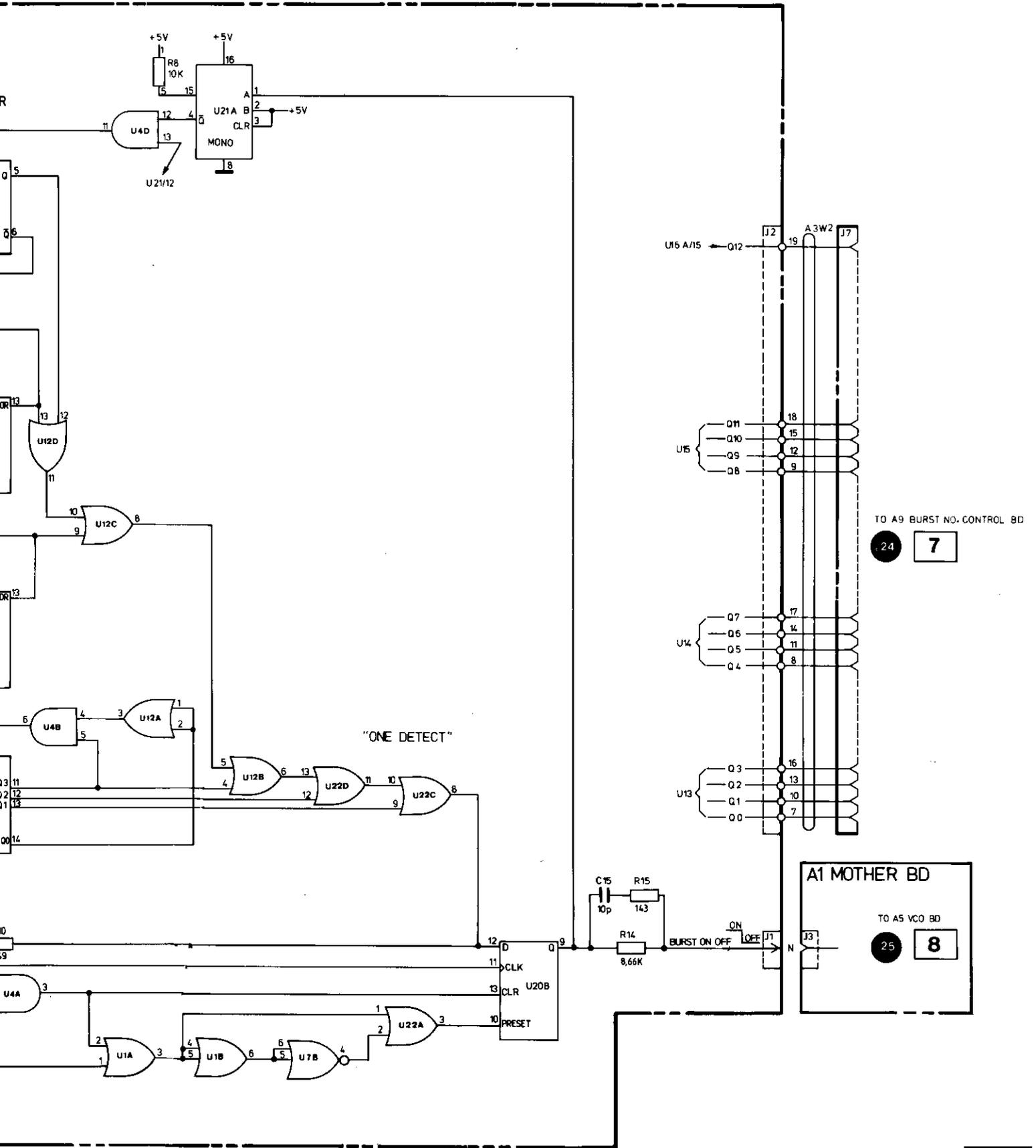
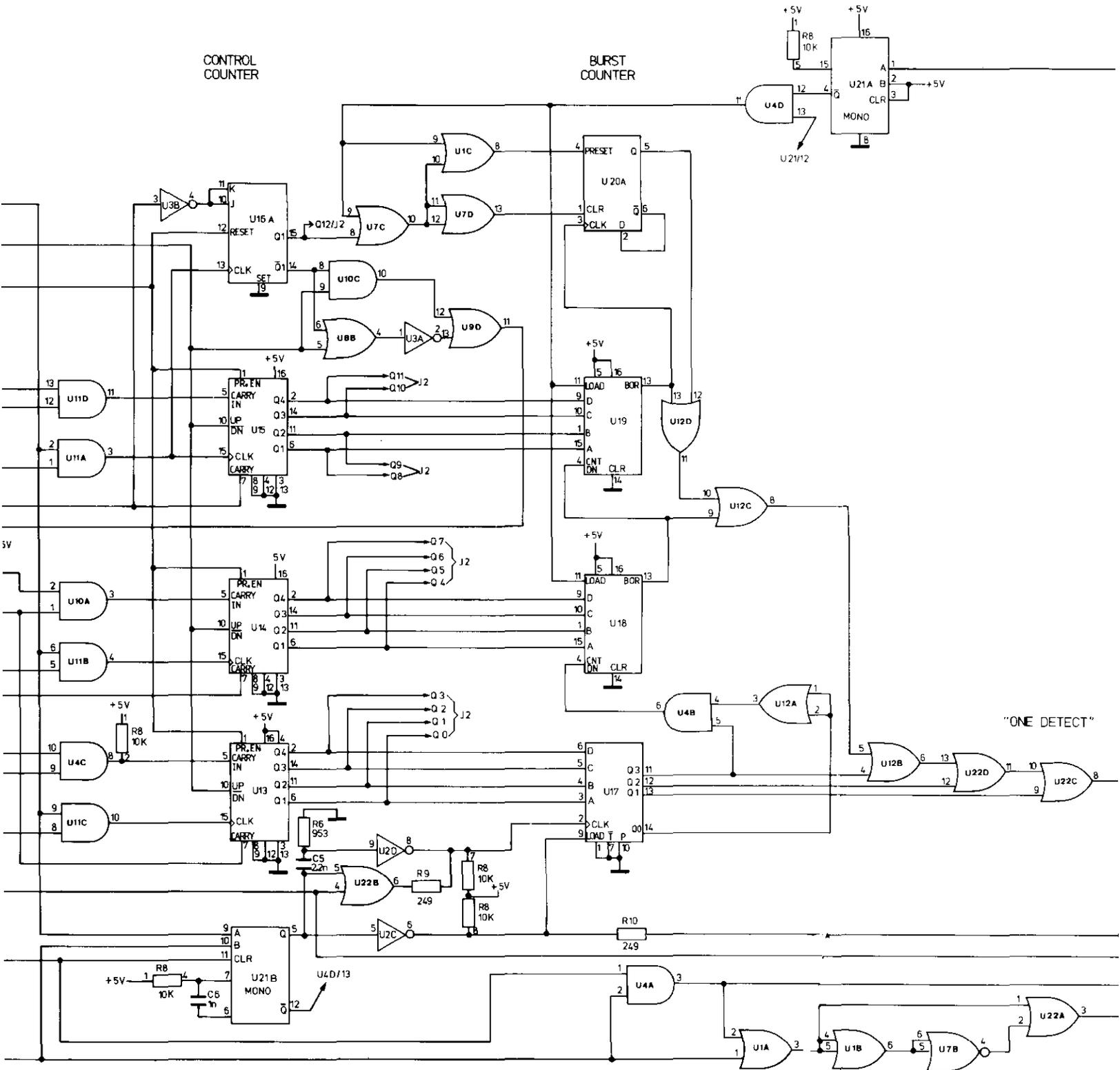


Figure 8-6-6. Burst No. Display Counter Troubleshooting Data

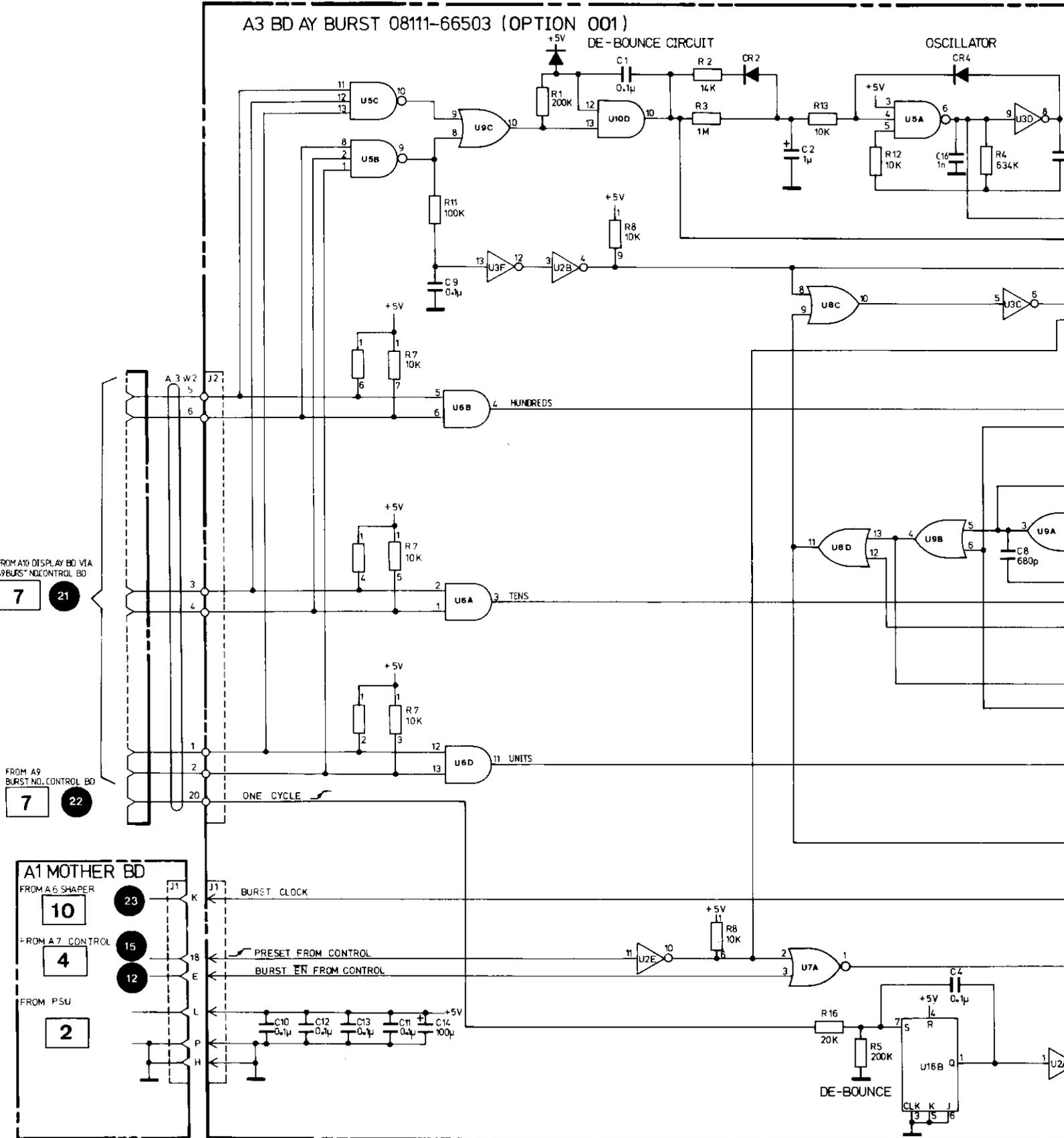


BURST BOARD A3

6

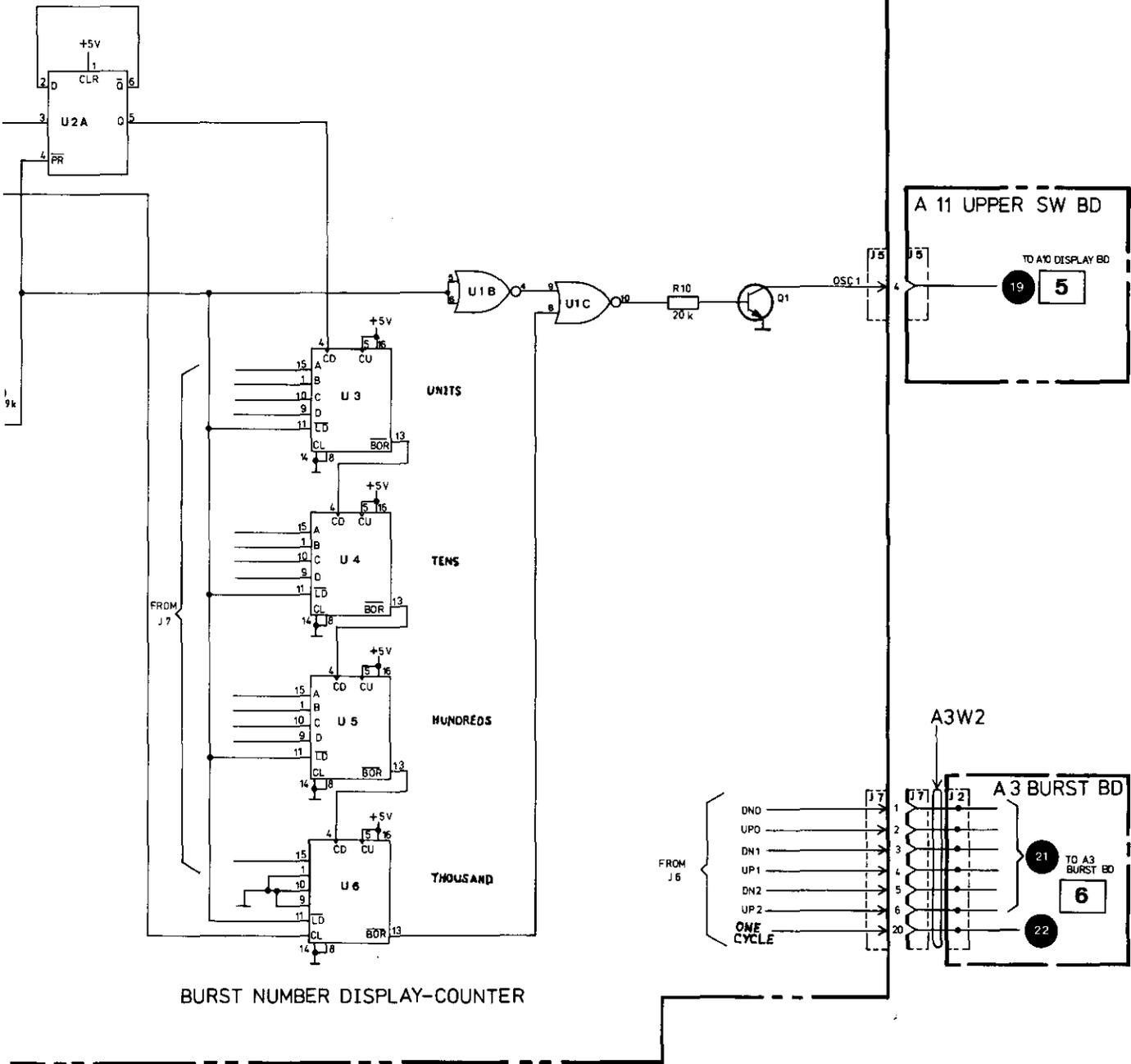


A3 BD AY BURST 08111-66503 (OPTION 001)

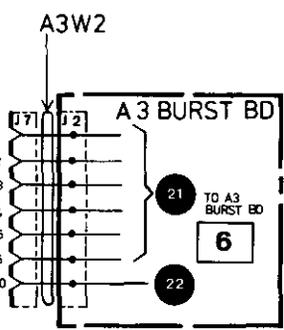
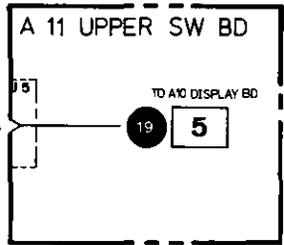


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**NOTE: FOR TROUBLESHOOTING
DISCONNECT R10**

