Issue 1
29.10.75

DESIGNS DEPARTMENT MANUFACTURING INFORMATION

NO. 5.297(75)

UHF Amplifier 470 - 860MHz

AM14/555

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for Head of Designs Department

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JJS

D.D.M.I. NO. 5.297(75)
Title Sheet

BBC

DS/SPA4

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C O N T E N T S

D R A W I N G S

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UHF Amplifier 470 - 860MHz AM14/555

SPECIFICATION

1. Introduction

The AM14/555 is a broadband UHF power amplifier for use in Television Translator type EP16M/501. It has a gain of approximately 46dB over Bands IV and V and an output power of 2 watts for a 3-tone intermodulation product of -52dB.

The unit consists of four amplifier modules, and each module has two identical amplifier chains which are combined with 3dB quadrature couplers. Each module has input and output impedances of 50Ω and constant gain over Bands IV and V.

The amplifier must be mounted with the heat sink fins vertical in order to ensure adequate heat dissipation.

A separate power supply input is provided for each module to enable DC faults to be traced easily.

2. Mechanical

Each module consists of a printed circuit board mounted on a cast aluminium block. The castings for the input and output modules incorporate end plates for mounting input and output connectors, etc. The four cast modules are mounted in line along a 'mother' casting which is 410 x 117 x 134mm and incorporates cooling fins.

The cast modules are fixed on the 'mother' casting with four 2.5mm screws, and heat sink compound is used on the interface to ensure good thermal conductivity.

A lid consisting of 3mm sheet aluminium covered on the inside with aluminium foil backed by rubber, is used to seal the sides of the mother casting and the end plates of the input and output modules.

Two 8.2mm diameter bolt holes which pass through the 'mother' casting and the cast module end plates are provided for fixing the unit to the transposer. Handles are fitted to ease withdrawal of the unit from the transposer.

Size: 410 x 117 x 134mm
Weight: 9.3kg

3. Electrical

Supply Voltage	+25 volts
Supply Current	2.7 amps ± 0.1 amps
Cooling	Natural convection (if mounted with fins vertical)

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Input Impedance	50Ω
Input Return Loss	⩾ 18dB (470 - 860MHz)
Output Impedance	50Ω
Output Return Loss	⩾ 14dB (470 - 860MHz)
Input Connector	TNC male at end of 240mm lead
Output connector	TNC male at end of 340mm lead
DC Input Connector	Varicon 20 way free plug at end of 350mm lead
RF Connections between Modules	Copper tape
DC Connections between Modules	Wire links fitted with ferrite beads
Supply current to each stage:	
Module 1 OM175	2 x 60mA
Module 2 BFR94	2 x 100mA
BLX92T	2 x 200mA
Module 3 BLX92T	2 x 200mA
BLX93T	2 x 400mA
Module 3 BLX93T	2 x 400mA
All Currents have a Tolerance of	± 10%
Vce on all RF Transistors is	24 volts ± 2%
Gain (470 - 860MHz)	
Module 1	14dB ± 1dB
Module 2	16dB ± 1dB
Module 3	11dB ± 1dB
Module 4	5dB +1dB -0.5dB
Overall Amplifier	46dB +3dB -2dB
Output Power (Minimum)	
(3-tone intermodulation product of -52dB)	
Module 1	+10dBm
Module 2	+27dBm
Module 3	+31dBm

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Module 4	+37dBm
Modules 1 and 2 in cascade	+26dBm
Modules 1, 2 and 3 in cascade	+30dBm
Overall Amplifier	+33dBm

The above power levels assume an input IP level not greater than -75dB w.r.t. PEP.

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PRODUCTION TEST SCHEDULE

1. Drawings

Circuit	D 39695 A1
Assembly	D 39697 A1
P. Board No. 1 Sub-assembly	D 39698 A2
P. Board No. 2 Sub-assembly	D 39699 A2
P. Board No. 3 Sub-assembly	D 39700 A2
P. Board No. 4 Sub-assembly	D 39701 A2
Current Versus Voltage for AM14/555	DSK 17661 A4

2. Equipment Required

	Example
Power Supply, adjustable 0 to 25V and 0 to 3A current limit	
Spectrum Analyser (covering 10 - 1000MHz)	Hewlett Packard 8554L 8552B and 141T
Tracking Generator (covering 10 - 1000MHz)	Hewlett Packard 8444A
Power Meter	Hewlett Packard 435A
UHF 3-tone generator consisting of:	
3 off UHF oscillator	General Radio 1209C
2 off 3dB coupler	
Attenuators:	
30dB 10 watt 50Ω	
10dB 1 watt 50Ω	
Continuously variable 10 - 60dB, 0.5 watt	WG 15229F
50Ω UHF termination	
AVO 8	
20dB Coupler	Hewlett Packard 775D

3. Mechanical Inspection

Check that the amplifier has been manufactured satisfactorily in accordance with the drawings. In particular check that:

3.1 All the leadless disc capacitors are soldered properly and that they are not cracked or shorted.

3.2 All the eyelets are soldered properly.

3.3 All the power transistors are mounted without strain and with their leads soldered securely to the PCB, without any lead length between the transistor body and the PCB.

