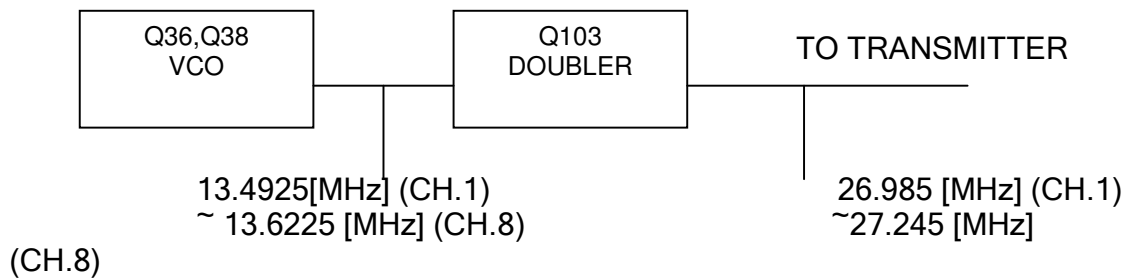


THEORY OF OPERATION

ALAN42-MULTI

Description Of Frequency Determining And Stabilizing Circuit Introduction

THE FREQUENCIES FOR TRANSMITTER AND RECEIVER LOCAL FREQUENCIES ARE ALL DERIVED A SIGNAL 4.0 [MHz] CRYSTAL BY MEANS OF A PHASE LOCKED LOOP. THE FIRST LOCAL OSCILLATOR FREQUENCIES ARE 16.29 [MHz] (CH.1) TO 16.55 [MHz] (CH.80). THE SECOND LOCAL FREQUENCY IS FIXED AT 10.6950 [MHz] TO GENERATE SECOND IF 455 [KHz]. DURING TRANSMIT, THE VCO OF THE PLL OPERATES 13.4925[MHz] (CH.1) TO 13.6225 [MHz] (CH.8) THE VCO FREQUENCY GOES TO THE DOUBLER CIRCUIT Q103, L10, L11 WHICH DOUBLES THE FREQUENCY TO GENEGATE 26.985 [MHz] (CH.1) TO 27.245 [MHz] (CH.8).



THE VCO OPERATING FREQUENCY FOR THE RECEIVER IS 16.29 [MHz] (CH.1) TO 16.55 [MHz] (CH.8) AS THE FIRST LOCAL OSCILLATOR, INJECTED THROUGH THE BUFFER AMP Q38 INTO THE FIRST FET BALANCED MIXER Q5, Q6

DESCRIPTIONS OF EACH BLOCK

(1) INTRODUCTION

THE SYNTHESIZER IS IMPLEMENTED WITH THE FOLLOWING COMPONENTS : PLL IC (IC4), X-TAL (X 2), VCO, VARICAP DIODE (D13) IC1 IS A CPU THAT INCLUDES LCD DRIVER AND ALL OF CONTROL CIRCUIT. THE PLL IC (IC4) OF PLL BLOCK, THE Q36, L7, C91, C92, C85, C90, VARICAP DIODE D13 ARE CLAPP OSCILLATOR CIRCUIT TO OPERATE AS A VCO .Q35 IS A SWITCHING TRANSISTOR TO CONNECT OR DISCONNECT THE TUNING CAPACITOR IN THE VCO OSCILLATOR TANK CIRCUIT FOR TRANSMITTER OR RECEIVER. Q38 WORKS AS A BUFFER AMP FOR RX LOCAL FREQUENCIES (16 [MHz]) AND TX CARRIER GENERATING FREQUENCIES (13 [MHz]) .

(2) REFERENCE FREQUENCY

THE CRYSTAL, X2(4.0 [MHz]) AND OTHER COMPONENTS AT PIN 1 AND 16 OF IC4 CAN MAKE A REFERENCE FREQUENCY OSCILLATOR WITH INTERNAL AMPLIFIER .

(3) VCO

Q36 AND SURROUNDING PARTS ARE CONSISTING A CLAP OSCILLATOR WORKS AS A VCO OF IC4 WITH APPROPRIATE CONTROL VOLTAGE ON D13, THE VCO CAN BE OSCILLATE OVER THE REQUIRED RANGE OF 13.4925 [MHz] TO 16.55 [MHz] .

