The Storno CQM5114S (Part of the 5000 series) transceiver has recently become available on the surplus market. The CQM5114S is a synthesised high band transceiver with a power output of 25w, and in its basic form as received is a 6 channel 12.5KHz unit.The modification described in this article will enable the amateur to convert this to a very useful 12 channel transceiver, the choice of channels being programmed into a diode matrix board with a binary adder providing the necessary 600KHz offset for repeater use.
The conversion is very straight forward requiring only 2 crystals to be changed, and the test equipment required is as follows:-

1. DC voltmeter with diode probe.
2. Frequency counter.
3. Oscilloscope.
4. Signal generator (or use local transmission)

The synthesiser block diagram shows the basic relationships between the various sections situated on the synthesiser board. In this application, the TX and RX crystals are arranged so that an input to the programmable divider of 0000000 will give an output frequency from the transceiver of 144Mhz. The 'N' divider is programmable between 256 and 511 giving a total of 255 channels each spaced at 12.5Khz.
The output from the synthesiser is at signal frequency on transmit and signal frquency - 10.7Mhz on receive.
On transmit, the output is amplified by 3 stages of tuned amplifiers before being passed to the broadband PA which on the authors prototype produced nearly 40 watts (Turned down to 25 watts in deference to the life of the transistor!).
On receive, the oscillator injection is fed via an amplifier to the mixer, with an RF amplifier with band pass tuned circuits preceding it.
As the units have just been taken out of service, the IF stages will be on alignment and should not be touched.

SYNTHESISER MODIFICATION.

The following crystals are required:-
1 off 43.36666 Mhz series resonant
1 off 46.93333 Mhz series resonant

With reference to the Synth board layout,remove the small L shaped PCB containing the original PROM and connect a dummy load to the aerial socket.
Replace the TX crystal with the 46.9333 Mhz and the RX crystal with 43.3666 Mhz. Connect the diode probe to TP1 and tune L1 and L3 for max reading on receive. Operate the PTT switch (The red TX LED will not light as the PLL is unlocked) and adjust L2 and L4 for max reading.
Remove the diode probe and connect a high impedance DC meter to TP3. Adjust the RX VCO trimmer to give a reading of approx 2v. Operate the PTT and adjust the TX VCO trimmer to give a similar reading.
The red TX LED should now glow, but there will be no power indicated on the load.
Remove the DC meter and connect an oscilloscope to TP2 and re-adjust L3 and L4 for max amplitude.
Connect a frequency counter to TP4 and adjust L1 to give a reading of 133.300 Mhz on receive and L2 to give 144.000 on transmit.

RF BOARD

RX ALIGNMENT

with reference to the RF board layout, carefully remove the RF board from the chassis and remove the screening cans from L1,L2,L3,L4 and L5. Locate and remove C1,C2,C3,C4 and C5 and replace with 12pf,10pf,12pf,15pf and 8.2pf respectively.The crystal filter is a 12.5Khz type and may be replaced with a 25Khz type if required to reduce clipping on heavily modulated signals.
Replace the RF board.
Connect the Diode probe to TP1 and tune L6 and L7 for maximum reading. Connect a signal generator set to 144.00 Mhz (or use a local transmission) and connect the diode probe to TP5.
Adjust L1,L2 and L4 in that order for max reading on the meter, reducing the RF input as each coil peaks. DO NOT READJUST L4. Finally. adjust L3 and L5 for best signal to noise. The RX AF level control should not need adjusting, the squelch preset should be adjusted in the usual manner.

TX ALIGNMENT.

Connect a power meter to the aerial socket.
Connect a DC voltmeter to TP2 and tune L8 for maximum. Move the DC meter to TP3 and adjust L9 L10 for maximum. Connect the diode probe to TP4 and adjust L11 and L12 for maximum reading, power should now be seen on the power meter.The PA is broadband and needs no adjustment.
Set RV1 for an output of 25w.
There are 2 deviation controls on the set, the author found the best way to set deviation was by using the control on the synthesiser board. Mic gain was found to be lacking and increasing the value of the 22k resistor indicated on the layout improves this.

MODIFICATION FOR MULTI-CHANNEL OPERATION

This is achieved by a diode matrix board which is easily programmed to the users requirements. The board is double sided and etching patterns for both sides are given.
Repeater shift (+600 Khz on receive) is acheived using a binary adder IC 4008. With S1 closed a logic level '1' is applied to the 16 and 32 lines adding 48 to the divide ratio of the programmable divider within the PLL IC. This arrangement also allows 'Listen on input' when operating through a repeater. For normal simplex operation S1 is open and the 4008 is inoperative.
Carefully remove the synth board from the chassis and remove all the diodes in the area shown on the layout. Using ribbon cable connect to each pole and the common of the channel switch. Carefully remove the stop pins on the switch body.
The synth board may now be refitted.
Wire the channel selector switch to the diode matrix board, position 1 to line 1 on the board and so on to position 12 and line 12.
Remove the 14 way socket from the original PROM board and using an insulating pad underneath refit on the 14 way pin connector P1 on the synth board. Using the socket allows the matrix board to be unplugged if the screen needs to be removed at any future time.
Wire this up to the output line pins on the matrix board as follows:-

Matrix	Synth P1
1	3
2	4
3	5
4	6
5	7
6	8

Link pin 1 on P1 to pin7 on P2.
Link +ve on the matrix board to pin7 on P2
Link -ve on the matrix board to pin8 on P2
Connect 'R' on the matrix board via a front panel mounted switch S1 to RX+ on the synth board.
When the diode board has been programmed check that the VCO steering line voltage on TP3 is approx 4v on S20.

PROGRAMMING THE DIODE MATRIX

FREQ	LINE 1	2	3	4	5	6	7
144.500			*		*		
.525	*		*		*		
.550		*	*		*		
.575	*	*	*		*		
.600				*	*		
.625	*			*	*		
.650		*		*	*		
.675	*	*		*	*		
.700			*	*	*		
.725	*		*	*	*		
.750		*	*	*	*		
.775	*	*	*	*	*		
.800						*	
.825	*					*	
.850		*				*	
.875	*	*				*	
.900			*			*	
.925	*		*			*	
.950		*	*			*	
.975	*	*	*				
145.000				*		*	
.025	*			*		*	
.050		*		*		*	
.075	*	*		*		*	
.100			*	*		*	
.125	*		*	*		*	
.150		*	*	*		*	
.175	*	*	*	*		*	
.200					*	*	
.225	*				*	*	
.250		*			*	*	
.275	*	*			*	*	
.300			*		*	*	
.325	*		*		*	*	
.350		*	*		*	*	
.375	*	*	*		*	*	
,400				*	*	*	
.425	*			*	*	*	
.450		*		*	*	*	
.475	*	*		*	*	*	
.500			*	*	*	*	
.525	*		*	*	*	*	
.550		*	*	*	*	*	
.575	*	*	*	*	*	*	
.600							*
.625	*						*

.650			*			*
.675	*		*			*
.700				*		*
.725	*			*		*
.750			*	*		*
.775	*		*	*		*
.800					*	*
.825	*				*	*
.850			*		*	*
.875	*		*		*	*
.900				*	*	*
.925	*			*	*	*
.950			*	*	*	*
.975	*		*	*	*	*

For repeater operation, program the transmit frequency, the +600 khz shift is taken care of by the binary adder.

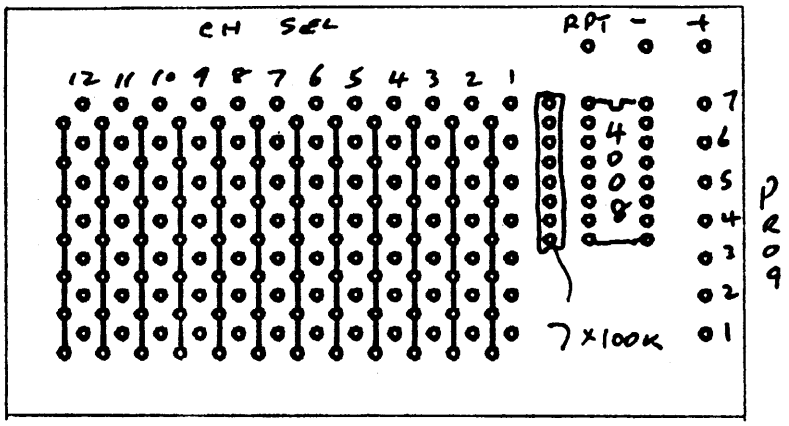
A tone burst generator for repeater access may be fitted. A suitable unit is to be found in the ..... issue of HRT,reference to the synth board layout gives a suitable TX+ connection point.