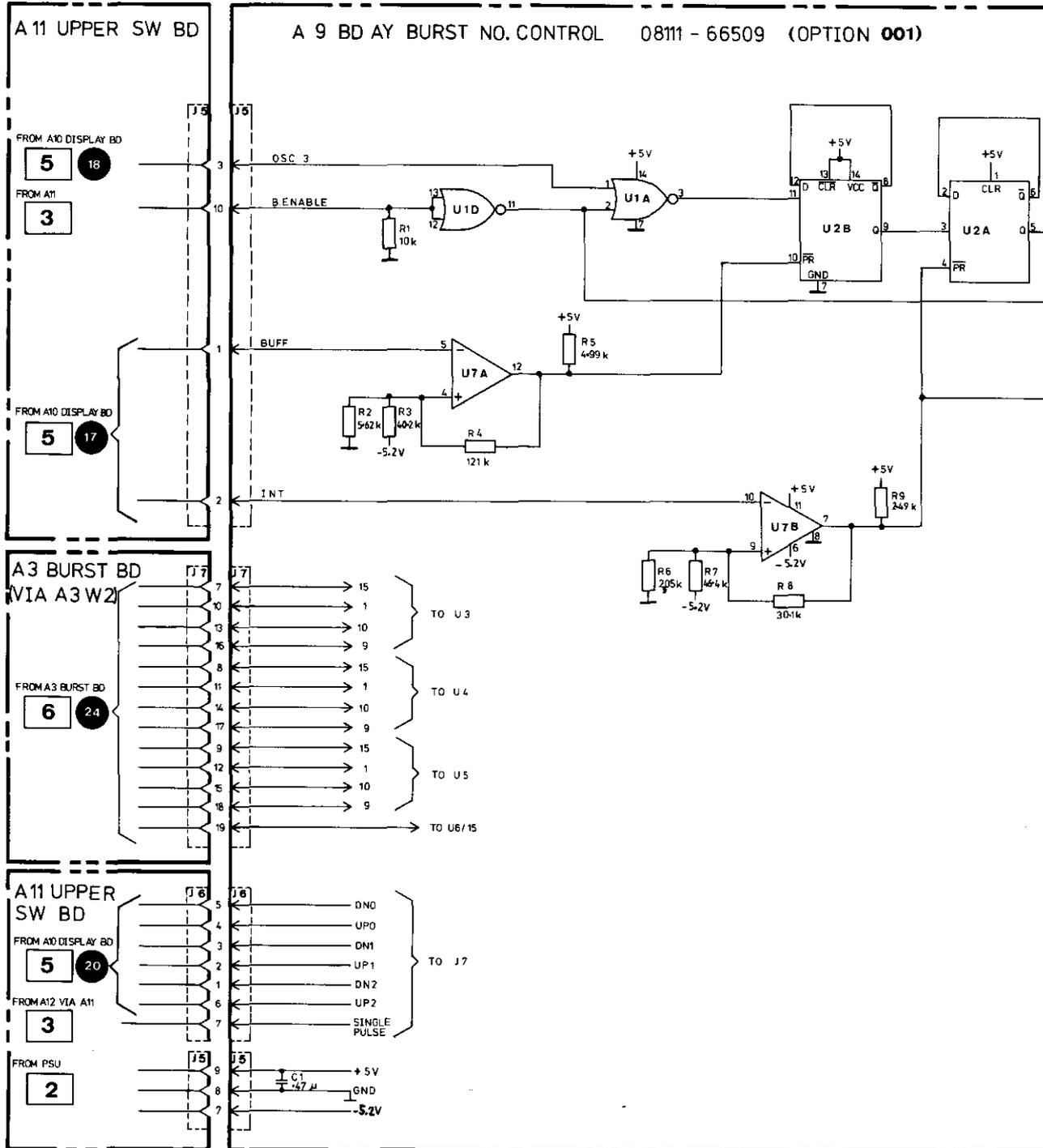


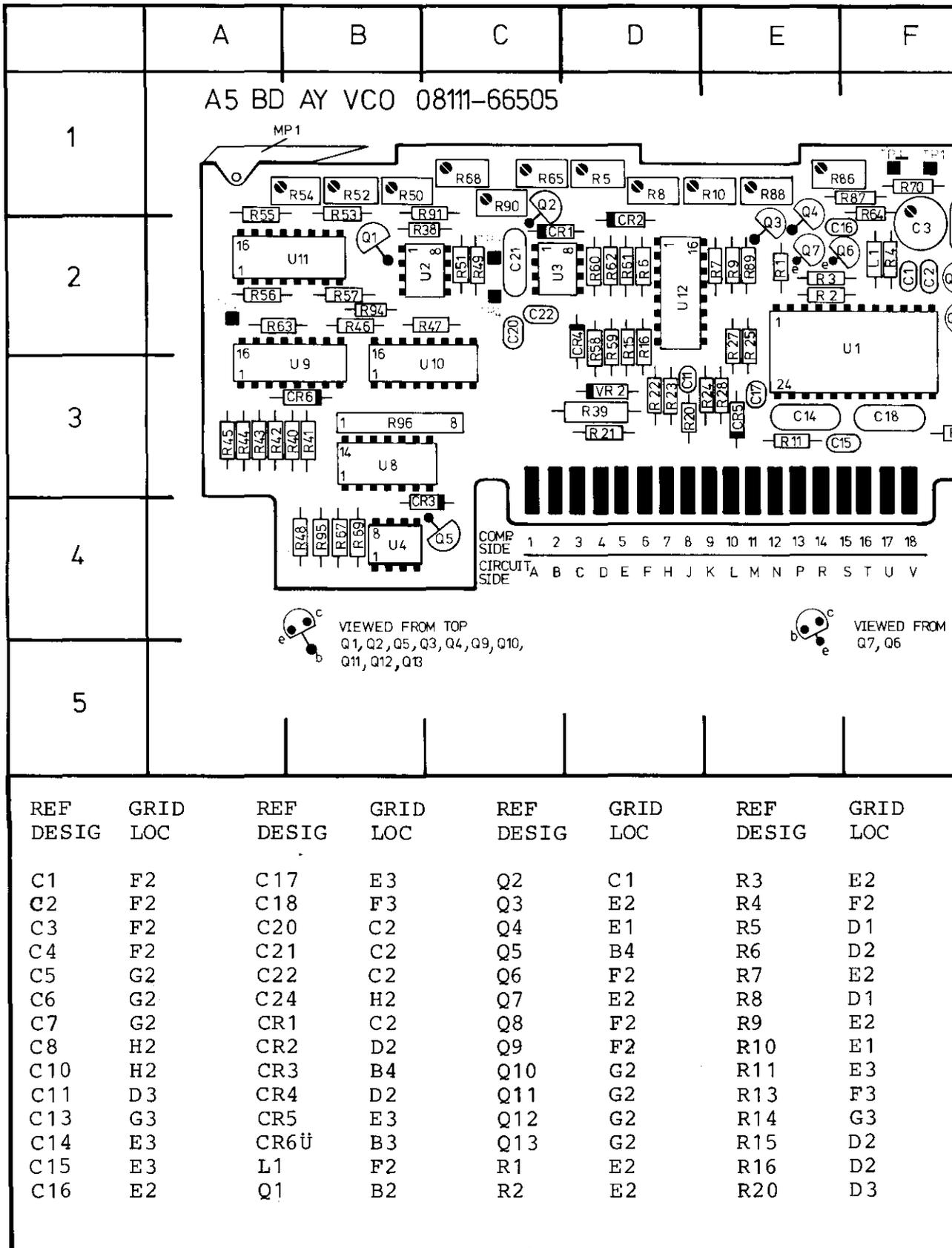
BURST NUMBER DISPLAY-COUNTER

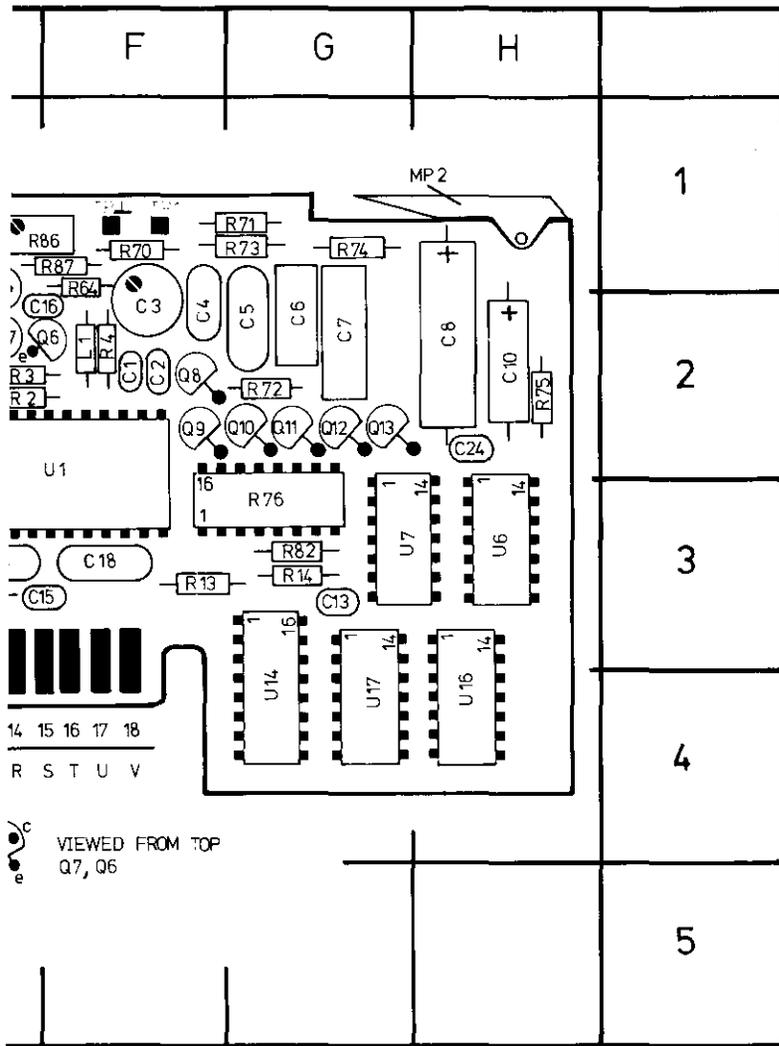


BURST NO. CONTROL A9

7







REF DESIG	GRID LOC
R59	D2
R60	D2
R61	D2
R62	D2
R63	A2
R64	F2
R65	C1
R67	B4
R68	C1
R69	B4
R70	F1
R71	G1
R72	G2
R73	G1
R74	G1
R75	H2
R76	G3
R82	G3
R86	E1
R87	F1
R88	E1
R89	E2
R90	C1
R91	C1
R94	B2
R95	B4
R96	B3
TP1	F1
TP2	A2
TP3	C2
TP4	C2
TPGND	F1
U1	F2
U2	B2
U3	C2
U4	B4
U6	H3
U7	G3
U8	B3
U9	A3
U10	B3
U11	A2
U12	D2
U14	G4
U16	H4
U17	G4
VR2	D3

GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
E2	R21	D3	R45	A3
F2	R22	D3	R46	B2
D1	R23	D3	R47	B2
D2	R24	D3	R48	A4
E2	R25	E3	R49	C2
D1	R27	E3	R50	B1
E2	R28	E3	R51	C2
E1	R38	B2	R52	B1
E3	R39	D3	R53	B1
F3	R40	B3	R54	B1
G3	R41	B3	R55	A1
D2	R42	A3	R56	A2
D2	R43	A3	R57	B2
D3	R44	A3	R58	D2

SERVICE BLOCK 7 VCO BOARD A5 7

THEORY OF OPERATION

General

The function of the VCO board is to generate the required signal frequency in accordance with either the 8111A front panel settings or an external control voltage. When TRIGGER mode is selected, the output signal repetition rate is controlled by the applied external frequency but the VCO board's operation is different depending on whether the 8111A is in waveform (sine, triangle or square) or pulse mode.

In TRIGGER/waveform function mode the VCO produces the waveform frequency, in accordance with the front panel settings but in TRIGGER/PULSE mode the board serves only as a Schmitt trigger/level shifter to shift the incoming trigger signal for compatibility with the trigger converter circuit of the Width board (A4).

The VCO frequency range is from 1 Hz to 20 MHz (with the capability to reduce to 0.1 Hz in VCO mode — see Table 3-2). The frequency is distributed over 7 decades

(from 1 Hz to 10 MHz) and a top 10 – 20 MHz range.

An error detection circuit provides an output signal (in TRIGGER/waveform function mode) whenever an external trigger signal arrives before completion of the current cycle. Reference to Figure 8-7-1 shows that the VCO board comprises a main control IC—U1 and associated external signal and current sources. A range decoder enables selection of a suitable ramp capacitor and also influences, via reference voltages, the current source. A more detailed description of the board's operation will now be given, schematic 8 should be referred to together with the appropriate figures as required.

OPERATION

There are two operating modes for the VCO board — Free Running Mode which includes NORMAL and VCO operation and Triggered Mode which includes TRIGGER, GATE and BURST modes. Although the circuit operation is similar for both modes there are some slight differences which will be described after the general operational description.

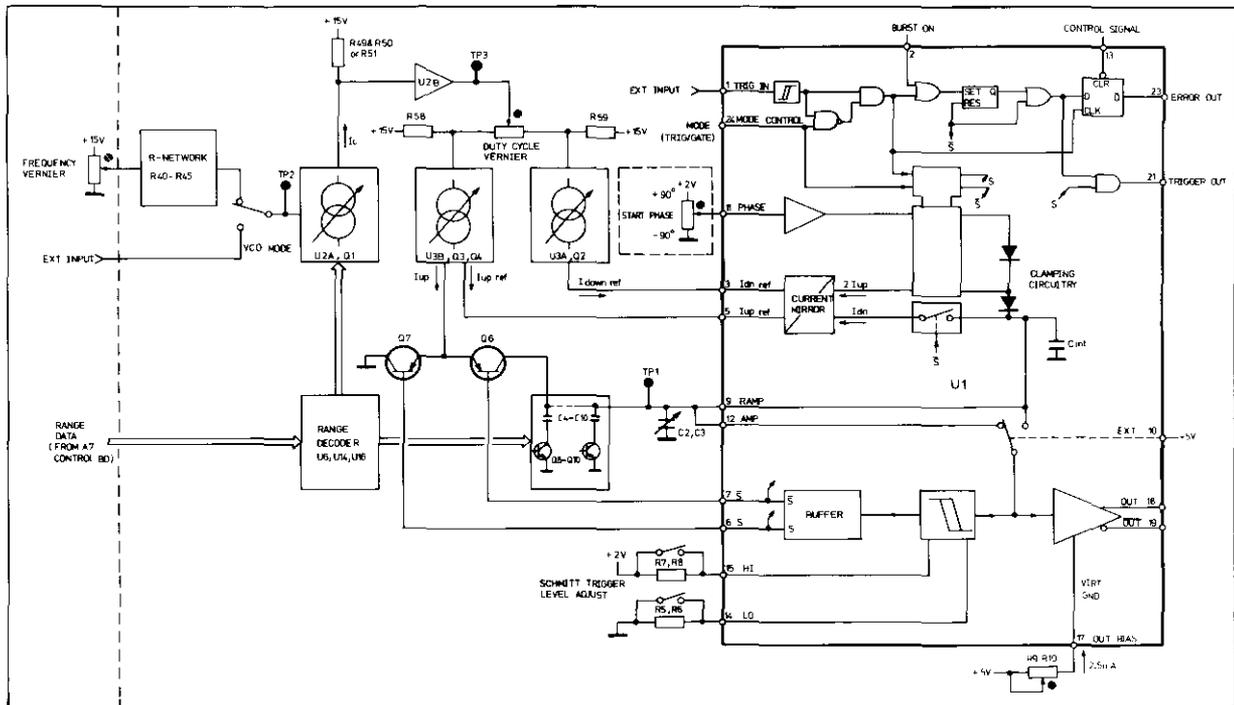
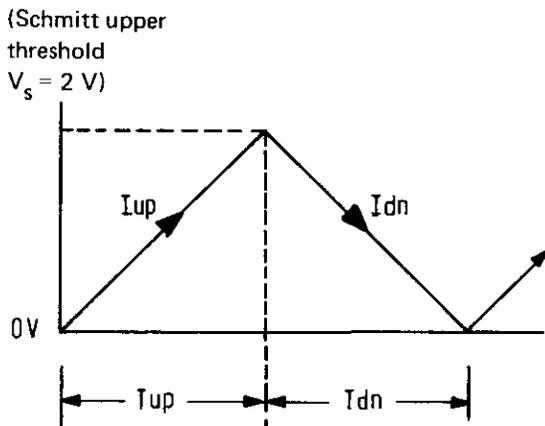


Figure 8-7-1. Simplified VCO Board Block Diagram

In both modes the principle of operation is that a ramp capacitance (one or more of C4–C10) is charged up by I_{UP} to the fixed upper threshold level of a Schmitt trigger (within U1) by switching Q6 on. At this point, Q6 is switched off and Q7 on so discharging the capacitance towards ground and also diverting I_{UP} to ground until the lower Schmitt threshold is reached, the cycle is then repeated. The charge and discharge sequences are illustrated below:



The frequency depends on the two currents and the ramp capacitance. Duty cycle of the waveform is determined by the ratio of $T_{up}/(T_{up} + T_{dn})$ where T_{up} is the time taken to charge up to V_s and T_{dn} is the time taken to discharge to 0 V.

The difference between the two modes is that in Triggered mode an external trigger signal is required at U1 pin 1 to initiate a charge cycle. Also, the ramp capacitors are preset or changed to a voltage determined by the Start Phase potentiometer setting and therefore the charge or "ramp up" process commences from this level. The clamping is achieved via I_{UPref} and the current mirror internal to U1 which produces $2 \times I_{UPref}$ and the required clamp voltage. A more detailed operational description of the main circuit blocks comprising the VCO board will now be given. Unless otherwise mentioned references are to Figure 8–7–1.

R-Network (R40–R45)

The reference voltage from the front panel FREQUENCY vernier is converted by the network to one of two possible values depending on the operative frequency range i.e. – 1 Hz – 9.99 MHz (decades) or 10–20 MHz (non-decades). The resulting voltage is then used to control U2A, Q1 current source.

Control Current Source (U2A, Q1)

This current source output I_C converts the output voltage from the R-Network to a +15 V reference voltage (instead of ground referenced). U11 (see schematic 8) enables one of three resistive networks to be selected depending on which of the three indicated frequency range bands is operative. This will be explained in the Range Decoder and Ramp Capacitor section. The selected network limits I_C and therefore the voltage produced across R49/50 or R51 within one of three different ranges.

Duty Cycle Vernier

The output voltage from U2B is fed either via the Duty Cycle vernier potentiometer (used in an inverse mode) to the two constant current sources shown or, directly connected when fixed 50 % duty cycle or pulse mode is selected. Note: in pulse mode the duty cycle potentiometer is used to control pulse width and the trigger output signal from U1 has a fixed 50 % duty cycle.

Current Sources (I_{up} , I_{upref} , I_{dnref})

Current source U3B, Q3, Q4 etc. supplies the range capacitance charging current (I_{up}) via Q6 which is controlled by U1 SW-output. I_{upref} is used as a reference by the current mirror of U1 to provide the start phase clamp voltage $I_{downref}$ is used as a reference by U1 current mirror to enable the correct discharge or ramp down rate of the previously charged capacitance.

Transistors Q6 and Q7

Q6 is operated as a switch under the control of U1 to supply charging current to the ramp capacitors. Q7, whose operation is always complementary to Q6, serves to bypass current I_{up} to ground at the end of the ramp up period (I_{up} flows constantly).

Range Decoder and Range Capacitors (refer to schematic 8 and Figure 8–7–1)

The range data from A7 Control board is decoded by U14/U16 and used to enable the appropriate range capacitors. Also, depending on which of the three frequency bands (1 Hz – 1 MHz, 1 – 10 MHz or 10 – 20 MHz) is operative pre-limiting of control current I_C within one of three-ranges is done via U11, e.g. a frequency setting of 50 KHz is in band 1 of 1 Hz –

1 MHz, U11 will therefore select the frequency pre-ranging resistive network R55/R54.

The range capacitors are enabled by transistor switches Q8–Q13. C2 and C3 are always enabled and C4–C10 are sequentially enabled in an additive or summing sequence. For the two fastest frequency ranges only C2 and C3 are operative, the 10–20 MHz value being achieved by increasing the available ramp current. This is done by selecting the R56 network which results in maximum I_c and therefore maximum control voltage being available. For the 1–10 MHz range the I_c is reduced via R52/R53 network and therefore the ramp current is reduced. All other ranges use R54/R55 and have the same ramp current control voltage and ramp current limits. For the 0.1 – 1 MHz range C2, C3 and C4 are enabled, for 10–100 KHz C2, C3, C4 and C5 are enabled etc. The complete range capacitor selection data is given in Table 8–7–4. in the Troubleshooting section.