(4) PROGRAMMABLE DIVIDER AND ITS CONTROL

THE CPU(IC1) AND PLL IC (IC4) COMMUNICATE BY SERIAL DATA. THE PROGRAMMABLE INPUTS FOR EACH CHANNELS ARE SETTED CPU (IC1) . EACH INPUT SIGNAL TO CONTROL THE PLL IC IS DONE WITH THE PROVIDED KEY INPUT PINS PIN 36, 37, AND PIN38 OF IC1.

(5) PHASE DETECTOR AND VCO CONTROL

THE PHASE DETECTOR IS A DIGITAL PHASE COMPARATOR WHICH COMPARES THE PHASE OF THE REFERENCE SIGNAL WITH PROGRAMMABLE DIVIDER OUTPUT SQUARE WAVES AND DEVELOPS A SERIES OF PULSES WHOSE DC LEVEL DEPENDS ON THE PHASE ERROR SIGNAL . THE PHASE DETECTOR PULSE OUTPUT IS FED TO AN ACTIVE LOW PASS FILTER AND RC LOW PASS FILTER OUTPUT SIGNAL OF IC4 IS FILTERED AND FED TO VARICAP D13 CONTROL THE VCO FREQUENCY.

(6) TRANSMITTER / RECEIVER BUFFER AMP

OUTPUT SIGNAL OF Q36 IS FED INTO THE BUFFER AMP Q38, L8 TO INCREASE THE STRENGTH OF TX CARRIER FREQUENCY AND 1st LOCAL FREQUENCIES.

(7) TRANSMITTER DOUBLER

THE OUTPUT SIGNAL OF Q38, L8 GOES TO AN AMPLIFIER WITH TUNING CIRCUIT Q103, L10, L11 WHICH DOUBLES INCOMING 13 MHz SIGNALS.

(8) SWITCHING OF TUNING CAPACITOR IN VCO

THE VCO CIRCUIT MUST TUNE WITH A WIDE RANGE OF FREQUENCIES 13.4925 ~ 13.6225 [MHz] FOR TRANSMITTER AND 16.29 ~ 16.550 [MHz] FOR RECEIVER. TO COMPLY ABOVE RANGE OF VCO, THE TUNING CAPACITANCE SHOULD SWITCHED FOR TRANSMISSION OR RECEPTION. THE TUNING CIRCUIT CONSISTS WITH L7, C91, C92, C85, C90, WHEN THE VCO IS WORKING AS A RECEIVER Q35 BECOMES TURN OFF. SO, L7 AND D13 MAKES TUNING FUNCTION. WHEN TRANSMITTING Q406 BECOMES ON. SO, L7 AND THE PARALLEL CAPACITANCE OF C89 AND D13 MAKE TURNING FUNCTION.

(9) RECEIVER LOCAL OSCILLATOR OUTPUTS

1ST MIXER : THE SECONDARY OUTPUT SIGNALS OF L3 IS INJECTED TO THE SOURCE OF

1ST MIXER Q4, Q5 IN THE 1ST IF MIXER SECTION.

2ND MIXER : THE OUTPUT OF 10.695 [MHz] OSCILLATOR CIRCUIT WITH X2 IS INJECTED

INTO THE IF MODULE (IC3).

INCOMING IF SIGNAL AND 10.695 [MHz] SIGNAL ARE MIXED

INSIDE THE IF

IC TO EXTRACT 2ND IF SIGNAL 455 [MHz].

FM SIGNALS ARE RECOVERED WITH ENVELOPE DETECTOR.

FREQUENCY STABILITY

LET : F_o = CRYSTAL OSCILLATOR FREQUENCY

F_r = PHASE DETECTOR REFERENCE FREQUENCY

F_{vco} = VCO FREQUENCY

F_t = TRANSMIT FREQUENCY

THEN : $F_r = F_o/1800$

AND UNDER LOCKED CONDITIONS : $F_r = F_{vco} / N$

Where , "N" IS THE PROGRAMMABLE DIVIDER DIVIDE RATIO.

THEN : $F_{vco} = N \times F_r$

FROM WHICH IT CAN BE SEEN, THE PERCENTAGE ERROR IN F_t IS THE SAME AS THE PERCENTAGE ERROR IN F_o . THE STABILITY OF THE CRYSTAL OSCILLATOR IS DETERMINED PRIMARILY BY THE ITSELF AND HAVING PASSIVE COMPONENTS OF THE OSCILLATOR.

THE CHOICE OF CRYSTAL AND COMPONENTS IS SUCH THAT THE REQUIRED FREQUENCY STABILITY IS MAINTAINED OVER THE REQUIRED VOLTAGE AND TEMPERATURE RANGE.

