ALL MODE MULTI-BAND TRANSCEIVER

TS-2000/X

SERVICE MANUAL

KENWOOD

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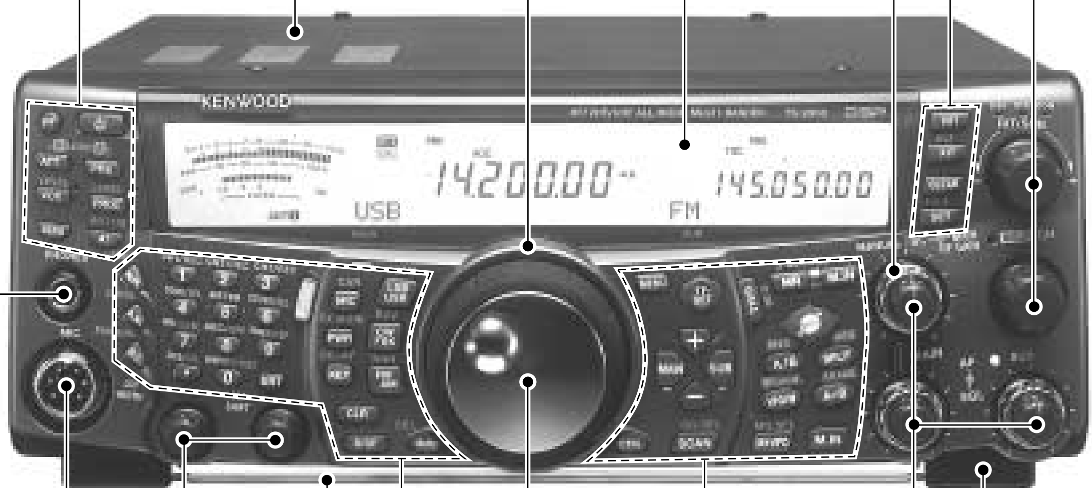

CONTENTS

CIRCUIT DESCRIPTION

Overview of the Operation

The TS-2000/X basically consists of an all-mode-receiver incorporating an IF/AF DSP for satellite communication with an independent FM/AM sub-receiver for the VHF and UHF bands.

■ Overview of the operation of the all-mode transceiver unit (main band side) with an IF/AF DSP for satellite communication

The receiver unit has an independent front end for each of the HF, 50MHz, 144MHz, 430MHz and 1.2GHz bands (some products do not support the 1.2GHz band). The circuits following the 10.695MHz IF stage are common to all the bands. (Thus, it cannot receive two SSB signals at the same time.)

The IF frequency of the transmitter unit is shifted from the IF frequency of the receiver unit by 100kHz to enable satellite operation (full duplex operation). The final section is independent of the HF, 50MHz, 144MHz, 430MHz and 1.2GHz bands. Consequently, you can select a combination of bands permitting satellite communication from the HF, 50MHz, 144MHz, 430MHz and 1.2GHz bands.

The transmitter unit and receiver unit on the main band side operate simultaneously during satellite transmission. The receiver unit on the sub-band side does not work. (The sub-band receiver is not used during satellite operation.)

Two 16-bit DSP ICs are used; one performs IF processing (main band side) and the other carries out AF processing (main and sub bands). Although the DSP IC is a 16-bit unit, it carries out "double-precision operations" for critical parts of IF processing to perform 32-bit equivalent processing. In addition, the DSP IC uses a 100-MHz high-speed internal clock. The conversion from an analog signal to a digital signal (A/D conversion) is performed with 24 bits at high precision.

The DSP circuit for IF operates in any mode other than FM mode for both transmission and reception. FM modulation, detection and squelch processing are conventional analog processes. (The processing prior to modulation and after demodulation in FM is performed by the DSP.)

In the mode in which the IF DSP circuit operates, it carries out modulation and demodulation, digital IF filtering, digital AGC, and CW waveform processing during transmission, as in the TS-870. All these functions are operated in all the bands on the main band side, including satellite operation.

The AF unit is processed by the DSP in all modes. The operating range of the DSP circuit depends on the mode, but it performs beat cancellation, noise reduction, AF DSP filtering, etc.

■ Overview of the operation of the independent FM/AM sub-receiver unit (sub-band side) for the VHF and UHF bands

The local oscillator system and IF/AF signal system of the sub-receiver unit are independent of the main band side. Therefore, the sub-band receiver can receive signals while the main band receiver is sending a signal. (Except when reception is impossible due to harmonics of the transmit frequency and when the main band and sub-band are on the same frequency band.)

The sub-band receive signal is branched from the RF unit on the main band side. It is, therefore, not necessary to install a dedicated antenna for sub-band reception.

Transmission can be performed with the sub receive frequency by shifting the "PTT band" to the sub-band side. It is made possible by internally using the transmission function on the main band side.

AF processing is also carried out by the DSP on the sub-band side and the noise reduction function works.

The sub-band reception function, including display, can be turned off.

Frequency Configuration (Fig. 1)

This transceiver utilizes double conversion in FM mode and triple conversion in non-FM modes during transmission.

It utilizes triple conversion in FM mode and quadruple conversion in non-FM modes during reception. The fourth 12kHz IF signal is converted from analog to digital and connected to the DSP.

When the carrier point frequency of the signal input from the antenna is f_{IN}, the relationship between these signals when demodulating this signal is expressed by the following equations:

HF MAIN $f_{IN} = f_{LO1} - f_{LO2} - f_{LO3} + f_{LO4} - 12kHz$
VHF MAIN $f_{IN} = f_{LO1} - f_{LO2} - f_{LO3} + f_{LO4} - 12kHz$
UHF MAIN $f_{IN} = f_{LO1} + f_{LO2} + f_{LO3} - f_{LO4} + 12kHz$
1.2G MAIN $f_{IN} = f_{LO1} \times 2 + f_{LO2} + f_{LO3} - f_{LO4} + 12kHz$

Reference Signal Generation Circuit

The 15.6MHz reference frequency fstd for PLL frequency control is generated by the TCXO (X400). The signal passes through a buffer amplifier (Q420) and is used as the reference signal for the second local oscillator (HFLO2) for HF band reception and the first local oscillator (SLO1) subband reception.

The reference signal is doubled by Q412, and the resulting 31.2MHz signal is used as the reference signal for DDSs (IC406, IC407, IC408, IC601, IC602, IC603).

The 31.2MHz signal is supplied to the TX-RX2 unit (X57-606 A/11) as LO2 for VHF and UHF bands.

CIRCUIT DESCRIPTION

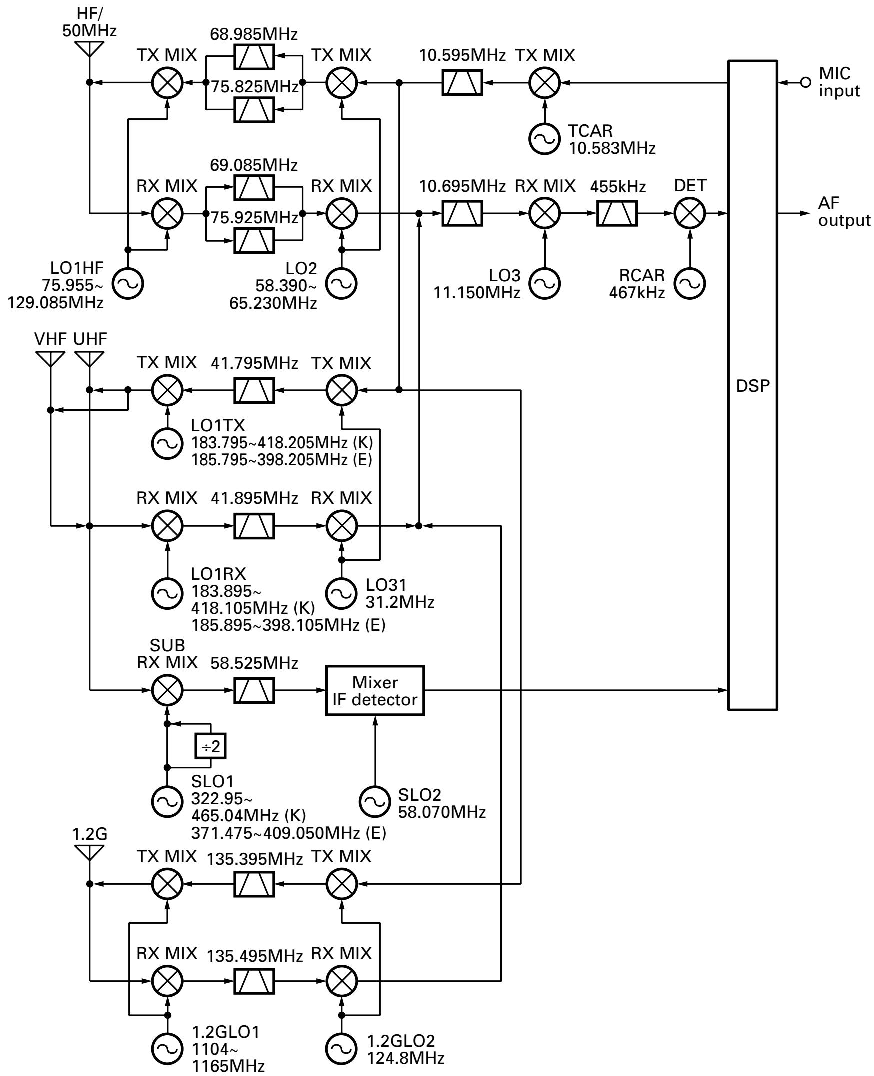

Fig. 1 Frequency configuration

HF/50MHz LO1

When the HF and or 50MHz band is operating in the main band, the HF REF VCO (Q427) generates 31.17 to 32.834 MHz. (See Table 1, frequency configuration.)

The output signal from the DDS (IC408) is input to pin 8 of the PLL IC (IC409) for HF REF, divided into 1/16 in IC409 to produce comparison frequency fø 2 of 487 to 513kHz.

The output signal from the VCO (Q427) goes to pin 6 of PLL IC (IC409), is divided into 1/64 in IC409, and compared with the signal with comparison frequency fø 2 by a phase comparator. The frequency is locked and the HF REF signal is output.

The output signal from the PLL IC (IC409) for HF REF is fed to pin 8 of the PLL IC (IC414) for HF LO1 as a reference frequency, and divided to produce comparison frequency fø 1 of 975 to 1358kHz.

The HF LO1 VCO (Q459, Q460, Q464) generates 75.955 to 129.185MHz. The output from this VCO goes to pin 6 of IC414, is divided into 1/N 1 in IC414, compared with the signal with comparison frequency fø 1 by a phase comparator. The frequency is locked and the HF LO1 output frequency is generated.

The DDS (IC408) sweeps output frequency (7.792 to 8.209MHz) in 10Hz steps by equation $f_{DDS\ STEP}$ (Hz) = (10*R 1)/(N 1*4) and in 1Hz steps by equation $f_{DDS\ STEP}$ (Hz) = (1*R 1)/(N 1*4), the HF LO1 covers the frequencies of 75.955 to 129.085MHz in 10Hz or 1Hz steps.

One of three VCOs (Q459, Q460, Q464) is selected by the signal (HF VCO1,HF VCO2,HF VCO3) from the serial-parallel IC (IC404).

The output from the VCOs (Q459, Q460, Q464) passes through a buffer amplifier (Q462), is amplified by Q476, and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output as HFLO1.

The cut-off frequency of the low-pass filter in the output section is changed by turning Q474 ON/OFF with a VCO select signal (HF VCO1).

CIRCUIT DESCRIPTION

HF LO2

When the HF and or 50MHz band is operating, the HF LO2 VCO (Q409) generates 65.230 to 58.390MHz. (See Table 1, frequency configuration.)

The 15.6MHz reference signal fstd is input to pin 8 of the PLL IC (IC401) for HF LO2, divided into 1/226 and 1/319 in IC401 to produce comparison frequency fø of 69.027 to 48.903kHz.

The output signal from the VCO (Q409) goes to pin 6 of IC401, its frequency is divided into 1/945 and 1/1194 in IC401, compared with comparison frequency fø by a phase comparator, and locked. The division ratio data comes from the control unit.

The output signal from the VCO (Q409) passes through a buffer amplifier (Q415), is amplified by Q421, and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output as HF LO2.

When the HF and or 50MHz band is not operating, Q403 is turned OFF with the LO2SEL signal and HF LO2 VCO (Q409) stops operation.

Display frequency f_{RX} (MHz)		LO1 OUT (MHz)	IC414 : LMX2306TMX		HF REF (MHz)	IC409 : LMX2306TMX		DDS output (MHz) IC408 : AD9835BRU
Start	Stop		R1	N1		N2	R2	
0.030000	1.999999	LO1	32	76	HF REF	64	16	f_{DDS}
2.000000	5.999999	$= f_{RX} + IF$	30	75	$= \frac{(f_{RX} + IF)}{N1} * R1$			$= \frac{HF\ REF}{N2} * R2$
6.000000	8.999999		32	84				
9.000000	12.999999		30	75				
13.000000	16.999999		32	84				
17.000000	17.999999		32	92				
18.000000	21.999999		30	90				
22.000000	23.999999		32	100				
24.000000	24.999999		32	92				
25.000000	25.999999		30	90				
26.000000	29.999999		24	78				
30.000000	32.999999		32	100				
33.000000	36.999999		30	97				
37.000000	40.999999		32	115				
41.000000	44.999999		32	119				
45.000000	48.999999		30	115				
49.000000	51.999999		30	113				
52.000000	55.999999		30	115				
56.000000	60.000000		32	127				

LO2 OUT (MHz)	IC401 : LMX2306TMX		IF	
	N3	R3	RX	TX
65.230088	945	226	75.925088	75.825088
58.389969	1194	319	69.084968	68.984968
65.230088	945	226	75.925088	75.825088
58.389969	1194	319	69.084968	68.984968
65.230088	945	226	75.925088	75.825088
58.389969	1194	319	69.084968	68.984968
65.230088	945	226	75.925088	75.825088
58.389969	1194	319	69.084968	68.984968

Table 1 Main HF and 50MHz band frequency configuration

CIRCUIT DESCRIPTION

144MHz LO1

When the VHF band is operating in the main band, the VHF REF VCO (Q441) generates 36.057 to 37.288MHz (K), 36.450 to 36.842MHz (E). (See Table 2, Frequency Configuration.)

The output signal from the DDS (IC406) is input to pin 8 of the PLL IC (IC411) for VHF REF and divided into 1/16 in IC411 to produce comparison frequency fø 2 of 563 to 583kHz (K), 569 to 576kHz (E).

The output signal from the VCO (Q441) goes to pin 6 of IC411 and its frequency is divided into 1/64 in IC411, compared with the signal with comparison frequency fø 2 by a phase comparator, and is locked.

The VHF REF PLL output signal is fed to pin 8 of IC410 as a reference frequency, and divided into 1/30 in IC410 to produce comparison frequency fø 1 of 1202 to 1243kHz (K), 1215 to 1228kHz (E).

The VHF LO1 VCO (Q433) generates 183.895 to 193.895 MHz (K), 185.795 to 187.895MHz (E) in receive mode and 183.795 to 193.795MHz (K), 185.795 to 187.795MHz (E).