Schmitt Trigger Level Adjust

The two trigger levels are fixed at 0 V and +2 V for all frequency ranges except the two fastest when they are changed by switching in external resistors.

TROUBLESHOOTING

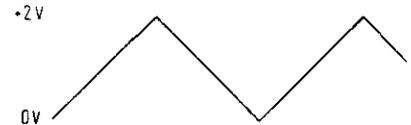
1. General Troubleshooting Information
2. Analogue Data
3. Digital Data

1. General Troubleshooting Information:

It is suggested that troubleshooting the VCO board is started at TP 1 since it is possible to confirm, by the presence of either a triangular waveform or a constant dc level as shown, that particular circuit components are operating correctly. For all operating modes of the 8111A except TRIGGER/PULSE the following details apply:

Modes

A. (free running)
NORMAL, VCO
(50 % DUTY
CYCLE)



Waveshape at TP 2.

0 V and +2 V apply for frequencies between 1 Hz – 1000 KHz for frequencies 1 MHz – 20 MHz values are slightly changed,

b. (Triggered)
TRIGGER,
GATE, BURST

When there is no external trigger signal present the voltage at TP 1 should be fixed at between 0 and 2 V depending on the position of the START PHASE potentiometer.

–90° start phase 0 V approx.

0° start phase 1 V approx.

+90° start phase 2 V approx.

In TRIGGER/PULSE mode the VCO board works only as a Schmitt trigger/level shifter with the external trigger signal passing through U1 and being made compatible with circuitry on board A4. If the fault appears to originate from the VCO board then check that U1 pin 13 is clamped at TTL low since, if not, then the input trigger signal will not be transferred to U1 pin 21 (Trigger Out).

If the test condition for the triggered modes (B) is wrong then check whether current source U33, Q3, Q4 is operating correctly, if so and waveshape for mode A is correct then U1 is suspect. Ensure that problem is not with Q3 and that Q6, Q7 are not faulty before replacing U1.

If checks show that the correct test results at TP1 do not occur then the following faultfinding information should help to isolate the faulty component. The voltages given are referenced to ground unless otherwise stated.

2. Analogue Data:

1 Referring to Figure 8-7-2. and Schematic 8, it can be seen that the voltage at TP2 comes from either the FREQUENCY potentiometer or, when in VCO mode, the EXT INPUT connector. When not in VCO mode, adjustment of the FREQUENCY vernier should produce the following values:

Vernier position:	CCW	CW
TP2 voltage:	< 1 V	> 10 V
or:	< 1 V	> 2 V (for 10-20 MHz range)

IC Current Source

3 The current source converts the input voltage from either the FREQUENCY vernier or the EXT INPUT (in VCO mode). The voltage, which is referenced to ground, is converted to a new value referenced to +15 V. A check on the correct operation of the complete current source circuit of U2, Q1 etc. can be done by confirming the values given in Table 8-7-2.

2 The voltage at TP 3 is referenced to +15 V (TP4) and controls the current sources I_{up} , I_{upref} and I_{down} ref. Adjustment of the FREQUENCY/vernier should produce the values shown in Table 8-7-1.

Table 8-7-1. Test Voltages for Current Sources

	Vernier position		Applicable Ranges and Duty Cycle
	CCW	CW	
TP3 Voltage swing	-0.1 V	-1.4 V	(1 Hz-1 MHz Ranges, fixed 50 % DTY) (1 Hz-1 MHz Ranges, variable DTY) (1 Hz-10 MHz range) (10 - 20 MHz Range) } fixed 50 % DTY
	-0.6 V	-7.8 V	
	-0.26 V	-3.1 V	
	-2.6 V	-6.4 V	
The given values are referenced to +15 V (TP4). Tolerance: $\pm 10\%$.			

Table 8-7-2. Voltage drops across Range resistors

Frequency Range	Selected R (Operative Resistors)	Freq. vern. pos.:	CCW	CW
1 Hz - 1 MHz	R54/55	voltage drop	0.45 V	5.5 V
1 - 10 MHz	R52/53			5.5 V
10 - 20 MHz	R56			1.1 V
Tolerance: 10 % given values are for fixed 50 % DUTY CYCLE				

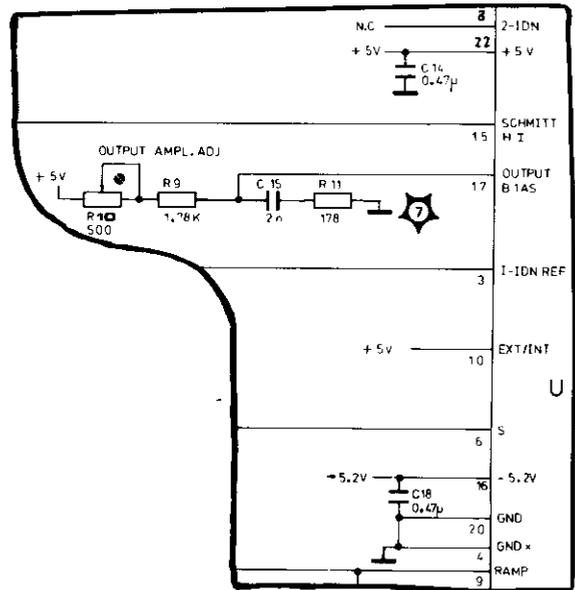
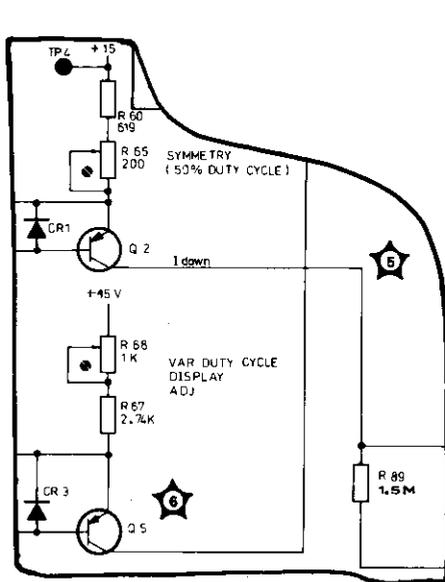
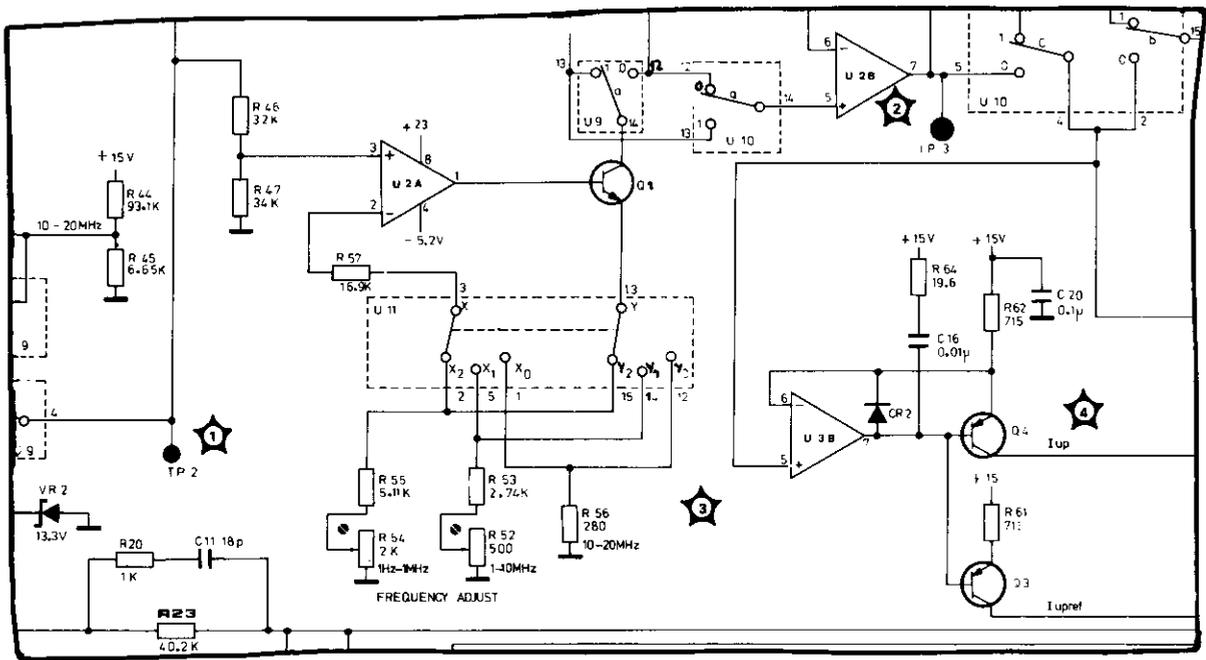


Figure 8-7-2. Troubleshooting Test Points

I_{UP} Current Source

★ The I_{UP} current may be checked by connecting a current meter between the collector of Q4 and ground (therefore routing I_{UP} to ground). Set the 8111A to TRIGGER mode and fixed 50 % DUTY. Verify that Q6 is switched on and Q7 off.

Check, when the FREQUENCY vernier is adjusted, that the values are as in Table 8-7-3.

$I_{downref}$ Current Source

★ $I_{downref}$ can be measured (after removing U1 from its connector) by connecting a current meter between Q2 collector and ground. The values and test conditions for I_{down} are as given in Table 8-7-3 previously.

Variable Duty Cycle Display Current Source

★ The current source U4, Q5 etc. outputs a current which is proportional to I_{UP} , the resulting voltage drop produced across A11R18 is then used to produce the displayed DUTY CYCLE percentage value. The circuit operation can be checked by setting the 8111A to fixed 50 % DUTY and checking the voltage at Q5 collector. The value should change as shown when the FREQUENCY vernier is adjusted:

Output Bias Control Current

★ This current, which controls the output amplifier of U1 is typically 2.5 mA and pin 17 of U1 must be at 0 V (virtual ground).

Table 8-7-3. I_{UP} Values

	Vernier Position		Applicable Frequency Ranges
	CCW	CW	
Current }	0.14 mA	1.9 mA	(1 Hz – 1 MHz Ranges)
	0.36 mA	4.3 mA	(1 MHz – 10 MHz Range)
	3.6 mA	8.9 mA	(10 MHz – 20 MHz Range)

Tolerance: ± 10 %.

Table 8-7-4.

	Vernier Position		Applicable Frequency Range
	CCW	CW	
Voltage at the collector of Q5: }	70 mV	0.87 V	(1 Hz – 1 MHz Ranges)
	0.15 V	1.9 V	(1 MHz – 10 MHz Range)
	1.6 V	4.0 V	(10 MHz – 20 MHz Range)

Tolerance: ± 10 %.

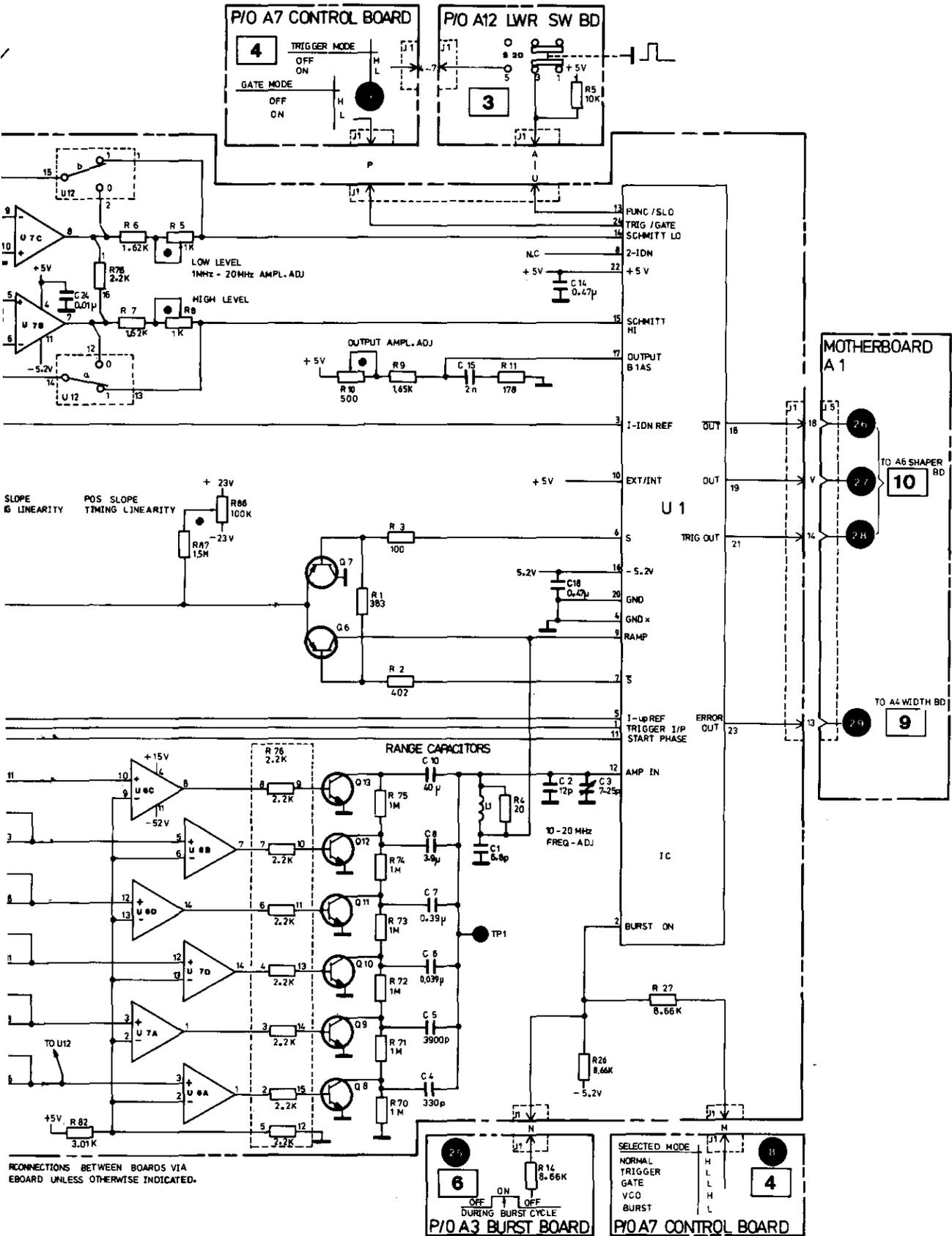
3. Digital Data

If the fault appears to be related to range capacitor selection i.e. a digital data decoding problem then use Table 8-7-4 to verify that the appropriate devices are operating correctly.

The truth table of the other digital devices are given on schematic 8.

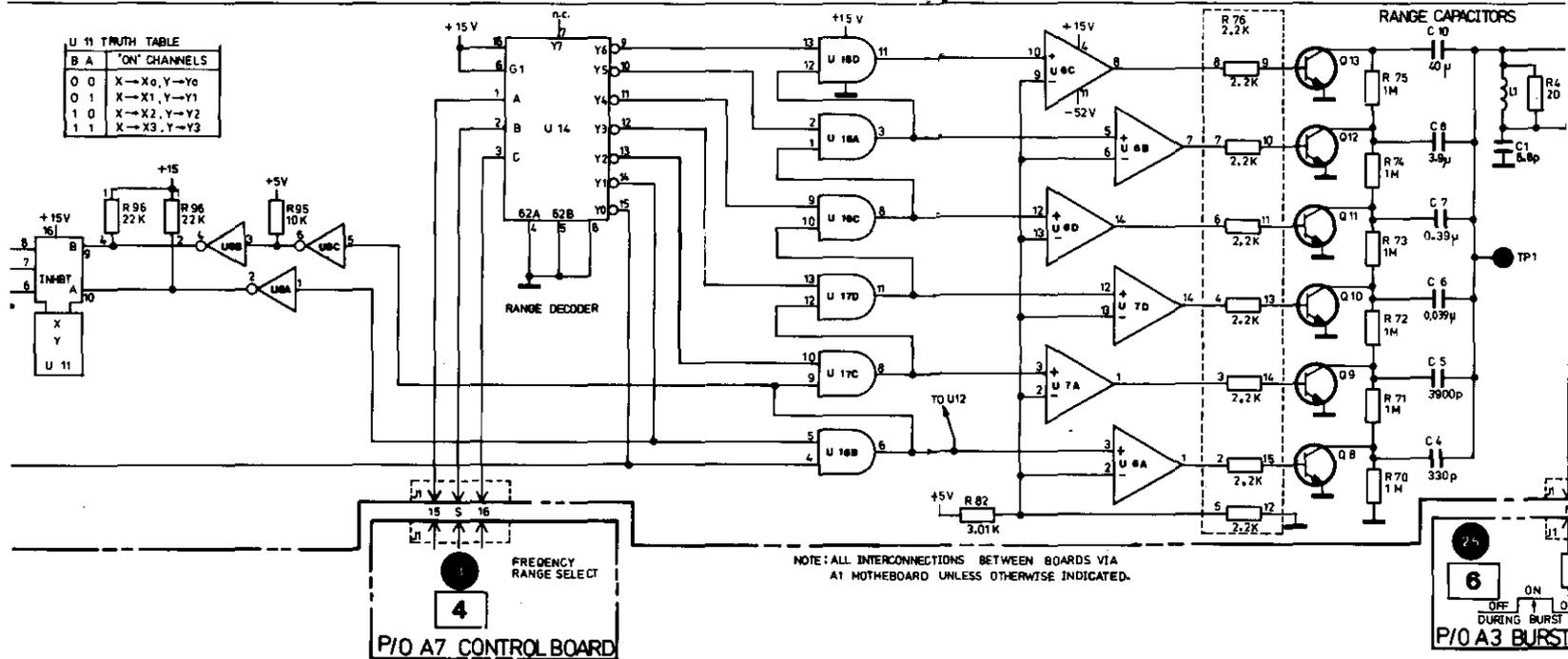
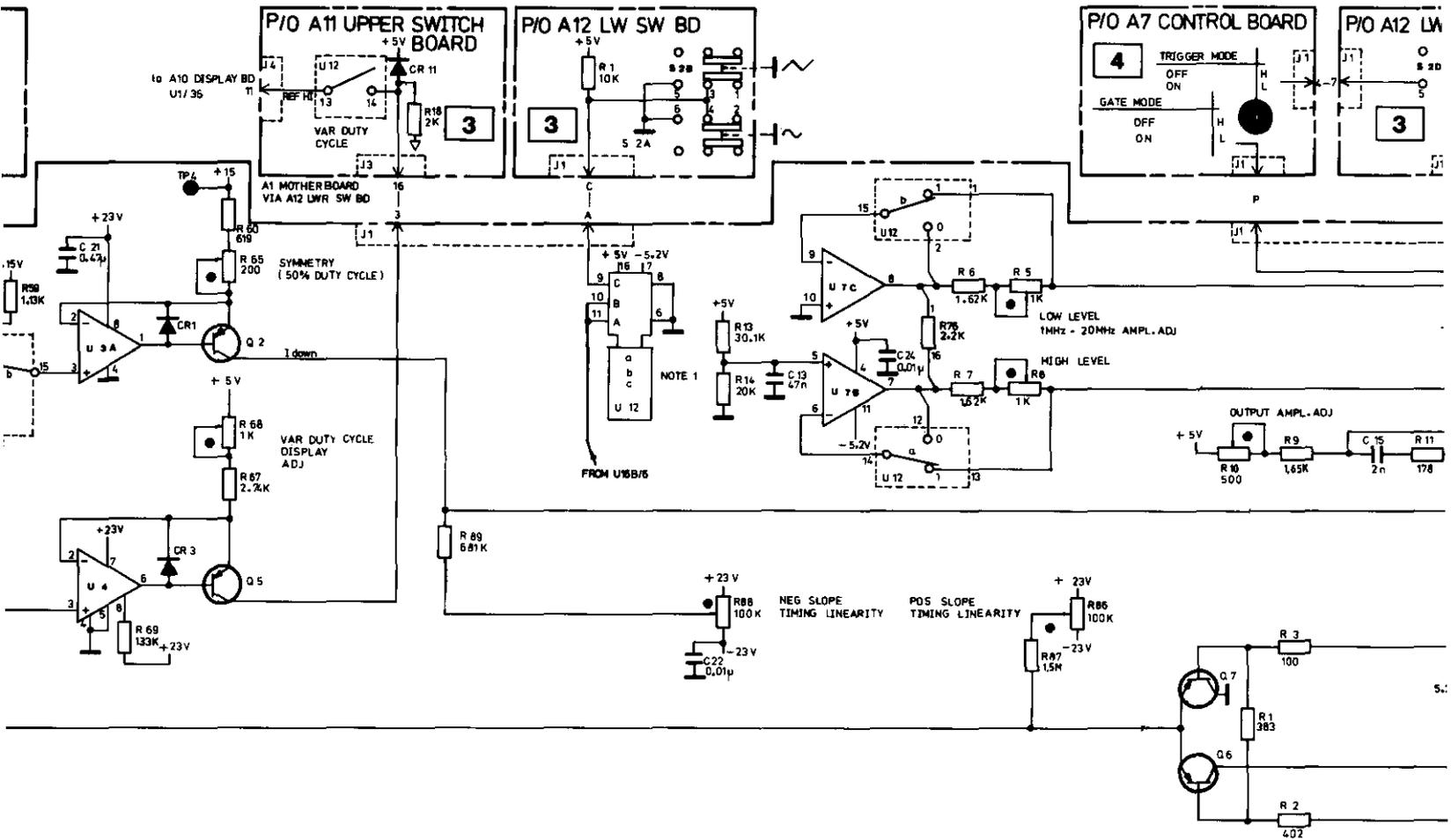
Table 8-7-5. Range Capacitor Selection Truth Table