PARTS REQUIRED

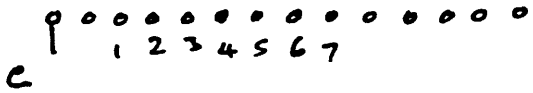
1 off 8.2pf min plate ceramic
1 off 10 pf min plate ceramic
2 off 12 pf min plate ceramic
1 off 15 pf min plate ceramic
1 off 4008 IC
1 off 7 x 100k SIL resistor pack
1 off SPST Sub-min toggle switch (Maplin)
1N4148 diodes for matrix
43.3666 Mhz SR Crystal (McKnight style K +/- 10ppm @ 25C)
46.9333 Mhz SR Crystal (McKnight style K +/- 10ppm @ 25C)

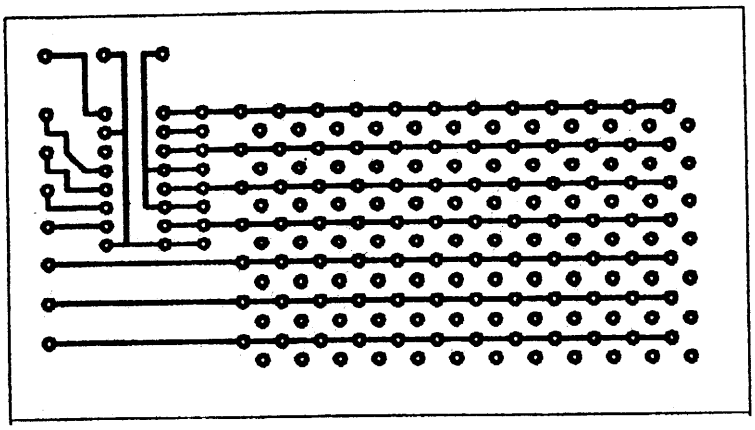
ACKNOWLEDGMENT

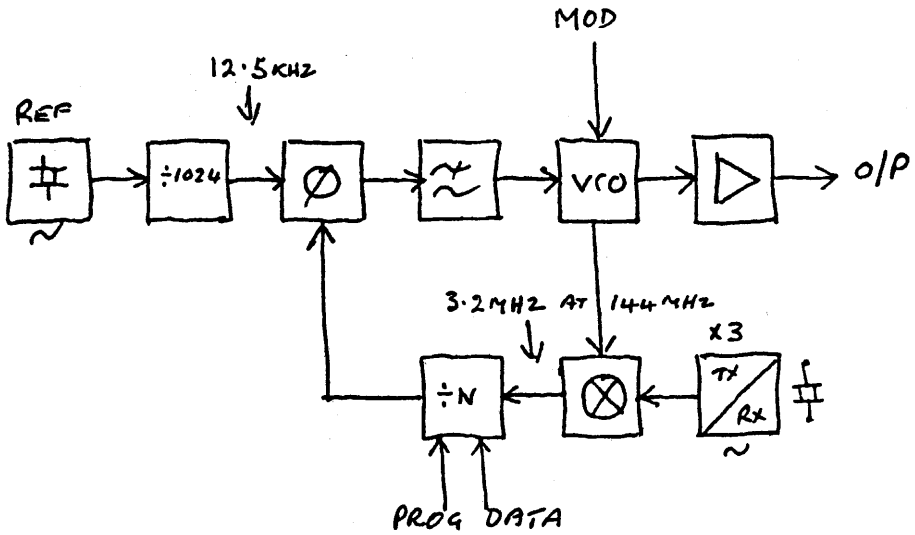
Thanks to GWM Radio for the loan of the transceiver used in the preparation of this article.