The VCO (Q433) output signal goes to pin 6 of IC410, and its frequency is divided into 1/N1 in IC410 and compared with comparison frequency fø 1 by a phase comparator. The frequency is locked and LO1 is generated.

The DDS (IC406) sweeps output frequency (9.014 to 9.321MHz (K), 9.112 to 9.210MHz (E)) in 10Hz steps by equation $f_{DDS\ STEP}$ (Hz) = (10*R1)/(N1*4) and in 1Hz steps by equation $f_{DDS\ STEP}$ (Hz) =(1*R1)/(N1*4), the LO1 covers the frequencies of 183.895 to 193.895 MHz (K), 185.895 to 187.895MHz (E) in receive mode and 183.795 to 193.795MHz (K), 185.795 to 187.795MHz (E) in transmit mode in 10Hz or 1Hz steps.

The PLL output signal is changed by the switching circuit of Q469 (receive) and Q470 (transmit) so that the output amplifier and low-pass filter correspond to VHF band transmission and reception.

In receive mode, the signal is amplified by the broadband amplifier (IC415), and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output to the RF unit (X57-606) as the first local oscillator RXLO1.

In transmit mode, the signal is amplified by the broadband amplifier (IC416), and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output to the RF unit (X57-606) as the first local oscillator TXLO1.

When the VHF is not operating, Q436 is turned OFF with a signal from the serial-parallel IC (IC404) and VHF LO1 VCO (Q433) stops operation.

Display frequency f_{RX} (MHz)		LO1 OUT (MHz)	IC410 : LMX2306TMX		VHF REF (MHz)	IC411 : LMX2306TMX		DDS output (MHz) IC406 : AD9835BRU
Start	Stop		R1	N1		N2	R2	
142.000000 (K)	146.999999 (K)	LO1 = f_{RX} + IF	30	153	VHF REF = $\frac{(f_{RX} + IF)}{N1}$ *R1	64	16	f_{DDS} = $\frac{VHF\ REF}{N2}$ *R2
144.000000 (E)	146.000000 (E)							
147.000000 (K)	151.999999 (K)			156				

IF = RX : 41.895
TX : 41.795

Table 2 Main VHF band frequency configuration

430MHz LO1

When the UHF band is operating in the main band, the UHF REF VCO (Q431) generates 378.105 to 418.105MHz (K), 388.105 to 398.105MHz (E) in receive mode and 378.205 and 418.205MHz (K), 388.205 to 398.205MHz (E). (See Table 3, Frequency Configuration.)

The output signal (8.328 to 8.475MHz (K), 8.344 to 8.469MHz (E)) from the DDS (IC407) passes through a ceramic filter (CF400), is input to pin 8 of the PLL IC (IC412) for UHF and divided into 1/16 in IC412 to produce comparison frequency fø of 520 to 530 kHz.

The output signal from the VCO (Q431) goes to pin 6 of IC412 and its frequency is divided into 1/N in IC412, compared with comparison frequency fø by a phase comparator, and is locked.

The DDS (IC407) sweeps output frequency (8.328 to 8.475MHz (K), 8.344 to 8.469MHz (E)) in 10Hz steps by equation $f_{DDS\ STEP}$ (Hz) = 10*R/N and in 1Hz steps by equation $f_{DDS\ STEP}$ (Hz) = 1*R/N, the LO1 covers the frequencies of 378.105 to 418.105MHz (K), 388.105 to 398.105MHz (E) in receive mode and 378.205 to 418.205MHz (K), 388.205 to 398.205MHz (E) in transmit mode in 10Hz or 1Hz steps.

The PLL output signal is changed by the switching circuit of Q471 (receive) and Q472 (transmit) so that the output amplifier and low-pass filter correspond to UHF band transmission and reception.

In receive mode, the signal is amplified by the broadband amplifier (IC415), and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output to the RF unit (X57-606) as the local oscillator signal RXLO1.

In transmit mode, the signal is amplified by the broadband amplifier (IC416), and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output to the RF unit (X57-606) as the local oscillator signal TXLO1.

When the UHF is not operating, Q434 is turned OFF with a signal from the serial-parallel IC (IC404) and UHF VCO (Q431) stops operation.

CIRCUIT DESCRIPTION

Display frequency f_{RX} (MHz)		LO1 OUT (MHz)	IC412ÅF LMX2306TMX		DDS output (MHz) IC407 : AD9835BRU
Start	Stop		R	N	
420.000000 (K)	425.999999 (K)	LO1	16	726	f_{DDS}
425.000000 (K) 430.000000 (E)	431.499999 (K)	$= f_{RX} - IF$		736	$= \frac{f_{RX} - IF}{N} * R$
431.500000 (K,E)	435.499999 (K,E)			747	
435.500000 (K,E)	439.499999 (K,E)			754	
439.500000 (K,E)	443.499999 (K) 440.000000 (E)			762	
443.500000 (K)	447.999999 (K)			770	
448.000000 (K)	449.999999 (K)			778	

IF = RX : 41.895
TX : 41.795

Table 3 Main UHF band frequency configuration

SUB LO1

When the sub band receiver is operating, the sub VCO (Q406, Q407) generates 322.95 to 465.040MHz. (See Table 4, frequency configuration.)

The 15.6MHz reference signal fstd is input to pin 8 of the PLL IC (IC402) for the sub VCO, divided into 1/R in IC402 to produce comparison frequency fø of 5 and 6.25kHz. The division ratio data comes from the control unit.

The output signal from the VCO (Q406, Q407) goes to pin 6 of IC402, its frequency is divided into 1/N in IC402, compared with comparison frequency fø by a phase comparator, and locked.

The output signal from the VCO (Q406, Q407) passes through a buffer amplifier (Q413, Q414), is amplified by the broad-band amplifier (IC405), and passes through a low-pass filter. The impedance is converted by an attenuator and the signal is output as SLO1.

When the sub band receiver is not operating, Q411 and Q411 are turned OFF with the BSW1 and BSW2 signals and sub VCO (Q406, Q407) stops operation.

Display frequency f_{RX} (MHz)		SLO1 OUT (MHz)	IC404 : BU4094BCFV			IC402 : LMX2316TMX			
						Step : 5,10,15,20,30 (kHz)		Step : 6.25,12.5,25,50,100 (kHz)	
			13pin : Q6 (BSW2)	12pin : Q7 (BSW1)	11pin : Q8 (B LU SW)	R	N Formula	R	N Formula
Start	Stop								
118.00000 (K)	118.94500 (K)	SLO1	L	H	L	3120	$N = \frac{2 \times (f_{RX} + 58.525)}{0.005}$	2496	$N = \frac{2 \times (f_{RX} + 58.525)}{0.00625}$
118.95000 (K)	134.99500 (K)	$= (f_{RX} + 58.525) *2$	H	L					
135.00000 (K)	154.49500 (K)		L	H	H				
144.00000 (E)	146.00000 (E)								
154.50000 (K)	173.99500 (K)		H	L					
220.00000 (K)	235.99500 (K)	SLO1	L	H	L		$N = \frac{2 \times (f_{RX} - 58.525)}{0.005}$		$N = \frac{2 \times (f_{RX} - 58.525)}{0.00625}$
236.00000 (K)	252.49500 (K)	$= (f_{RX} - 58.525) *2$	H	L					
252.50000 (K)	271.54500 (K)		L	H	H				
271.55000 (K)	289.99375 (K)		H	L					
290.00000 (K)	296.42000 (K)	SLO1	L	H	L		$N = \frac{f_{RX} + 58.525}{0.005}$		$N = \frac{f_{RX} + 58.525}{0.00625}$
296.42500 (K)	328.99500 (K)	$= f_{RX} + 58.525$	H	L					
329.00000 (K)	367.52000 (K)		L	H	H				
367.52500 (K)	399.99500 (K)		H	L					
400.00000 (K)	413.47000 (K)	SLO1	L	H	L		$N = \frac{f_{RX} - 58.525}{0.005}$		$N = \frac{f_{RX} - 58.525}{0.00625}$
413.47500 (K)	445.99500 (K)	$= f_{RX} - 58.525$	H	L					
430.00000 (E)	440.00000 (E)								
446.00000 (K)	484.57000 (K)		L	H	H				
484.57500 (K)	511.99500 (K)		H	L					

Table 4 Sub band frequency configuration

CIRCUIT DESCRIPTION

1.2GHz Unit Local Oscillator

The 12LO31 signal (31.2MHz) is quadrupled to 124.8MHz in Q14 and 15. This signal is sent to the mixers of the transmitter section (Q1 and Q2) and the mixers of the receiver section (Q7 and Q8)

In the DDS (C4) , 8.323~8.488MHz are output using 12LO31 as the reference signal. This signal passes through a filter (CF1 and CF2) and is input to the mixers for reference PLL signals (Q313 and 314).

In Q313 and Q314, the DDS output is mixed with 12LO31 (31.2MHz) and an approximately 39.6MHz signal is obtained. This signal passes through a filter and an amplifier (Q312) and becomes the reference signal of the PLL IC (IC5).

The VCO (Q301) oscillates at 552.253~582.303MHz. This signal is amplified in Q302 and goes to the PLL IC (IC5) and Q19.

The PLL IC (IC5) divides the reference signal (approximately 39.6MHz) to 1/72. The signal from Q302 is divided to 1/N (N=1006~1058).

The two signals are compared in the phase comparator within the IC and the VCO (Q301) oscillation frequency is locked.

The signal input into Q19 is doubled. This signal passes through a filter and an amplifier (Q20) and goes to the sending mixer (D1) and the receiving mixer (Q10).

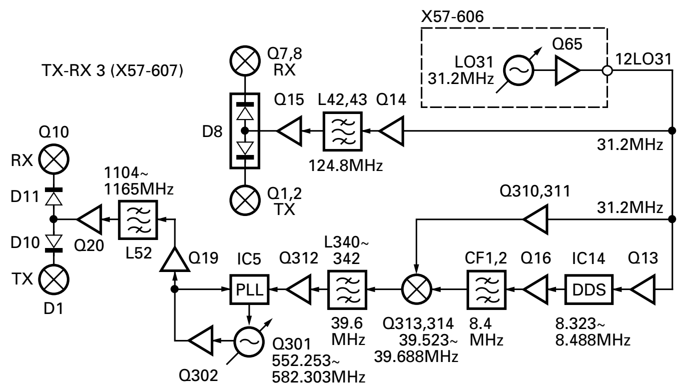

Fig. 2 1.2GHz unit local oscillator

Display frequency fRF (MHz)		Q301 oscillation frequency	C5 : LMX2316TMX		DDS output (MHz) IC4 : AD9851BRS
Start	Stop	fVCO (MHz)	R	N	
1240.000000 (K)	1243.999999 (K)	fVCO	72	1006	fDDS
1244.000000 (K)	1245.999999 (K)	$= (f_{RF} - IF)/2$		1008	$= \frac{(f_{RF} - IF)*R}{2*N} - 31.2$
1246.000000 (K)	1249.999999 (K)			1011	
1250.000000 (K)	1253.999999 (K)			1015	
1254.000000 (K)	1255.999999 (K)			1017	
1256.000000 (K)	1258.999999 (K)			1020	
1259.000000 (K) 1260.000000 (E)	1262.999999			1023	
1263.000000	1266.999999			1027	
1267.000000	1270.999999			1030	
1271.000000	1274.999999			1034	
1275.000000	1277.999999			1037	
1278.000000	1280.999999			1040	
1281.000000	1284.999999			1043	
1285.000000	1288.999999			1047	
1289.000000	1292.499999			1050	
1292.500000	1294.999999			1053	
1295.000000	1297.999999			1056	
1298.000000	1299.999999			1058	

IF=RX : 135.495
TX : 135.395

Table 5 1.2GHz band frequency configuration

Local Signals

The RXLO3 (11.15MHz) and RCAR (467kHz) for reception and TCAR (10.583MHz) for transmission are output from DDSs (RXL03 : IC603, RCAR : IC601, TCAR : IC602).

The frequencies of local oscillator output signals (LO1, LO2, RCAR, TCAR) for each band are shifted by offset (IF filter setting), RIT, XIT, IF SHIFT as listed in Tables 5 to 11.

CIRCUIT DESCRIPTION

HF TX/RX LO1	DDS IC408 : AD9835BRU							
	LSB		USB		CW		CW-R	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–1.5k	–1.5k	+1.5k	+1.5k	+0.7k	+0.7k	–0.7k	–0.7k
RIT	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(SSB H)	–	–(SSB H)	–	–(CW H)	–	+(CW H)	–
10.695MHz Filter Adj.	+(D 10.695)	–	–(D 10.695)	–	–	–	–	–
HF TX/RX LO1	FSK		FSK-R		AM		FM	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–(1.5k–Fcenter)	0	+(1.5k–Fcenter)	0	0	0	0	0
RIT	+(D XIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(FSK H)	–	–(FSK H)	–	–	–	–	–
10.695MHz Filter Adj.	–	–	–	–	–	–	–	–

Table 6 HF band LO1 frequency shift data

144MHz TX/RX LO1	DDS IC406 : AD9835BRU							
	LSB		USB		CW		CW-R	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–1.5k	–1.5k	+1.5k	+1.5k	+0.7k	+0.7k	–0.7k	–0.7k
RIT	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(SSB H)	–	–(SSB H)	–	–(CW H)	–	+(CW H)	–
10.695MHz Filter Adj.	+(D 10.695)	–	–(D 10.695)	–	–	–	–	–
144MHz TX/RX LO1	FSK		FSK-R		AM		FM	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–(1.5k–Fcenter)	0	+(1.5k–Fcenter)	0	0	0	0	0
RIT	+(D XIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(FSK H)	–	–(FSK H)	–	–	–	–	–
10.695MHz Filter Adj.	–	–	–	–	–	–	–	–

Table 7 144MHz band LO1 frequency shift data

430MHz TX/RX LO1	DDS IC407 : AD9835BRU							
	LSB		USB		CW		CW-R	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–1.5k	–1.5k	+1.5k	+1.5k	+0.7k	+0.7k	–0.7k	–0.7k
RIT	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(SSB H)	–	–(SSB H)	–	–(CW H)	–	+(CW H)	–
10.695MHz Filter Adj.	+(D 10.695)	–	–(D 10.695)	–	–	–	–	–
430MHz TX/RX LO1	FSK		FSK-R		AM		FM	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–(1.5k–Fcenter)	0	+(1.5k–Fcenter)	0	0	0	0	0
RIT	+(D XIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(FSK H)	–	–(FSK H)	–	–	–	–	–
10.695MHz Filter Adj.	–	–	–	–	–	–	–	–