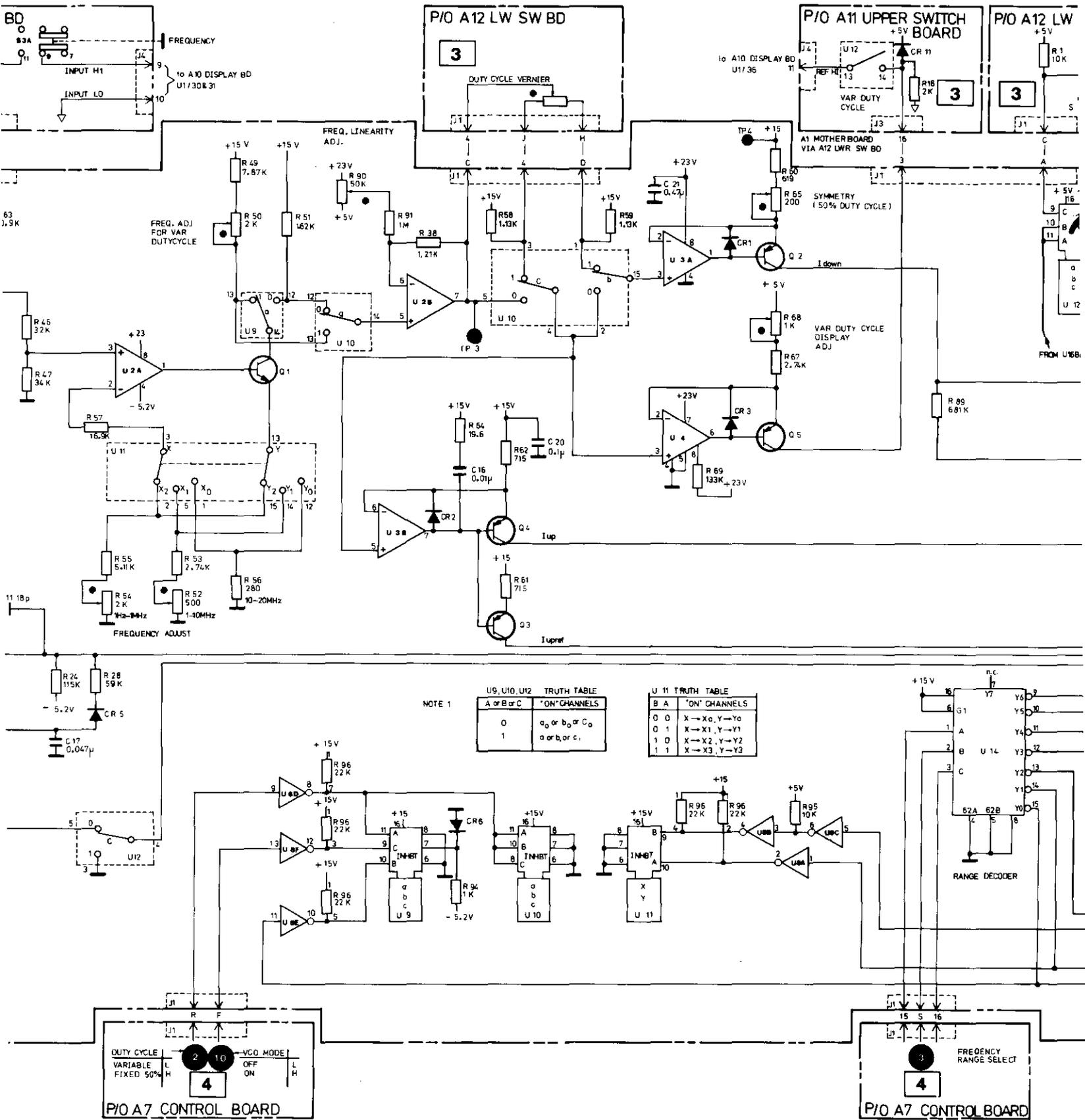
Frequency Range	U14 pin No.									U16 pin No.			U17 pin No.		U16 pin No.	Selected Capacitors * (C2 and C3 are selected in all ranges)	
	3	2	1	15	14	13	12	11	10	9	11	3	8	11	8		6
10 – 20 MHz	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	*
1 – 10 MHz	0	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	*
0.1 – 1 MHz	0	1	0	1	1	0	1	1	1	1	0	0	0	0	0	1	C4
10 – 100 KHz	0	1	1	1	1	1	0	1	1	1	0	0	0	0	1	1	C4, C5
1 – 10 KHz	1	0	0	1	1	1	1	0	1	1	0	0	0	1	1	1	C4-C6
0.1 – 1 KHz	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1	C4-C7
10 – 100 Hz	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	C4-C8
1 – 10 Hz	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	C4-C10



VCO BOARD A5

8

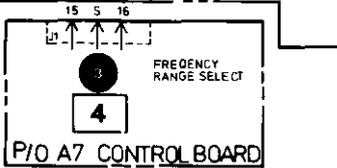
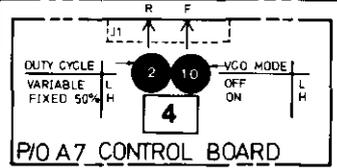




NOTE 1

U 9, U 10, U 12 TRUTH TABLE	
A or B or C	"ON" CHANNELS
0	a ₀ or b ₀ or c ₀
1	a or b, or c.

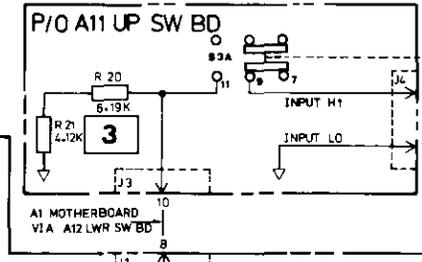
U 11 TRUTH TABLE	
B A	"ON" CHANNELS
0 0	X → X ₀ , Y → Y ₀
0 1	X → X ₁ , Y → Y ₁
1 0	X → X ₂ , Y → Y ₂
1 1	X → X ₃ , Y → Y ₃



A5 BD AY VCO 08111-66505

P/O FRONT PANEL

3



A1 MOTHERBOARD VIA A12 LWR SW BD

FREQUENCY VERNIER

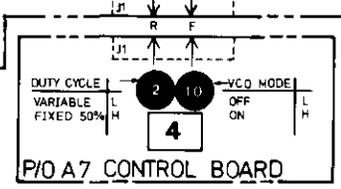
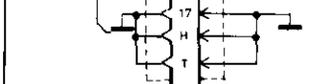
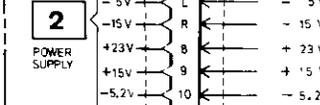
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MAN

START PHASE

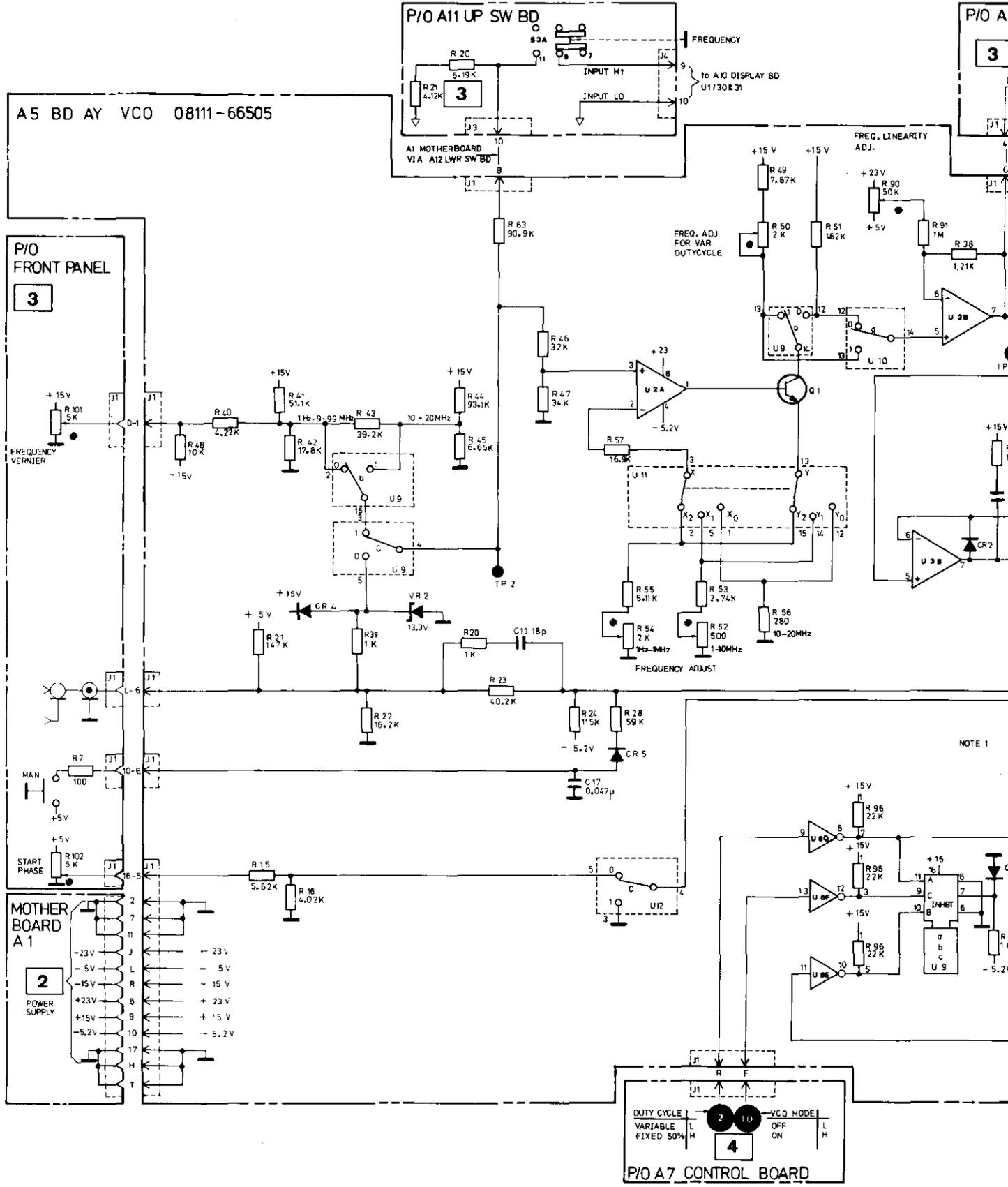
MOTHER BOARD A1

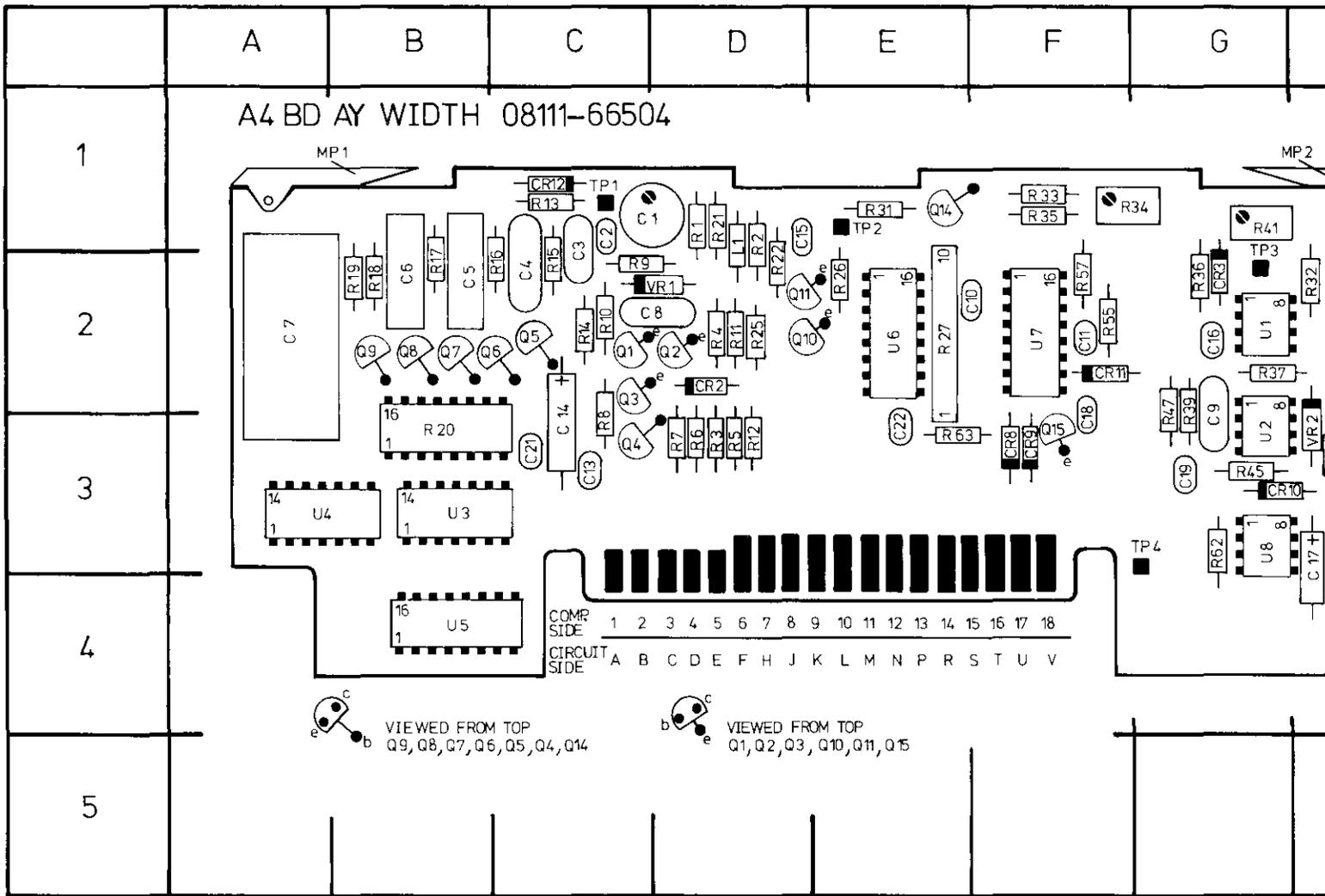
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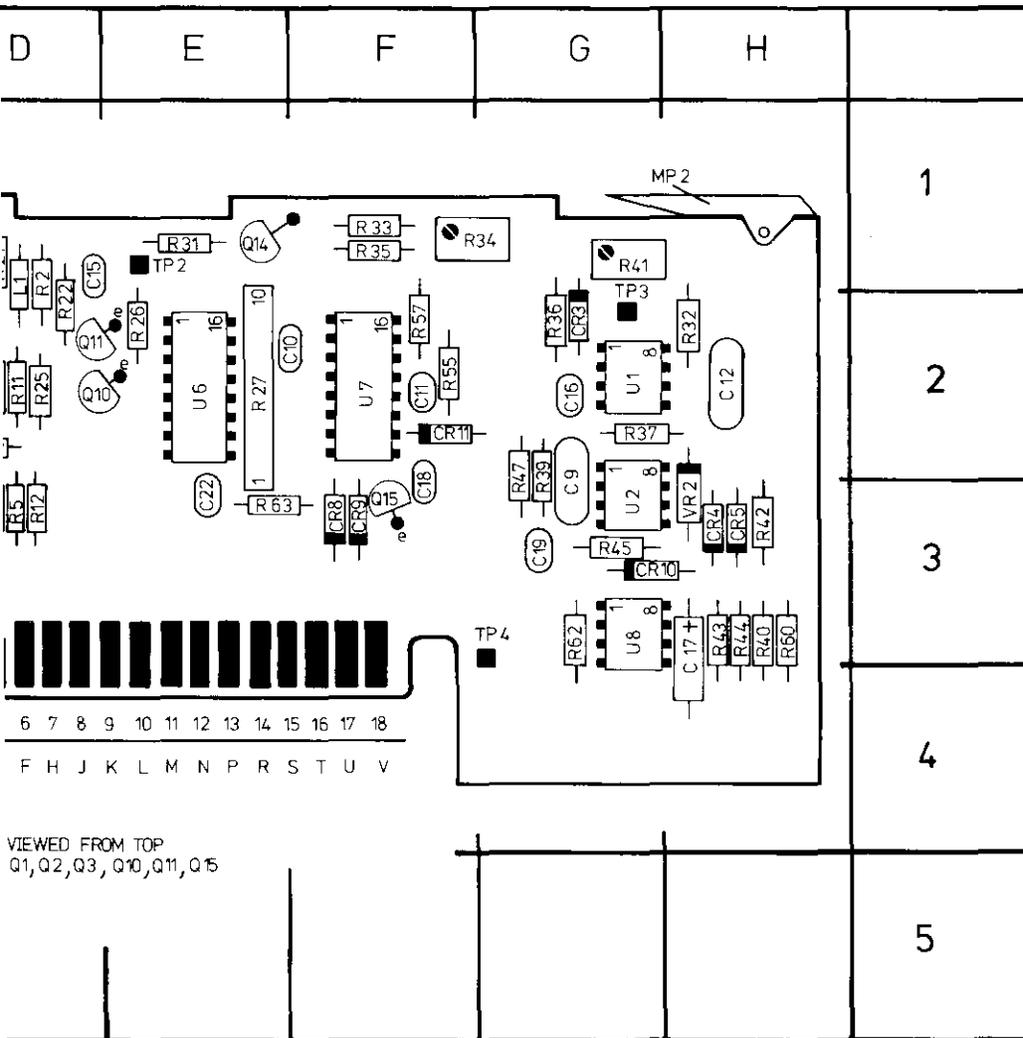
P/O A7 CONTROL BOARD

