8. SERVICE

8-1. Maintenance

Maintenance is necessary to keep any system running smoothly. Due to the severe operating conditions in the automobile environment, which include constant vibration and mechanical shock, wide temperature variations, and high humidity, the MSS in particular should receive regular maintenance checks.

8-1-1. Necessary Maintenance Equipment

The main instruments needed in maintenance of the MT9300 radio section are listed in Table 8-1.

8-1-2. Measurement Setups

The measurement setups used in maintenance of the MT9300 radio section are as follows.

(1) Setup for measuring transmitter output power: see Fig. 8-1.

(2) Setup for measuring transmitter output performance (frequency deviation, modulation factor): see Fig. 8-2.

(3) Setup for measuring receiver performance (receiver sensitivity, squelch, carrier detect, AF output level): see Fig. 8-3.

(4) Setup for comprehensive measurement of transmitter performance, receiver performance, receiver performance during transmission, etc.: see Fig. 8-4. The setup in Fig. 8-4 may be used in place of the setups in Figs. 8-1, 8-2, and 8-3 for measurements (1)-(3) above. If this is done, when measuring transmitter output power and receiver sensitivity, the measurement-system loss must be considered.

8-1-3. Channel Tester

Normally the MSS does not operate autonomously, but is commanded from a mobile base station (MBS). To operate it independently for maintenance or other purposes, a special code must be entered by the handset key board or a TOYOCOM Channel Tester and conversion adaptor of frequency synthesizer code must be connected. The procedure for independent operation by the handset will be explained in the service manual for the MCC and handset. The channel tester procedure, which is quite simple, will be described below.
The channel tester is connected in the following three steps.

(1) Open the MSS cover on the MCC side and remove the MCC board.

(2) Plug the channel tester connector into the multi-pin connector on the rear panel of the MSS.

(3) Plug the RF connector of the measuring instruments into the antenna connector on the rear panel of the MSS.

8-1-4. Measurement and Adjustment

Table 8-2 shows the main adjustments to be made on the MT9300 radio section. If maintenance measurements give any results outside the nominal values, open the MSS cover on the radio section side and adjust the points indicated on each module to the preferable adjusting ranges given in Table 8-2. If these adjustments do not bring measurements within the preferable adjusting range, it is recommendable to replace the corresponding module.

8-2. Troubleshooting and Module Replacement

The modules of the MT9300 radio section contain densely packed components. To shorten recovery time as much as possible, the radio section is designed for repair in principle by replacement of the faulty module.

8-2-1. Troubleshooting

Every trouble has a cause. When the MSS malfunctions, before going inside it and trying to repair it you should identify the cause of the trouble by making external tests. The first step is to determine whether the trouble is in the radio section or the MCC.

Use the instruments listed in Table 8-1 and the measurement setups described in Section 8-1-2 to locate a fault in the MT9300 radio section. A standard troubleshooting flowchart is given in Fig. 8-5.

This flowchart need not be strictly followed, but should be used as a guide in finding the faulty module.

Table 8-3 lists the principal performances of the modules making up the MT9300 radio section.

8-2-2. Module Replacement

The procedure for replacing a defective module once it has been found is given below.

(1) Replacement of the TX module

- After taking off the top shield cover, remove the three screws holding the printed circuit board of the TX module to the chassis.

- Desolder the coaxial cable to the synthesizer module from the TX module.

- Remove the rear cover of the POW AMP module (which is on the MCC side) and desolder the terminal of the coaxial cable going to the TX module.

- Draw the pull-string of the TX module slowly straight up to unplug its multi-pin connector.

- Install a new module, following the above steps in reverse.

- When installing the new module, secure it with the same screws as before. These screws have set dimensions; if other screws are used, they will damage the chassis and the flexible printed wiring board.

- After installing the new module, make the following checks and adjustments. (Since spare modules are pre-adjusted before shipment, only fine adjustments should be necessary.)

  (a) Check that the printed circuit board and coaxial cables are securely attached.

  (b) Set the DC supply voltage to +9.5 - +10.0V.

  (c) Set the channel setting switch of the channel tester to channel 41.

  (d) Turn the transmitter on at normal power.

  (e) Turn the trimmer (CV4) located on the output side of the TX module slowly and fix it at the point that gives maximum deflection of the pointer on the RF power meter.

  (f) Set the DC supply voltage to +13.2V and check that normal power is 15W and reduced powers are 5W and 2W.

  (g) Check the maximum deviation and standard deviation against Table 8-2 in Section 8-1-4.

  (h) Turn the transmitter on and off several times and check for normal RF output power. (An even better way is to check the output with the spectrum analyzer.)