Table 8 430MHz band LO1 frequency shift data

1.2GHz TX/RX LO1	DDS IC4 : AD9851BRS							
	LSB		USB		CW		CW-R	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–1.5k	–1.5k	+1.5k	+1.5k	+0.7k	+0.7k	–0.7k	–0.7k
RIT	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(SSB H)	–	–(SSB H)	–	–(CW H)	–	+(CW H)	–
10.695MHz Filter Adj.	+(D 10.695)	–	–(D 10.695)	–	–	–	–	–
1.2GHz TX/RX LO1	FSK		FSK-R		AM		FM	
	RX	TX	RX	TX	RX	TX	RX	TX
Filter offset	–(1.5k–Fcenter)	0	+(1.5k–Fcenter)	0	0	0	0	0
RIT	+(D XIT)	–	+(D RIT)	–	+(D RIT)	–	+(D RIT)	–
XIT	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)	–	+(D XIT)
SLOPE H	+(FSK H)	–	–(FSK H)	–	–	–	–	–
10.695MHz Filter Adj.	–	–	–	–	–	–	–	–

Table 9 1.2GHz band LO1 frequency shift data

RX LO3		DDS IC603 : AD9835BRU							
		LSB	USB	CW	CW-R	FSK	FSK-R	AM	FM
BASE		11.150 (MHz)							
HF	SLOPE H	+(SSB H)	–(SSB H)	–(CW H)	+(CW H)	+(FSK H)	–(FSK H)	–	–
	SLOPE L	+(SSB L)	–(SSB L)	–(CW L)	+(CW L)	+(FSK L)	–(FSK L)	–	–
	10.695MHz Filter Adj.	+(D 10.695)	–(D 10.695)	–	–	–	–	–	–
	455kHz Filter Adj.	+(D 455)	–(D 455)	–	–	–	–	–	–
144 MHz	SLOPE H	+(SSB H)	–(SSB H)	–(CW H)	+(CW H)	+(FSK H)	–(FSK H)	–	–
	SLOPE L	+(SSB L)	–(SSB L)	–(CW L)	+(CW L)	+(FSK L)	–(FSK L)	–	–
	10.695MHz Filter Adj.	+(D 10.695)	–(D 10.695)	–	–	–	–	–	–
	455kHz Filter Adj.	+(D 455)	–(D 455)	–	–	–	–	–	–
430 MHz	SLOPE H	–(SSB H)	+(SSB H)	+(CW H)	–(CW H)	–(FSK H)	+(FSK H)	–	–
	SLOPE L	–(SSB L)	+(SSB L)	+(CW L)	–(CW L)	–(FSK L)	+(FSK L)	–	–
	10.695MHz Filter Adj.	–(D 10.695)	+(D 10.695)	–	–	–	–	–	–
	455kHz Filter Adj.	–(D 455)	+(D 455)	–	–	–	–	–	–
1.2 GHz	SLOPE H	–(SSB H)	+(SSB H)	+(CW H)	–(CW H)	–(FSK H)	+(FSK H)	–	–
	SLOPE L	–(SSB L)	+(SSB L)	+(CW L)	–(CW L)	–(FSK L)	+(FSK L)	–	–
	10.695MHz Filter Adj.	–(D 10.695)	+(D 10.695)	–	–	–	–	–	–
	455kHz Filter Adj.	–(D 455)	+(D 455)	–	–	–	–	–	–

Table 10 RX LO3 frequency shift data

CIRCUIT DESCRIPTION

RCAR		DDS IC601 : AD9835BRU							
		LSB	USB	CW	CW-R	FSK	FSK-R	AM	FM
BASE		467 (kHz)							
HF	Filter offset	+1.5k	–1.5k	–0.7k	+0.7k	+(1.5k–Fcenter)	–(1.5k–Fcenter)	0	0
	CW pitch	–	–	–(PITCH)	+(PITCH)	–	–	–	–
	FSK tone H	–	–	–	–	+2.125k	–2.125k–FSK SHIFT	–	–
	FSK tone L	–	–	–	–	+1.275k	–1.275k–FSK SHIFT	–	–
	SLOPE L	+(SSB L)	–(SSB L)	–(CW L)	+(CW L)	+(FSK L)	–(FSK L)	–	–
	455kHz Filter Adj.	+(D 455)	–(D 455)	–	–	–	–	–	–
144 MHz	Filter offset	+1.5k	–1.5k	–0.7k	+0.7k	+(1.5k–Fcenter)	–(1.5k–Fcenter)	0	0
	CW pitch	–	–	–(PITCH)	+(PITCH)	–	–	–	–
	FSK tone H	–	–	–	–	+2.125k	–2.125k–FSK SHIFT	–	–
	FSK tone L	–	–	–	–	+1.275k	–1.275k–FSK SHIFT	–	–
	SLOPE L	+(SSB L)	–(SSB L)	–(CW L)	+(CW L)	+(FSK L)	–(FSK L)	–	–
	455kHz Filter Adj.	+(D 455)	–(D 455)	–	–	–	–	–	–
430 MHz	Filter offset	–1.5k	+1.5k	+0.7k	–0.7k	–(1.5k–Fcenter)	+(1.5k–Fcenter)	0	0
	CW pitch	–	–	+(PITCH)	–(PITCH)	–	–	–	–
	FSK tone H	–	–	–	–	–2.125k	+2.125k+FSK SHIFT	–	–
	FSK tone L	–	–	–	–	–1.275k	+1.275k+FSK SHIFT	–	–
	SLOPE L	–(SSB L)	+(SSB L)	+(CW L)	–(CW L)	–(FSK L)	+(FSK L)	–	–
	455kHz Filter Adj.	–(D 455)	+(D 455)	–	–	–	–	–	–
1.2 GHz	Filter offset	–1.5k	+1.5k	+0.7k	–0.7k	–(1.5k–Fcenter)	+(1.5k–Fcenter)	0	0
	CW pitch	–	–	+(PITCH)	–(PITCH)	–	–	–	–
	FSK tone H	–	–	–	–	–2.125k	+2.125k+FSK SHIFT	–	–
	FSK tone L	–	–	–	–	–1.275k	+1.275k+FSK SHIFT	–	–
	SLOPE L	–(SSB L)	+(SSB L)	+(CW L)	–(CW L)	–(FSK L)	+(FSK L)	–	–
	455kHz Filter Adj.	–(D 455)	+(D 455)	–	–	–	–	–	–

Table 11 RCAR frequency shift data

TCAR		DDS IC602 : AD9835BRU							
		LSB	USB	CW	CW-R	FSK	FSK-R	AM	FM
BASE		10.583 (MHz)							
HF	Filter offset	–1.5k	+1.5k	+0.7k	–0.7k	0	0	0	0
144MHz	Filter offset	–1.5k	+1.5k	+0.7k	–0.7k	0	0	0	0
430MHz	Filter offset	+1.5k	–1.5k	–0.7k	+0.7k	0	0	0	0
1.2GHz	Filter offset	+1.5k	–1.5k	–0.7k	+0.7k	0	0	0	0

Table 12 TCAR frequency shift data

Description of variables in Tables 6 to 12

(D RIT)	RIT frequency variable amount (–9.99~+9.99kHz)
(D XIT)	XIT frequency variable amount (–9.99~+9.99kHz)
(SSB H)	SSB slope high cut frequency variable amount = 2.8k – Fhi
(SSB L)	SSB slope low cut frequency variable amount = Flow – 300
(CW H)	CW slope high cut frequency variable amount = 2.7k – (FSK SHIFT + Fwidth / 2)
(CW L)	CW slope low cut frequency variable amount = FSK SHIFT – Fwidth / 2 – 100
(FSK H)	FSK slope high cut frequency variable amount = 2.8k – (Fcenter + Fwidth / 2)
(FSK L)	FSK slope low cut frequency variable amount = Fcenter – Fwidth / 2
(D 10.695)	RX 10.695MHz filter adjustment frequency variable amount
(D 455)	RX 455kHz filter adjustment frequency variable amount
(PITCH)	CW pitch frequency (400~1000Hz, Initial value 800Hz)
(FSK SHIFT)	FSK shift width frequency (170Hz, 200Hz, 425Hz, 850Hz, Initial value 170Hz)
(Fcenter)	FSK RX center frequency = (2125Hz or 1275Hz) + (FSK SHIFT / 2)

CIRCUIT DESCRIPTION

HF Receiver System and Main IF System

Three antenna terminals used for the HF and 50MHz band reception are ANT1, ANT2 and HF RX ANT.

After the incoming signal from ANT1 and ANT2 passes through the transmission/reception changeover relay in the filter unit (X51-315), and is sent to the HFRX terminal of the TX-RX unit (X57-605). There is an HF RX ANT terminal there, and one of the antennas can be selected from the menu for reception .

The HF RX ANT terminal is used to connect a dedicated HF-band low-band receiving antenna, such as a Beverage antenna, and operates at frequencies up to 30MHz. (If an antenna, such as a solid wire antenna, is connected to this terminal, unwanted radio signals in the shack may be picked up. It is recommended that a 50 (coaxial cable be used for routing in the shack.)

The signal passes through an RF ATT, an image filter and a limiter for surge absorption and enters the RF BPF for both transmission and reception. The division of the RF BPF is in the range shown in the block diagram. For 6.9~7.5MHz, 13.9~14.5MHz and 49~54MHz, a dedicated BPF (adjustable type) is used and particularly effective for eliminating unwanted signals in the low band. Other BPFs (non-adjustable type) are designed as circuits with independent armature bands, except that the 24MHz and 28MHz bands are shared. Signals pass through these BPFs at the time of transmission, so they are useful for producing radio signals with little radiation.

Although the conventional RF ATT had an attenuation level of 20dB, the attenuation level of the current RF ATT is 12dB. It can, however, be changed to approximately 20dB by removing the jumper (CN2) near the ATT within the unit.

The pre-amplifier (Q12, Q705) have been changed to a power MOS FET from the combination of the conventional cascade amplifier and MOS FET amplifier. This element is a FET that is used in a younger stage for transmission and has excellent large input characteristics. The actual circuit contains two amplifiers using this FET. Large input characteristics with a low gain are given priority on the low band (Q12) with respect to 21.5MHz, and sensitivity is given priority on the high band (Q705). circuit on the low band side bordering 21.5 MHz favoring a gain with moderately large input characteristics and that on the hybrid side (Q705) favoring . When the pre-amplifier is off, the signal from the RF BPF enters the receiving first mixer (Q7~Q10) in the next stage as it is.

The receiving first mixer circuit uses a double balance type mixer with four joint type FETs. The signal is converted to the first IF frequency by the first local oscillator signal. The TS-2000S has adopted a method that changes the first IF frequency according to the receive frequency. For this reason, it has two sets of roofing filters (MCF) that determine the selectivity of the first IF. Table 1 shows the relationship between the receive frequency and the first IF frequency. The central frequencies for the reception and transmission of the first IF frequency are different from each other by 100kHz because the transmission and reception is performed simultaneously during satellite communication.

RX/TX frequency (MHz)	RX 1st IF (MHz)	TX 1st IF (MHz)
0.03~ 9.0	75.925	75.825
9.0 ~17.0	69.085	68.985
17.0 ~24.0	75.925	75.825
24.0 ~26.0	69.085	68.985
26.0 ~30.0	75.925	75.825
30.0 ~37.0	69.085	68.985
37.0 ~49.0	75.925	75.825
49.0 ~60.0	69.085	68.985

Table 13 RX frequency and 1st IF frequency

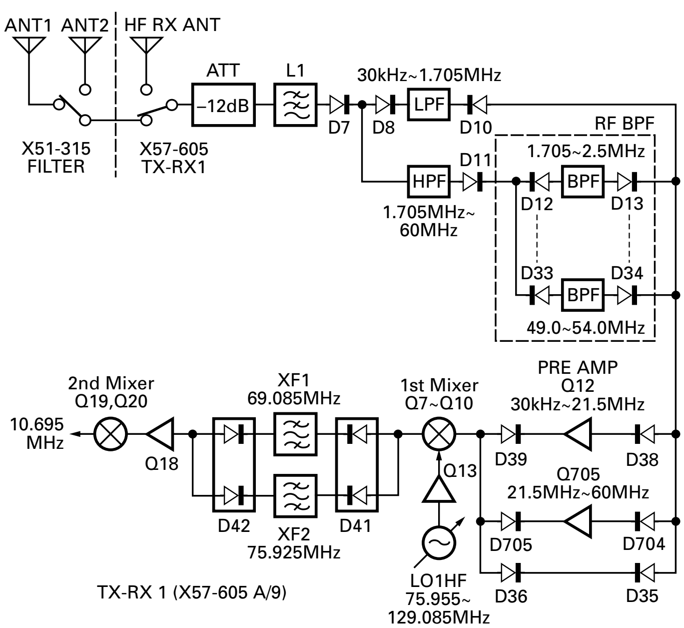

Fig. 3

CIRCUIT DESCRIPTION

The signal is then amplified by the first IF amplifier (Q18) and is converted to the second IF frequency of 10.695MHz in the second receive mixers (Q19, 20). The tuning frequency of each stage, the second local oscillator frequency and others are changed according to the receive frequency to respond to the changeover of the previously stated first IF frequency.

A circuit for changing over the IF signal from the units of the VHF, UHF and 1.2GHz bands and IF signal from the HF band is provided on the output side of the second receive mixer. That is, the circuits following this stage are commonly used circuits, regardless of the receive frequency on the main side.

In addition, there is a semi-fixed volume (VR4) on the output side of the first receive mixer. The volume is used to eliminate the gain differential generated due to the changeover of the first IF frequency.

The signal for the noise blanker is extracted from this point by passing through Q22. The noise blanker circuit is based on the same principle of operation as the conventional one, but can change the threshold level by changing the emitter potential of the noise detection stage (Q29).

The 10.695MHz signal is amplified by Q26 which also serves as a noise blanker gate circuit and passes through a 10.695MHz IF filter. It has three bandwidths, 2.7kHz, 6kHz and through, and when it is combined with the 455kHz filter group, the same continuous band change function (analog IF throughput: operation in modes other than FM) as in conventional analog devices is implemented. The band in this analog stage does not affect the operation of the digital IF filter in the IF DSP and is automatically set to the optimum band for removing unwanted signals outside the band.

Then, the signal is converted to the third IF frequency of 455kHz in the third receive mixer (Q700, 701). The 455kHz filter has three bandwidths: 2.7kHz, 9kHz and 15kHz. In FM mode (main band side) the 15kHz filter is selected for WIDE and the 9kHz filter is selected for NARROW, and signals passing through the filter are sent to the FM IC (ICI), amplified and detected. IC1 processes squelch, S meter, etc.

As a characteristic operation in this stage, a tuning error detection voltage for the ALT function operating in the 1.2GHz band FM mode is generated. It utilizes the DC voltage that is overlapped with the ICI detection output.

In a mode other than FM, the receive signal is amplified by the next third IF amplifier (Q38) and operational amplifier (IC18) and converted to the final 12kHz IF frequency by the fourth receive mixer (IC3). The converted IF signal in FM (audio signal) and non-FM mode (IF signal) is selected by the multiplexer (IC7) and the signal is sent to the DSP of the control unit for processing. The signals processed in the control unit become audio signals in all modes and return to the TX-RX1 unit (X57-605). These audio signals are power amplified to the level that drives the speaker with the AM amplifier (IC9).

A speaker separation function is available as an accessory circuit. The bands can be changed as shown in Table 14.