NOTE 1





REF DESIG	GRID LOC								
C1	C1	C16	G2	L1	D2	R2	D1	R18	B2
C2	C1	C17	H4	Q1	C2	R3	D3	R19	B2
C3	C1	C18	F3	Q2	D2	R4	D2	R20	B3
C4	C1	C19	G3	Q3	C2	R5	D3	R21	D1
C5	B2	C21	C3	Q4	C3	R6	D3	R22	D2
C6	B2	C22	E3	Q5	C2	R7	D3	R25	D2
C7	A2	CR2	D2	Q6	B2	R8	C3	R26	E2
C8	C2	CR3	G2	Q7	B2	R9	C2	R27	E2
C9	G2	CR4	H3	Q8	B2	R10	C2	R31	E1
C10	E2	CR5	H3	Q9	B2	R12	D3	R32	H2
C11	F2	CR8	F3	Q10	D2	R13	C1	R33	F1
C12	H2	CR9	H3	Q11	D2	R14	C2	R34	F1
C13	C3	CR10	G3	Q14	E1	R15	C2	R35	F1
C14	C3	CR11	F2	Q15	F3	R16	B2	R36	G2
C15	D1	CR12	C1	R1	D1	R17	B2	R37	G2



REF DESIG	GRID LOC
U1	G2
U2	G3
U3	B3
U4	A3
U5	B4
U6	E2
U7	F2
U8	G3
VR1	D2
VR2	H3

SERVICE BLOCK 8 WIDTH GENERATOR A4 9

THEORY OF OPERATION

General

The function of the width generator (applicable only in pulse mode) is to provide an output pulse of known, predetermined width in accordance with the 8111A front panel settings.

The Width board (A4) includes the circuitry to do this and also a width error detector/display driver.

The width range, as stated in the Specifications Table, is from 25 ns to 100 ms, this is divided into seven ranges the fastest being 25 ns to 100 ns and then reducing in decade steps from 100–1000 ns to the slowest, 10 ms – 100 ms.

A block diagram of the main sections of the board is shown in Figure 8–8–1, these are: a current source and associated control devices, a set of range capacitors, a range data decoder and associated capacitor selection devices, a Schmitt trigger, a trigger signal converter and an error detector/display driver.

Reference to schematic 9 should be made when reading the following operational description.

OPERATION

The basic operation of the width generator is as follows: A trigger signal (WIDTH TRIGGER) produced either by the VCO or an external source and routed via A6 Shaper, is input to A4.

This sets the Schmitt trigger which then causes the width output signal to go high and enables a constant current to charge up a range capacitor. When the capacitor (or ramp) voltage reaches the Schmitt trigger threshold the width output signal is "reset": – width cycle completed. The capacitor is rapidly discharged and the overall circuit is now ready to receive the next trigger signal from A5.

If, prior to completion of the width cycle the next trigger signal should arrive an error signal will be generated. A more detailed description of the operation of the individual functional "blocks" of the overall circuit will now be given.

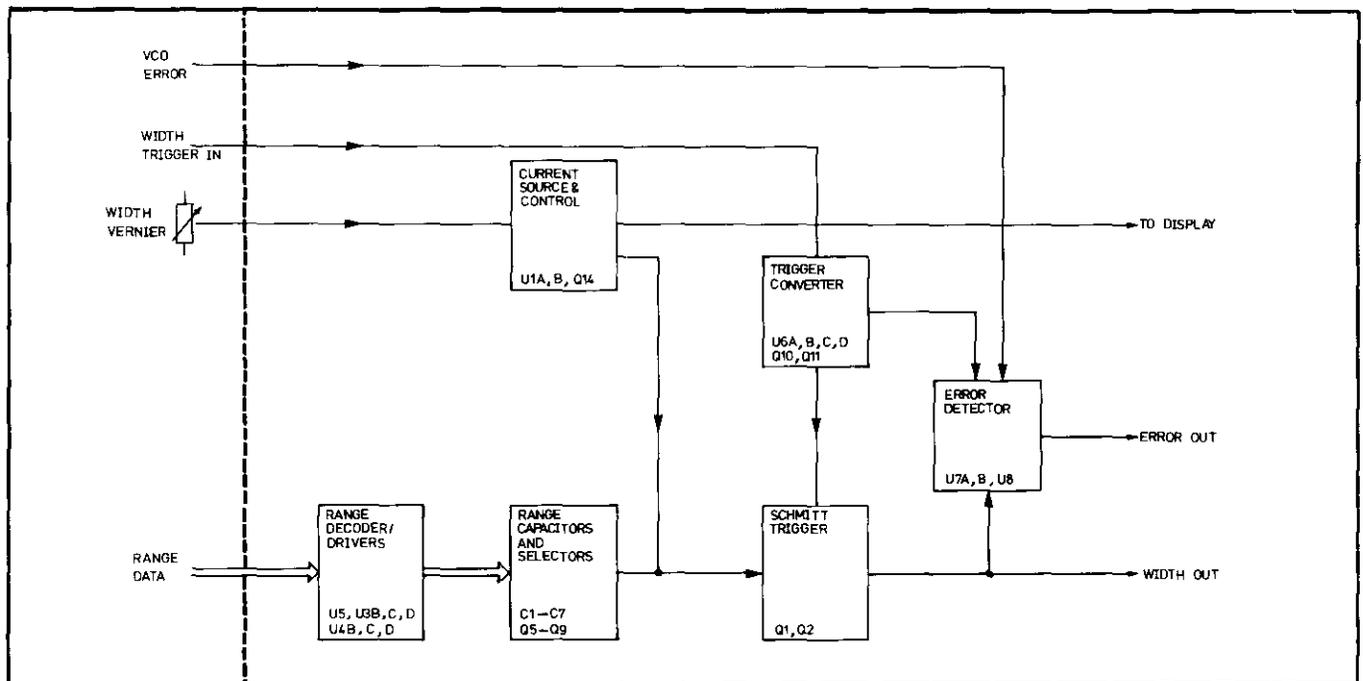


Figure 8–8–1. Simplified Width Board Block Diagram

Current Source

Figure 8-8-2 shows a simplified diagram of the current source.

The front panel mounted width vernier controls the output voltage of U2A, CCW or zero resistance for highest output voltage/fastest value and vice-versa for CW. The adjustable range of output values is dependent on the two reference voltages -5.2 V and -4.16 V . In the fastest width range (25 ns – 100 ns), "switch" S2 is open, so the adjustable range is dependent only on the -5.2 V reference voltage.

The output voltage of U2A together with R41 + R39 controls the current supplied to the range capacitors except when in the fastest range, here S1 is closed to increase the current by a factor of 10 (compared to that required for the other ranges) and therefore achieving faster ramp times. "Switch" functions S1 and S2 as shown in the figure are provided by U1B and U2B together with associated peripheral components. In all ranges except the fastest S2 is closed and S1 open.

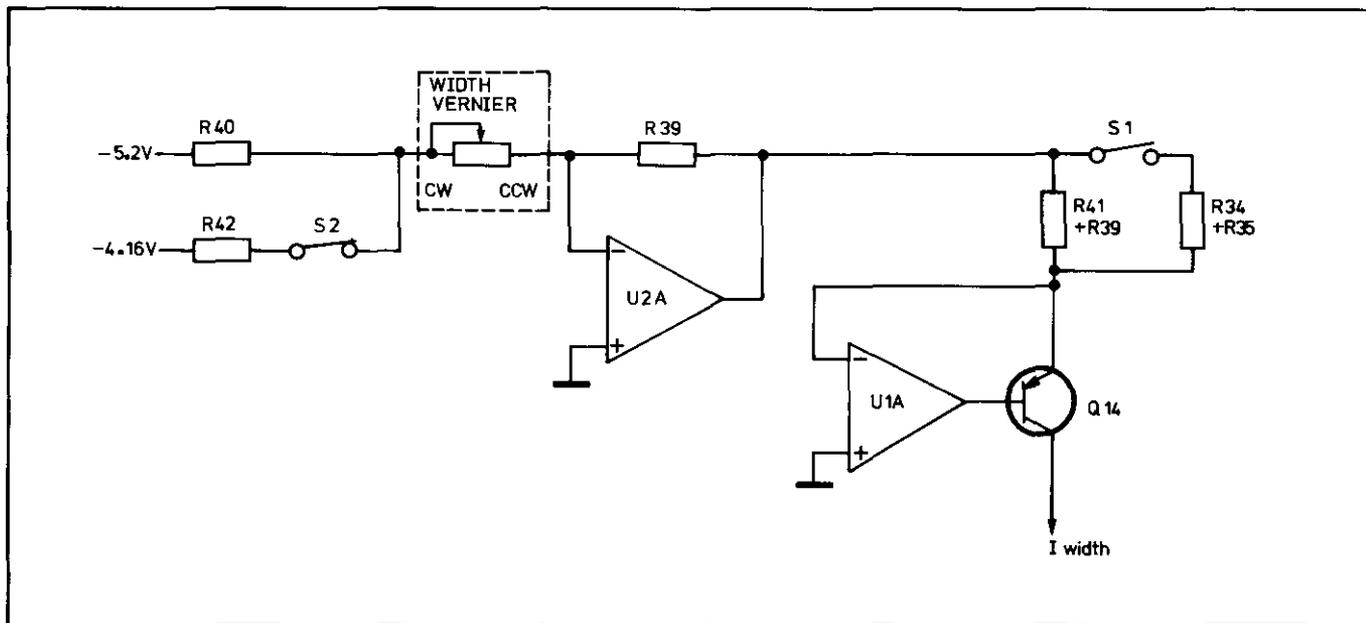


Figure 8-8-2. Simplified Current Source Circuit

Width Range Decoder and Capacitors

Range data, from the front panel switch via board A7, is decoded by the 3-8 decoder U5 (see Figure 8-8-3) to enable either one of the five capacitors C3-C7 plus C1, C2 or only C1, C2. C1, C2 are in fact permanently switched in and are used either as a stand-alone pair for the two fastest width ranges or combined with any of the other five capacitors for all other ranges. The capacitor select/enable transistors Q5-Q9 are operated in both the forward and reverse modes to enable current to flow to charge and also discharge the capacitors.

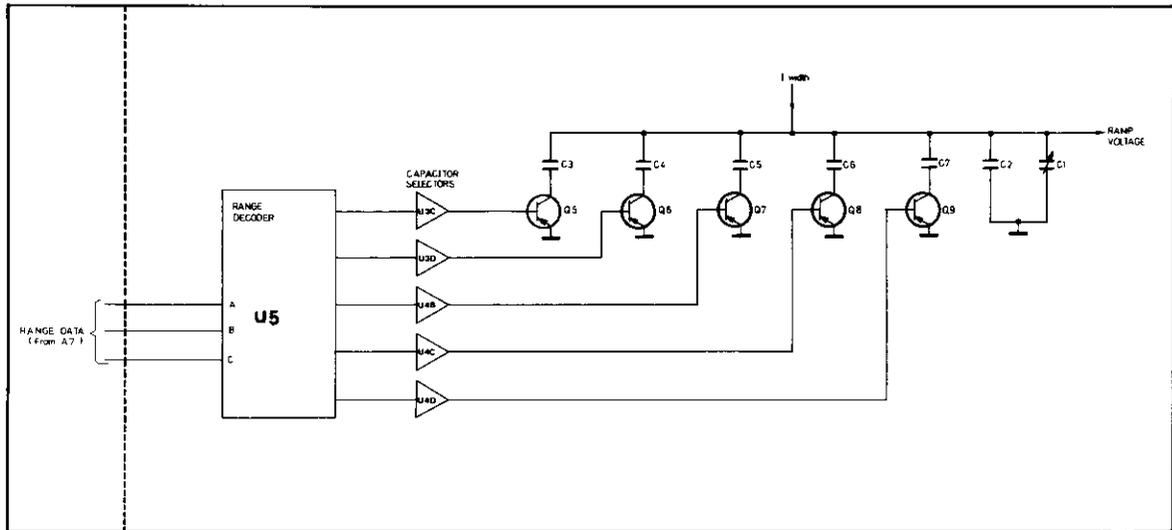


Figure 8-8-3. Simplified Width Range Selector Diagram

Error Detector Circuit

Reference to schematic 9 shows that the width trigger input signal is connected to the clock input of U7A (D type flip-flop) and the width output signal to the D input. A positive going edge at the clock input will cause the data at the D input to be transferred to the Q output, i.e. if D is still high (width signal not completed) when a trigger signal arrives an error signal is produced. A timing diagram to illustrate the error detection process is shown in Figure 8-8-4.

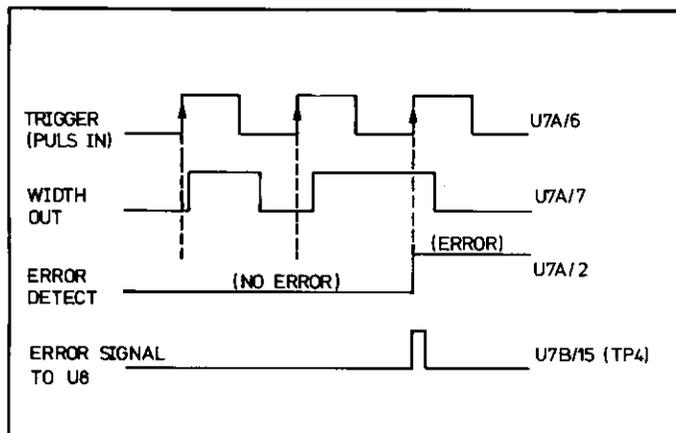


Figure 8-8-4. Error Detection Timing Diagram

Comparator U8 lengthens the output pulse of the monostable U7B and provides a signal suitable for driving the ERROR LED.

Schmitt Trigger

Reference to schematic 9 shows that the Schmitt trigger circuit comprises a differential amplifier with feedback-Q1, Q2 etc. and an emitter follower Q3, Q4.

In the non-active state Q1 conducts and Q2 is turned off. The output voltage of the range capacitors' common connection is clamped at -7.4 V via the emitter follower Q3, Q4. CR2 is biased on and provides base current for Q1 and quiescent current for Q4.

On receipt of a positive trigger pulse, Q2 turns on and switches Q1 off allowing the width output signal to go "high" or active.

The potential at the base of Q4 increases, CR2 is biased off and Q4 is therefore turned off. A charging current is now allowed to flow through the selected range capacitor until the threshold level of the Schmitt trigger is reached. Q1 is then turned on which switches Q2 off and the width output signal goes "low" or off.

The ramp capacitor voltage is discharged to -7.4 V via emitter follower Q4.

Service

Trigger Converter

Refer to schematic 9, the trigger converter generates a 12 ns output pulse (at U6A output) on the positive going edge of the VCO derived input signal. The pulse length is derived from the propagation delay of R27/C10 and the ECL NOR gate U6A. This pulse is then used to set the Schmitt trigger.

TROUBLESHOOTING

When troubleshooting the width board set the 8111A Waveform to Pulse Mode.

Referring to Figure 8-8-5, check the conditions at the following test points, this assists in isolating the fault.