3.4 All the power transistors are mounted on their cast sub-modules using Dow Corning 340 heat sink compound (NOT MS4).

3.5 All the power transistor nuts are tightened to a torque of 8 $\pm$ 0.5Kg cm.

3.6 All the 3dB wireline couplers have been wired correctly with the shortest possible leads.

3.7 All the variable capacitors are soldered with the rotor earthed.

4. Alignment and Test

4.1 DC Checks

In order to prevent catastrophic failure of the RF power transistors due to bias circuit faults it is important to test each module as detailed below. It is essential to use an adjustable current-limit power supply capable of delivering 0 to 25V at 3A. The modules should be mounted on the 'mother' casting if they are powered for more than 3 minutes.

4.1.1 Module 1

Wire the DC connection to module 1. Set the power supply current supply limit to 150mA and the output to zero volts and connect to module 1. Slowly increase the voltage to 25V while monitoring the current taken. The current should increase linearly as shown in DSK 17661 A4. If excess current is taken at low voltage check for shorting capacitors or faulty wiring.

4.1.2 Modules 2 to 4

The procedure is similar to that outlined in 4.1.1. With the supply current limit set at 100mA slowly increase the voltage to a maximum of 12V.

As can be seen from DSK 17661 A4 the current increases rapidly from almost zero to 100mA at a knee voltage of 9 volts. If the current taken below 8 volts is greater than 20mA there is a fault in one or more bias circuits. To assertain which circuits are at fault, increase the voltage until the supply just current limits, and check the Vbe of the RF power transistors. A fault in one bias circuit usually diverts all the current into one transistor, yielding a higher Vbe whilst starving the other transistors on the board.

When the current taken conforms with DSK 17661 A4, increase the current limit to the nominal value for the module and slowly increase the voltage to 25V. Check that the current taken is within 10% of that indicated in Fig. 1. If the module is out of

spec, connect the -ve of lead of an AVO on 2.5V FSD to the HT +ve and monitor the voltage on the collectors of each RF transitor in turn using the -ve lead. The voltage should be 1.0V ± 0.1V.

4.2 Module 1 Gain

Fix module 1 to the heat sink casting and set up the test equipment as shown in Fig. 1, but with module 1 replaced with a direct link.

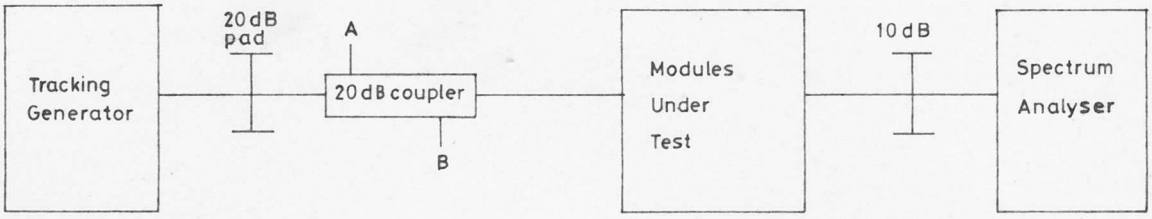


Fig. 1

Adjust the tracking generator and spectrum analyser to produce a 0 to 1GHz sweep, with the trace approximately in the centre of the screen and the resolution 2dB/div. Store the trace on the screen then insert module 1 followed by a 10dB attenuator, increase the attenuation in the spectrum analyser by 4dB and superimpose the response on the previous display. Check that the two traces do not depart by more than 1dB over the range 470 - 860MHz.

4.3 Module 1 Input Return Loss

Replace the spectrum analyser with a 50Ω termination. Connect the spectrum analyser (set to 10dB/div) to port A of the 20dB coupler (forward wave), adjust the attenuators to produce a trace 10dB below the top graticule line and display the response from 0 to 1GHz. Now connect the spectrum analyser to port B of the coupler and check that the trace is at least 18dB below the previous trace from 470 to 860MHz. If it is not, connect 50mm of wire to 1IC1 pin 2 and another 50mm of wire to pin 3. Starting at the PCB end of the wires, twist them together one turn at a time until the return loss meets the above specification (after each turn arrange the ends of the wire to point away from the PCB at approximately 45° and at approximately 90° from each other; also ensure that no object is close to the wires). When the required return loss is reached cut off the wires at the point where they diverge and lay the remains over the top of 1IC1. Check the return loss is still 18dB from 470 - 860MHz. Repeat section 4.2.

4.4 Modules 1 and 2 Gain

Fix module 2 to the heat sink (using heat sink compound on the interface) and connect it to module 1 as shown in the assembly diagram. Set up the equipment as shown in Fig. 2 but replace the modules under test with a direct link. Adjust the tracking generator and spectrum analyser to produce a 0 to 1GHz sweep, with the trace approximately in the centre of the screen and 2dB/div resolution. Replace the direct link with modules 1 and 2 followed by a 30dB attenuator and adjust the trimmer capacitors to produce maximum gain at 860MHz. Adjust the trimmers in the following order: 2C5, 2C19, 2C11, 2C14, 2C28.