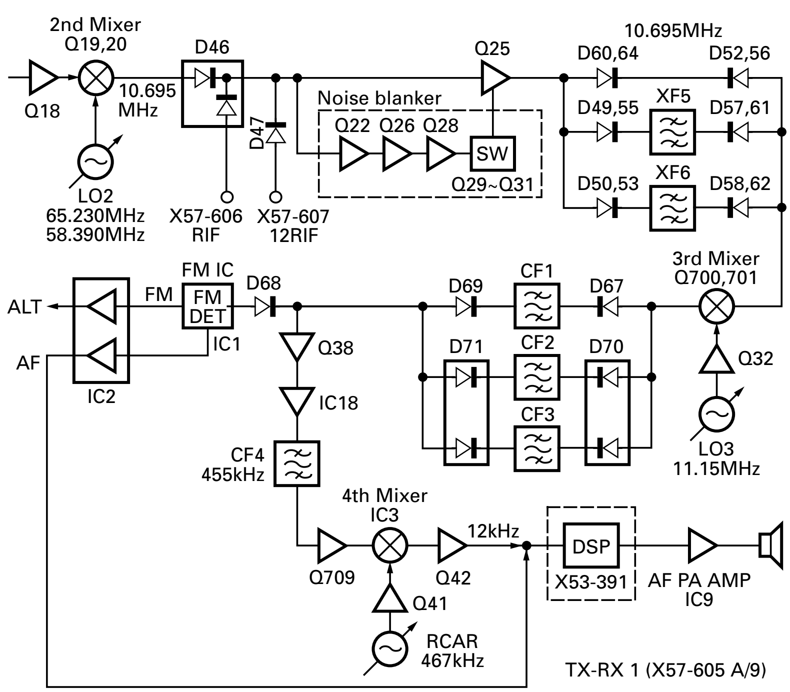

Fig. 4

CIRCUIT DESCRIPTION

■ Speaker output changeover

When external speakers 1 and 2 and headphones are connected, you can change over the sub/main band outputs.

The headphone connection is preferred over the all the speaker output and you can select from three patterns for headphone left-right changeover.

When SP1 only has been connected, the built-in speaker will change over to SP1.

When SP1 and SP2 are connected, you can select the SP1 and SP2 output method from three patterns, the same as for the headphones.

Connection Conditions (● : connected)				Output condition by connection of left table			
Headphone	SP1	SP2		Headphone	Built-in speaker	SP1	SP2
●	X	X	→	Pattern 0~2	Stop	X	X
●	●	X	→	Pattern 0~2	Stop	Stop	X
●	●	●	→	Pattern 0~2	Stop	Stop	Stop
●	X	●	→	Pattern 0~2	Stop	X	Stop
X	●	●	→	X	Stop	Pattern 0~2 (Left)	Pattern 0~2 (Right)
X	X	●	→	X	Pattern 0~2 (Left)	X	Pattern 0~2 (Right)
X	●	X	→	X	Stop	Main-sub full mix	X
X	X	X	→	X	Main-sub full mix	X	X

Left-right output patterns

	In case of headphones		In case of SP1 & SP2	
Selected Pattern	Left side	Right side	SP1 or Built-in	SP2
Pattern 0	Main-sub full mox	Main-sub full mix	Main-sub full mix	Main-sub full mix
Pattern 1	Main : Full sound Sub : 1/4 sound	Main : 1/4 sound Sub : Full sound	main : Full sound Sub : 1/4 sound	Main : 1/4 sound Sub : Full sound
Pattern 2	Main	Sub	main	Sub

This is a reverse function and left-right changeover is possible.

Table 14

Main VHF/UHF Band Front-End and Sub Receiver System

The VHF and UHF band receiver circuit is configured with two systems, a main band (FM/ AM/ SSB/ CW/ FSK) and a sub-band (FM/AM), each of which has a VHF and a UHF band path.

In the main band, the first IF is 41.895MHz and the second IF is 10.695MHz and the signal lower hetero to the second IF is sent to the TX-RX1 unit (X57-605) and linked to the second IF, which is shared by the other bands. The sub-band is a double conversion where the first IF is 58.525MHz and the second IF is 455kHz. It is configured so that detected AF signals are sent to the control unit (X53-391).

■ VHF/ UHF band front end

The circuit operation of the sub-receiver unit differs depending on whether it is for K destination or others. The circuit operation for each of the destinations is described below.

- **K destination**

The incoming signal from the VHF band antenna terminal passes through the TX/RX changeover relay (K2) in the filter unit (X51-315) and goes to the TX-RX2 unit (X57-606). Then, it passes through the 12dB ATT circuit and is divided to the 136~155MHz path and the 118~136MHz, 155~174MHz and 220~300MHz path by the L distribution circuit. The 136~155MHz signal passes through a 2-pole BPF (band-pass filter) and enters the pre-amplifier (Q15). The amplified receive signal is again distributed to the paths for the main and sub receiver units by the L distribution circuit.

The signal distributed to the main receiver unit passes through the 2-pole variable tuning BPF, is amplified by the second amplifier (Q24) and goes to the mixer (IC4) for the main band common to the VHF and UHF bands through the variable tuning BPF. The 2-pole x 2-stage BPF for the main band VHF controls the tuning frequency by output from the D/A of the TX-RX1 unit (X57-605).

CIRCUIT DESCRIPTION

The 118~174MHz signal distributed to the sub-receiver unit passes through a variable tuning filter and is amplified by the second amplifier (Q24). Then, it passes through the 2-pole variable tuning BPF, and the 220~300 MHz signal is amplified by Q23 and is then input into the mixer (IC5) for the sub-band common to the VHF and UHF bands. The 1-pole and 2-pole BPFs for the sub-band VHF also controls the tuning frequency by the output from the D/A of the TX-RX1 unit (X57-605).

The incoming signal from the UHF band antenna terminal enters the UHF section of the final unit (X45-360), passes through the HPF and LPF and goes to the TX-RX2 unit (X57-605). Then, it passes through the 12dB ATT circuit and goes to the pre-amplifier (Q14). The amplified receive signal is distributed to the paths of the main and sub-receiver sections by the L distribution circuit.

The signal distributed to the main receiver section passes through the 3-pole variable tuning BPF and is amplified by the second amplifier (Q21). Then, it passes through the 3-pole variable tuning BPF and is input into the mixer (IC4) for the main band.

This 3-pole x 2 stage BPF for the UHF also controls the tuning frequency by the output from the D/A of the TX-RX1 unit (X57-605).

The 438~450MHz signal distributed to the sub-receiver section passes through the SAW filter (L29), is amplified by the second amplifier (Q25), and passes through another SAW filter (L50). The 300~438MHz and 450~512MHz signals are amplified by Q19 and goes to the mixer (IC5) for the sub-band.

- **E, E2 destinations**

Then, the signal passes through the 12dB ATT circuit and the 2-pole BPF (band-pass filter) and enters the pre-amplifier (Q15). The amplified receive signal is distributed to the paths of the main and sub receiver sections by the L distribution circuit.

The signal distributed to the sub-receiver section passes through a variable tuning filter and is amplified by the second amplifier (Q22). Then, it passes through the 2-pole tuning BPF, and goes to the mixer (IC5) for the sub-band common to the VHF and UHF bands. The 1-pole + 2-pole BPFs for the sub-band VHF also control the tuning frequency by the output from the D/A of the TX-RX1 unit (X57-605).

The signal distributed to the sub-receiver section passes through the SAW filter (L29), is amplified in the second amplifier (Q25), passes through another SAW filter (L50) and goes to the mixer (IC5) for the sub-band.

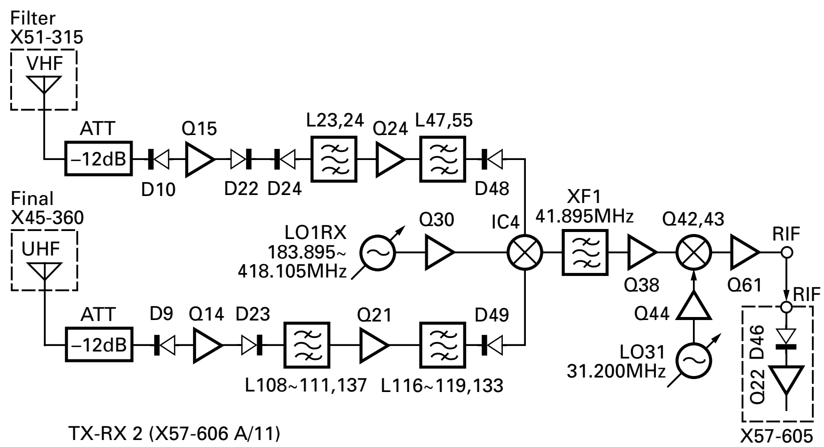

Fig. 5 Main band receiver section

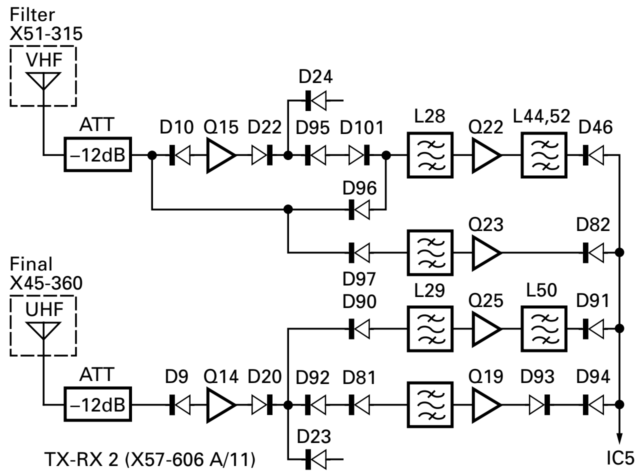

Fig. 6 Sub band receiver section

CIRCUIT DESCRIPTION

■ Main receiver IF section

The signal input to IC4 is mixed with the signal produced by amplifying the first local oscillator RXLO1 from the PLL section by Q30 and lower hetero to the first IF of 41.895MHz. Then, it passes through the MCF (XF1) and AGC amplifier (Q38) and goes to the second mixer (Q42 and 43). The signal input to the second mixer is mixed with the signal produced by amplifying the second local oscillator 21.2MHz from the PLL section by Q44 and lower hetero to the second IF of 19.695MHz. The signal then passes through a temperature compensating resistor and the IF amplifier (Q61) and is sent to the TX-RX1 unit (X57-605).

■ Sub receiver IF section

The signal input to IC5 is lower hetero to the first IF of 58.525MHz. In the VHF band, the local oscillator SLO1 from the PLL section is divided into two by the divider (IC6) and passes through amplifier (Q23). In the UHF band, the IF signal passes through amplifier (Q33) and is input to IC5. The IF signal passes through the MCF (XF2), passes through the post amplifier (AGC amplifier in the AM mode) Q37 and goes to the FM IC (IC7). The local oscillator is supplied to IC7 by the 58.07MHz crystal oscillator (X1) and is lower hetero to the second IF of 455kHz by a mixer in the IC.

The circuit operation when the signal passes through a ceramic filter after lower hetero is different for K destination and E destination. The circuit operation for each of the destinations is explained below.

• K destination

In FM mode, the signal passes through a ceramic filter (CF1), is quadrature-detected, and the resulting signal is output.

• E, E2 destinations

The signal passes through a ceramic filter (CF1) in FM WIDE mode and it passes through a ceramic filter (CF2) in FM NARROW mode. The signal is then quadrature-detected and the resulting signal is output.

In AM mode, a 455kHz signal passes through the AGC amplifier (Q51) and amplifier (Q48 and Q45) and is detected by D58. The detection signal retrieved for the AGC is rectified, passes through the DC amplifier (Q39) for AGC control and goes to the Q37 gate terminal (G2).

The FM/AM detection signal is switched by the multiplexer (IC8). Then, it is amplified by the operational amplifier (IC9) and output to the control unit (X53-391).

■ Squelch voltage and S-meter voltage of the sub receiver section

The S meter voltage is introduced to the A/D through a LPF for RSSI output of the FM IC (IC7).

The squelch voltage is supplied to the A/D by passing the detection output of the FM IC through a filter amplifier in the FM IC, amplifying it with the noise amplifier (Q63), and rectifying it with D83.

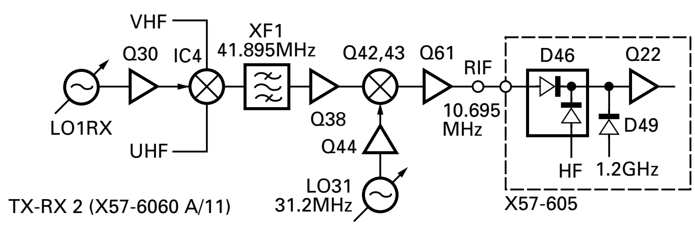

Fig. 7

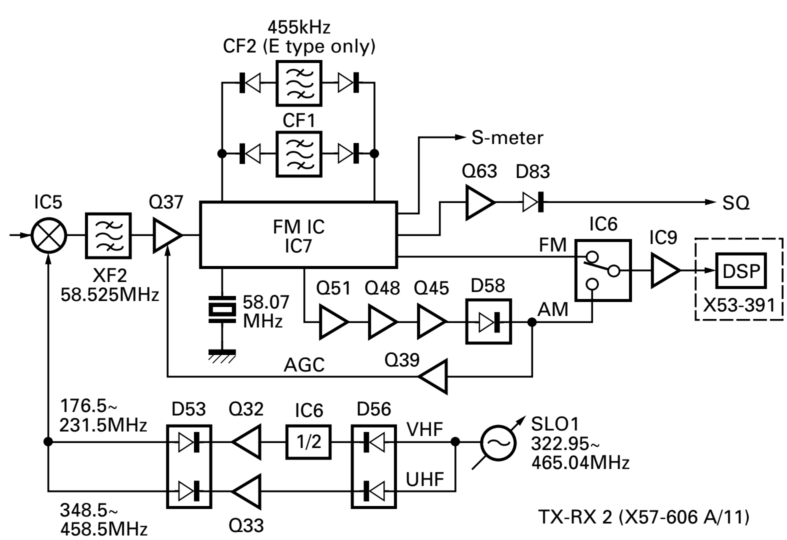

Fig. 8

CIRCUIT DESCRIPTION

Ref No.	XF1	XF2	XF3	CF1	CF2
Parts No.	L71-0566-05	L71-0565-05	L71-0582-05	L72-0984-05	L72-0986-05
Nominal center frequency	41.895MHz	58.525MHz	41.795MHz	455kHz	455kHz
Pass bandwidth	3dB : ±7.5kHz	3dB : ±7.5kHz	3dB : ±15kHz	6dB : ±7.5kHz or more 50dB : ±15kHz or less	6dB : ±4.5kHz or more 50dB : ±10kHz or less
Ripple	1.0dB or less	1.0dB or less	1.0dB or less	2.0dB or less	2.0dB or less
Insertion loss	3.0dB or less	3.5dB or less	1.5dB or less	6.0dB or less	6.0dB or less
Guaranteed attenuation	Fo+(500~1000)kHz Fo–(200~1000)kHz 70dB or more	Fo±1MHz 80dB or more	Fo–(500~1000)kHz 50dB or more	Fo±100kHz 35dB or more	Fo±100kHz 35dB or more
Cener	–	–	–	455kHz±1.0kHz	455kHz±1.0kHz
Terminating impedance	960Ω//1.0pF CC=7.0pF	350Ω//4.0pF CC=15.5pF	960Ω//1.0pF	1.5kΩ	2.0kΩ
Spurious	Fo±1.0MHz 40dB or more	Fo±1.0MHz 40dB or more	–	–	–

CF2 : Only E destination

Table 15 Filters rating (TX-RX 2 unit : X57-606)

1.2GHz Unit Receiver Section

The incoming signal from the antenna (12ANT) passes through a filter, is amplified in the receiver RF amplifier (Q11 and 12) and input to the first mixer (Q10).