★ The voltage at TP3 is used to control the current source. It should vary by turning the width vernier as follows:

CW	CCW
from 0.7 V to 9.8 V	
or 0.7 V to 3.9 V in 25 ns-100 ns Range	

★ The voltage drop across R31 indicates the current supplied by the current source. Depending on the width vernier position it should vary as follows:

CW	CCW
from 50 mV to 650 mV	
or 0.5 V to 2.6 V in 25 ns-100 ns Range	

★ ★ ★ and ★ see below :

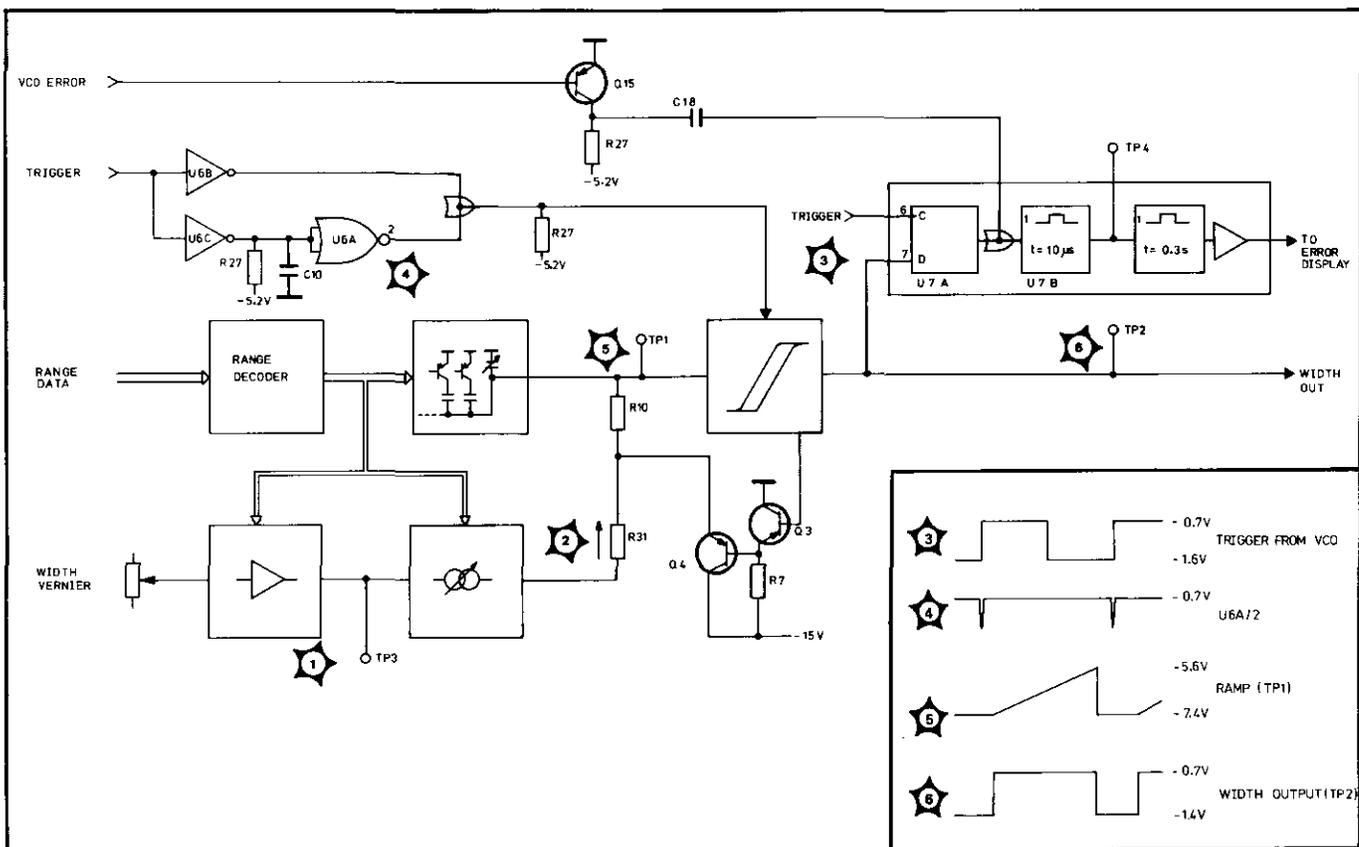
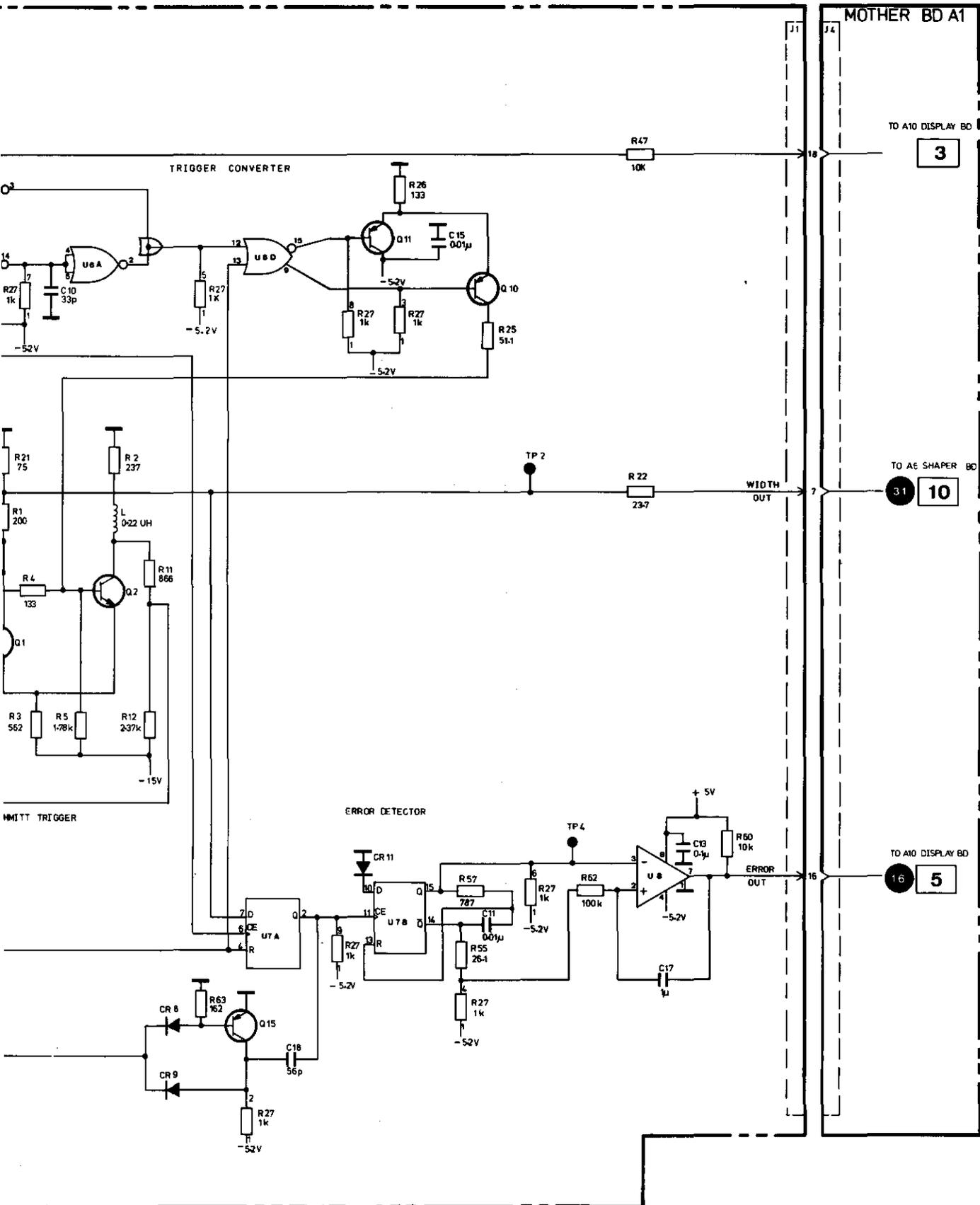


Figure 8-8-5. Width Troubleshooting Diagram

For checking standby conditions of the width board it is recommended that the 8111A be set to a non-pulse waveform. Should the fault appear to be in the WIDTH RANGE SELECTOR section, U5 outputs can be checked against the truth Table 8-8-1.

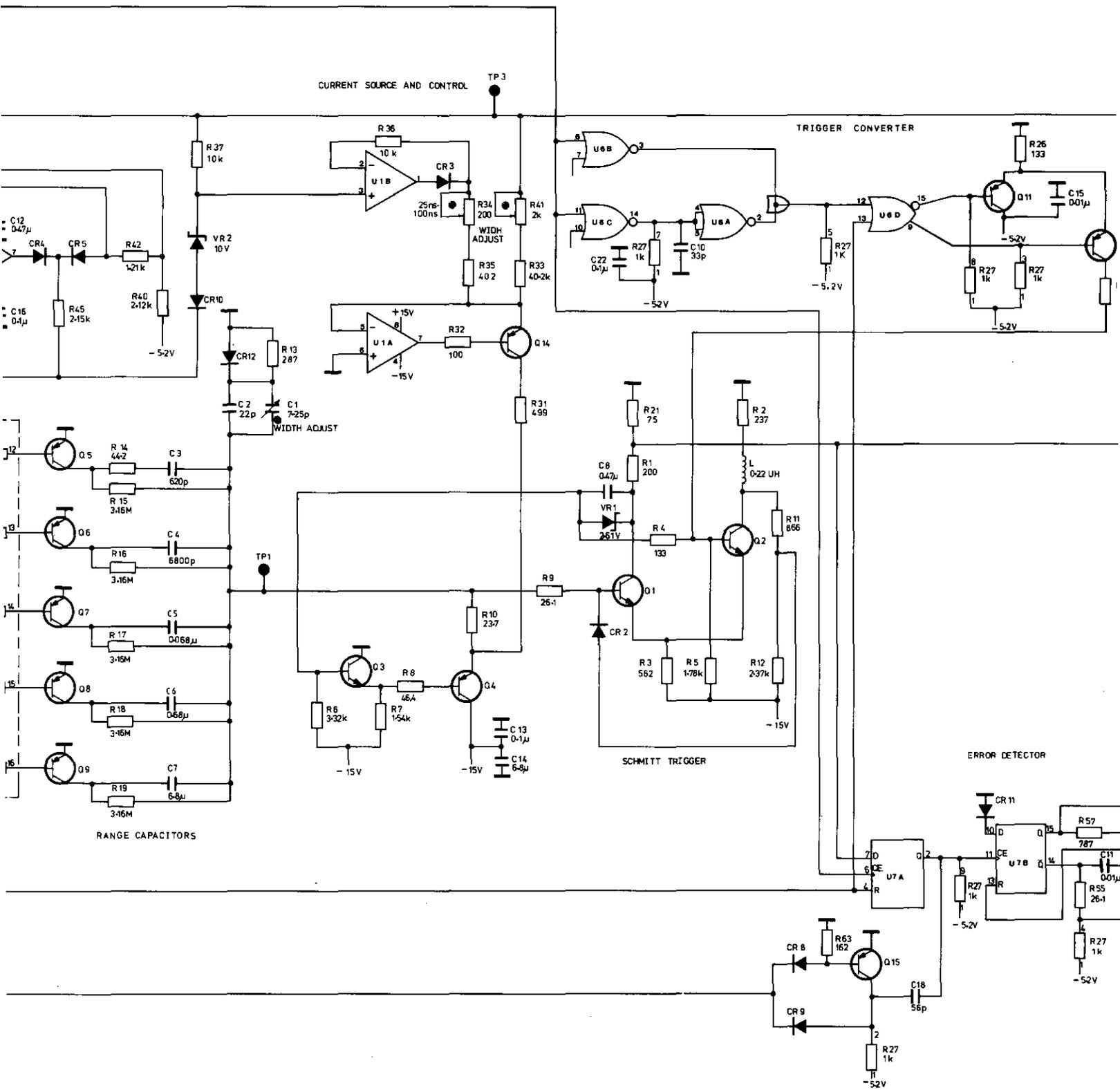
Table 8-8-1. Range Decoder (U5) Truth Table

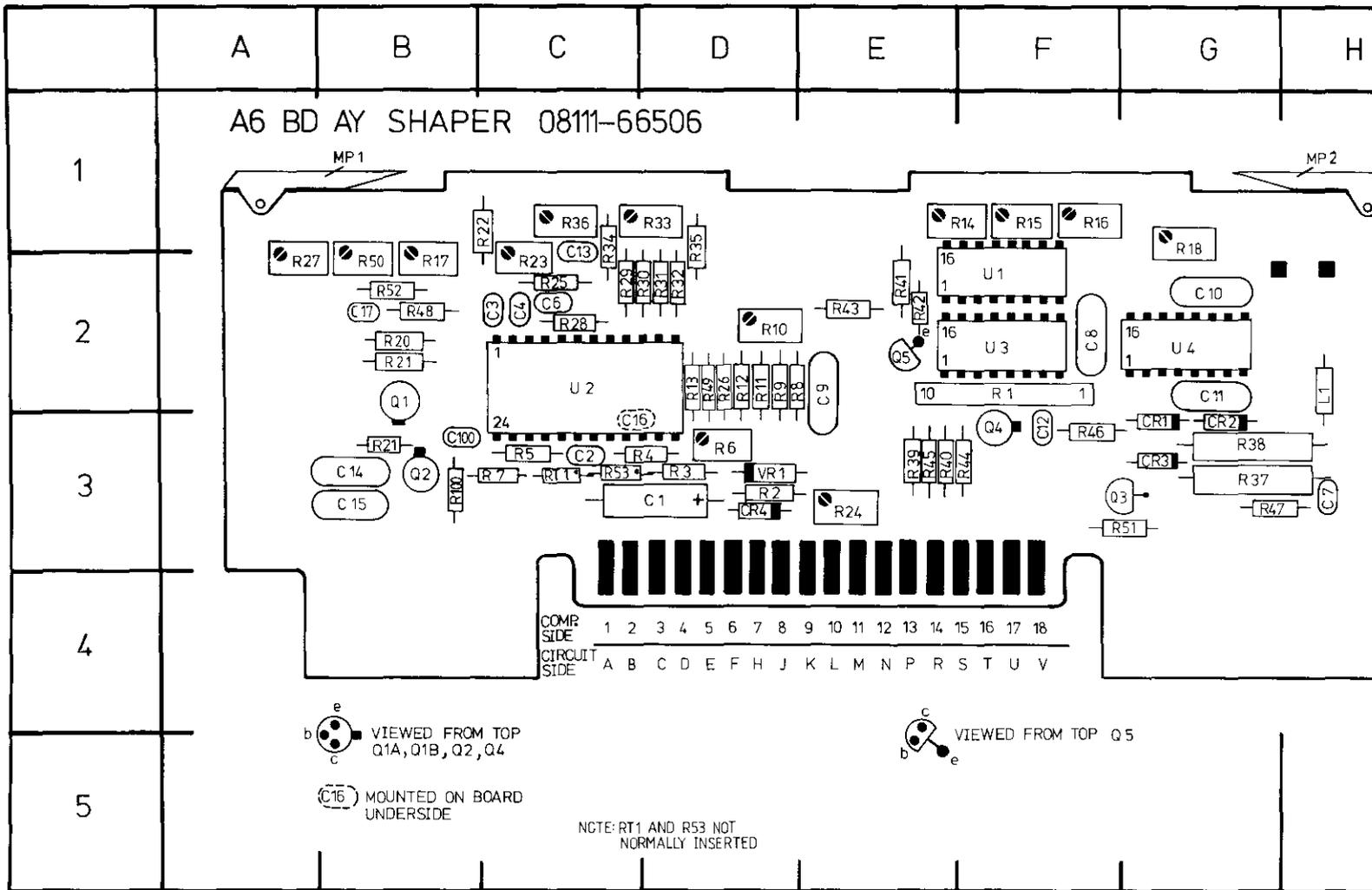
Width Range	Range Data (U5 Inputs)			Range Data (U5 Outputs)						Selected Capacitor
	C pin 3	B pin 2	A pin 1	Y ₀ pin 15	Y ₁ pin 14	Y ₂ pin 13	Y ₃ pin 12	Y ₄ pin 11	Y ₆ pin 9	
10 ms – 100 ms	0	0	0	0	1	1	1	1	1	C7
1 ms – 10 ms	0	0	1	1	0	1	1	1	1	C6
100 μs – 1 ms	0	1	0	1	1	0	1	1	1	C5
10 μs – 100 μs	0	1	1	1	1	1	0	1	1	C4
1 μs – 10 μs	1	0	0	1	1	1	1	0	1	C3
100 ns – 1 μs	1	0	1	1	1	1	1	1	1	—
25 ns – 100 ns	1	1	0	1	1	1	1	1	0	—



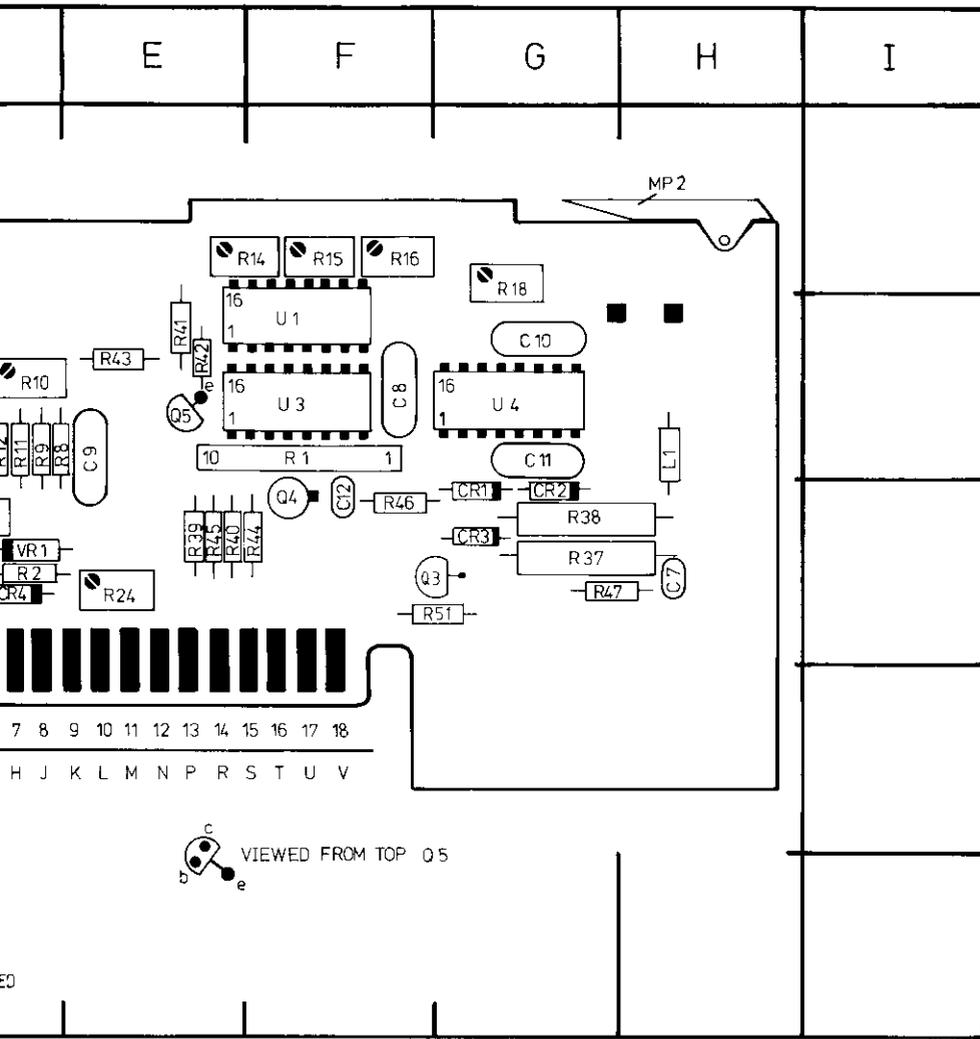
WIDTH GENERATOR A4

(08111-66504)





REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D3	C16	C3	R3	D3	R18	G1/2	R33	D1	R48	
C2	C3	C17	B2	R4	C3	R19	B2	R34	C1	R49	
C3	C2	CR1	G3	R5	C3	R20	B2	R35	D1	R50	
C4	C2	CR2	G3	R6	D3	R21	B2	R36	C1	R51	
C5	B2	CR3	G3	R7	C3	R22	B1	R37	G3	R52	
C6	C2	CR4	D3	R8	D2	R23	C2	R38	G3	R53	
C7	H3	L1	H2	R9	D2	R24	E3	R39	E3	RT1	
C8	F2	Q1	B2	R10	D2	R25	C2	R40	E3	U1	
C9	E2	Q2	B3	R11	D2	R26	D2	R41	E2	U3	
C10	G2	Q3	F3	R12	D2	R27	A2	R42	E2	U4	
C11	G2	Q4	F3	R13	D2	R28	C2	R43	E2	VR1	
C12	F3	Q5	E2	R14	E1	R29	C2	R44	F3		
C13	C1	R1	F3	R15	F1	R30	C2	R45	E3		
C14	B3	R2	D3	R16	F1	R31	D2	R46	F3		
C15	B3	R3	D3	R17	B2	R32	D2	R47	G3		



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
R18	G1/2	R33	D1	R48	B2
R19	B2	R34	C1	R49	D2
R20	B2	R35	D1	R50	B1/2
R21	B2	R36	C1	R51	G3
R22	B1	R37	G3	R52	B2
R23	C2	R38	G3	R53*	C3
R24	E3	R39	E3	RT1*	C3
R25	C2	R40	E3	U1	F2
R26	D2	R41	E2	U3	F2
R27	A2	R42	E2	U4	G2
R28	C2	R43	E2	VR1	D3
R29	C2	R44	F3		
R30	C2	R45	E3		
R31	D2	R46	F3		
R32	D2	R47	G3		

SERVICE BLOCK 9 SHAPER BOARD A6 10

THEORY OF OPERATION

General

The function of the Shaper board is to process the input signal delivered by either the VCO (A5) if in function mode or Width board (A4) if in pulse mode. Its main operational features include triangle to sine wave conversion and a pulse transition time speed up circuit. This is operative for both pulse and square waveforms.