Store the trace on the spectrum analyser, replace the modules and 30dB attenuator with a direct link, and superimpose the new trace on the previous trace. Check that the two traces do not depart by more than 2dB. If they do, replace the direct link with the modules and attenuator, and adjust the trimmers to compensate for the error, but ensure that the gain at 860MHz is within 0.3dB of maximum. If there is a large error it is probable that a fault exists.

4.5 Modules 1, 2 and 3 Gain

Repeat 4.4 with the following changes:

(a) Fix module 3 and connect it to module 2.

(b) Increase the spectrum analyser attenuator by 11dB each time the modules and 30dB attenuator are connected in circuit.

(c) Adjust the trimmers in the following order: 3C5, 3C19, 3C11, 3C25, 3C14, 3C28.

4.6 Modules 1, 2, 3 and 4 Gain

Repeat 4.4 with the following changes:

(a) Fix module 4 and connect it to module 3.

(b) Connect a 10dB 1 watt attenuator after the 30dB attenuator and increase the spectrum analyser attenuator by 6dB each time the modules and 40dB attenuator are connected in circuit. Check that the frequency response of the amplifier is within the limits +3 to -2dB relative to the stored (direct link) display.

(c) Adjust the trimmers in the following order: 4C5, 4C14, 4C8,4C18.

4.7 Dummy Load - Signal Level

Store the response of the entire amplifier on the screen of the spectrum analyser, then interchange the connections to PLC and SKA, reduce the IF attenuation of the spectrum analyser by 15dB, superimpose the new response and check that it falls below the original response. If the power in the dummy load is not at least 15dB below the available output power it is probable that module 4 is unbalanced and slight re-adjustment of 4C8 and 4C18 may be needed.

4.8 Output Power

The linearity of the amplifier must be checked at two spot frequencies in Bands IV and V. This is done by measuring the output powers obtained for specific levels of intermodulation. It is only necessary to check the entire amplifier, however, if it does not meet the specification then check the following sections of the amplifier in turn until the fault is found: modules 1, 2 and 3, the modules 1 and 2, then module 1. The performance of these sections is given in the specification.

4.9 Set up the equipment as shown in Fig. 2.

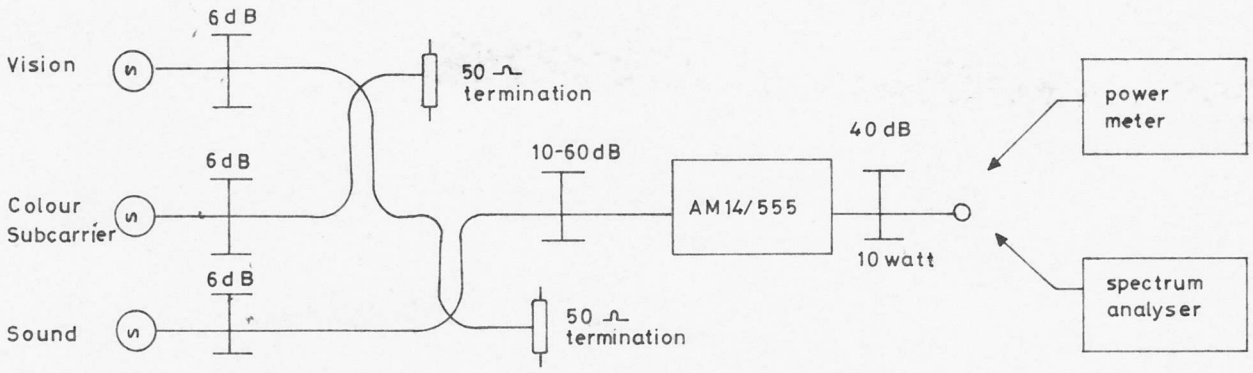


Fig. 2

Adjust the oscillators to the following groups of frequencies:

Oscillator Frequencies (MHz)

Vision	Colour Sub-carrier	Sound
470	474.4	476
847	851.4	853

It is sufficiently accurate to use the oscillator frequency scale to set the vision frequency, and the spectrum analyser (set to 1MHz/div) to set the colour and sound frequency increments to 4.4 and 6MHz respectively.

4.10 Adjust the amplifier input attenuator to obtain intermodulation products at least 60dB below the levels of the three main signals. Set the spectrum analyser as follows:

Input Attenuator	20dB
Display	2dB/div
Bandwidth	100kHz/div
Scan Width	1MHz/div

Adjust the IF attenuators to display the sound oscillator in the centre of the screen, then adjust the level of the vision oscillator to be 1dB lower; reduce the IF attenuation by 10dB and adjust the level of the colour sub-carrier oscillator to be displayed in the centre of the screen.

Increase the IF attenuation by 10dB, check the levels of the vision and sound oscillators then switch to 10dB/div. The oscillators should now be set to -8dB, -17dB and -7dB relative to peak envelope power for the vision, colour and sound oscillators respectively.