CH SEL
12 11 10 9 8 7 6 5 4 3 2 1
RPT - +
4
0
0
8
7 x 100K
7
6
5
4
3
2
1
PROG

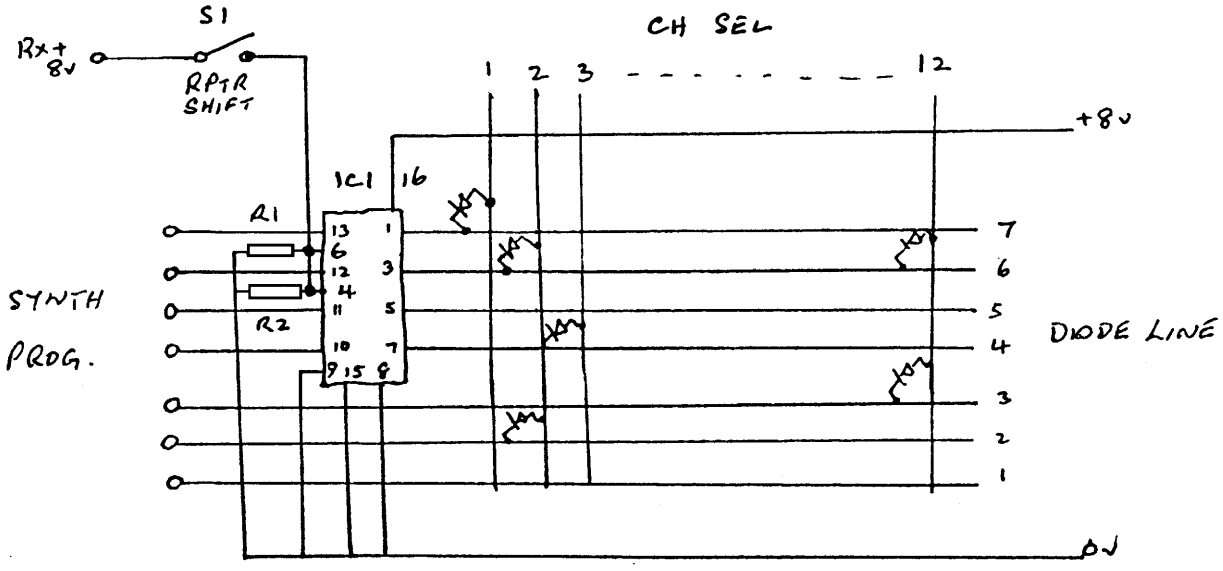
PROG LINES


1 2 3 4 5 6 7





SYNTHESISER BLOCK DIAGRAM



PINS 1,2,3,5,7 ALSO CONNECTED TO 0v THROUGH 7 x 100K SIL RESISTOR PACK

R1, R2 ARE PART OF THIS PACK

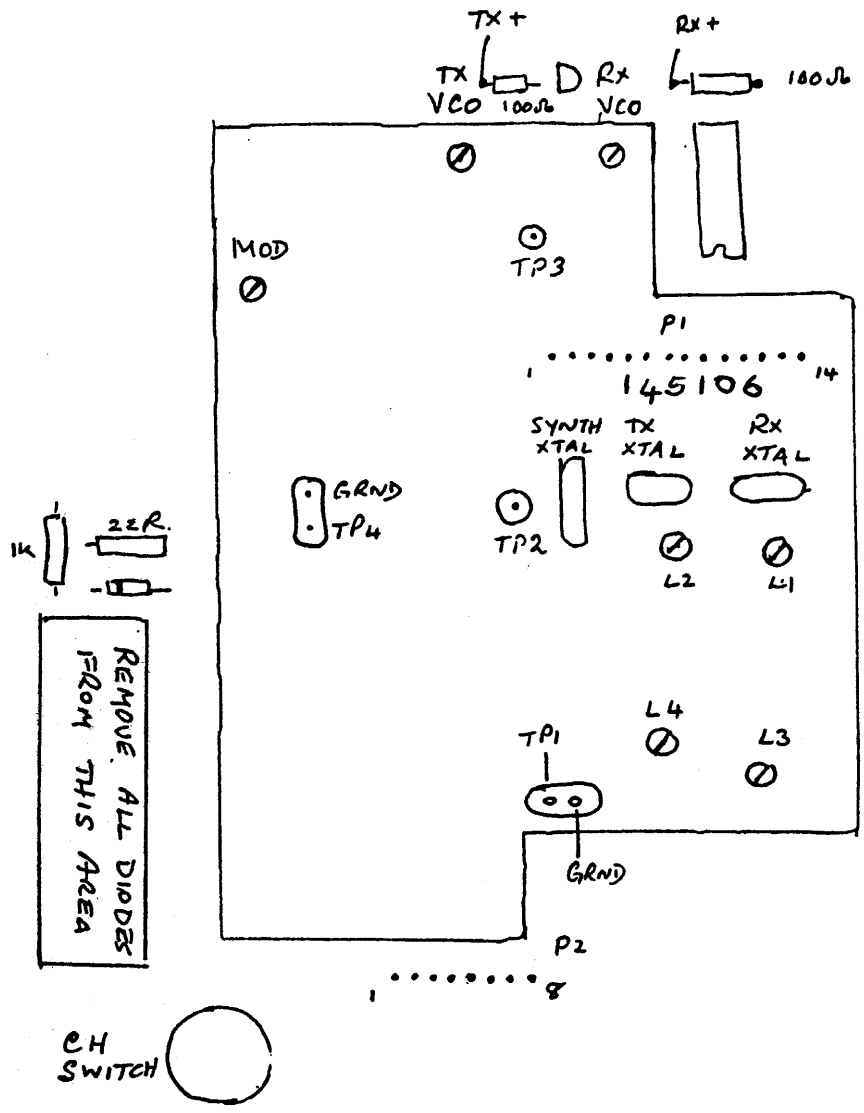
Tx 55.2666 169.50
Rx 55.1 179.20

$Tx = Tx_c * 3 + (0.0125 \times 256)$ mhz

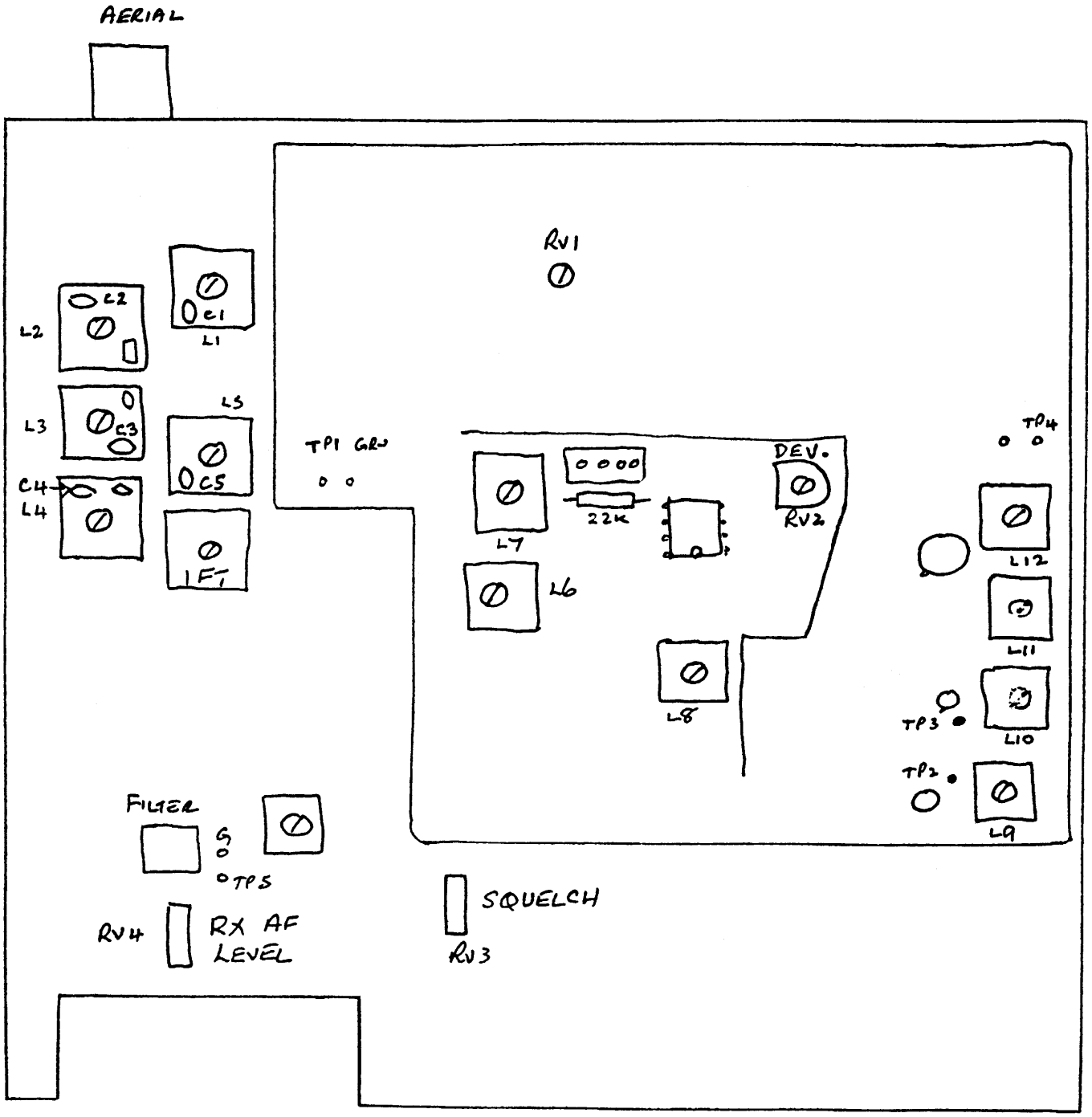
$Rx = RX_c * 3 + (0.0125 \times 256) + 10.7$ mhz

Doesn't like counts less than 32

MSB of Divider (pin 9) wired high giving range of 256 → 512 * 12.5khz channels



SYNTH BOARD


AERIAL
RV1
L2
C2
C1
L1
L3
C3
L3
C5
C4
L4
IFT
TP1 GRD
L7
22K
DEV.
RV2
TP4
L12
L6
L11
L8
TP3
L10
TP2
L9
FILTER
GND
TP5
RV4
RX AF LEVEL
SQUELCH
RV3

RF BOARD

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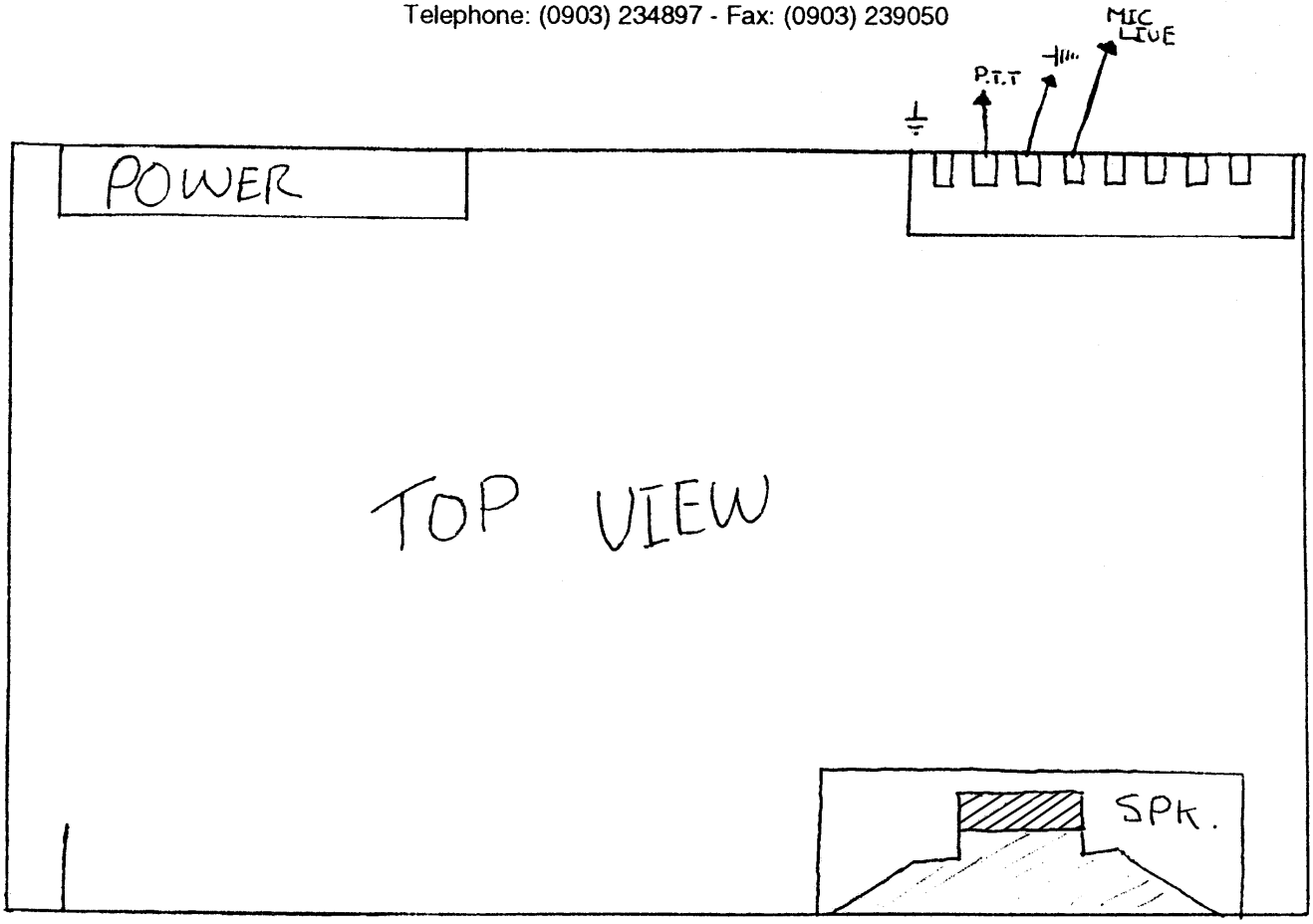