Additional features of the Shaper are a 1:10 attenuation stage for all output signals controlled by a simple external reference voltage (potentiometer), a level shifter enabling positive and negative offset output signals and a normal/complement switching facility.

The OUTPUT signal from A6 is fed to the Output board (A8) and the TRIGGER OUTPUT goes directly to the front panel connector.

OPERATION

The most significant part of the board is the IC-U2 which performs the signal shaping and conversion functions. A simplified diagram of the board is shown in Figure 8-9-1

and this clearly illustrates the significance of U2. The various IC capabilities are enabled by control inputs, these include the two mode select pins which enable either linear preamplifier mode (for triangular waveforms), triangle to sine conversion of fast pulse. This last mode requires the application of an EECL (Emitter Emitter Coupled Logic) level input signal whereas the "triangle and sine" modes require the application of normal and complement triangular waveforms. Additional control inputs enable NORM/COMPLEMENT control (Pin 15) and POS/SYMMETRICAL/NEG (pins 10 and 11) biasing.

Apart from U1 and its input, biasing and adjustment components, the two remaining significant circuit elements comprising the board are the input stage for square or pulse operation - U3, Q4, Q5, etc. - and the output or "current mirror" stage.

Square/Pulse Input Stage

Either the TRIGGER IN or the WIDTH IN signal is selected, selection depends on U1B and U3B (WIDTH DISABLE) pin 11 status. Q4 converts the incoming trigger signal to an ECL level and Q5 changes this to the special EECL levels (-0.6 V for "low" and 0 V for "high"). The TRIGGER OUTPUT signal is derived from Q4 emitter, and converted from ECL to TTL by A6 U4.

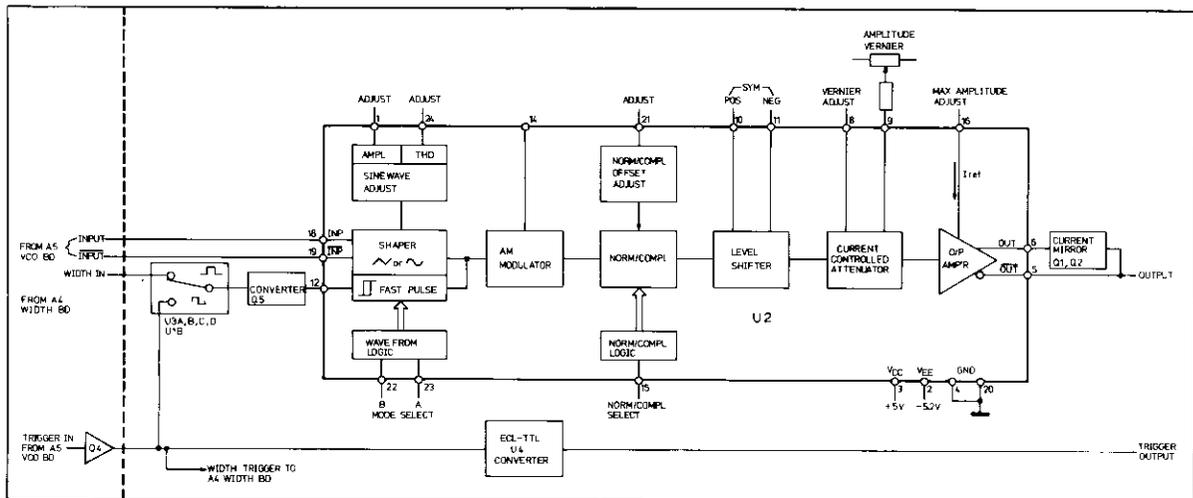


Figure 8-9-1. Simplified Shaper Board Block Diagram

Output Stage (Current Mirror) or)

The output waveforms from U2 comprise differential current stages, by summing these with a "current mirror", undesirable offset effects are reduced to zero and a doubling of the available output signal amplitude is achieved. The operating principle is shown in Figure 8-9-2, the Current mirror performs a current inversion (without this the summing would result in a zero output) and in effect produces an output current which is a true "reflection" of its input current provided that Q1A and Q1B are a matched pair.

By summing the differential output currents, the quiescent currents I_q and their effect is eliminated.

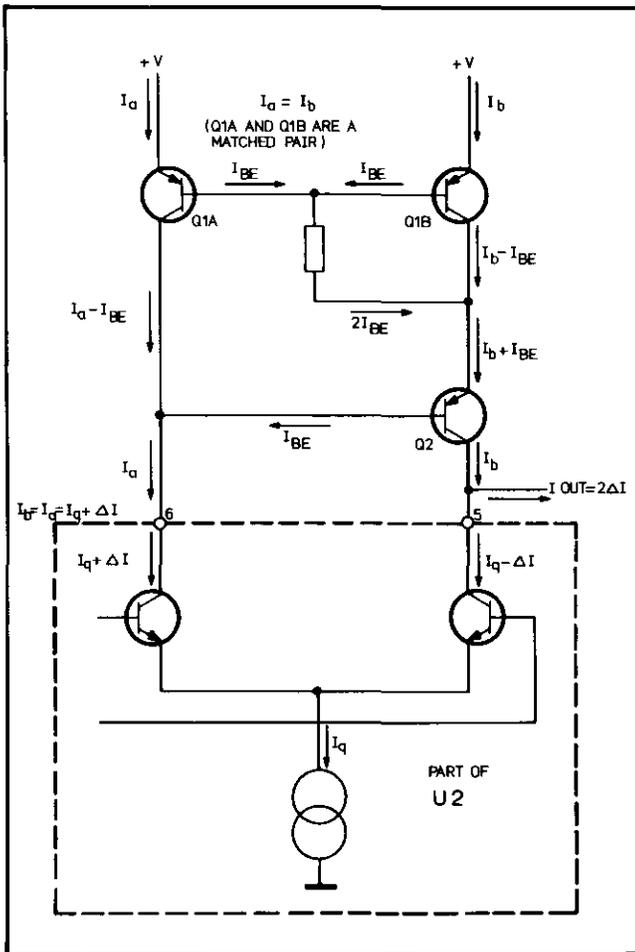


Figure 8-9-2. Current Mirror Operating Principle

TROUBLESHOOTING

General

As a first step confirm that the problem is in fact at the Shaper board by ensuring that the required input signals as shown in Figure 8-9-3 are present.

Once these conditions are confirmed check that the appropriate adjustment potentiometer is not open or short circuited since this type of fault can cause a failure condition which appears to come from U2.

If maximum signal amplitude is not obtainable check that the voltage across VR1 is at least +5.12 V. The output amplitude level from A6 for all waveforms should be approximately 500 mV_{pp} when the front panel AMPLITUDE vernier is fully CW.

Current Mirror

To confirm correct operation check that the signal levels at Q1A and A1B emitters are the same (the transistors are a matched pair).

Signal Output in Pulse or Square Waveform

If a fault is seen only when in pulse or squarewave then check that the logic conditions of gates U3A, B, C and D is in accordance with Table 8-9-1. These levels are ECL and can be checked with an ECL probe.

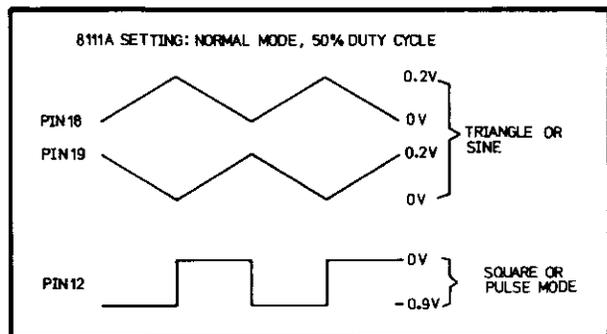


Figure 8-9-3. Input Signals

Waveform and Output Mode Selection

The various control signal logic levels input to IC U2 can be checked against Tables 8-9-2 and 8-9-3. The logic levels in the tables are all TTL.

Table 8-9-1. Waveform and Output Mode Selection

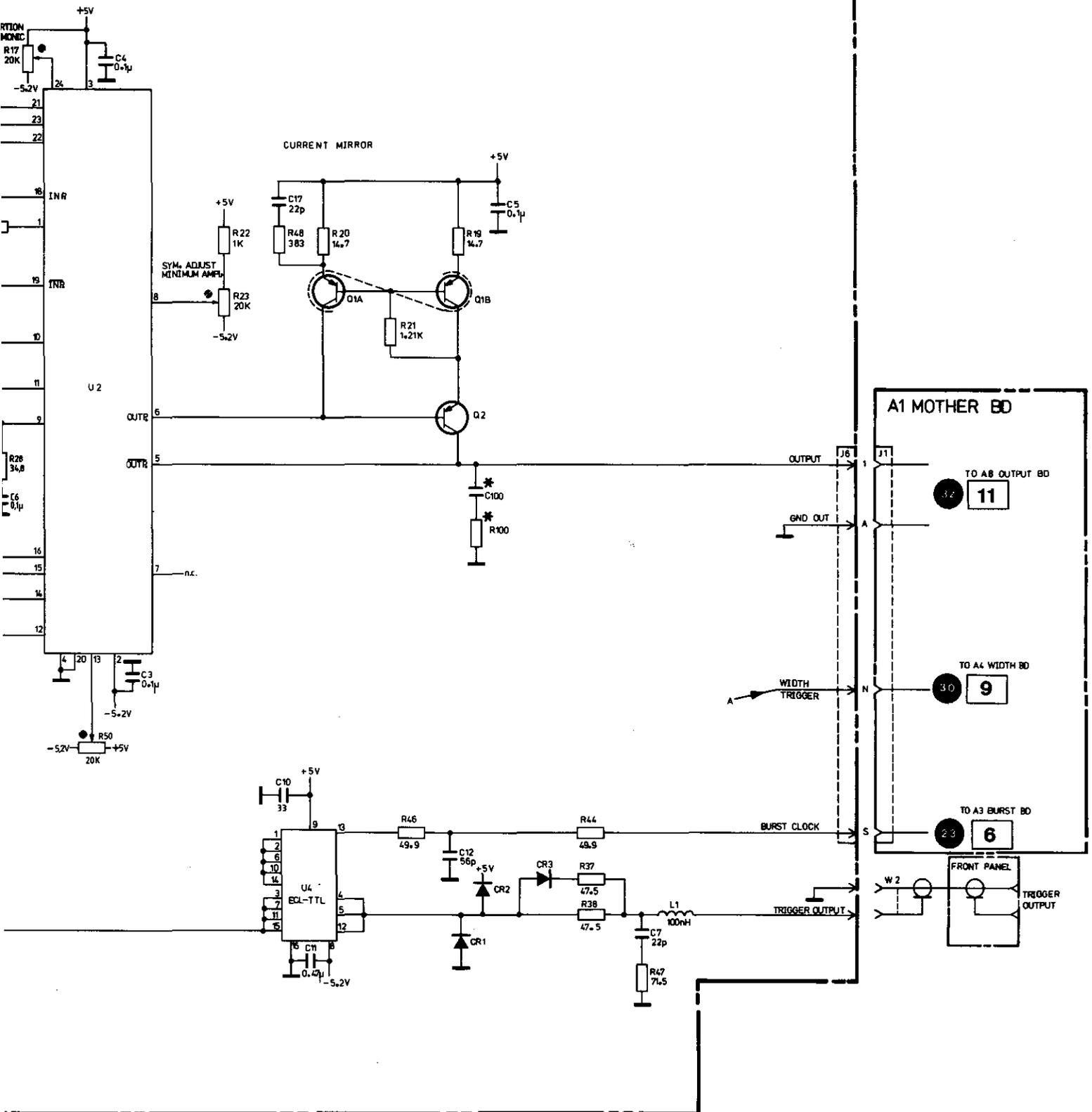
8111A Setting	U3/5 R11	U3/14	U3/6	U1B/4 → 3
	H	L	H	non conducting
	H	L	L	conducting
	L	H	H	conducting

Table 8-9-2.

8111A	U2/23	U2/22
	L	L
	L	H
	H	H

Table 8-9-3.