4.11 Reduce the amplifier input attenuation and increase the spectrum analyser IF attenuation until the vision carrier is 8dB from the top of the screen, and the intermodulation product (at 1.6MHz above the vision frequency) is 52dB from the top of the screen. The amplifier is now running at a power level that produces an intermodulation product of -52dB with respect to peak envelope power.

4.12 Connect the amplifier output to a power meter via the 10 watt 30dB pad and 1 watt 10dB pad then note the reading. It is important to ensure that the attenuation between the amplifier and the power meter is exactly 30dB, at UHF even short leads have appreciable loss. The peak envelope output power of the amplifier is 44.2dB above the power meter reading (peak envelope power is 4.2dB above mean power). Check that the power meets the specification.

4.13 Put the lid on the amplifier and measure its frequency response from 0 - 1GHz using the method described in 4.6. Check that the gain is 46dB +3dB -2dB from 470 to 860MHz and less than 60dB below 470MHz. Replace the tracking generator with a 50Ω termination and use the spectrum analyser to check that there is no output from the amplifier.

D39696A4

SHEET 1 OF 11 SHEETS

ISS.	CHANGE	
1	6-10-75	
1A	* ADDED. ITEM 1 REVISED. L.F.M. 8.10.75.	
2	ITEM 8 ADDED. JCR. 10.10.75.	
3	ITEM 4 DELETED. CF 12055. JCR. 10.12.75.	

AM14/555
AMPLIFIER, U.H.F., BANDS IV & V
PARTS LIST

ITEM No.	No. OFF		DESCRIPTION		C'C'T REF.	BBC REF. OR DRG. No.
			DRAWING NUMBERS			
			CIRCUIT	D39695A1		
			PARTS LIST	D39696A4		
			ASSEMBLY	D39697A1		
			P. BOARD No 1 SUB-ASSY	D39698A2		
			" " " 2 " "	D39699A2		
			" " " 3 " "	D39700A2		
			" " " 4 " "	D39701A2		
			DETAIL 1	D39702A1		
			DETAILS 2-6	D39703A1		
			DETAIL 7	D39704A2		
			DETAIL 9	D39705A1		
			DETAIL 10	D39706A4		
			P.B. WIRING (BD. No 1)	D39707A3		
			" DRILLING (" " 1)	D39708A4		
			" WIRING (" " 2)	D39709A3		
			" " , COMP. SIDE (" " 2)	D39710A3		
			" DRILLING (" " 2)	D39711A4		
			" WIRING (" " 3)	D39712A3		
			" " , COMP. SIDE (" " 3)	D39713A3		
			" DRILLING (" " 3)	D39714A4		
			" WIRING (" " 4)	D39715A3		
			" DRILLING (" " 4)	D39716A4		
			FURTHER INFORMATION REQUIRED FOR MANUFACTURE			
			UNIT ASSEMBLY INFORMATION	EA10484		
			" WIRING INFORMATION	EA10139		
			" " "	EA10140		
			" " "	D26841A4		
			3dB COUPLER	D35052A4CP		
			LABEL	D39107A4CP		
1	1	*	BODY (CASTING) MADE FROM			ED/DD/37
1a			1 - CASTING UNMACHINED			ED/DD/36
2	1	*	LABEL, D39107A4CP, ENGRAVED TO			D39703A1 " 6
3	1		GASKET			D39704A2 " 7
4						
5	1		COVER			D39705A1 " 9
6	1	*	LABEL			D39706A4 " 10
7						
8	4	*	LABEL			D38817 A4
9						
10	A/R		COPPER FOIL STRIP, 0·1 THICK x 12·7 WIDE			
11						
12						
13						
14	A/R.		SILICONE GREASE, MIDLAND SILICONES MS4			
15						