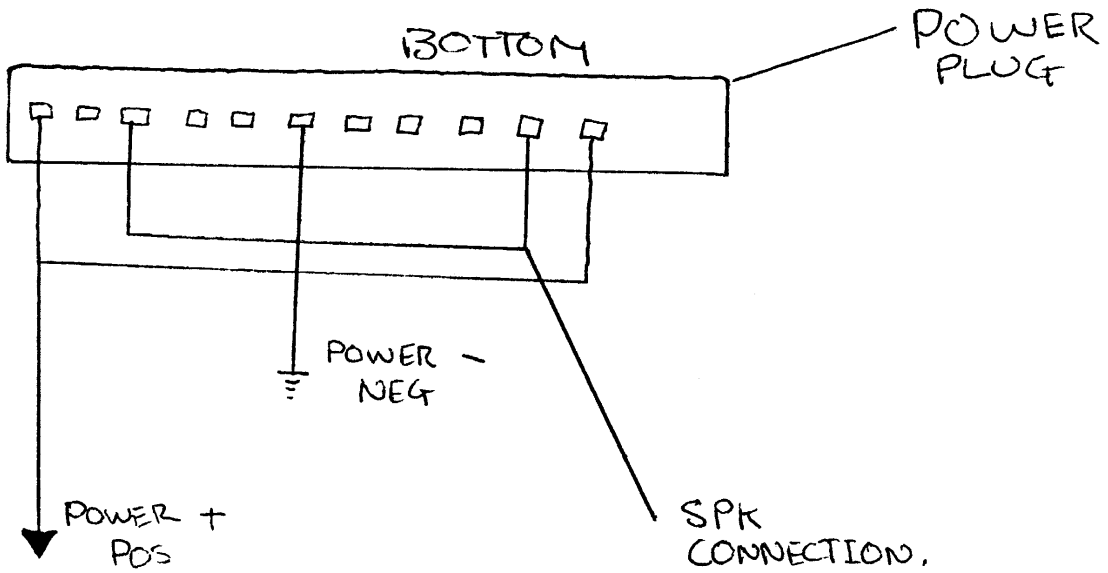

W.D.A.
15/10/93

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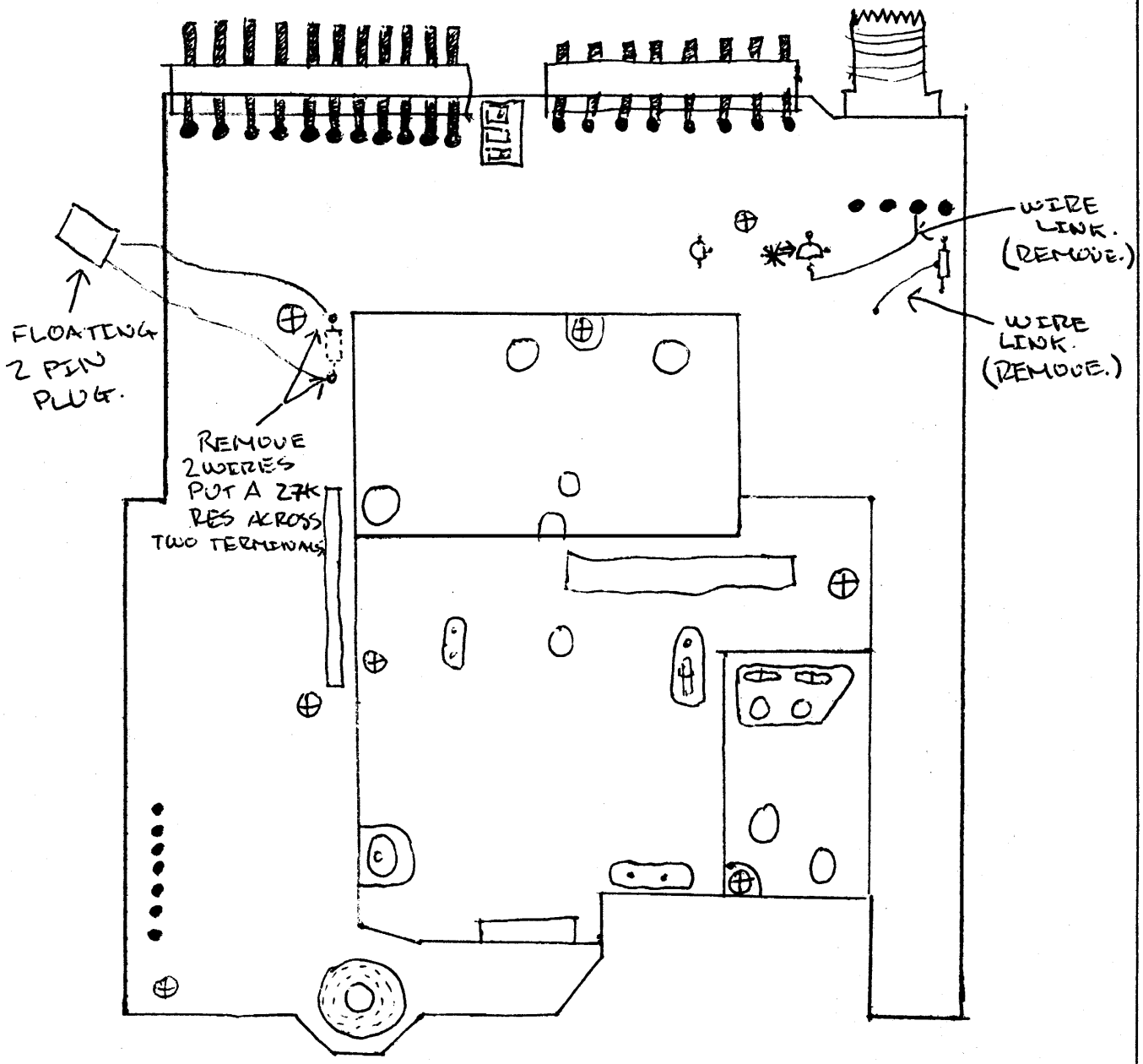
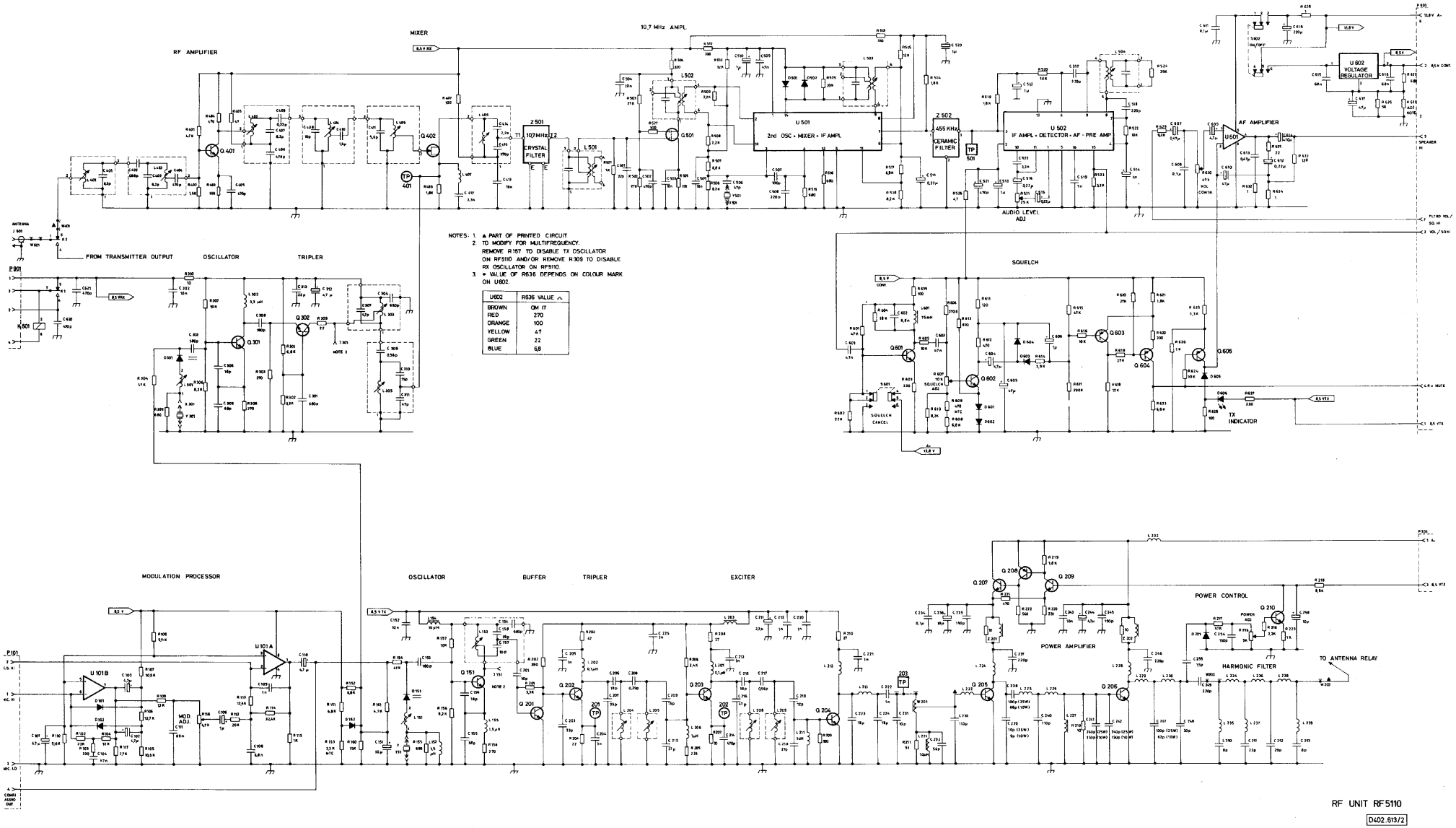


* THIS TRANSISTOR MUST BE MOVED 90° ANTI CLOCKWISE. THE LEGS MUST ALSO COINSIDE WITH THE MOVE.