DESCRIPTION OF OTHER CIRCUITS TRANSMITTER

(1) TX AMPLIFICATION

THE OUTPUT OF DOUBLER AMP Q103 IS FED THROUGH TUNING IFT L10 AND L11 TO THE BASE OF PRE DRIVER AMP Q104. THE OUTPUT IS THEN SUPPLIED THROUGH TUNING CIRCUIT L12 TO RF DRIVER AMP Q107. THE OUTPUT OF Q107 IS SPLITTED WITH TUNING CIRCUIT L13, C112, C84 AND GOES TO THE BASE OF FINAL RF AMP Q108. THE OUTPUT OF Q108 IS SUPPLIED TO THE ANTENNA THROUGH L-C TUNING CIRCUIT.

(2) CIRCUIT FOR SUPPRESSION OF SPURIOUS RADIATION

THE TUNING CIRCUIT BETWEEN THE OUTPUT OF FINAL AMP Q108 AND ANTENNA,

7-STAGE "LPF" NETWORK L16, L17, L18, L1, C139, C144, C79, C83, C128, C129, C131, C142, C133, C134 SERVES AS A SPURIOUS RADIATION SUPPRESSOR

THIS NETWORK ALSO SERVES TO MATCH THE IMPEDANCE BETWEEN TX POWER AMP Q303 AND THE ANTENNA

(3) CIRCUITS FOR LIMITING POWER

AFTER FINISHED ALL ALIGNMENT, TO CONSTANT VOLTAGE SUPPLY CIRCUIT LIMITS THE AVAILABLE POWER 4 [W] OR SLIGHTLY LESS. RV5 AND CORRESPONDING THREE TRANSISTORS CONTROL SUPPLY VOLTAGE OF RF AMPLIFIER AND OTHER CIRCUITS.

TUNE ALL THE TRIMMING PARTS FOR MAXIMUM INDICATION OF RF POWER METER AND ADJUST RV5 TO MAKE 4 [W] INDICATION OF RF POWER METER. THE TUNING IS ADJUSTED SO THAT THE ACTUAL POWER IS FROM 3.8 TO 4.0 [W]. THERE ARE NO OTHER ADDITIONAL CONTROLS FOR ADJUSTING THE TX OUTPUT POWER.

(4) MAX DEVIATION CONTROL

DEVIATION SIGNALS ARE FILTERED WITH RC NETWORK AND GOES TO THE OP AMP IC IC5A MAKE NOMINAL SIGNAL LEVEL TO ACHIEVE WANTED MODULATION. TO CONTROL INCOMING AUDIO SIGNAL, DIODE D17 AND CORRESPONDING LIMITER CIRCUIT CONTROLS WITH PROPORTIONAL TO SAMPLED AUDIO OUTPUT LEVEL ADJUST RV4 SHALL NOT EXCEED ± 2 [KHz] MAX DEVIATION UNDER 1.25 [KHz] AF 20 dB UP FROM 1 kHz MOD LEVEL INPUT.

RECEIVER

- (1) RF AMP Q1 AMPLIFY RF SIGNAL FROM ANTENNA, THE AMPLIFIED RF SIGNAL IS FED THROUGH TUNING COILS L401, L402, L403 TO THE GATE OF DOUBLE BALANCE MIXER FET, Q5, Q6 ALSO VCO SOURCES FREQUENCY LOWER 10.695 MHz THAN THE FREQUENCY OF EACH CHANNEL IS SUPPLIED TO MIXER.
- (2) THE SOURCE OF 10.695MHz FREQUENCY FILTERED BY CF1 IS FED TO THROUGH TO IC2.
- (3) THE 455KHz FREQUENCY SIGNAL PRODUCED FROM IC2 BY MIXING THE OUTPUT SOURCE OF CF1 10.695MHz FILTER AND THE SOURCE OF 4.00MHz FREQUENCY FROM CRYSTAL OSCILLATOR X2.
- (4) INTERNAL AM AND FM DETECTOR OF IC2 DETECT AM & FM AUDIO SIGNAL.
- (5) A.G.C(AUTOMATIC GAIN CONTROL) SIGNAL OF IC2 FED TO IC2A, D3, Q7CONTROL RECEIVING SENSITIVITY.
- (6) FM AUDIO OUTPUT DETECTED AND AMPLIFIED AUDIO SIGNAL IS FED THROUGH HIGH CUT FILTER R20,C35,VR1,IC3 TO SPEAKER.