BBC

DS/PLA4

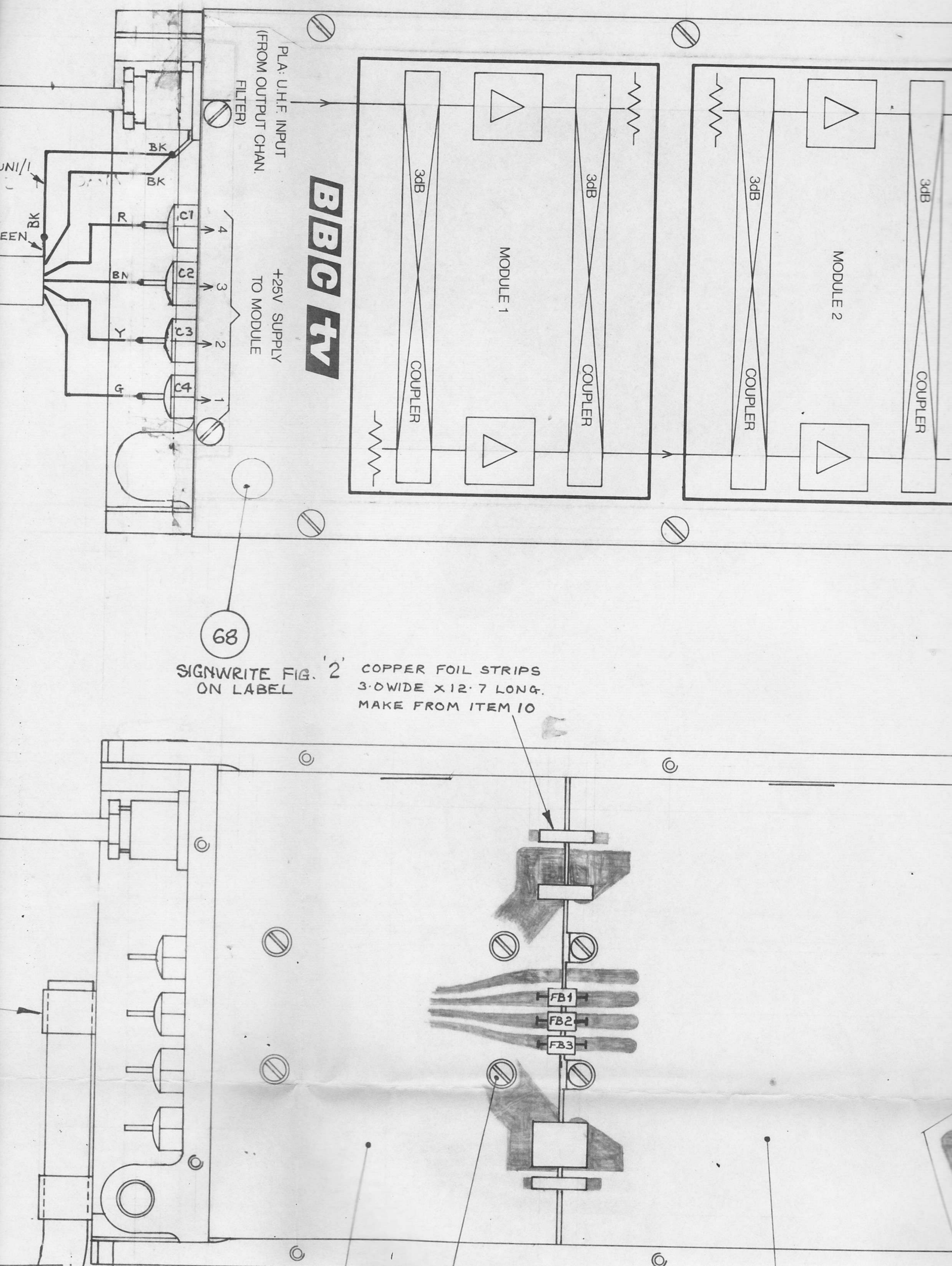
AM14/555
AMPLIFIER, U.H.F., BANDS IV & V