(2) Replacement of the POW AMP module

- The POW AMP module has two printed circuit boards.

- Open the bottom shield cover to gain access to the POW AMP sub-board. Remove its two screws and draw its pull-string slowly straight up to unplug the connector, being careful not to break any wiring.

- Open the top shield cover to gain access to the input and output coaxial cables and the power wiring. Desolder these cables and wires from the printed circuit board of the POW AMP module.

- Remove the four screws holding the printed circuit board of the POW AMP module.

- Remove the two screws holding the RF power amplifier module. (These screws are located beside the cooling fins.) The POW AMP module can now be removed.

- Install a new module, following the above steps in reverse.

- Installation precautions:

(a) Secure the new module with proper screws.
(b) Before securing the module, apply silicone grease to the

contact surface between the RF power amplifier module and the fins. The grease is necessary to lower the thermal resistance of the contact to improve heat-exchange efficiency.

(c) Tighten the screws holding the RF power amplifier module to the cooling fins firmly.

After installing the new module, make the following checks and adjustments.

(a) Check that the two printed circuit boards, the two coaxial cables, the power cord, and the RF Power amplifier module are all securely attached.

(b) Set V_{CC} to +9.5V, switch to channel 41, and turn the transmitter on at normal power. Turn the trimmer (CV4) located on the output side of the TX module slowly and fix it at the point that gives, maximum deflection of the pointer on the RF power meter.

(c) Set V_{CC} to +13.2V and check that normal level of power is 15W and reduced levels are 5W and 2W as indicated in Table 8-2 in Section 8-1-4. Adjust if there is any difference.

(d) Turn the transmitter on and off several times and check for normal RF output power. (An even better way is to check the output with the spectrum analyzer.)

(3) Replacement of the TX BEF module

- The TX BEF module is mounted on the top side of the chassis.

- Desolder the coaxial interface cable to the POW AMP module from the printed circuit board of the POW AMP module.

- Slowly turn and uncouple the OSM connector between the TX BEF module and the circulator.

- The TX BEF module is fastened by four screws from the bottom side of the chassis. Remove the printed circuit board of the synthesizer module including the VCO, then remove these four screws. (It is not necessary to detach the input-output coaxial cables of the synthesizer module.) The TX BEF can now be removed. If it does not come out easily, loosen the screws holding the circulator.

- Install a new module, following the above steps in reverse.

- Installation precautions:

  (a) Secure the new module with the proper screws.

  (b) Tighten all four screws firmly. (The TX BEF heats up under high power transmission, and the heat must be conducted to the chassis.)

- After installing the new module, make the following checks and adjustments.

  (a) Check that the input-output coaxial cables are securely attached.

  (b) Set V_{CC} to +13.2V and check that normal power is 15W. If it is not, adjust the power of the POW AMP module. Check both normal power and reduced power after making this adjustment.

  (c) Turn the transmitter on and off several times and check for normal RF output power.

(4) Replacement of the circulator

- The circulator is mounted on the top side of the chassis.

- Uncouple the OSM connectors connecting the circulator to the TX BEF and antenna cables and the UM connector connecting it to the RX BPF. The UM connector to the RX BPF can be easily uncoupled if the four screws holding the RX BPF are removed.

- The circulator is fastened by four screws from the bottom side of the chassis. Remove the printed circuit boards of the TX and RX modules, then remove these four screws. (It is not necessary to detach the input-output coaxial cables of the TX and RX modules.) THe circulator can now be removed. If it does not come out easily, loosen the screws holding the TX BEF.

- Install a new module, following the above steps in reverse.

- Installation precautions:

  (a) Secure the new module with the proper screws.

  (b) Tighten all four screws firmly. (The circulator heats up under high power transmission, and the heat must be conducted to the chassis.)

- After installing the new module, make the following checks and adjustments.

  (a) Check that the input-output coaxial cables are securely attached.

  (b) Set V_{CC} to +13.2V and check transmitter and receiver performances according to Table 8-2 in Section 8-1-4.

(5) Replacement of the RX BPF module

- The RX BPF module is mounted on the top side of the chassis.

- Uncouple the UM connectors to the circulator and RX modules from the RX BPF.

- Remove the four screws holding the RX BPF to the top side of the chassis.

pull-string of the synthesizer module slowly straight up to unplug the connector attached to the chassis.

- Install a new module, following the above steps in reverse. Observe the same installation precautions as for the other modules.

- After installing the new module, make the following adjustments and checks.