8111A Setting	U2/15
NORMAL, POS or SYM	L
NORMAL, NEG	H
COMPL, NEG	L
COMPL, POS or SYM	H

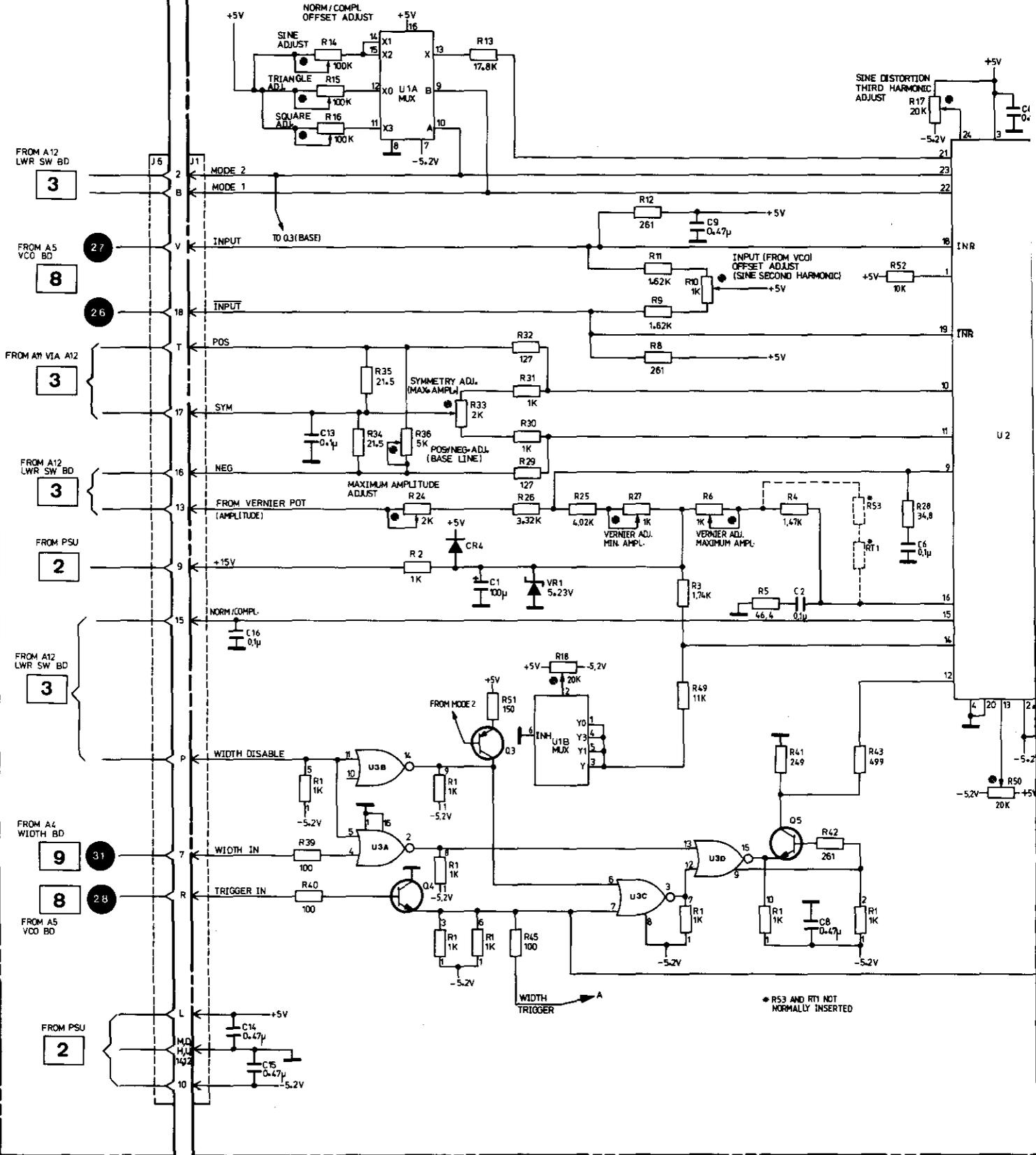


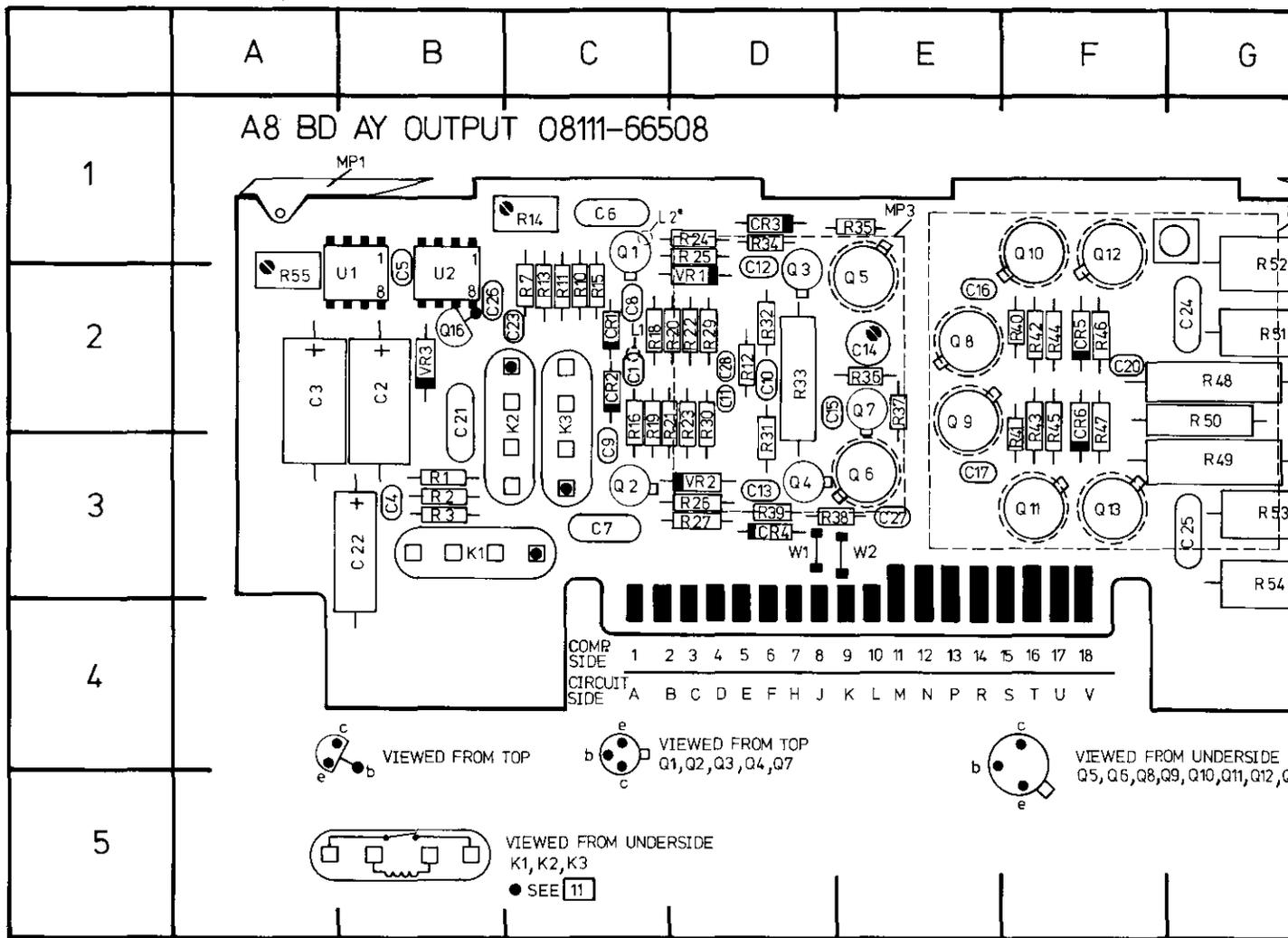
SHAPER BOARD A6

10

A1 MOTHER BD

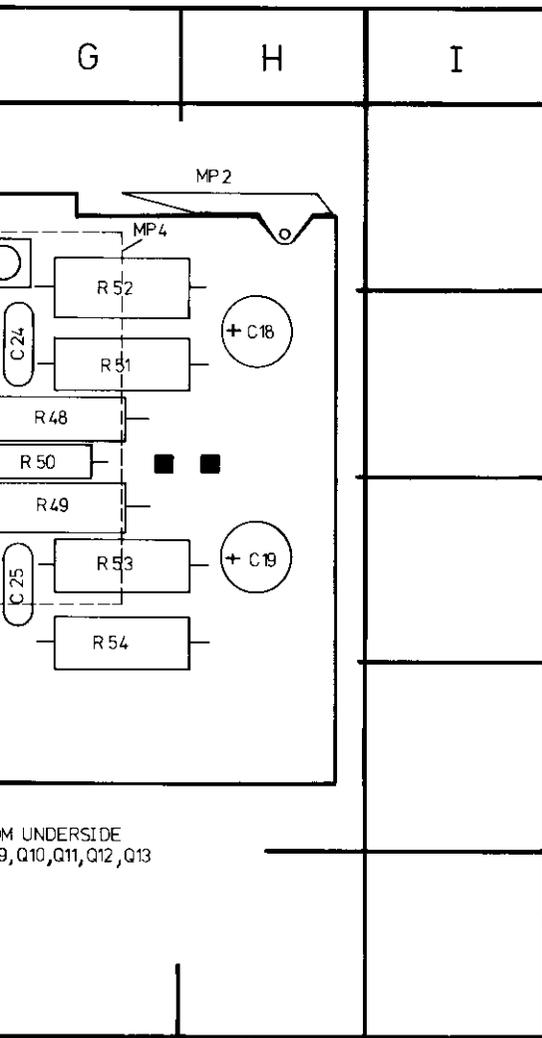
A6 BD AY SHAPER 08111-66506





REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG
C1	C2	C16	E2	CR3	D1	Q8	E2	R14
C2	B2	C17	E3	CR4	D3	Q9	E2	R15
C3	A2	C18	H2	CR5	F2	Q10	F1	R16
C4	B3	C19	H3	CR6	F2	Q11	F3	R18
C5	B2	C20	F2	K1	B3	Q12	F1	R19
C6	C1	C21	B2	K2	B2	Q13	F3	R20
C7	C3	C22	B3	K3	C2	Q16	B2	R21
C8	C2	C23	C2	L1	C2	R1	B3	R22
C9	C3	C24	G2	Q1	C1	R2	B3	R23
C10	D2	C25	G3	Q2	C3	R3	B3	R24
C11	D2	C26	B2	Q3	D2	R7	C2	R25
C12	D1	C27	E3	Q4	D4	R10	C2	R26
C13	D3	C28	D2	Q5	E2	R11	C2	R27
C14	E2	CR1	C2	Q6	E3	R12	D2	R29
C15	D2	CR2	C2	Q7	E2	R13	C2	R30

11



REF DESIG	GRID LOC	REF DESIG	GRID LOC
R14	C1	R31	D3
R15	C2	R32	D2
R16	C2	R33	D2
R18	C2	R34	D1
R19	C2	R35	E1
R20	C2	R36	E2
R21	C2	R37	E3
R22	D2	R38	D3
R23	D2	R39	D3
R24	D1	R40	F2
R25	D1	R41	F3
R26	D3	R42	F2
R27	D3	R43	F2
R29	D2	R44	F2
R30	D2	R45	F2

REF DESIG	GRID LOC
R46	F2
R47	F2
R48	G2
R49	G3
R50	G2
R51	G2
R52	G2
R53	G3
R54	G4
R55	A2
U1	B2
U2	B2
VR1	D2
VR2	D3
VR3	B2
W1	D3
W2	E3

SERVICE BLOCK 10 OUTPUT BOARD A8 11

THEORY OF OPERATION

General

The main functions of the Output board are to amplify the signal derived from the Shaper (A6) and add (or subtract) the required offset voltage as set by the front panel vernier. In addition, 20 dB of attenuation can be applied to the signal (if -20 dB pushbutton pressed) by a passive attenuator. The output signal from A8 is fed to the Upper Switch board (A11) where it is either further attenuated (40 dB) or output directly to the front panel socket.

The main feature of board A8 is the actual output amplifier, this is in principle an inverting operational amplifier and is shown in simplified form in Figure 8-10-1. The voltage gain, as can be seen in the figure, is determined by R_{in} and R_{fb} , $A_v = R_{fb}/R_{in}$. The main amplifier (or HF AMP) has offset voltages and currents which have to be compensated for. This is achieved by U1 and U2. U1 compares the voltage at the inverting input of HF AMP with ground and maintains it at zero difference by supplying a current through R_c and therefore ensuring a "virtual ground". U2 detects any undesired offset voltage at HF AMP output via the feedback network $R_{in} \times V/R_{fb} \times V$ and compensates it via the non-inverting input.

The offset Input (derived via the offset vernier and fixed 20 dB attenuator as required) is added to the HF AMP output via R_{offs} and U2 etc.

As can be seen from Figure 8-10-2, the HF Amplifier can be considered as three stages - Input, Voltage Gain and Output. The operation of these will now be described:

Input Stage

The input signal (I/P-) is amplified by Q1, Q2 (common base amplifiers), CR1 and CR2 provide the required bias voltages. The offset signal (I/P+) is applied between CR1 and CR2, which ensures a constant reference point. The output signals, produced across R24, R27, are applied to the bases of Q3 and Q4.

Voltage Gain Stage

Transistors Q3, Q4 (operating as emitter follower) drive Q5 and Q6 respectively to provide the actual voltage amplification.

Output Stage

The emitter followers Q10, Q12 and Q11, Q13 decouple the low output impedance of R out from the voltage gain stage.

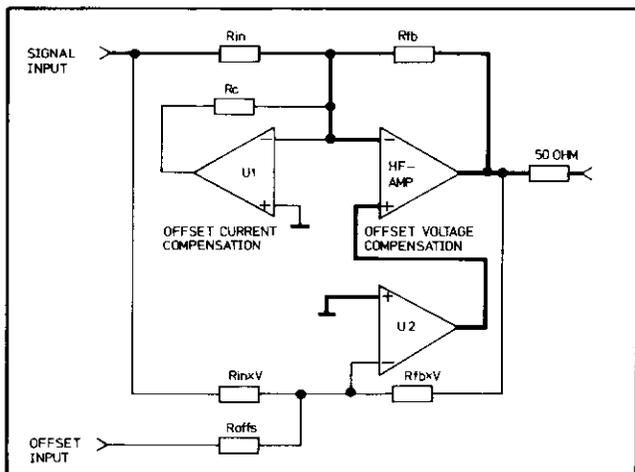


Figure 8-10-1. Simplified Output Amplifier

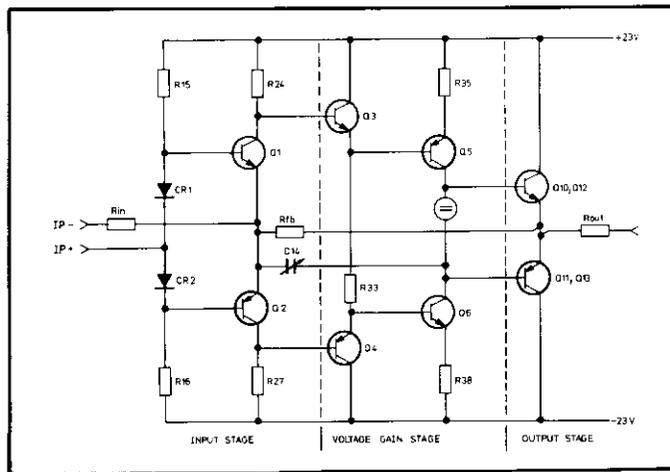


Figure 8-10-2. HF Amplifier Simplified Diagram

TROUBLESHOOTING

CAUTION

Do not operate without heat sinks on board A8. If replacement of one of the transistors Q5–Q13 is necessary, first remove all heat sink securing screws, then plate or bracket and finally, if necessary, the transistor adaptors. Do not attempt to remove a complete heat-sink assembly i.e. plate and transistor adaptors together since damage to transistors will be likely.

The troubleshooting information is given in two sections, first for the HF AMP and then the Offset Control.

HF Amplifier

The following hints will help to isolate a fault in the 8111A output amplifier.

The voltages, shown on Service sheet 11 in blue, should be measured by a DVM with the low terminal connected to ground.

The following test conditions are required:

- A6 Shaper board disconnected from connector
- 20 dB AMPL-ATTENUATOR pushbutton pressed
- Offset Vernier set to 0 V

If the voltage between CR1 and CR2 (★) is fully negative (approx. -15 V) check Q2, Q4 and Q6. If it is fully positive (approx. $+15\text{ V}$) check Q1, Q3 and Q5. If Q10/Q11 or Q12/Q13 fail (emitter/collector short circuit) the 8111A regulated power supply rails will switch off. If it is necessary to replace any of the output stage transistors Q8–Q13, check that CR5 and CR6 are not defective.

Distorted Leading and Trailing Edges

If the output from A8 in pulse or square wave has distorted leading or trailing edges, and the input signal from A6 is undistorted, then make the following test:

Set the 8111A to high output amplitude (16 V, Symmetrical)

If the leading edge is distorted, check Q3 and Q5.

If the trailing edge is distorted, check Q4 and Q6.

Offset Control

The offset of the 8111A output signal depends on the current through R7.

- ★ The offset control voltage at the offset input of A8 varies: from -0.9 V for $+8\text{ V}$ offset at the 8111A output to $+0.9\text{ V}$ for -8 V offset at the 8111A output.

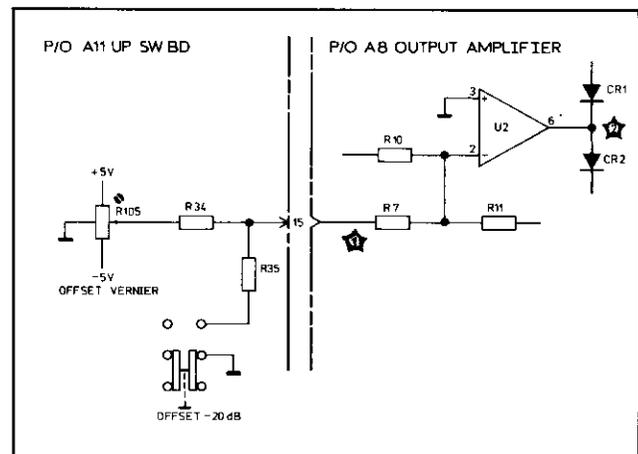
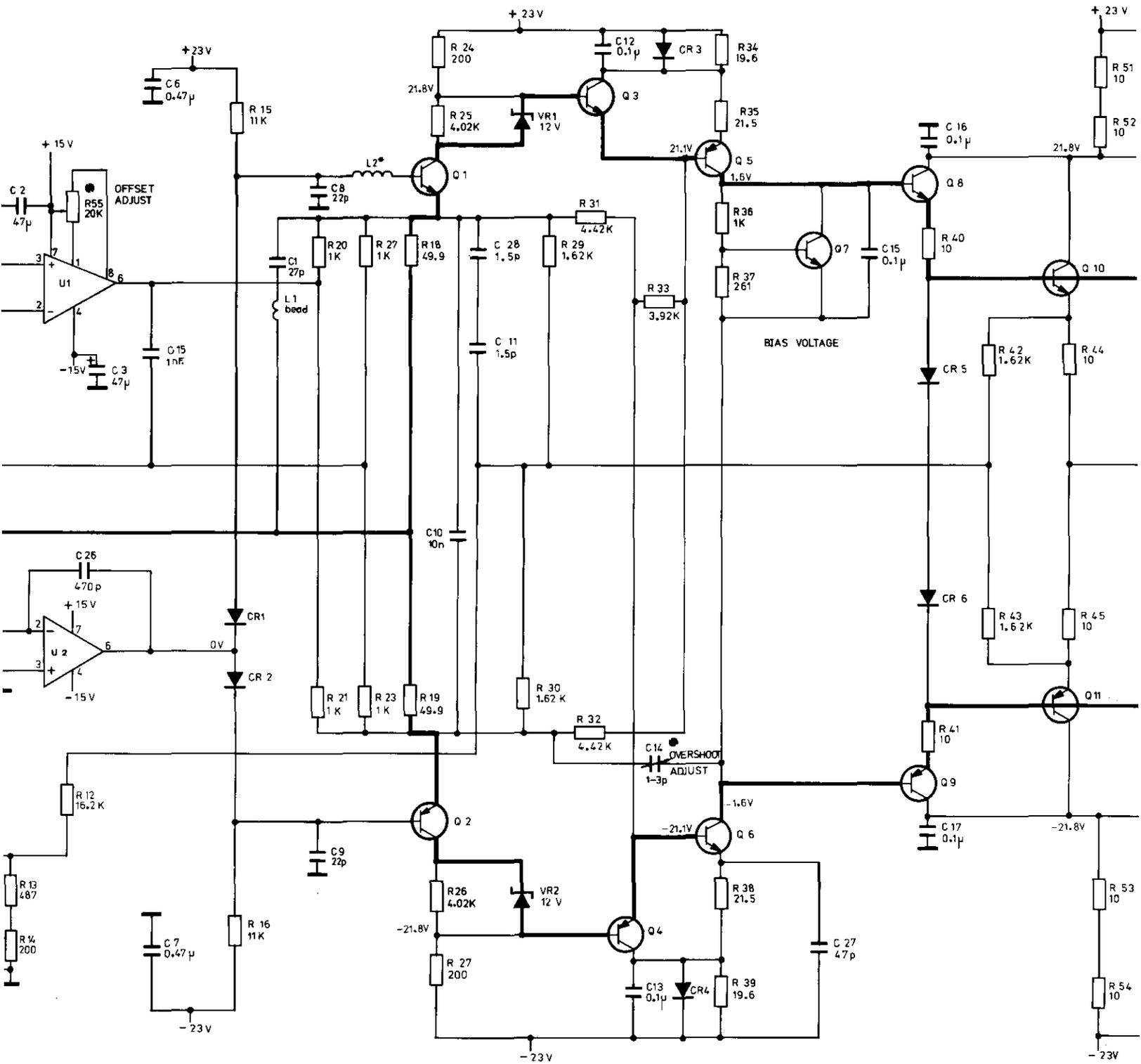


Figure 8-10-4 Offset Control.

Figure 8-10-3. Offset Control

- ★ Due to high internal gain of the HF-AMP, the voltage at its non-inverting input varies by only approximately 4 mV about 0 V over the whole offset range. If the voltage is at either the maximum positive or negative rail value ($\pm 15\text{ V}$) then, either U2 or the HF amplifier is defective.

An offset error or failure can also be caused by a fault at U1.



BOARD

A8 BD AY OUTPUT (08111- 66508)