PARTS LIST

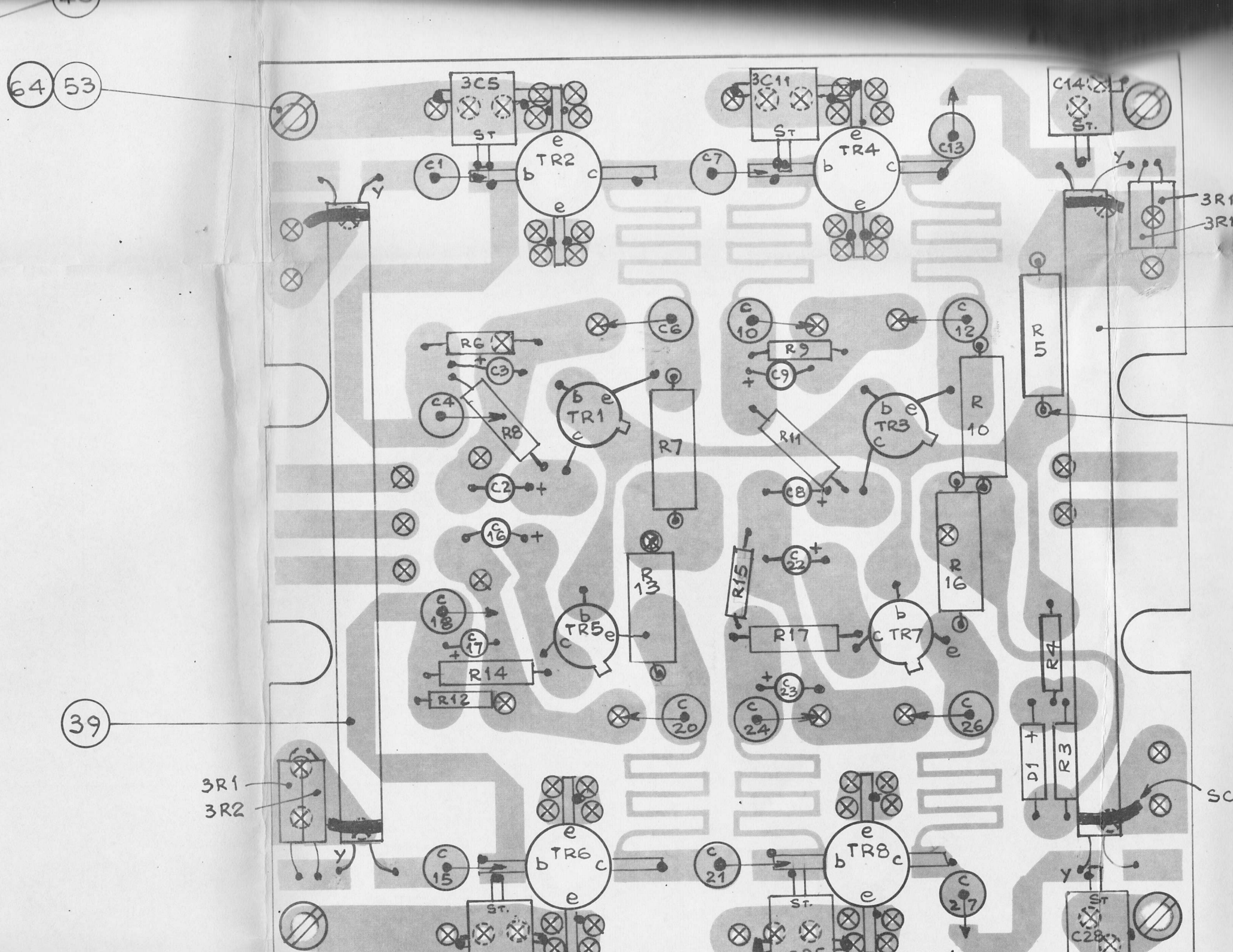
DRN. L. HB
TPD.
CKD.
APPD. JBS.