  (a) Adjust the RX module interface level. Set V_{CC} to +13.2V and switch to channel 41. Adjust the signal generator input level to approximately the nominal sensitivity. (Set the signal generator to TEST MODULATION.) Slowly turn the trimmer (CV3) on the RX output side of the synthesizer module and fix it at the point that gives the maximum SINAD value of RX demodulator output. Then check the receiver performances according to Table 8-2 in Section 8-1-4.

  (b) Check the transmitter performances. The synthesizer has an adjustment-free interface to the TX module, so you need only check the transmitter output characteristics. Check that the RF power output characteristics are normal according to Table 8-2 in Section 8-1-4.

  (c) Check the frequency stability of the transmitter output.

  (d) Set channels at random through the channel tester and check that the disignated channel frequencies are produced properly.

(8) Replacement of the PS module

- The PS module is mounted on the top side of the chassis.

- Remove the three screws holding its printed circuit board.

- Desolder the two cords (black and red) led to the POW AMP module from the POW AMP module.

- Draw the pull-string of the PS module slowly straight up to unplug the connector attached to the chassis.

- Install a new module, following the above steps in reverse. Observe the same installation precautions as for the other modules.

- After installing the new module, make the following checks.

  (a) Set V_{CC} to +10.8V, turn the power switch on and off several times, and check for normal operation. Repeat this check with V_{CC} set to +15.6V.

  (b) After remounting the MCC printed circuit board, set V_{CC} to approximately +8.5V and confirm that the power supply shuts off automatically in about 40 sec.

(9) Replacement of the chassis

- Most chassis troubles are caused by the flexible printed circuit board. Since the flexible printed curcuit board is attached firmly to the chassis at the factory, when it malfunctions it is best to replace the entire chassis. The flexible printed circuit board is made from a 40 - μm thickness of polyamide. Care should be taken not to scratch or damage it when replacing modules.

Table 8-1

LIST OF MEASURING APPARATUS FOR MAINTENANCE

	Designation	Rating	Note
1	RF POWER METER	Max: 20W, 400MHz Band Impedance: 50 ohm	
2	REGULATED POWER SUPPLY (DC)	+13.2V, 10A or more Serial regulation	
3	AF OSCILLATOR	300Hz - 3KHz Impedance: 600 ohm	
4	AF VARIABLE ATTENUATOR	Attenuation: 0 - 60 dB/0.1 dB step Impedance: 600 ohm	
5	DIRECTIONAL COUPLER	100MHz - 1GHz or more Coupling ratio: 20 dB	
6	RF FIXED ATTENUATOR	1W or more VSWR 1:1.1 DC - 1GHz or more	
7	FREQUENCY COUNTER	500MHz or more Frequency stability: $1x10^{-6}$ or better	
8	FREQUENCY DEVIATION METER	Deviation range: ±5KHz or more 400MHz band	
9	AF LEVEL/SINAD METER	Impedance: 600 ohm	
10	SIGNAL GENERATOR	400MHz band Impedance: 50 ohm FM modulation terminal provided	
11	CIRCULATOR	400MHz band Max.: 20W VSWR 1:1.2	
12	ISOLATOR	400MHz band Max.: 20W VSWR 1:1.2 Isolation: 20dB or more	
13	CHANNEL TESTER	(TOYO made)	
14	SPECTRUM ANALYZER	Band width 100MHz - 1GHz or more	

Table 8-2

MAIN ADJUSTMENT

Adjusting Item	Adjusting point indicating on module unit	Module	Adjusting target	Preferable adjusting range	Adjustment conditions			
					Vcc	CH	Temp.	
Normal power adjustment	NORM POW ADJ	POW AMP	15W	13 - 17W	+13.2V	41	Normal	Adjustment shall be done within 1 min. after TX "ON".
Reduced power adjustment	POW CONT ADJ	"	.5W .2.0W	4.5 - 5.5W 1.8 - 2.2W	"	"	"	Adjustment shall be done within 1 min. after TX "ON". This adjustment shall be made only after completion of full power adjustment.
Maximum deviation adjustment	MAX DEV ADJ	TX	±4.7KHz	±4.5 - ±4.9 KHz	"	"	"	AF (Audio Frequency): 2.0KHz AF input level: +10dBm/600 ohm
Standard deviation adjustment	STD DEV ADJ	"	±3.0KHz	±2.8 - ±3.2 KHz	"	"	"	AF: 1.0KHz AF input level: -10dBm/600 ohm N.B. As maximum deviation and standard deviation are in correlation, each shall be adjusted alternately.
CDL adjustment (Squelch adjustment)	CDL ADJ (SOL ADJ)	RX	0 dBμ	±3dB	"	"	"	Adjustment shall be made while TX "ON". SG modulation: AF 1KHz with ±3KHz deviation
CDM adjustment	CDM ADJ	"	15.5dBμ	±3dB	"	41	"	Adjustment shall be made while TX "ON". SG modulation: AF 1KHz with ±3KHz deviation
CDH adjustment	CDH ADJ	"	20 dBμ	±3dB	"	"	"	Adjustment shall be made while TX "ON". SG modulation: AF 1KHz with ±3KHz deviation
AF level adjustment	AF LEV ADJ	"	-10dBm	-11 - -9dBm	"	"	"	RF input: 60dBμ SG modulation: AF 1KHz with ±3KHz deviation
Frequency adjustment	FREQ ADJ	SYNTH	within 0±100Hz	within 0±300Hz	"	80	"	Adjustment shall be done at channel 80 = 452.975MHz (TX) within 1 min. after TX "ON" without modulation. N.B. For this adjustment, frequency counter shall be preheated and accuracy of its internal standard oscillator shall be kept $\pm 1x10^{-8}$ or better.