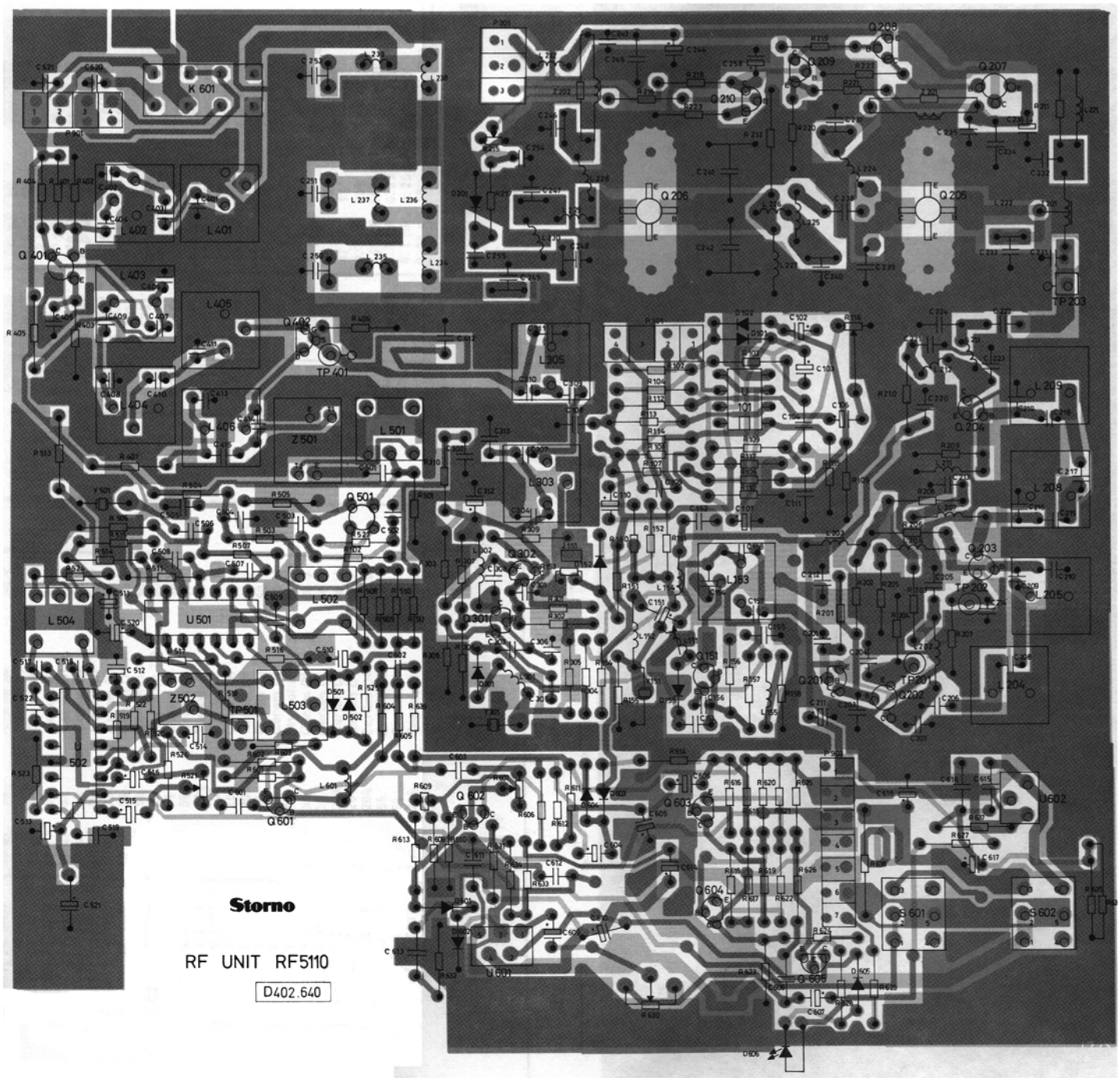
OLD WAY 

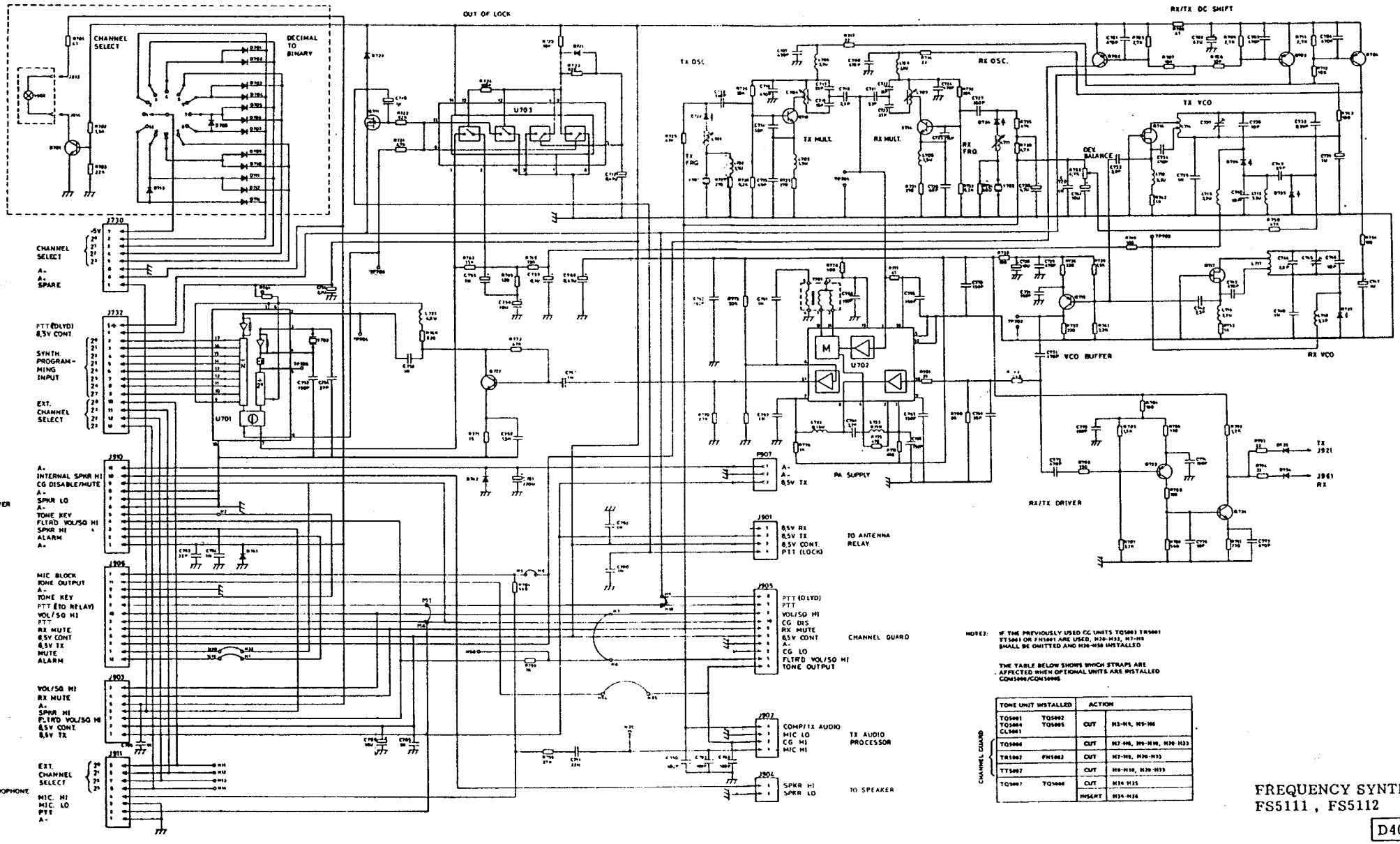
NEW WAY 



RF UNIT RF5110

D402.613/2


Storno
RF UNIT RF5110
D402.640



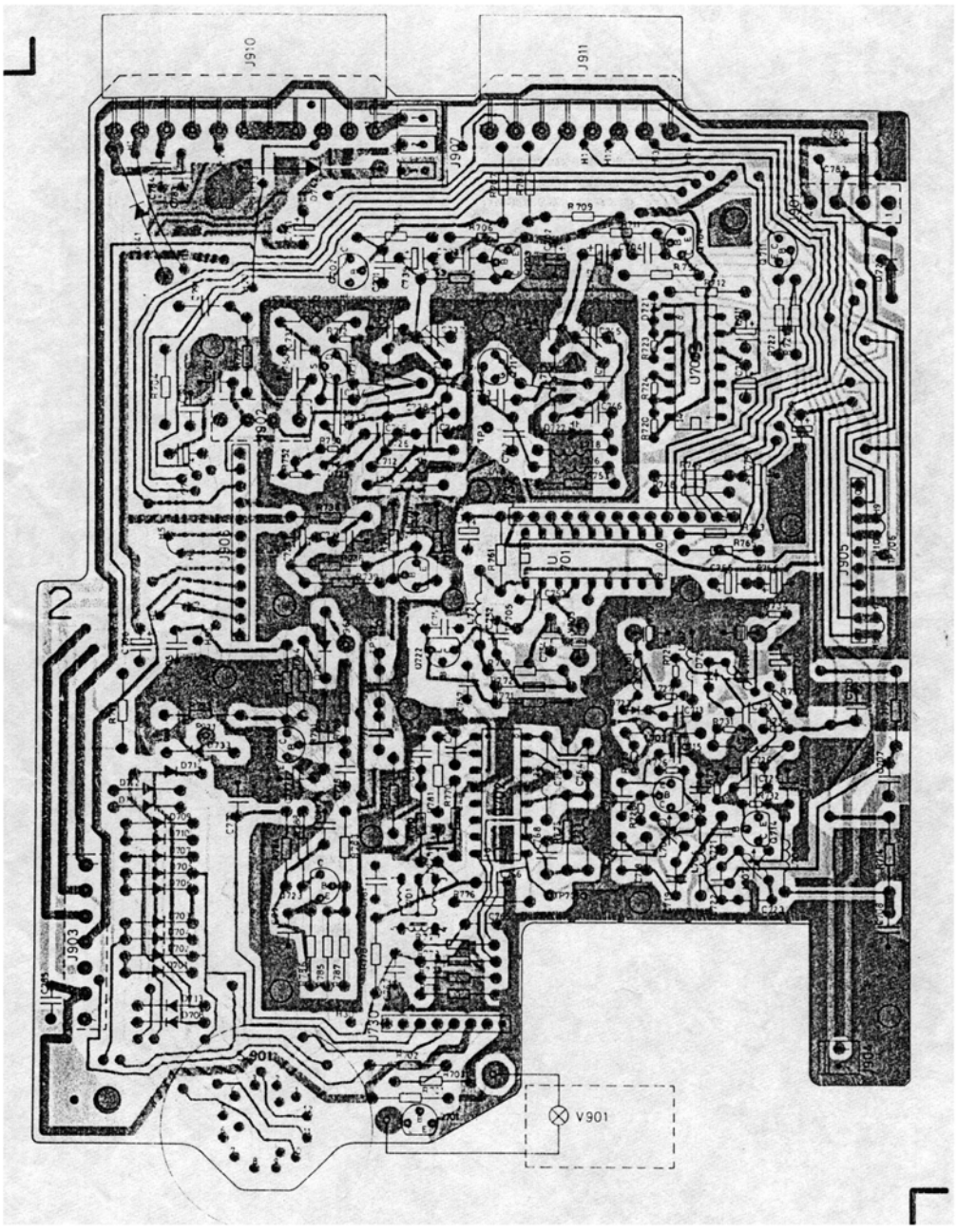
NOTE2: IF THE PREVIOUSLY USED CG UNITS TQ5001 TR5001 TT5001 OR FN5001 ARE USED, H20-H33, H7-H8 SHALL BE OMITTED AND H36-H50 INSTALLED