The signal is converted to the first IF (135.495MHz) in Q10, passes through the MCF (XF1) and the AGC amplifier (Q9) and enters the second mixer (Q7 and Q8).

The signal is converted to the second IF (10.695MHz) in Q7 and Q8, amplified in the receiver IF amplifier (Q303) and sent to the TX-RX1 unit (X57-605).

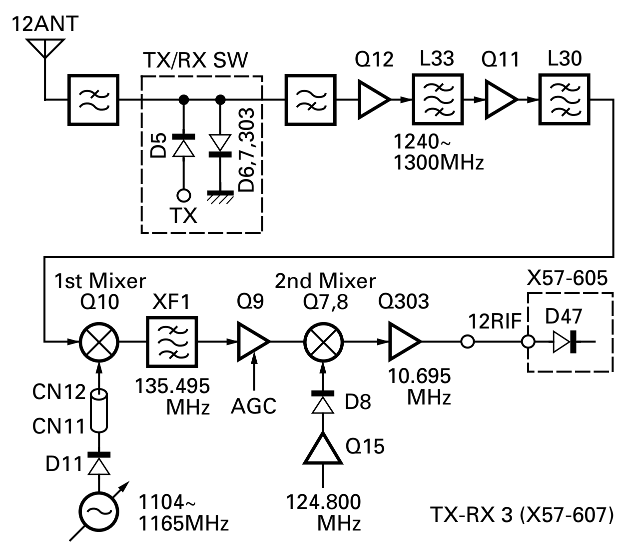

Fig. 9

CIRCUIT DESCRIPTION

Transmit System IF Section

■ Transmission IF

The details of the processing by the DSP depend on the mode.

• Modes other than FM

Transmission bandwidth change, speech processor and microphone gain control are performed in the AF stage. A 12kHz IF signal is produced after PSN modulation and output modulation control.

• FM mode

The baseband processing in the AF stage is carried out by the DSP and a VCXO (voltage controlled X'tal Oscillator) is used as a modulator.

The transmit signal output from the control unit (X53-391) is switched by an analog SW (IC8) and is input to the balanced mixer (IC6). The 12kHz IF signal and local oscillator signal enters the IC6 and become a 10.595MHz signal. The local oscillator signal is generated by the DDS (IC602).

The 10.595MHz IF component is amplified by the IF amplifier (Q54) and passes through the 6kHz bandwidth crystal filter, then becomes a 10.595MHz IF signal by eliminating local oscillator signals. The diode switch (D90) changes between FM modulator output and non-FM 10.595MHz IF signals.

The temperature compensation of the transmitter circuit is done by the thermistor near the IF amplifier (Q54) and the thermistor on the input side of the IF amplifier (Q711). They reduce the gain at low temperatures and raise it at high temperatures.

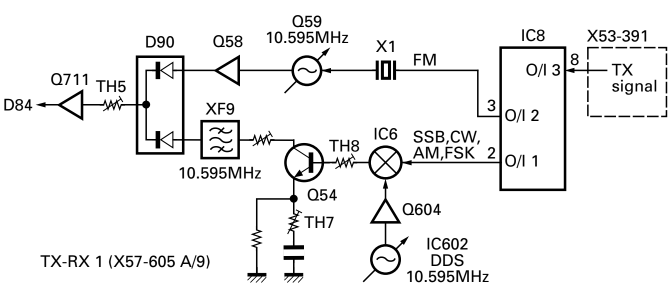

Fig. 10

The output signal from the IF amplifier (Q711) passes through D84, Q40, D82, D48, D80 and D81 and becomes the IF transmit signal for each band. D84 is a voltage controlled attenuator circuit. This circuit changes the attenuation level according to the control voltage (TGC), in the same way as the TGC (TX gain control) used in the TS-870 and TS-570 and is set to the adjusted attenuation level for each band. Q49 is an IF amplifier circuit with an ALC circuit. The gain is controlled by the voltage generated by the ALC circuit.

D82 is a voltage controlled attenuator circuit as D84. The attenuation level is minimum at full power and as the power decreases, the control voltage rises and the attenuation level increases. When the power is reduced, the gain will become relatively excessive if the IF gain is not lowered. It is set to an attenuation level adjusted by the PGC (Power Gain Control) accordance to the power of each band.

Q48 is an IF output buffer. It changes to the transmitter section of each band with a diode switch (D80, D81) to supply a 10.595MHz IF signal.

During transmission in the 144MHz and 420MHz bands, the signal is output to the TX-RX2 unit (X57-605), and during transmission in the 1.2GHz band, it is output to the TX-RX3 unit (X57-605).

In the 1.8~54MHz band, the frequency is converted to the final target transmit frequency in the TX-RX1 unit (X57-605).

The local oscillator frequency changes according to the band in second transmit mixer of Q46 and 47 to generate different IF frequencies. (TX third IF: 68.985MHz or 75.825 MHz)

D703 and D715 are used to change the tuning frequency of the local oscillator signal and D79, D78, D77 and D76 are used change the frequency of the IF filter (L102).

The variable tuning filter containing these variable capacitance diodes performs the coarse adjustment of the coil (L100, L99, L98, L96, L102) in the band (18.085MHz) where the IF is 75.825MHz. Then, it changes the tuning frequency control voltage from the D/A in the band (14.100MHz) where the IF is 68.985MHz and tunes it to the necessary frequency by readjusting the coil.

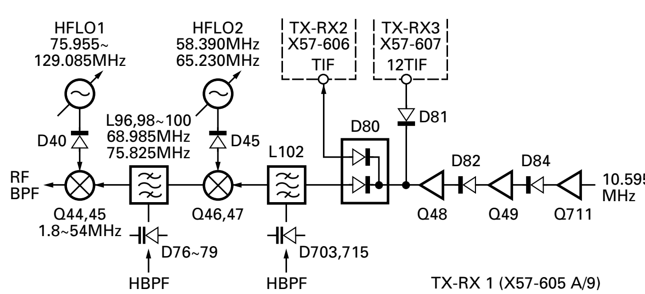

Fig. 11

CIRCUIT DESCRIPTION

The third IF signal is input to the third transmit mixer (Q44, 45).

A GaAs FET is used to obtain the satisfactory intermodulation characteristics. VR3 adjusts the second gate voltage to maximize the gain. VR2 adjusts the balance of the source current of two FETs and prevents the generation of spurious components by minimizing IF output leakage. It also adjusts the leakage of the IF signal (68.985MHz) to the minimum during 50MHz band transmission.

The signal with the target frequency passes through the BPF shared by the receiver section to eliminate spurious components. The transmitter circuit is separated from the receiver circuit to implement satellite communication, but only this BPF is shared to prevent generation of spurious components.

Finally, the signal is amplified to a sufficient level (approximately 0dBm) by the broadband amplifier and supplied to the final section. Q43 is a power MOS FET and provides an output of approximately 20dBm when the ALC is inactive.

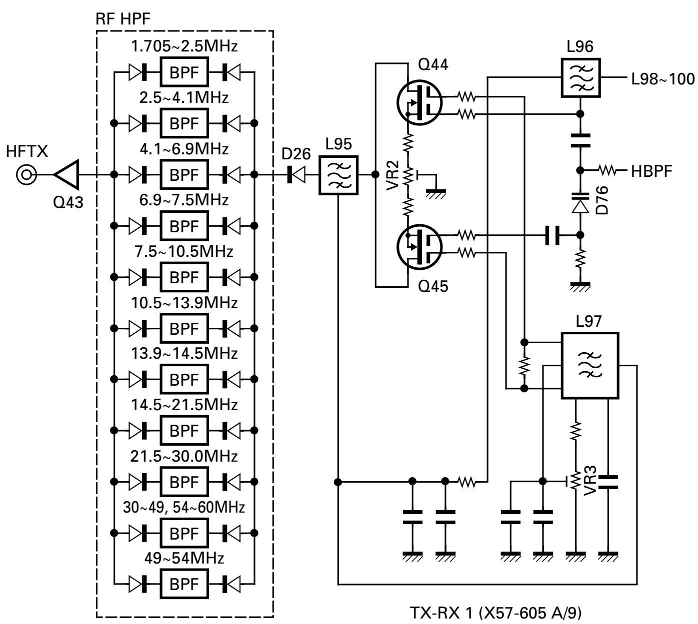

Fig. 12

■ ALC

The progressive and reflected wave signals detected by the final section in each band enters the TX-RX1 unit (X57-605) and is synthesized by a diode. It is synthesized simply because no signal is transmitted in multiple bands at the same time.

When the progressive signal voltage is input, it is divided by a resistor, and enters the differential amplifier composed of Q73 and Q74. When the voltage increases, the emitter voltage rises, the base current of Q74 decreases, and the collector voltage of Q74 also rises. When the voltage exceeds the base emitter voltage plus the emitter voltage (approximately 2.4V) of Q76, the base current of Q76 begins to flow and the voltage of the collector to which the ALC time constant CR is connected decreases. This collector voltage is buffered by Q78, the voltage is shifted by D108, and matched with the keying control voltage by Q79 and D111 to produce the ALC voltage. When the ALC voltage (2.7V when inactive) decreases, the second gate voltage of the IF amplifier (Q49) decreases and the gain lowers.

During AM transmission, Q75 turns on approximately 20ms after transmission, and the ALC voltage is controlled by the average power. The voltage output from the DAC (IC14) is applied to the base voltage of Q74, which is the reference voltage of the ALC. This DAC (IC14) is controlled by the adjustment value (POC) from the main microcomputer. In addition, the input voltage of the DAC fluctuates according to the power supply voltage and the output drops when the voltage is reduced.

■ SWR protection

The reflected wave detection signal is divided by the DAC (IC14) and input to the base of Q77. When this voltage increase, the collector current of Q77 increases and output power is limited.

■ Meter voltage

The progressive wave voltage is calculated as the power meter voltage, the reflected wave voltage is calculated as the progressive wave voltage and its value is input as the SWR meter voltage, and the ALC voltage is input as the ALC meter voltage. These voltages are input into the A/D converter of the main microcomputer.

■ Packet signal

The control unit contains a TNC and a changeover switch circuit that enables data signals to input from the ACC2 connector. (See the block diagram)

The 1200bps signal is processed by the DSP in the same way as for audio signals, but the 9600bps signal is input directly to the FM modulator without passing through the DSP.

CIRCUIT DESCRIPTION

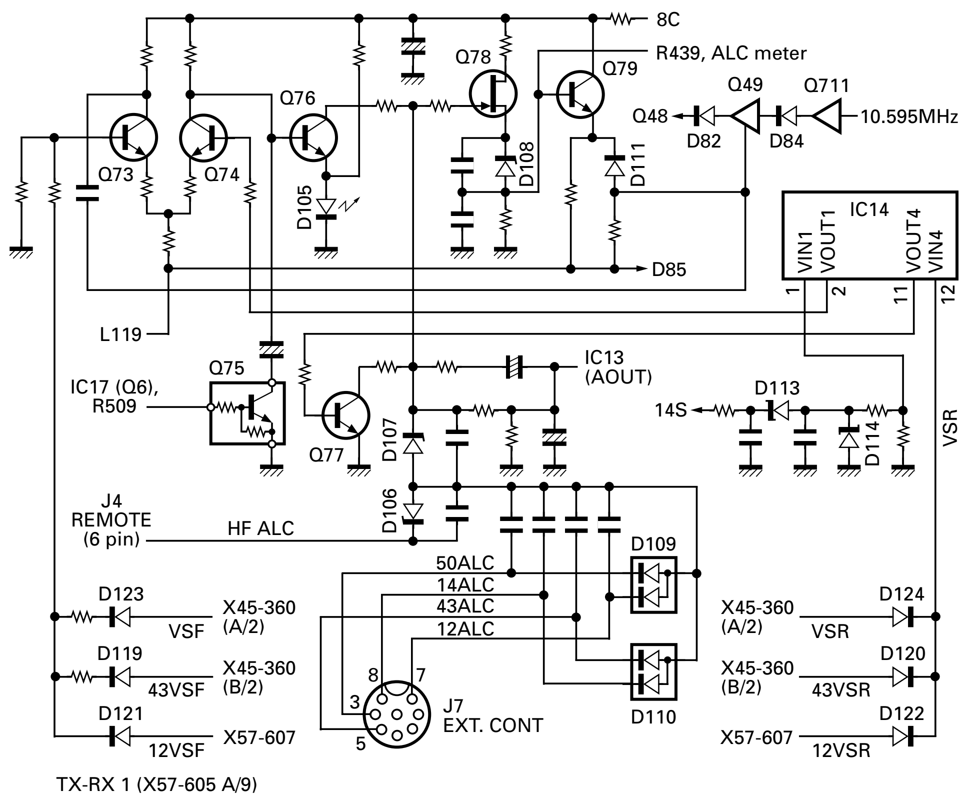

Fig. 13

VHF/UHF Band Transmitter Circuit (RF~IF)

The TIF (10.595MHz) signal input from the TX-RX1 unit (X57-605) first enters the mixers (Q46 and 47). The 31.2MHz signal from the PLL passes through the RF amplifier (Q50), enters the mixer as a local oscillator to output the 41.795MHz IF through both the signals. It passes through the 41.795MHz MCF (XF3) and enters the wideband diode mixer (D54) in the next stage, and upper hetero to a VHF/UHF band output signal. The local oscillator TXLO1 of the mixer is on a common line for both VHF and UHF band local oscillators, and the local oscillator signal is amplified by the VHF and UHF band broadband amplifier (Q34) and supplied to the mixer.

The signal converted to the VHF/UHF band is divided into a VHF band path and a UHF band path after it is output from the mixer.

The VHF band signal passes through a filter and a trap and is amplified in the 2-stage RF amplifiers (Q20, Q18), and the resulting signal goes to the wideband amplifier (IC3) common to the VHF and UHF bands.

The UHF band signal is amplified by the RF amplifier (Q17), passes through a 3-pole variable tuning BPF and is amplified by the amplifier (Q26). Then, it passes through a 2-pole variable tuning BPF and enters IC3. The total 5-pole variable tuning BPF controls the tuning frequency according to the control signal output from the D/A converter of the TX-RX1 unit (X57-605).

The signal amplified by IC3 is again divided into VHF band and UHF band paths by a diode switch and output to the final unit (VHF band: X45-360 A/2, UHF band: X45-360 B/2).