Table 8-3

PRINCIPAL PERFORMANCES OF MODULES

(1) 1A2 TX MODULE

SUPPLY VOLTAGE	Vcc: +13.2V
TX-KEY (IN)	TX On "H", TX Off "L"
TX ALM (OUT)	Normal "L", Alarm "H"
AF INPUT	300 Hz - 3 KHz, Normal Level: -10 dBm / 600 ohm
LOCAL INPUT	390.650 - 392.625 MHz, Level: -5 dBm / 50 ohm or more
OUTPUT SIGNAL	450.350 - 452.325 MHz, Level: +22 dBm / 50 ohm or more Deviation: Normal ±3 KHz Maximum ±5 KHz or less

(2) 1A3 POW AMP MODULE

SUPPLY VOLTAGE	Vcc: +13.2V
PWR ON/OFF (IN)	Power On "H", Power Off "L"
PWR CONT (IN)	"M" power 4V, "L" power 8V
TX ALM (IN)	Normal "L", Alarm "H"
PWR MONITOR (OUT)	Power Off "L", Power On "H"
INPUT SIGNAL	450.350 - 452.325 MHz Level: +22 dBm / 50 ohm
OUTPUT SIGNAL	450.350 - 452.325 MHz Normal Power: 20 W (+43 dBm) or more Reduced Power: 5W ±1.5dB, 2W±1.5dB

(3) 1A4 TX BEF

INPUT/OUTPUT FREQ.	450.350 - 452.325 MHz
INPUT PWR	20 W or less
IN-BAND LOSS	1.0 dB or less

(4) 1A5 CIRCULATOR

TX (1) TERMINAL	450.350 - 452.325 MHz Input Power: 20 W or less
RX (3) TERMINAL	460.350 - 462.325 MHz TX Leak Level: 20 dB or more when antenna terminal is matched to 50 ohm.
ANT (2) TERMINAL	450.350 - 462.325 MHz Loss between (1) and (2) Terminal: 0.5 dB or less Loss between (2) and (3) Terminal: 1.0 dB or less

(5) 1A6 RX BPF

INPUT/OUTPUT FREQ.	460.350 - 462.325 MHz
INPUT MAX. PWR	15 W or less
IN-BAND LOSS	3.0 dB or less

(6) 1A7 RX MODULE

SUPPLY VOLTAGE	Vcc: +13.2V
RF INPUT FREQ.	460.350 - 462.325 MHz
RF SENSITIVITY	-3 dBμ or less (12 dB SINAD) EMF
LOCAL INPUT	390.650 - 392.625 MHz Level: +5 dBm / 50 ohm or more
AF OUTPUT	300 Hz - 3 KHz Normal Level: -10 dBm / 600 ohm at 1 KHz
CDL LEVEL	-5dBμ(In case connected with CIRC and RXBPF; 0 dBμ)
CDH LEVEL	18dBμ(In case connected with CIRC and RXBPF; 20 dBμ)
CDM LEVEL	12.5dBμ (In case connected with CIRC and RXBPF; 15.5 dBμ)

(7) 1A8 SYNTH MODULE

SUPPLY VOLTAGE	Vcc: +13.2V
TX LOCAL OUT	390.650 - 392.625 MHz Output Level: -5 dBm / 50 ohm or more
RX LOCAL OUT	390.650 - 392.625 MHz Output Level: +5 dBm / 50 ohm or more
ALM OUT	Normal "L", Alarm "H"

(8) 1A9 PS MODULE

SUPPLY VOLTAGE	Vcc: +13.2V Maximum Passing Current: 5.0 A (FPC: 500 mA)
AUTONOMOUS TIMER	Approx. 10 sec. at 400 Hz Clock
LOW VOLTAGE DETECTION	Vcc: +9.0V Normal