THE TABLE BELOW SHOWS WHICH STRAPS ARE AFFECTED WHEN OPTIONAL UNITS ARE INSTALLED CQM5000/CQM5005

	TONE UNIT INSTALLED		ACTION	
CHANNEL GUARD	TQ5001 TQ5004 CL5001	TQ5002 TQ5005	CUT	H3-H9, H9-H6
	TQ5006		CUT	H7-H8, H9-H10, H20-H33
	TR5002	FN5002	CUT	H7-H8, H20-H33
	TT5002		CUT	H8-H10, H20-H33
	TQ5007	TQ5008	CUT	H34-H35
			INSERT	H34-H36

FREQUENCY SYNTHES
FS5111 , FS5112

D402.


J910
J911
J902
J903
V901
2

EXTRA NOTES ON THE STORM 5145

DE MODDING THE DATA VERSION

Remove both covers - The top board with 2 small screening covers exposed is the synthesiser board. - Beside this there may be a smaller board mounted upside-down held in place with 3 screws - this should be removed and lifted up this board is not required.

Remove the 3 screws holding the "Prom" board from the top of the synthesiser board and - keep.

You may find it helpful to remove the front panel at this stage. Then remove the synth-esiser board completly - and carefully lift it up as there are pins going through to the R.F board. Carefully remove the cut-off wires going out through the back of the case and to the board thats mounted where the speaker was.

On the top of the board, just to the back left of the synth screening cover locate where R799 was (probably with. A red + blue wire attached ending in a 2 pin plug - this is the L/S plug and should be retained) Refit R799 with a 27k Ω. resistor

LOCATE J906 JUST IN FRONT OF THIS AND MAKE SURE THAT THE LINKS H4-H3 AND H5-H6 ARE FITTED. THEN PROCEED AS PER THE NORMAL MOD SHEETS. FOR THE SYNTH.

R.F. BOARD.

REMOVE THE SCREENING COVER. WITH THE HELP OF THE LAYOUT LOCATE L303 AND C110 A TANTALUM CAPACITOR JUST BESIDE IT. YOU WILL SEE THAT THE TRACK HAS BEEN JUST BY THE -VE LEG OF THIS CAP. RE MAKE THIS CONNECTION (MICROPHONE AUDIO). REMOVE R.F. BOARD AND REMOVE SUNDRIES WIRES FROM THE UNDERSIDE - THEN PROCEED AS PER THE MOD SHEETS.

MOTOROLA

MC145104
MC145106
MC145107
MC145109
MC145112

CMOS MSI

(LOW-POWER COMPLEMENTARY MOS)

PLL FREQUENCY SYNTHESIZERS

PLL FREQUENCY SYNTHESIZERS

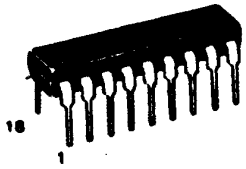
The MC145104, MC145106, MC145107, MC145109, and MC145112 are phase locked loop (PLL) frequency synthesizer parts constructed with CMOS devices on a single monolithic structure. These synthesizers find applications in such areas as CB and FM transceivers. The device contains an oscillator/amplifier, a 2^{10} or 2^{11} divider chain for that oscillator signal, a programmable divider chain for the input signal and a phase detector. The MC145104/5106/5112 have circuitry for a 10.24 MHz oscillator or may operate with an external signal. The MC145107/5109 require the external reference signal. Several of the circuits provide a 5.12 MHz output signal, which can be used for frequency tripling. A 2^9 (MC145106/5109/5112) or 2^8 (MC145104/5107) programmable divider divides the input signal frequency for channel selection. The inputs to the programmable divider are standard ground-to-supply binary signals. Pull-down resistors on these inputs normally set these inputs to ground enabling these programmable inputs to be controlled from a mechanical switch or electronic circuitry.

The phase detector may control a VCO and yields a high level signal when input frequency is low, and a low level signal when input frequency is high. An out of lock signal is provided from the on-chip lock detector with a "0" level for the out of lock condition.

The MC145106 is the full pinout version of this family of parts and has the capability of all parts in the family. The MC145104/5107/5109/5112 are limited pinout versions. See block diagrams for details.

- Single Power Supply
- Wide Supply Range: 4.5 to 12 Vdc
- 16 or 18 Pin Plastic Packages
- 10.24 MHz Oscillator on Chip
- 5.12 MHz Output
- Programmable Division Binary Input Selects up to 2^9
- On-Chip Pull Down Resistors on Programmable Divider Inputs
- Selectable Reference Divider, 2^{10} or 2^{11}
- Three-State Phase Detector

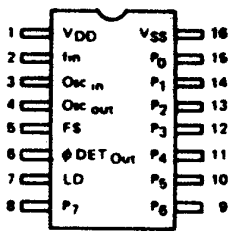
P SUFFIX
PLASTIC PACKAGE
CASE 648



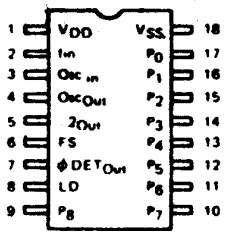
P SUFFIX
PLASTIC PACKAGE
CASE 707

Pin-for-Pin Replacements for:
MC145104 for SM5104, MM55104, MM55114
MC145106 for MM55106, MM55116
MC145107 for SM5107
MC145109 for SM5109
MC145112 for SM5106

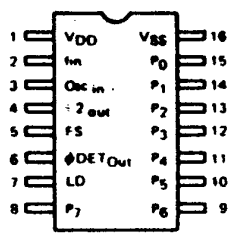
PIN ASSIGNMENTS



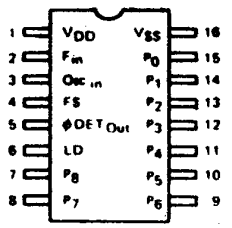
MC145104



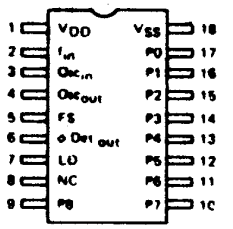
MC145106



MC145107



MC145109



MC145112

MAXIMUM RATINGS (Voltages referenced to V_{SS})

Rating	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	−0.5 to + 12	Vdc
Input Voltage, All Inputs	V_{in}	−0.5 to V_{DD} + 0.5	Vdc
DC Current Drain per Pin	I	10	mAdc
Operating Temperature Range	T_A	−40 to +85	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out} \leq V_{DD}$.

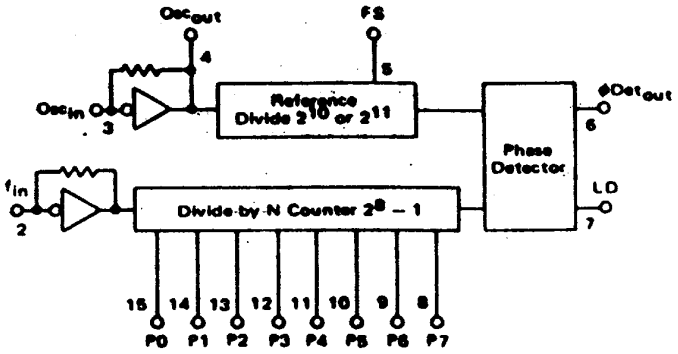
2

ELECTRICAL CHARACTERISTICS (T_A = 25° unless otherwise stated.)