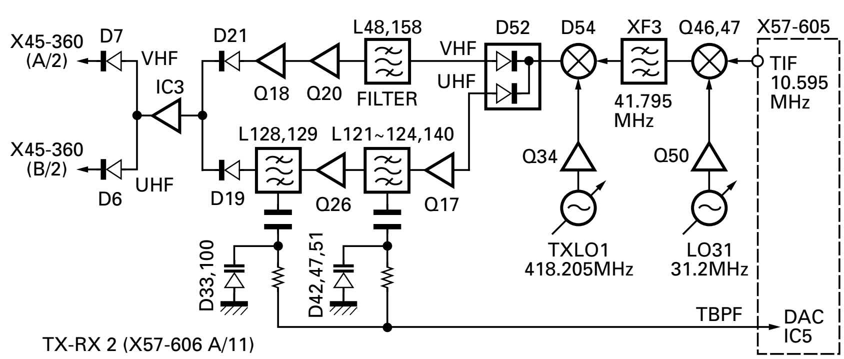

Fig. 14

CIRCUIT DESCRIPTION

Transmitter Final Amplifier

The final unit (X45-360 A/2) is composed of an HF and VHF band final amplifier, an antenna turner matching circuit, and a power supply circuit.

The LPF section and antenna tuner detection circuit are located in the filter unit (X51-315).

The 1.8~144MHz band is amplified by the final unit, but it operates in the broadband up to the drive amplifier. The final unit amplifies signals using independent amplifiers in the 8~50MHz and 144MHz bands. The amplifiers are switched with a diode switch (D1).

■ Q1 : First stage amplifier

This amplifier uses a FET. It has frequency characteristics so that the gain increases in the 144MHz band.

■ Q2 : Pre-drive amplifier

This amplifier uses a bi-polar transistor. It has unique frequency characteristics.

■ Q3 and 4 : Drive amplifier

This is a push-pull type amplifier. It amplifies a signal with a broadband up to the 144MHz band, then the signal is branched to the HF and 144MHz bands through a relay.

■ Q6 and 7 : HF final amplifier

This amplifier uses a bipolar transistor with push-pull. It amplifies a signal up to the 54MHz band, using an output transformer with a coaxial cable. It outputs the signal to the LPF section through an effective and light matching circuit in the 50MHz band.

■ Q101 and 102: 144MHz final amplifier

A 144MHz band signal passes through the HPF and enters the branch circuit with two amplifiers.

It functions as a parallel amplifier that branches the signal with the same phase, amplifies it with the Q101 and 102 amplifiers and re-synthesizes it. As a result a 100W output is produced.

Since the output matching section is an LPF type, it attenuates harmonics as well. After the output has been synthesized, it detects the power of the progressive wave and reflected wave with a directional coupler according to the strip line, and outputs it to the LPF section.

■ LPF section

In the 1.8~50MHz band, the signal passes through the LPF as shown in Table 3.

It has an independent LPF circuit and an antenna changeover circuit for the 144MHz band.

The signal output from the LPF passes through the detection circuits, the transmission/reception changeover relay (K1), the antenna tuner changeover relay (K3) and the antenna changeover relay (K4) and is output to ANT1 or ANT2.

Select signal	Frequency
2M	1.8~ 2.0
4M	2.0~ 4.1
7M	4.1~ 7.5
14M	7.5~14.5
21M	14.5~21.5
28M	21.5~30.0
50M	49.0~54.0

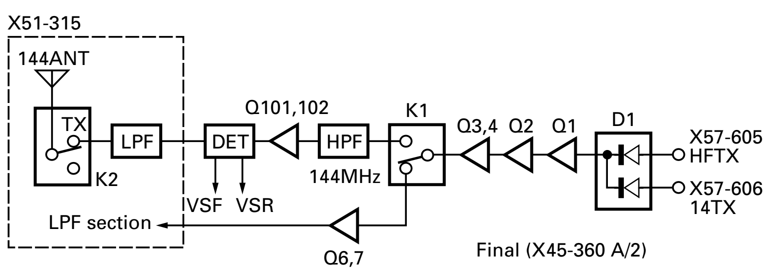

Fig. 15

■ Progressive wave and reflected wave output circuits

The signal is detected by L7, D3 and D4. A voltage output corresponding to the progressive wave and reflected wave is produced by synthesizing the magnetically combined component by L7 with the corrected electrostatically combined component by TC1 and C9 and detecting the resulting signal.

It is adjusted by TC1 so that the reflected wave voltage under a 50Ω load is minimized. VR1 adjusts the frequency characteristics in the 50MHz band.

These outputs are synthesized with detected output of the 144MHz band and are fed to the TX-RX1 unit (X57-605).

■ Antenna turner detection circuit

The passing current is converted to voltage by L9, and the voltage is stepped down and detected by L10. One of these components is buffered by Q1 and Q2 and rectified by Q3 and Q4, are input to the phase comparator (IC2) . The IC determines the IC2 Q output “H” or “L” according to the phase difference with a D-flip-flop. The other component is detected by diodes (D10 and D11) and the amplitude difference is compared with the comparator (IC1).

The capacitor capacitance on the input side is changed according to the phase difference detection output, and the capacitor capacitance on the output side is changed according to the amplitude difference detection output.

■ UHF final unit (X45-360 B/2)

The 430MHz band transmit signal output from the TX-RX2 unit (X57-606) is amplified to 50W by four amplifiers (Q901, 902, 903 and 905). The final unit consists of single amplifiers Q901, 902, 903 and 905. The input and output of the final stage is composed of micro-strip lines. The progressive wave and reflected wave detection circuit is also made of micro-strip lines and used for power control and reflected wave protection.

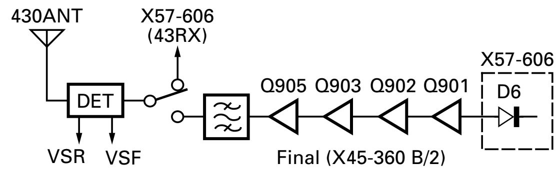

Fig. 17

1.2GHz Unit Transmitter Section

The 10.595MHz transmit signal from 12TIF is amplified in the sending IF amplifier (Q304). This signal is input into the sending mixer (Q1 and Q2).

The 135.395MHz signal converted in Q1 and 2 passes through the MCF (XF2) and IF amplifier (Q3), is input into the diode mixer (D1) and converted to 1240~1300MHz. This signal is amplified to approximately 0dB in the sending RF amplifier (IC1 and Q5), then input to IC2.

It is amplified to approximately 1W in the drive power module (IC2) and to approximately 10W in the final power module (IC3), then sent to the antenna terminal (12ANT).

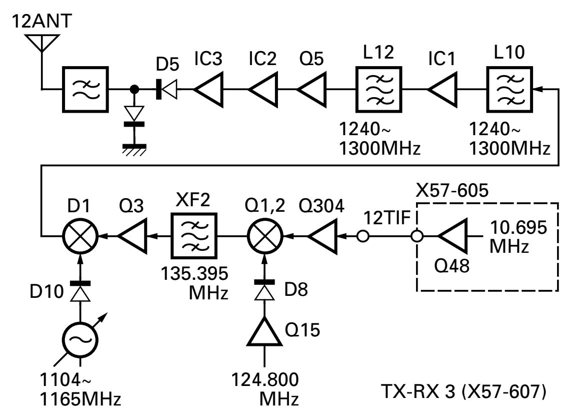

Fig. 18

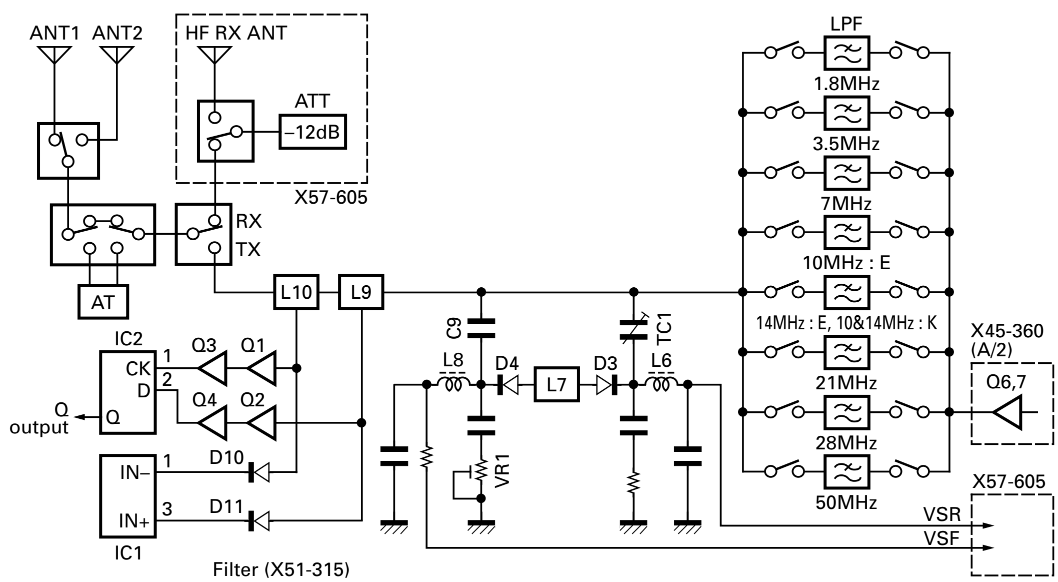

Fig. 16

CIRCUIT DESCRIPTION

Digital Control Circuit

■ Outline

The TS-2000/X control circuit has a multi-chip configuration centered around a main microcomputer (IC8), and contains a latch circuit for input/ output, a TNC and a DSP. Refer to the digital control block diagram.

■ Main microcomputer peripherals

Four serial communication devices utilizing a UART function (panel microcomputer, TNC, mobile head and PC serial port) are connected to the main microcomputer. An EEPROM (IC7) for backup and a DTMF decoder (IC12) for DTMF signal detection are also connected to the microcomputer.

The input/output circuit and DSP are connected through an address bus and a data bus. The bus to the DSP is connected through 5V ↔ 3V voltage conversion ICs (IC9, IC10, and IC11)

The microcomputer operates with an internal core voltage of 3.3V, an external I/O voltage of 5V and an internal frequency of 22.1184MHz (11.0592MHz x 2).

■ TNC

The TNC is the same as the one used in the TH-D7. The TNC uses a lithium battery to back up various settings. When a 9600bps communication speed is used, the TNC analog signal is connected directly to the transmitter/receiver circuit without passing through the DSP.

■ Input/output latch circuit

A latch IC is used in stead of several input/output ports. Since the latch IC has a latch function only, the latch circuit contains an input latch logic circuit (IC13, IC14, IC15) and an output latch logic circuit (IC16, IC17, IC18) to generate the signals required for the latch IC using the main microcomputer's address bus information. This configuration is also used for the latch IC of the DSP section.

■ Other peripheral circuits

The main microcomputer is connected with other peripheral circuits, such as a reset circuit that generates a reset signal, a reduced voltage detection circuit that detects reduced voltage and generates a reduced voltage signal, and an over-voltage detection circuit that detects over-voltage and generates an over-voltage signal.

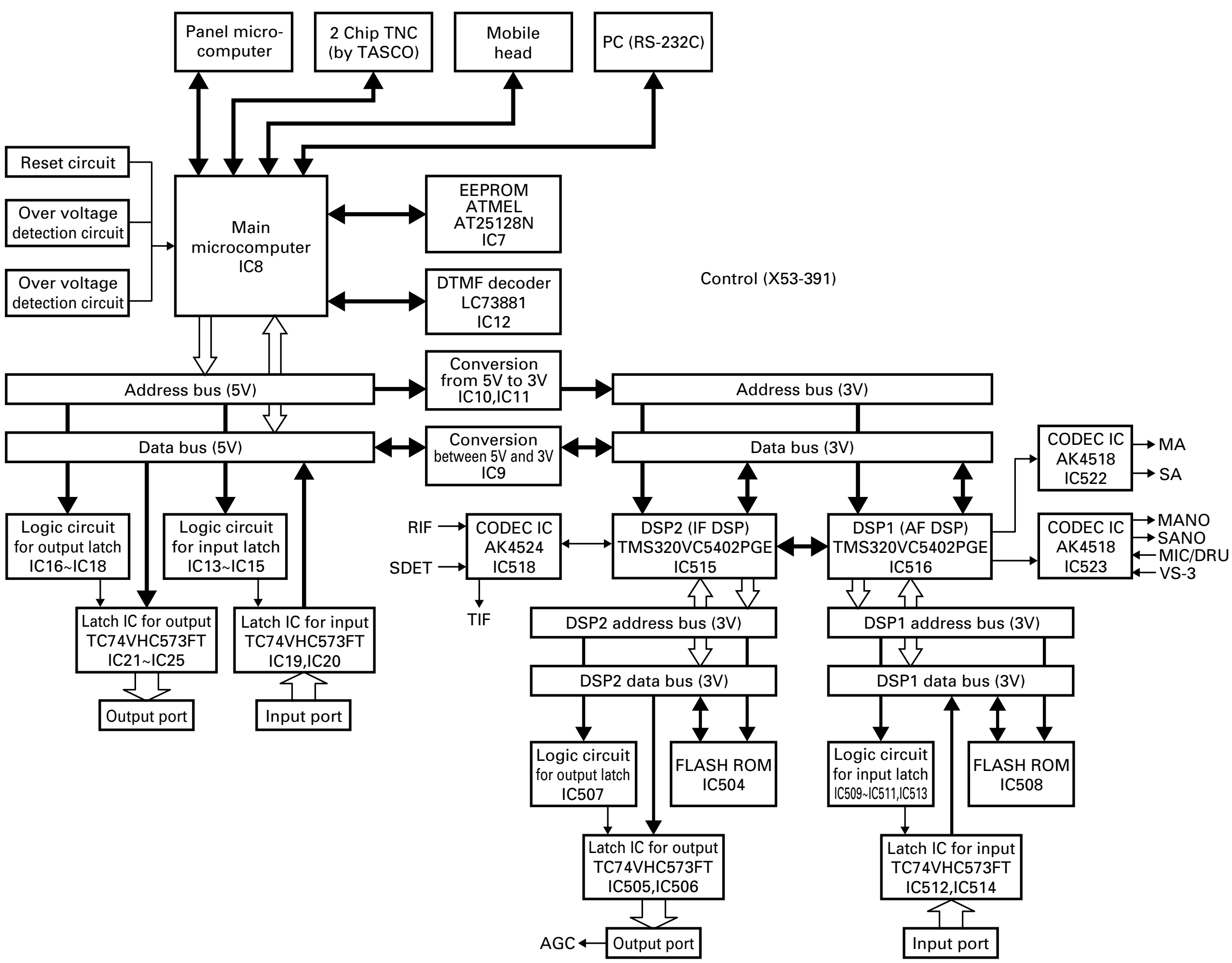

Fig. 19 Digital control block diagram

CIRCUIT DESCRIPTION

■ Firmware

The main microcomputer firmware includes adjustment firmware and user firmware. When repairs or adjustments are made in service, the user firmware must be rewritten to make adjustment firmware. It must be restored to the original user firmware after repairs or adjustments. The adjustment firmware provides a warning display and a warning sound when the power goes on.

DSP Circuit

■ Outline

The TS-2000/X DSP circuit is composed of two DSPs (IC515 and IC516) and CODEC ICs (IC518, IC522 and IC523), an input latch circuit, flash ROM (IC504 and IC508). It is connected with the main microcomputer (IC8) by an address bus and a data bus through the voltage conversion ICs (IC9, ID10 and IC11). The SSB, CW, AM and FSK detection, modulation and AGC operation are done by the DSP, and digital processing (digital filtering, noise reduction, etc.) is performed in all modes.