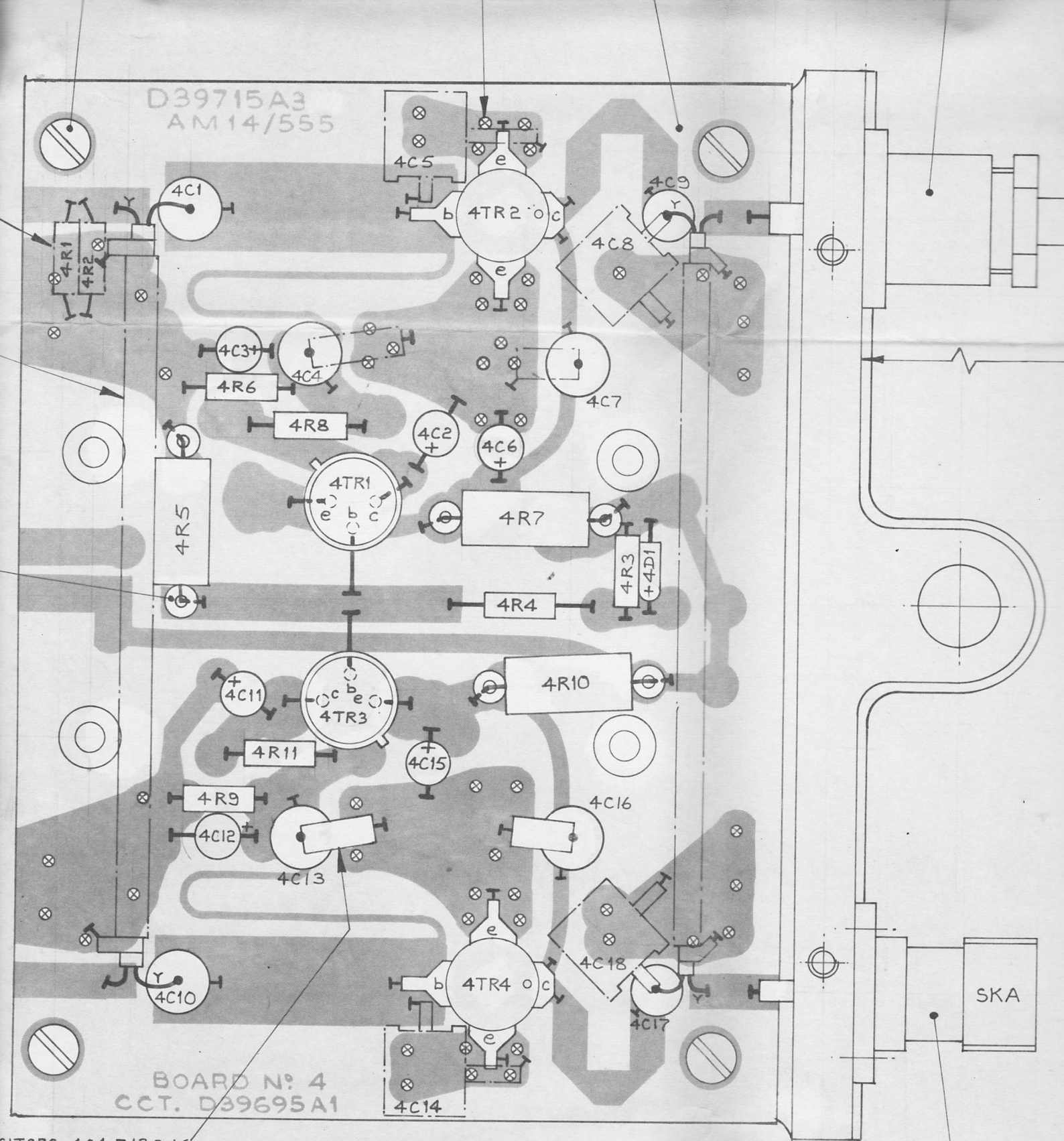
DESIGNS DEPARTMENT

D39696A4

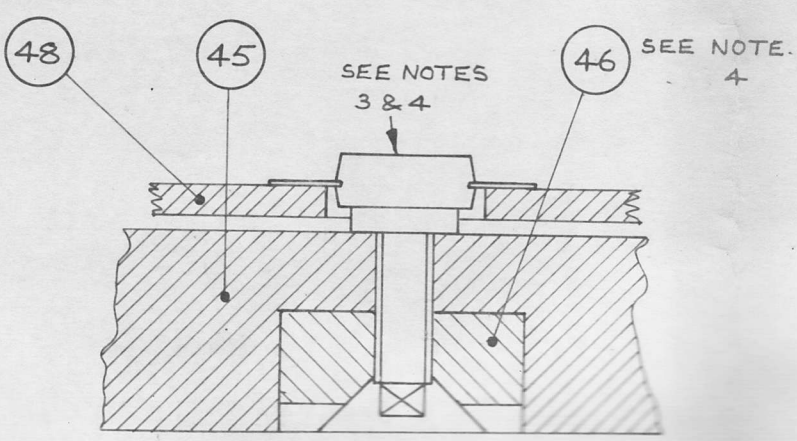
SHEET 1 OF 11 SHEETS


PLA: U.H.F. INPUT
(FROM OUTPUT CHAN. FILTER)
+25V SUPPLY TO MODULE
BBC tv
MODULE 1
MODULE 2
3dB COUPLER
3dB COUPLER
3dB COUPLER
3dB COUPLER
BK
BK
BK
R
BN
Y
G
C1
C2
C3
C4
4
3
2
1
UNI/1
EEN
68
SIGNWRITE FIG. '2' ON LABEL
COPPER FOIL STRIPS 3·0 WIDE X 12·7 LONG. MAKE FROM ITEM 10
FB1
FB2
FB3


64
53
39
3C5
ST
TR2
C1
3C11
TR4
C7
C13
C14
ST.
3R1
3R2
R5
R6
C3
C4
R8
C2
C6
TR1
R7
R9
C9
C10
C12
TR3
R11
R10
C8
C16
R13
R15
C22
R16
C18
C17
TR5
R14
R12
C20
R17
TR7
C23
C24
C26
R4
D1
R3
SC
TR6
C15
TR8
C21
C27
C28