Characteristic		Symbol	V_{DD} Vdc	All Types Min	Typ	Max	Unit
Supply Current		I_D	5.0	–	6	10	mAdc
			10	–	20	35	
			12	–	28	50	
Input Voltage	"0" Level	V_{IL}	5.0	–	–	1.5	Vdc
			10	–	–	3.0	
			12	–	–	3.6	
	"1" Level	V_{IH}	5.0	3.5	–	–	Vdc
			10	7.0	–	–	
			12	8.4	–	–	
Input Current (FS) (Pull-up Resistor)	"0" Level	I_{in}	5.0	-5.0	-20	-50	μAdc
			10	-15	-60	-150	
			12	-20	-80	-200	
(P0 to P8)			5.0	–	–	-0.3	
			10	–	–	-0.3	
			12	–	–	-0.3	
(FS)	"1" Level		5.0	–	–	0.3	μAdc
			10	–	–	0.3	
			12	–	–	0.3	
(P0 to P8) (Pull-down Resistor)			5.0	7.5	30	75	
			10	22.5	90	225	
			12	30	120	300	
(Osc_{in}, f_{in})	"0" Level		5.0	-2.0	-8.0	-15	μAdc
			10	-6.0	-25	-62	
			12	-9.0	-37	-92	
(Osc_{in}, f_{in})	"1" Level		5.0	2.0	8.0	15	
			10	6.0	25	62	
			12	9.0	37	92	
Output Drive Current (V_O = 4.5 Vdc) (V_O = 9.5 Vdc) (V_O = 11.5 Vdc)	Source	I_{OH}	5.0	-0.7	-1.4	–	mAdc
			10	-1.1	-2.2	–	
			12	-1.5	-3.0	–	
(V_O = 0.5 Vdc) (V_O = 0.5 Vdc) (V_O = 0.5 Vdc)	Sink	I_{OL}	5.0	0.9	1.8	–	mAdc
			10	1.4	2.8	–	
			12	2.0	4.0	–	
Input Amplitude (f_{in} @ 4.0 MHz) (Osc_{in} @ 10.24 MHz)		–	–	1.0	0.2	–	Vp-p Sine
			–	1.5	0.3		
Input Resistance (Osc_{in}, f_{in})		R_{in}	5.0	–	1.0	–	MΩ
			10	–	0.5	–	
			12	–	–	–	
Input Capacitance (Osc_{in}, f_{in})		C_{in}	–	–	6.0		pF
Three State Leakage Current (ϕ Det_{out})		I_{TL}	5.0	–	–	1.0	μAdc
			10	–	–	1.0	
			12	–	–	1.0	
Input Frequency (−40°C to +85°C)		f_{in}	4.5	4.0	–	–	MHz
			12	4.0	–	–	
Oscillator Frequency (−40°C to +85°C)		Osc_{in}	4.5		–	10.24	MHz
			12		–	10.24	

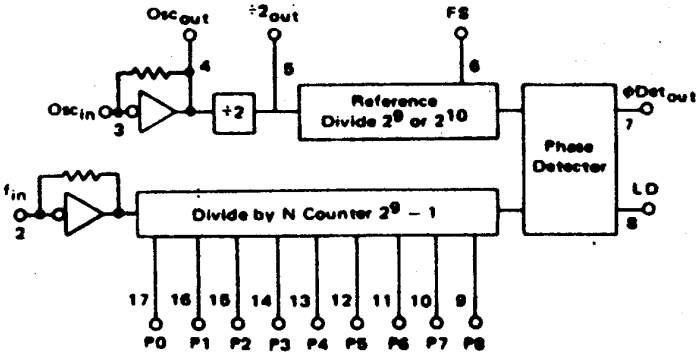
2

BLOCK DIAGRAMS



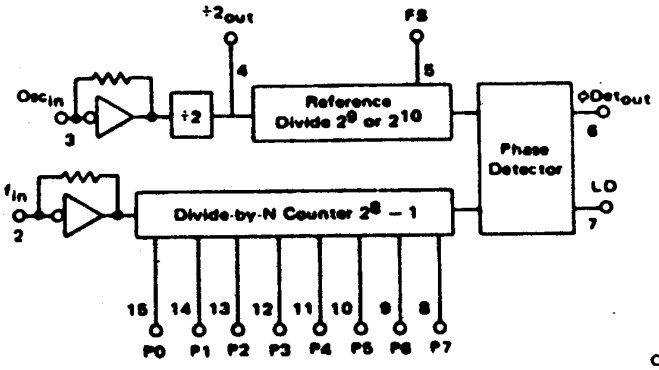
MC145104

V_{DD} = Pin 1
V_{SS} = Pin 16



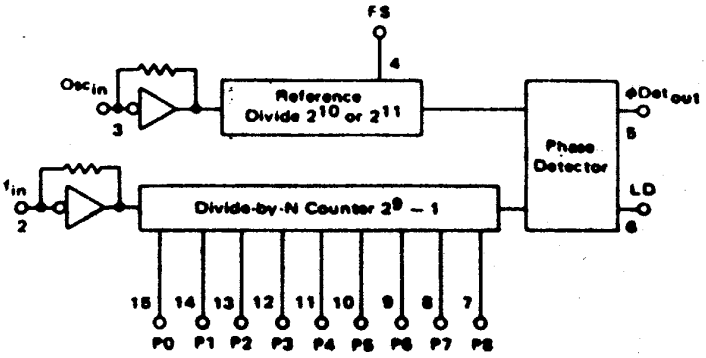
MC145106

V_{DD} = Pin 1
V_{SS} = Pin 18



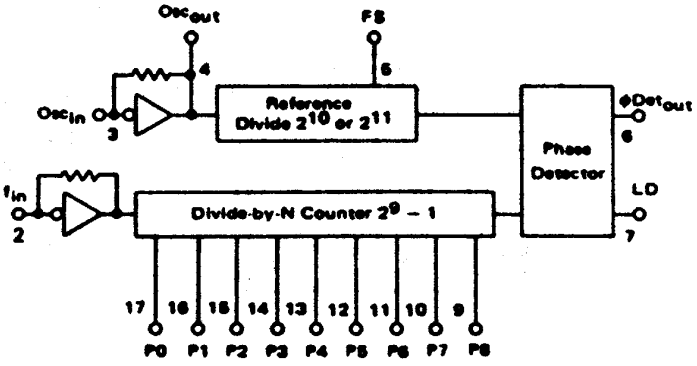
MC145107

V_{DD} = Pin 1
V_{SS} = Pin 16



MC145109

V_{DD} = Pin 1
V_{SS} = Pin 16



MC145112

N.C. = Pin 8
V_{DD} = Pin 1
V_{SS} = Pin 18

TYPICAL CHARACTERISTICS

FIGURE 1 – MAXIMUM DIVIDER INPUT FREQUENCY versus SUPPLY VOLTAGE

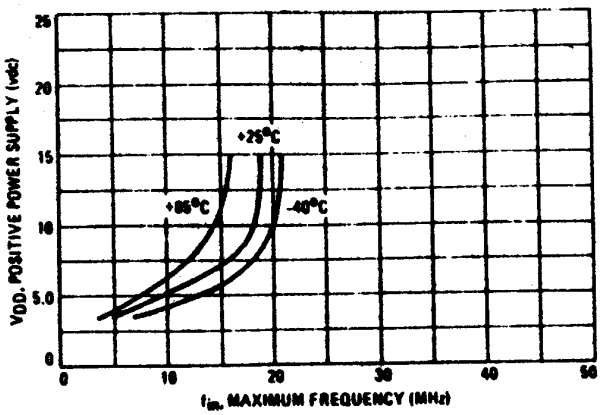
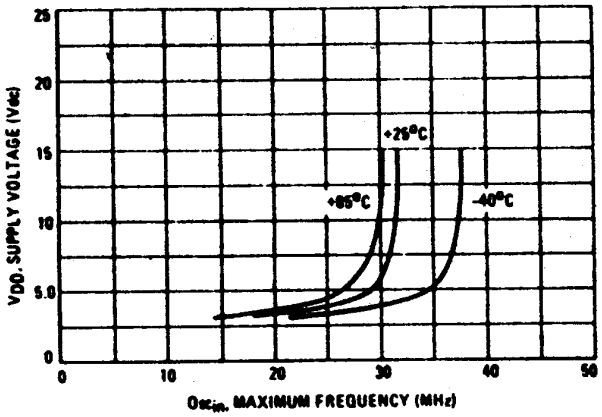


FIGURE 2 – MAXIMUM OSCILLATOR INPUT FREQUENCY versus SUPPLY VOLTAGE



2

TRUTH TABLE

Selection									
P8	P7	P6	P5	P4	P3	P2	P1	P0	Divide By N
0	0	0	0	0	0	0	0	0	2 (Note 1)
0	0	0	0	0	0	0	0	1	3 (Note 1)
0	0	0	0	0	0	0	1	0	2
0	0	0	0	0	0	0	1	1	3
0	0	0	0	0	0	1	0	0	4
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
0	1	1	1	1	1	1	1	1	255
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
1	1	1	1	1	1	1	1	1	511

1: Voltage level = V_{DD}
0: Voltage level = 0 or open circuit input

Note 1: The binary setting of 00000000 and 00000001 on P8 to P0 results in a 2 and 3 division which is not in the 2^N-1 sequence. When pin is not connected (or is not listed as for the MC145104 and MC145107), the logic signal on that pin can be treated as a "0".