■ DSP

The DSP operates with an internal core voltage of 1.8V, an external I/O voltage of 3.3V and an internal frequency of 99.5328MHz (11.0592MHz x 9).

The two DSPs perform the respective IF processing and AF processing. The IF processing is done by DSP2 (IC515) and a 24 bit CODEC IC (IC518) is connected to it. DSP2 performs detection, modulation, AGC processing and IF digital filtering. It is designed so it does not exceed the processing time, even if the main band transmission and reception and sub-band reception are done simultaneously. An output latch circuit is connected to DSP2 to convert the analog AGC voltage signal from digital to analog before output. The conversion is done by the ladder resistance method.

The AF processing is done by DSP1 (IC516) and a 16 bit CODEC IC (IC522, IC523) is connected to it. DSP1 performs the speech processing (signaling generation, detection, noise reduction, speech filtering, and various volume processing). The input latch circuit is connected to DSP1 and various signals from the main microcomputer and the microphone selection signal are input into it.

■ Flash ROM

The respective programs and data are stored in the Flash ROM (IC508 and IC504) connected to DSP1 and DSP2.

■ CODEC IC

A 24 bit CODEC IC (IC518) is used as the IF signal system. DSP2 carries out 32 bit digital processing for detection and modulation. The operation of this IC is controlled by the main microcomputer.

Two 16 bit CODEC ICs (IC522 and IC523) are used as the AF signal system. These IC outputs directly enter the AF amplifier, are amplified and then output from the speaker. The IC input consists of the MIC input and the optional speech synthesis unit (VS-3).

The various timing signals required by both CODEC ICs are generated and supplied by a 12.288MHz quartz crystal and a peripheral circuit.

■ Communication between DSPs

DSP1 and DSP2 are connected via serial communication and perform such interchanges as audio signals for transmission processed in DSP1, received speech signals detected in DSP2 and information from the DSP1 input latch circuit. If this interchange does not go well when the power starts up, a “DSP COMM” error will be displayed on the LCD and the fact that the DSPS is not operating will be notified to the main microcomputer. Likewise, when the content of the flash ROM is abnormal, a “DSP COMM” error is displayed.

DESCRIPTION OF COMPONENTS

FINAL UNIT (HF) (X45-360X-XX) (A/2)

Ref. No.	Use / Function	Operation / Condition
Q1,2	Predrive amplifier	HF/VHF band amplifier
Q3,4	Drive amplifier	HF/VHF band push-pull wide-band amplifier
Q6,7	Final amplifier	HF/50MHz band push-pull wide-band amplifier
Q8	Bias control	HF/50MHz band final stage bias current control
Q101,102	Final amplifier	VHF band push-pull wide-band amplifier
Q103	Bias control	VHF band final stage bias current control
Q201	Switching	ANT1 and ANT2 changeover relay control
Q202	Switching	AT relay control
Q203	Switching	HF RX antenna relay control
Q204	Switching	Fan control (high speed)
Q205	Switching	Fan control (low speed)
Q206	Switching	High power supply voltage protection
Q207	Switching	Power relay control (K201)
Q208~215	Switching	HF/50MHz band LPF band changeover
Q216,217	Switching	VHF band TX/RX changeover relay control
IC201,202	AVR	SB→8V
IC203	AVR	SB→10V
IC204	AVR	8V→5V
IC205	Extended I/O	LPF control signal serial-parallel
IC801	Extended I/O	AT input C control signal serial-parallel
IC802	Extended I/O	AT output C control signal serial-parallel
IC803	Extended I/O	AT coil control signal serial-parallel
D1	Switching	HF/VHF band drive input changeover
D2,3	Temperature compensation	Drive stage bias current control
D5	Switching	HF/VHF band drive stage bias changeover
D6	Surge absorption	Relay (K1)
D7,8	Temperature compensation	HF/50MHz band final stage bias current control
D101	High-frequency rectification	VHF band reflected wave detection
D102	High-frequency rectification	VHF band forward wave detection
D103,104	Temperature compensation	VHF band final stage bias current control
D201	Surge absorption	Power surge protection
D202	Surge absorption	Fan
D203	Zener diode	Over voltage detection
D204	Surge absorption	Relay (K201)
D206~209	Surge absorption	IC205 output line protection
D210	Reverse current prevention	VHF band TX/RX relay control line
D801~824	Surge absorption	Antenna tuning relay (K801~824)

FINAL UNIT (430) (X45-360X-XX) (B/2)

Ref. No.	Use / Function	Operation / Condition
Q901,902	Predrive amplifier	UHF band amplifier
Q903	Drive amplifier	UHF band amplifier
Q904	Bias control	Final stage bias current control
Q905	Final amplifier	UHF band final stage amplifier
D901	Temperature compensation	Drive stage bias current control
D902,903	Temperature compensation	Final stage bias current control
D904	High-frequency rectification	Forward wave voltage detection
D905	High-frequency rectification	Reflected wave voltage detection
D906	Switching	Antenna switch
D908,909	Switching	Antenna switch

FILTER UNIT (X51-315X-XX)

Ref. No.	Use / Function	Operation / Condition
Q1	Signal amplifier	AT phase signal amplifier
Q2	Signal amplifier	AT amplitude signal amplifier
Q3	Signal amplifier	AT phase signal amplifier
Q4	Signal amplifier	AT amplitude signal amplifier
IC1	Comparator	AT control amplitude signal discrimination
IC2	D flip-flop	AT control phase signal discrimination
D2	Surge absorption	Relay (K2)
D3	High-frequency rectification	HF/50MHz band reflected wave detection
D4	High-frequency rectification	HF/50MHz band forward wave detection
D5~7	Surge absorption	Relay (K1,K3,K4)
D8,9	Surge absorption	Lightning surge protection
D10	High-frequency rectification	AT phase signal detection
D11	High-frequency rectification	AT amplitude signal detection
D201,251	Surge absorption	Relay (K201/K202, K251/K252)
D301,351	Surge absorption	Relay (K301/K302, K351/K352)

DESCRIPTION OF COMPONENTS

Ref. No.	Use / Function	Operation / Condition
D401,451	Surge absorption	Relay (K401/K402, K451/K452)
D501,551	Surge absorption	Relay (K501/K502, K551/K552)

CONTROL UNIT (X53-391X-XX)

Ref. No.	Use / Function	Operation / Condition
Q1	Switching	TT signal output control of external AT
Q2	Switching	TT signal input control of external AT
Q3	Switching	TS signal output control of external AT
Q4	Switching	TS signal input control of external AT
Q5	Switching	Power on at L level
Q9,10	Switching	
Q13	Buffer amplifier	9600 bps RX signal
Q14	Buffer amplifier	1200 bps RX signal
Q15,16	Amplifier	Waveform shaping of TNC TX signal
Q17	Switching	Backup processing control of panel microcomputer
Q18	Switching	RS-232C related power source (X57-605 A/9)
Q19,20	Switching	
Q501	Switching	
IC1	Reset IC	For main microcomputer
IC2	AVR	Digital system 5V generation
IC3	AVR	5V constantly on
IC4	3.3V AVR for DSP	3.3V
IC5,6	Analog switch	Main microcomputer ADC input changeover
IC7	EEPROM	For storage of various set values
IC8	Main microcomputer	Primary main unit operation
IC9	Conversion between 5V and 3V	Two-way conversion
IC10,11	Conversion from 5V to 3V	Main microcomputer and DSP data conversion
IC12	DTMF decoder IC	For DTMF decoding
IC13~18	Input/output port logic	Logic of latch IC used as input/ output port
IC19,20	Input port	Used as input port for main micro-computer
IC21~25	Output port	Used as output port for main micro-computer
IC26	TNC microcomputer	Dedicated TNC microcomputer
IC27	OP amplifier	A/2 : 1200 bps RX AF amplifier B/2 : 9600 bps RX AF amplifier
IC28	TNC logic circuit	TNC logic
IC29	OP amplifier	A/2 : 1200 bps RX AF amplifier B/2 : 9600 bps RX AF amplifier
IC30	Comparator	Waveform shaping of modem TX signal
IC31	AND	Sends DSP1 and DSP2 WAIT signal to CPU through AND circuit
IC32,33	Reset IC	
IC501	AVR	3V within control
IC502,503	1.8V AVR for DSP	1.8V
IC504	Flash ROM for DSP2	For program and coefficient storage
IC505,506	For DSP port output	Used as output port (AGC output)
IC507	Input/output port logic	Logic of latch IC used as input/ output port
IC508	Flash ROM for DSP1	For program and coefficient storage
IC509	Input/output port logic	Logic of latch IC used as input/ output port
IC510	Input/output port logic	
IC511	Input/output port logic	Logic of latch IC used as input/ output port
IC512	For DSP port input	Used as input port
IC513	Input/output port logic	Logic of latch IC used as input/ output port
IC514	For DSP port input	Used as input port
IC515	DSP	For IF processing
IC516	DSP	For AF processing
IC517	Analog AGC buffer	Analog AGC voltage buffer
IC518	CODEC (24 bit)	RIF input, TIF output
IC519,520	For CODEC clock division	
IC521	For CODEC clock division	Operation at 12.288MHz frequency
IC522,523	CODEC (16 bit)	Microphone input, AF output
IC524~529	Buffer for analog signal input/output	Connection to CODEC input/output
IC530	Serial/parallel	For microphone input changeover
IC531~534	Analog switch	For input/output changeover
IC535	Buffer for analog signal input/output	Connection to CODEC input/output
D5,6	Reverse current prevention	
D11,12	Reverse current prevention	
D13	Reference voltage source	
D14~17	Reverse current prevention	
D501~504	Reverse current prevention	

DESCRIPTION OF COMPONENTS

DISPLAY UNIT (X54-3320-00)

Ref. No.	Use / Function	Operation / Condition
Q1~3	AVR	LCD backlight
IC1	LCD driver	LCD 7-segment driver (B-SEG)
IC2	LCD driver	LCD 7-segment driver (A-SEG)
IC3	LCD driver	LCD dot segment driver
IC4	Serial/parallel	LED control, backlight dimmer control
D1	LED	On when VOX is selected
D2	LED	On when PROC is selected
D3~9	LED	Key illumination

TX-RX 1 UNIT (X57-605X-XX)

Ref. No.	Use / Function	Operation / Condition
Q1	RF mute	On in HF/50MHz TX mode
Q2	Switching	On in HF/50MHz RX mode
Q3	Switching	Q2 control
Q4	Switching	Dedicated external RX antenna changeover relay control
Q5	Switching	HF/50MHz RF ATT control
Q6	Switching	On in 50MHz TX mode
Q7~10	RX 1st mixer	RX 1st IF 69.085/75.925MHz
Q11	Switching	Off when HF/50MHz preamplifier on
Q12	RF amplifier	When HF-21.5MHz
Q13	Amplifier	1st local oscillation amplifier
Q14,15	Switching	Q12 control
Q16,17	Switching	Q16 turns on when first IF change-over control is 75.925MHz
Q18	Amplifier	RX 1st IF 69.085/75.925MHz
Q19,20	RX 2nd mixer	Converts RX 1st IF to 10.695MHz
Q21	Switching	Reserved
Q22	Amplifier	For NB 10.695MHz
Q25	Amplifier	RX 2nd IF amplifier 10.695MHz
Q26	Amplifier	NB amplifier 10.695MHz
Q27	DC amplifier	NB AGC amplifier
Q28	Amplifier	NB amplifier 10.695MHz
Q29	Switching	On at time of NB blanking
Q30	Buffer amplifier	Impedance changeover
Q31	Switching	On at time of NB blanking
Q32	Amplifier	RX 3rd local oscillation amplifier (11.150MHz)
Q33	Switching	On when 1st IF frequency is 69.085MHz
Q34	Switching	Creates RXB in FM mode
Q37	Switching	Creates RXB in non-FM mode
Q38	Amplifier	3rd IF amplifier (455kHz)
Q40	Switching	On during RX in non-FM mode
Q41	Amplifier	RX 4th local oscillation amplifier (467kHz)
Q42	Buffer amplifier	4th IF frequency (12kHz)
Q43	Amplifier	HF/50MHz TX drive amplifier
Q44,45	TX 3rd mixer	Converts 68.985/75.825MHz to TX frequency
Q46,47	TX 2nd mixer	Converts 10.695MHz to 68.985/ 75.825MHz
Q48	Buffer amplifier	10.695MHz
Q49	TX 2nd IF amplifier	10.695MHz
Q51	Switching	Keying control
Q52	DC buffer amplifier	ALC keying control
Q53	Switching	On during TX in non-FM mode
Q54	TX 2nd IF amplifier	10.695MHz
Q57	Switching	On during transmission in FM mode
Q58	Limiter	FM modulation signal limiter (elimination of AM component)
Q59	Oscillator	FM oscillator, modulation 10.595MHz
Q60	Switching	On during TX in non-FM mode
Q61,62	Mute	On when main and sub are simultaneously AF muted
Q63,64	DC-DC oscillator	–6V generation
Q65	Switching	On when relay for HF band linear is used
Q66	Switching	On when relay for HF band linear is transmission
Q67	Switching	On when relay for HF band linear is used
Q69,70	AVR	AVR for mobile controller (Power about 9.4V)
Q71,72	Switching	50MHz/VHF/UHF/1.2GHz band external linear control
Q73,74	Amplifier	ALC amplifier
Q75	Switching	On in AM mode, makes it an average value type ALC
Q76	Amplifier	ALC amplifier
Q77	Switching	Turns on and lowers the power at time of protection
Q78,79	Amplifier	ALC amplifier
Q80~91	Switching	Produces the respective TXB and RXB from 8C to HF/50MHz, VHF band, UHF band and 1.2GHz bands. The synthesis of the TXB becomes IF TXB and the synthesis of the RXB becomes IF RXB. This control voltage is necessary for simultaneous TX/RX, such as for satellite communication.
Q92	Switching	Cancels the time constant for VSF and VSR voltage lines during antenna tuning
Q93	Buffer amplifier	Buffer amplifier for external modulation input signal