CITORS 4C4,7,13,&16
CONNECTED WITH
ER FOIL STRIPS,
IDE x 6·0 LONG.
FROM ITEM 10



165 55 63

IMPORTA

SEE DSK
BEFORE A

VM246A4

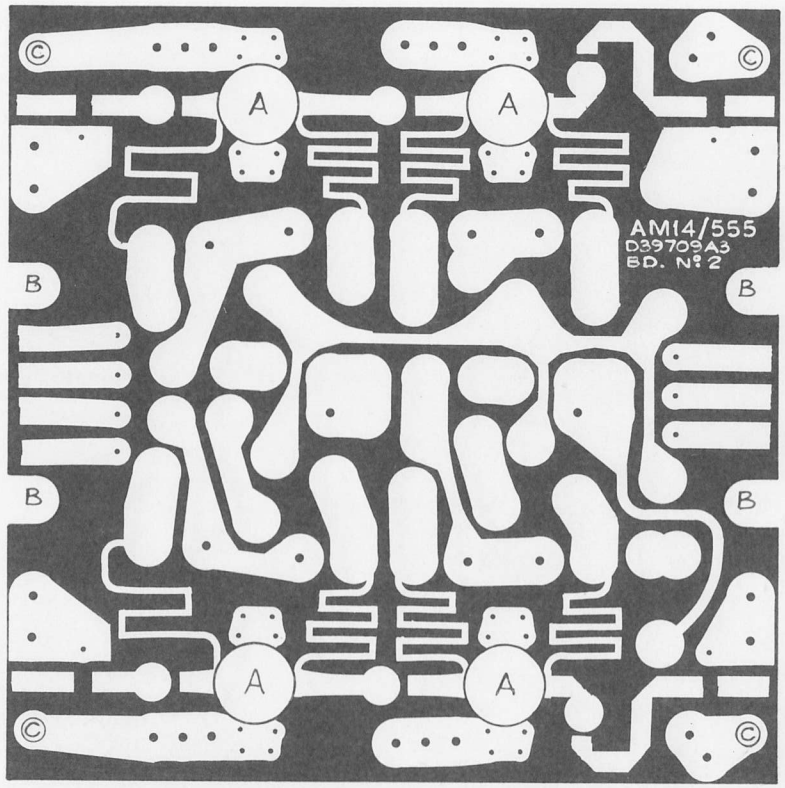
BBC

AM14/555 PRINTED BOARD No 2 DRILLING

D39711A4

CHANGE	ISS
6/10/75	1
UNLETTERED HOLES WERE 1·3: JCR. 10.12.75	2

AM14/555
PRINTED BOARD No 2
DRILLING



DRN	L. Hill	
TCD		
CKD		
APPD		

DESIGNS DEPARTMENT

D39711A4

HOLE REF.	DRILL ~~NO. OR SIZE~~	DIAMETER ~~DEC~~ MM
A		10·5
B		6·5
C		3·0
UN-LETTERED		1·8

& SLOT AS SHOWN

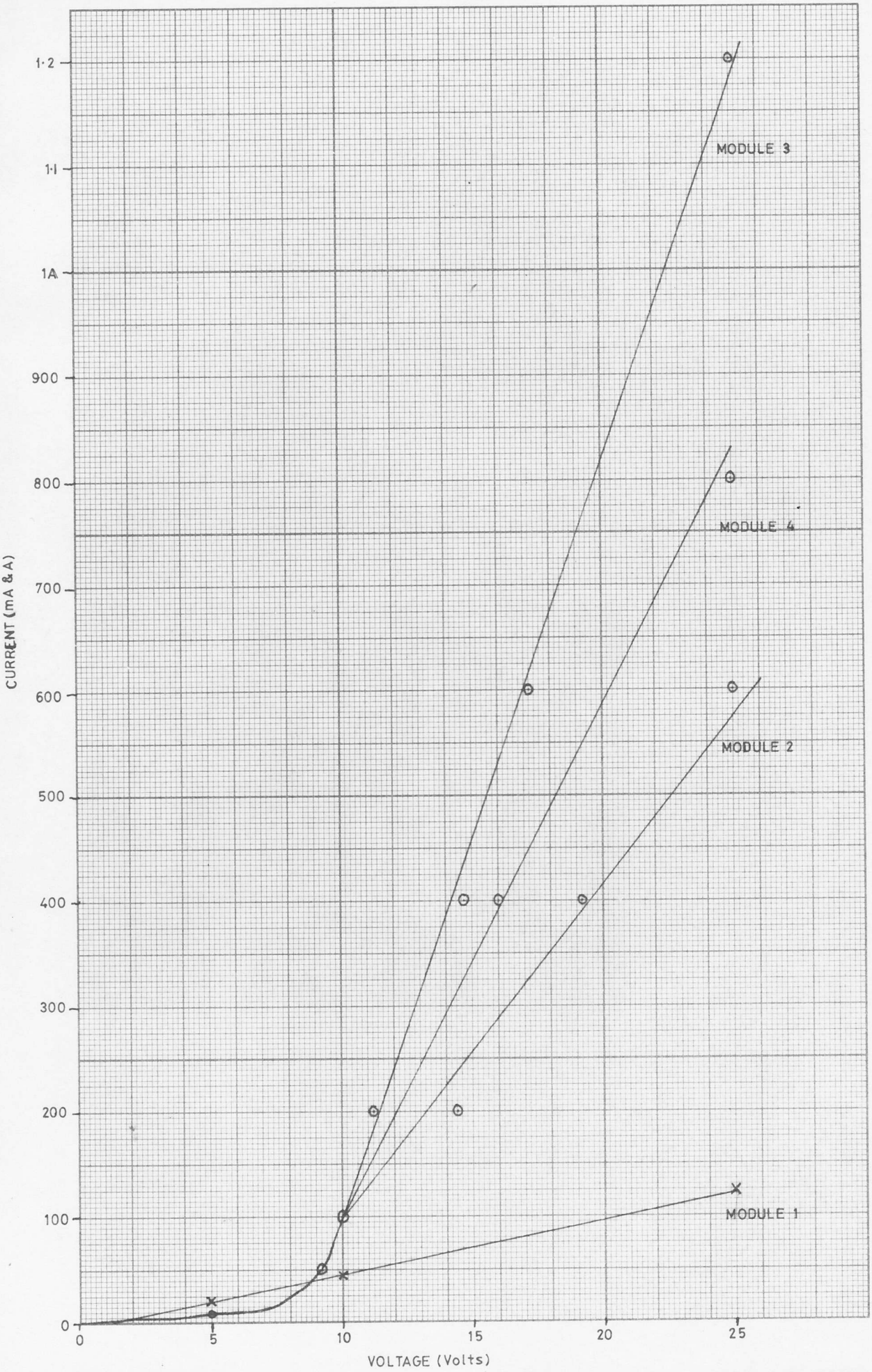
CUT BOARD TO OUTER EDGE OF COPPER. SCALE 1:1

MATERIAL : 1·6 THK. TO BS4584, + CL 5·2, EP-GC-Cu-3, 35/35, 1·6 ± 0·20 (EPOXIDE WOVEN GLASS FABRIC, CLAD ON ~~ONE~~/BOTH SIDES WITH 35μm COPPER)

FINISH : TINNED

MANUFACTURED TO D39709A3 & D39710A3

DSK17661A4



BBC

DS/MGA4

CURRENT — VOLTAGE FOR SUB-UNITS OF AM14/555

DRN.	JBS
TCD.	
CKD.	
APPD.	

DESIGNS DEPARTMENT

DSK17661A4