PIN DESCRIPTIONS

P0 – P8 – Programmable divider inputs (binary)
f_{in} – Frequency input to programmable divider (derived from VCO)
Osc_{in} – Oscillator/amplifier input terminal
Osc_{out} – Oscillator/amplifier output terminal
LD – Lock detector, low when out of lock
ϕ Det_{out} – Signal for control of external VCO, output high when f_{in}/N is less than the reference frequency; output low when f_{in}/N is greater than the reference frequency. Reference frequency is the divided down oscillator input frequency typically 5.0 or 10 kHz.
FS – Reference Oscillator Frequency Division Select. When using 10.24 MHz Osc frequency, this control selects 10 kHz, a "0" selects 5.0 kHz.
$+2_{out}$ – Reference Osc frequency divided by 2 output; when using 10.24 MHz Osc frequency, this output is 5.12 MHz for frequency tripling applications.
V_{DD} – Positive power supply
V_{SS} – Ground

PLL SYNTHESIZER APPLICATIONS

The MC145104, MC145106, MC145107, MC145109, MC145112 ICs are well suited for Applications in CB radios because of the channelized frequency requirements. A typical 40 channel CB transceiver synthesizer using a single crystal reference is shown in Figure 3 for receiver IF values of 10.695 MHz and 455 kHz.

In addition to applications in CB radios, the MC145104-12 ICs can be used as a synthesizer for several other systems. Various frequency spectrums can be achieved through the use of proper offset, prescaling and loop programming techniques. In general, 300-400 channels can be synthesized using a single loop, with many additional channels available when multiple loop approaches are employed. Figures 4 and 5 are examples of some possibilities.

In the aircraft syntheizer of Figure 5, the VHF loop (top) will provide a 50 kHz 360 channel system with 10.7 MHz R/T offset when only the 11.0500 MHz (transmit) and 12.1200 MHz (receive) frequencies are provided to mixer #1. When these signals are provided with crystal oscillators, the result is a three crystal, 360 channel, 50 kHz step synthesizer. When using the offset loop (bottom) in Figure 5 to provide the indicated injection frequencies for mixer #1 (two for transmit and two for receive) 360 additional channels are possible. This results in a 720 channel, 25 kHz step synthesizer which requires only two crystals and provides R/T offset capability. The receive offset value is determined by the 11.31 MHz crystal frequency and is 10.7 MHz for the example.

The VHF marine synthesizer in Figure 4 depicts a single loop approach for FM transceivers. The VCO operates on-frequency during transmit and is offset downward during receive. The offset corresponds to the receiver I F (10.7 MHz) for channels having identical receive/transmit frequencies (simplex), and is (10.7 – 4.6 = 6.1) MHz for duplex channels. Carrier modulation is introduced in the loop during transmit.

FIGURE 3 – SINGLE CRYSTAL CB SYNTHESIZER FEATURING ON-FREQUENCY VCO DURING TRANSMIT

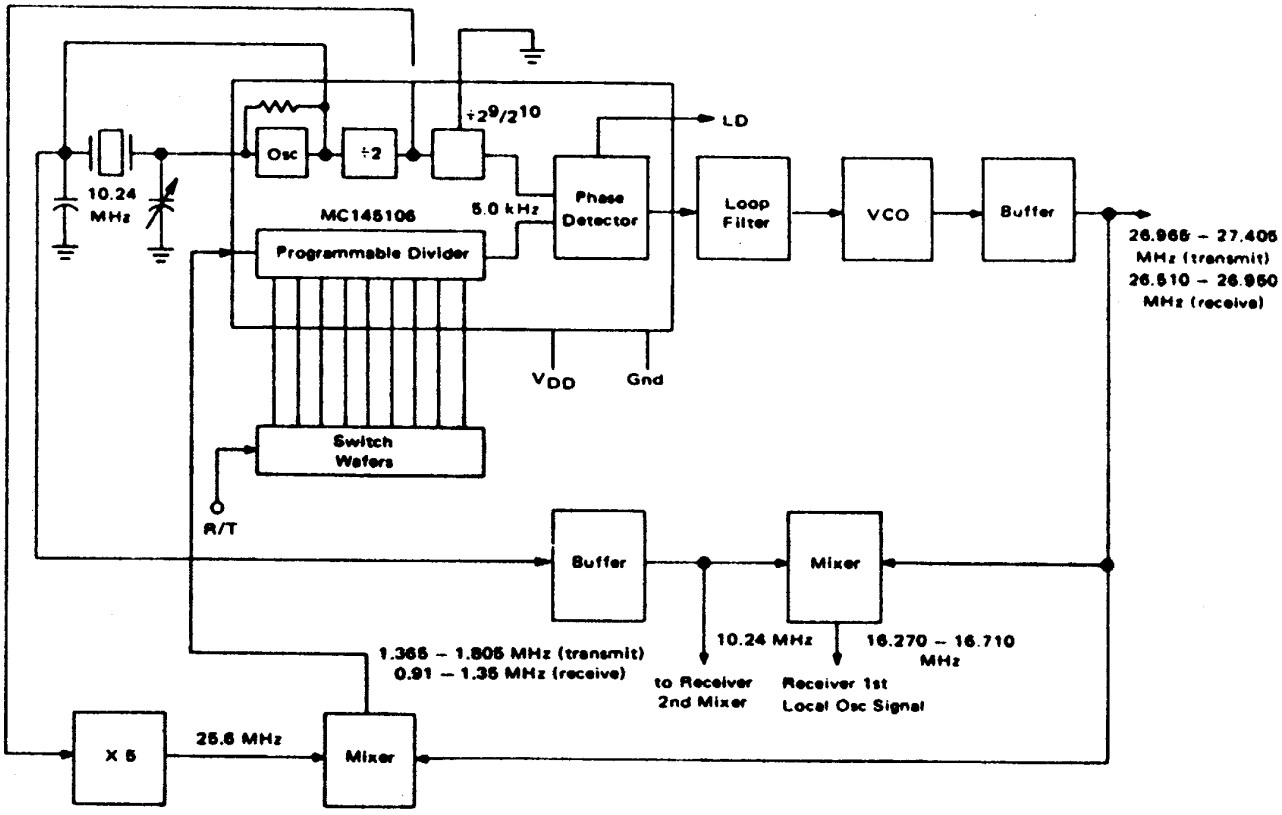


FIGURE 4 – VHF MARINE TRANSCEIVER SYNTHESIZER

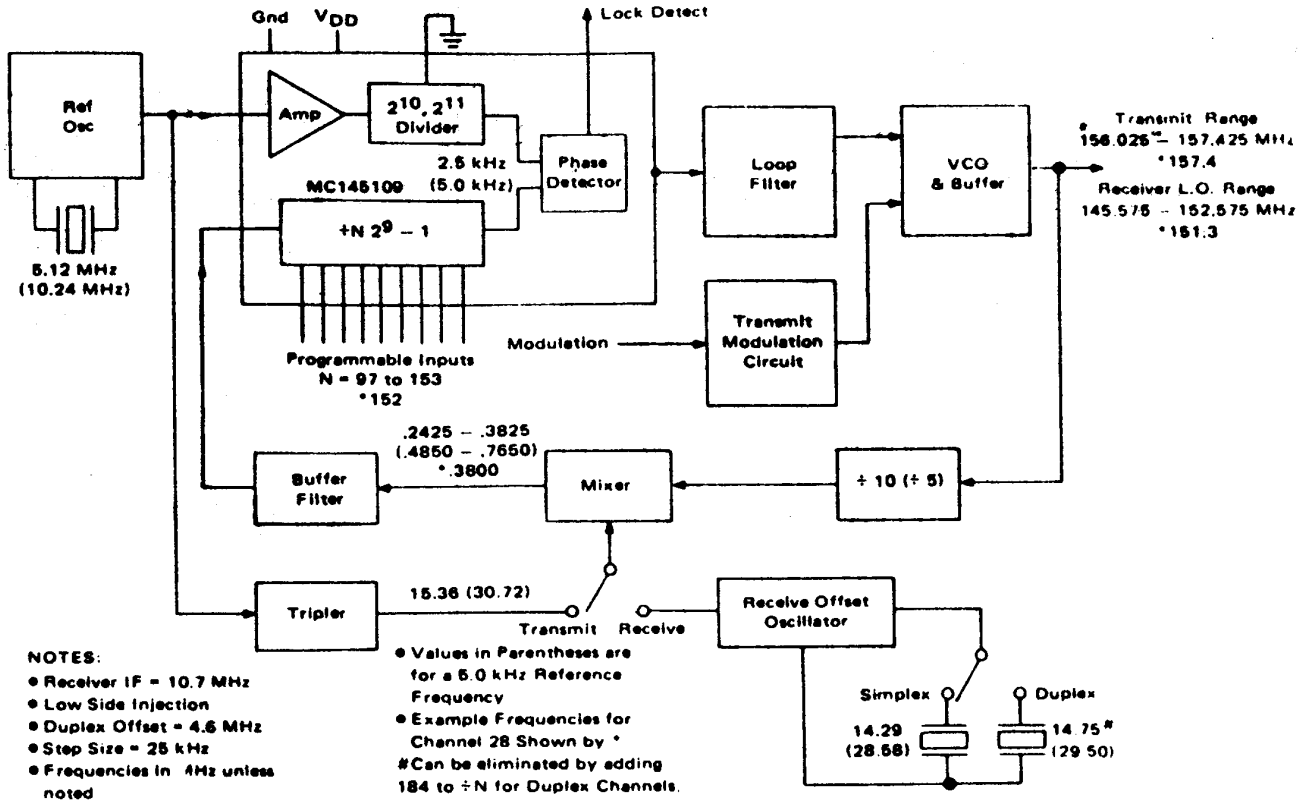


FIGURE 5 – VHF AIRCRAFT 720 CHANNEL TWO CRYSTAL FREQUENCY SYNTHESIZER