DESCRIPTION OF COMPONENTS

Ref. No.	Use / Function	Operation / Condition
Q94,95	Buffer amplifier	Buffer amplifier for ANO output of main and sub band
Q96	Switching	External squelch output of main and sub bands (open collector)
Q97	DC buffer amplifier	Ripple filter for AF IC (IC9) power supply
Q101~112	Switching	On when RF BPF SW is selected
Q601	Amplifier	31.2MHz
Q602	Buffer amplifier	RX 4th local oscillator (467kHz)
Q603	Amplifier	31.2MHz
Q604	Buffer amplifier	TX 1st oscillator (10.595MHz)
Q605	Amplifier	31.2MHz
Q606	Buffer amplifier	RX 3rd local oscillator (11.150MHz)
Q607,608	Switching	On when 1st IF frequency is 69.085MHz
Q609	Switching	DC switch
Q700,701	Mixer	RX 3rd mixer and 3rd IF frequency (455kHz)
Q702	Switching	Gain correction, on when RX 1st IF is 69.085MHz
Q703	Switching	L69 tuning correction, on when RX 1st IF is 69.085MHz
Q704	Switching	On during TX in FM mode
Q705	Amplifier	On RF amplifier is 21.5~60MHz
Q706~708	Switching	On at time of Q705 operation
Q709	Buffer amplifier	455kHz
Q710	Amplifier	Squelch noise amplifier
Q711	TX 2nd IF amplifier	10.695MHz
Q712,714	Switching	On during TX in FM mode
Q715	Amplifier	DRU output amplifier
Q800	Switching	On when FUNC switch is selected
Q801	AVR	For LED
Q802	Switching	On in main band TX mode
Q803	AVR	For LED
Q804	Switching	On when main band BSY
Q805	AVR	For LED
Q806	Switching	On in sub band TX mode
Q808	Switching	On when sub band BUSY
Q811	Switching	On when modem 9600 bps is selected
Q813	Switching	On when modem STA is active
Q815	Switching	On when a modem is connected
Q817	Switching	On when MULTI ENC is sctive
Q819	Switching	On when sub receiver is on
Q820,822	Switching	On when key illumination is on
Q951	Switching	Reset control
IC1	FM IF	IF amplifier, Squelch
IC2	OP amplifier	A/2 : ALT voltage buffer B/2 : FM AF amplifier
IC3	Mixer	RX 4th mixer (Output : 12kHz)

Ref. No.	Use / Function	Operation / Condition
IC4	OP amplifier	A/2 : Unused B/2 : AGC reference voltage buffer
IC5	Extended I/O	RF BPF changeover control
IC6	Mixer	TX 1st mixer (Output : 10.595MHz)
IC7	Multiplexer	Receiver output, FM (AF) and non-FM (IF) changeover
IC8	Analog switch	Modulation input, FM (AF), non-FM (IF) and packet (AF) changeover
IC9	AF PA	Main and sub 2 channels
IC10	Level converter	RS-232C level and 5V conversion
IC11	Buffer amplifier	Voltage buffer
IC12	OP amplifier	1/4 : TX power gain control voltage buffer 2/4 : Unused 3/4 : RX IF gain control voltage buffer 4/4 : TX band gain control voltage buffer
IC13	OP amplifier	A/2 : ALC reference voltage buffer B/2 : ALC meter voltage buffer
IC14	DAC	1/8 : TX power control voltage 2/8 : ALC reference voltage 3/8 : Unused 4/8 : Protection voltage 5/8 : TX power gain control voltage 6/8 : Unused 7/8 : TX band gain control voltage 8/8 : RX IF gain control voltage
IC15	DAC	1/8 : HF/50MHz TX BPF control voltage 2/8 : RF unit RX sub BPF control voltage 3/8 : RF unit RX main BPF control voltage 4/8 : RF unit TX UHF BPF control voltage 5/8 : H in non-FM mode 6/8 : Unused 7/8 : Unused 8/8 : NB level control voltage
IC16	Extended I/O	Q0 : L when RX 10.695MHz XF5 is selected Q1 : L when RX 10.695MHz XF6 is selected Q2 : L when RX 10.695MHz through is selected Q3 : L when AT tuning Q4 : L when RX 455kHz CF1 is selected Q5 : L when RX 455kHz CF2 is selected Q6 : L when RX 455kHz CF3 is selected Q7 : Reserved Q8 : Reserved Q9 : Unused Q10 : H when main squelch is open Q11 : H when sub squelch is open

DESCRIPTION OF COMPONENTS

Ref. No.	Use / Function	Operation / Condition
IC17	Extended I/O	Q0 : H when UHF ATT is on Q1 : H when VHF ATT is on Q2 : H when HF/50MHz ATT is on Q3 : L when external RX antenna terminal is selected Q4 : L when HF/50MHz preamplifier is selected Q5 : H when RX 1st IF 75.925MHz is selected Q6 : H during AM TX Q7 : H during TX in PKD and 9600 bps is selected Q8 : H during TX in non-FM mode Q9 : H during RX in non-FM mode Q10 : H when linear amplifier usage is selected in HF or 50MHz band Q11 : H when linear amplifier usage is selected in either band
IC18	OP amplifier	A/2 : 5V voltage source B/2 : Amplifier 455kHz
IC19	OP amplifier	A/2 : VSR voltage amplifier B/2 : VSF voltage amplifier
IC601	DDS	RX 4th local oscillator (467kHz)
IC602	DDS	TX 1st local oscillator (10.595MHz)
IC603	DDS	RX 3rd local oscillator (11.150MHz)
IC604	Inverter	Polarity inversion
IC605	AVR	14S→8V
IC801	CPU	Display microcomputer
D1	Surge absorption	Relay (K1)
D2	Surge absorption	External RX antenna terminal
D3	Surge absorption	Relay (K2)
D4~6	Surge absorption	Internal circuit protection
D7	Switching	RX/TX changeover, on during RX
D8	Switching	On when RF BPF under 1.705MHz is selected
D9	Surge absorption	Internal circuit protection
D10	Switching	On when RF BPF under 1.705MHz is selected
D11	Switching	On when RF BPF over 1.705MHz is selected
D12,13	Switching	On when RF BPF of 1.705~2.5MHz is selected
D14,15	Switching	On when RF BPF of 2.5~4.1MHz is selected
D16,17	Switching	On when RF BPF of 4.1~6.9MHz is selected
D18,19	Switching	On when RF BPF of 6.9~7.5MHz is selected

Ref. No.	Use / Function	Operation / Condition
D20,21	Switching	On when RF BPF of 7.5~10.5MHz is selected
D22,23	Switching	On when RF BPF of 10.5~13.9MHz is selected
D24,25	Switching	On when RF BPF of 13.9~14.5MHz is selected
D26	Switching	RX/TX changeover, on during TX
D27,28	Switching	On when RF BPF of 14.5~21.5MHz is selected
D29,30	Switching	On when RF BPF of 21.5~30MHz is selected
D31,32	Switching	On when RF BOF of 30~49MHz and 54~60MHz is selected
D33,34	Switching	On when RF BPF of 49~54MHz is selected
D35,36	Switching	On when ~60MHz preamplifier is on
D38,39	Switching	On when ~21.5MHz preamplifier is on
D40	Switching	HF/50MHz LO1 TX/RX changeover
D41,42	Switching	RX 1st MCF changeover
D45	Switching	HF/50MHz LO2 changeover
D46	Switching	HF/50MHz and VHF/UHF band RX IF input changeover, 10.695MHz
D47	Switching	1.2GHz RX IF input changeover, 10.695MHz
D48	Reverse current prevention	Main RBK and NB mute signal matching, main side mute when on
D49	Switching	10.695MHz IF filter changeover, on when wide (6kHz) is selected
D50	Switching	10.695MHz IF filter changeover, on when narrow (2.7kHz) is selected
D52	Switching	10.695MHz IF filter changeover, on when through is selected
D53	Switching	10.695MHz IF filter changeover, on when narrow (2.7kHz) is selected
D55	Switching	10.695MHz IF filter changeover, on when wide (6kHz) is selected
D56	Switching	10.695MHz IF filter changeover, on when through is selected
D57	Switching	10.695MHz IF filter changeover, on when wide (6kHz) is selected
D58	Switching	10.695MHz IF filter changeover, on when narrow (2.7kHz) is selected
D60	Switching	10.695MHz IF filter changeover, on when through is selected
D61	Switching	10.695MHz IF filter changeover, on when wide (6kHz) is selected
D62	Switching	10.695MHz IF filter changeover, on when narrow (2.7kHz) is selected

DESCRIPTION OF COMPONENTS

Ref. No.	Use / Function	Operation / Condition
D64	Switching	10.695MHz IF filter changeover, on when through is selected
D65	Reverse current prevention	Matching of main VHF and main UHF changeover signal
D66	Detection	NB switching pulse detection
D67	Switching	455kHz IF filter changeover
D68	Switching	On when FM mode is selected in main band
D69	Switching	455kHz IF filter changeover
D70,71	Switching	455kHz IF filter changeover
D73	Switching	On when non-FM mode is selected in main band
D75	Switching	On during HF/50MHz TX
D76~79	Variable capacitor	Voltage varies (2 stages) according to the TX band
D80	Switching	TX IF output HF/50MHz, VHF/UHF changeover
D81	Switching	TX IF output 1.2GHz changeover
D82	PIN diode	TX IF gain variable according to TX power
D83	Reverse current prevention	Matching of VTXB and UTXB
D84	PIN diode	TX gain setting of each band
D85	Reverse current prevention	
D86	LED	For constant voltage
D87~89	Reverse current prevention	
D90	Switching	TX IF FM mode/non-FM mode changeover, 10.595MHz
D91	Variable capacitor	FM modulation 10.595MHz
D92,93	Reverse current prevention	Creates IF TXB
D94,95	Reverse current prevention	Creates IF RXB
D96	Zener diode	Stabilizes minus power source to –6V
D97	Rectifier	Creates minus voltage
D98	Surge absorption	Relay (K3)
D99	Reverse current prevention	Matching of start signals from PC and mobile panel
D100	Zener diode	Port protection
D101	Poly-switch	Over voltage detection
D102	Zener diode	Reference voltage of constant voltage power source for mobile panel
D103,104	Surge absorption	
D105	LED	Creates reference voltage
D106	Reverse current prevention	External ALC matching
D107	Zener diode	External ALC voltage shift

Ref. No.	Use / Function	Operation / Condition
D108	Zener diode	Voltage shift
D109,110	Reverse current prevention	External ALC matching
D111	Reverse current prevention	
D112	Zener diode	Port protection
D113	Zener diode	Voltage shift, lower power when power voltage drops
D114	Zener diode	Set so the power does not to rise when the power voltage goes up
D115,116	Reverse current prevention	Meter line
D117,118	Reverse current prevention	External standby
D119	Reverse current prevention	UHF forward wave
D120	Reverse current prevention	UHF reflected wave
D121	Reverse current prevention	1.2GHz forward wave
D122	Reverse current prevention	1.2GHz reflected wave
D123	Reverse current prevention	VHF forward wave
D124	Reverse current prevention	VHF reflected wave
D130	PIN diode	RX gain adjustment 455kHz
D700~702	Reverse current prevention	
D703	Variable capacitor	Voltage varies (2 stages) according to the TX band
D704,705	Switching 21.5~60MHz	On when preamplifier is on at
D706	Reverse current prevention	On at 21.5~60MHz
D707	Rectifier	Noise rectification for FM squelch
D708	Reverse current prevention	Leak current prevention
D709	Zener diode	8V→5V
D710	Voltage shift	Temperature compensation
D711	Reverse current prevention	Discharge path (non-FM mode)
D712,713	Cliper	External modulation input
D714	Voltage shift	
D715	Variable capacitor	Voltage varies (2 stages) according to the TX band
D716	Reverse current prevention	

DESCRIPTION OF COMPONENTS

Ref. No.	Use / Function	Operation / Condition
D717	Surge protection	
D719,720	Zener diode	External surge voltage protection
D721	Reverse current prevention	
D801	LED	On in main band TX mode
D802	LED	On when main band BSY
D803	LED	On in sub band TX mode
D804	LED	On when sub band BSY
D805~809	Reverse connection prevention	Key matrix
D810~824	LED	Key illumination
D826~834	LED	Key illumination
D825	LED	On when FUNC switch is selected
D950~952	Reverse current prevention	
D953	LED	On when TNC 9600 bps is selected
D954	LED	TNC TX buffer state display
D955	LED	TNC connection state display
D956	LED	On when MULTI is selected
D957	LED	Lights when the sub is on

TX-RX 2 UNIT (X57-606X-XX)

Ref. No.	Use / Function	Operation / Condition
Q1	Switching	UHF RX ATT control
Q2	Switching	VHF RX ATT control
Q3	Switching	Sub band local oscillator power supply
Q11	Switching	VHF RX power supply
Q13	Switching	UHF power supply
Q14	Amplifier	UHF preamplifier
Q15	Amplifier	VHF preamplifier
Q16	Switching	UHF RX power supply
Q17	Amplifier	UHF TX signal amplification
Q18	Amplifier	VHF TX signal amplification
Q19	Amplifier	UHF RX signal amplification
Q20	Amplifier	VHF TX signal amplification
Q21	Amplifier	UHF main RX signal amplification
Q22,23	Amplifier	VHF sub RX signal amplification
Q24	Amplifier	VHF main RX signal amplification
Q25	Amplifier	VHF sub RX signal amplification
Q26	Amplifier	UHF TX signal amplification
Q30	Amplifier	Main RX local oscillator signal amplification
Q31	Switching	Main RX mixer power supply
Q32	Amplifier	VHF sub RX local oscillator signal amplification
Q33	Amplifier	UHF sub RX local oscillator signal amplification
Q34	Amplifier	VHF/UHF TX local oscillator signal amplification
Q35	Switching	Sub RX AM power supply
Q36	Switching	VHF sub RX IC6 power supply
Q37	Amplifier	Sub RX 1st IF signal amplification
Q38	Amplifier	Main RX 1st IF signal AGC control amplification
Q39	DC amplifier	Sub RX AM AGC control signal DC amplification
Q40,41	Switching	Sub RX FM wide/narrow change-over control
Q42,43	Mixer	Main RX 2nd mixer
Q44	Amplifier	Main RX 2nd mixer local oscillator signal amplification
Q45	Amplifier	Sub RX AM signal amplification
Q46,47	Mixer	TX mixer
Q48	Amplifier	Sub RX AM signal amplification
Q50	Amplifier	TX mixer local oscillator signal amplification
Q51	Amplifier	Sub RX AM signal amplification
Q55	Switching	VHF sub RX power supply
Q56	Switching	UHF sub RX power supply
Q57	Switching	Sub RX IF amplifier gain RBK control
Q58	Switching	VHF main RX preamplifier through
Q59	Switching	UHF main RX preamplifier through
Q60	Switching	VHF/UHF TX wide-band amplifier power supply
Q61	Amplifier	Main RX 2nd IF signal amplification
Q62	Switching	VHF/UHF TX wide-band amplifier power supply
Q63	Amplifier	Sub RX squelch signal noise amplification
Q65	Amplifier	31.2MHz reference signal amplification
Q66,67	Switching	Sub RX band changeover control
Q400~402	Active LPF	Comparison frequency 5kHz
Q403	Switching	HF LO2 VCO changeover
Q404	Switching	Sub VCO1 oscillation frequency changeover
Q405	Switching	Sub VCO2 oscillation frequency changeover
Q406	SUB VCO1	322.950~426.040MHz (K) 371.475~381.475MHz (E)
Q407	SUB VCO2	354.950~465.050MHz (K) 405.050~409.050MHz (E)
Q409	LO2 VCO	58.390~65.230MHz
Q410	Switching	Sub VCO1 changeover
Q411	Switching	Sub VCO2 changeover
Q412	Doubler	15.6MHz x 2 = 31.2MHz
Q413	Amplifier	For sub VCO1 (322.950~426.040MHz (K) 371.475~381.475MHz (E))
Q414	Amplifier	For sub VCO2 (354.950~465.050MHz (K) 405.050~409.050MHz (E))