MOTOROLA INC.
Communications
Sector

# ALIGNMENT PROCEDURES

## 1. RECOMMENDED TEST EQUIPMENT

The list of equipment contained in Table 1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specially for servicing the P200 radio. Battery operated test equipment is recommended when available. The "Characteristics" column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or substitution is not recommended.

## 2. GENERAL

**THIS RADIO HAS BEEN FACTORY ALIGNED AND DOES NOT REQUIRE ANY ADJUSTMENTS.** Realignment may be required if components are replaced or have aged, or if any transmitter/receiver frequencies are changed. If it is necessary to realign the radio, perform the following procedures:

1. When using the RTX-4005 test box, place the **MT PL** switch in the **OFF** position.

2. Remove the battery and front cover as described in the "DISASSEMBLY" paragraphs located in the maintenance section of this manual.

*Table 1. Test Equipment*

| Motorola Model No. | Description | Characteristics | Application |
|---|---|---|---|
| R2200, R2400, or R2001D with Trunking Option | Service Monitor | This monitor will substitute for items with an asterisk (*) | Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment |
| *R1049A | Digital Multimeter | | Two meters recommended for ac/dc voltage and current measurements |
| *S1100A | Audio Oscillator | 67-Hz to 161.4-Hz tones | Used with service monitor for injection of PL tones |
| *S1053D<br>*SKN6009A<br>*SKN6001A | AC Voltmeter<br>Power Cable for Meter<br>Test Leads for Meter | 1 mV to 300 V, 10-megohm input impedance | Audio voltage measurements |
| R1053 | Dual-Trace Oscilloscope | 20-MHz bandwidth 5 mV/cm - 20 V/cm | Waveform measurements |
| *S1350C<br>*T1013A | Wattmeter | 50 ohm, ±5% accuracy | Transmitter power output measurements |
| S1339A | RF Millivolt Meter | 100 μV to 3 V rf<br>10 kHz to 1.2 GHz | RF level measurements |
| *R1013A | SINAD Meter | | Receiver sensitivity measurements |
| S1347D or<br>S1348D (programmable) | DC Power Supply | 0-20 Vdc, 0-5 amperes current limited | Bench supply for 7.5 Vdc |
| RTX4005B<br>RTK4205A | Portable Test Set and Test Cable | | Enables convenient connection to the accessory jack, with switching for complete testing of radio |

*R2200, R2400, or R2001D will substitute for items with an asterisk (*)



technical writing services
1301 E. Algonquin Road, Schaumburg, IL 60196

68P81085E59-O
8/15/90-UP

3. Refer to the Test Set-Up Detail illustration and connect the test equipment and Computer/RIB to the radio as illustrated.

4. Connect a dc power supply to the battery eliminator and attach the battery eliminator to the radio.

5. Adjust the power supply for 10.0 Vdc. Set current limit to 2.0 A.

6. Turn the radio off then on to reinitialize the radio.

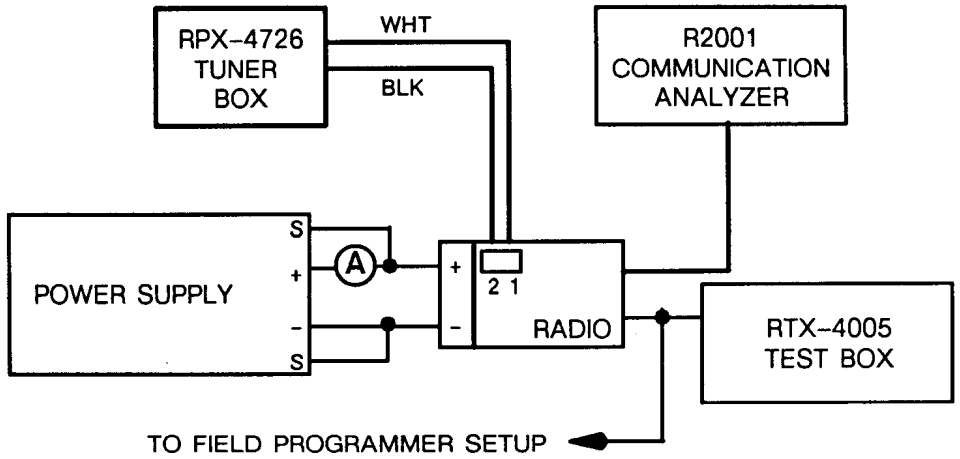
7. **Frequency Adjust (Synthesizer)** - Terminate the program/test cable (RTK-4205A), RF lines (pins 10 and 12), through a 30-dB pad to a frequency counter or service monitor. Set the radio to any channel. Key the radio using the external PTT switch. Compare the frequency reading on the counter (or service monitor) to the customer frequency assigned to that channel. The frequency difference should be less than ±300 Hz. Adjust R129 if the frequency difference is more than ±300 Hz.

8. Perform either the "RECEIVER ALIGNMENT" procedure or "TRANSMITTER ALIGNMENT" procedure or both procedures as required.

## ALTERNATE LOWBAND REFERENCE OSCILLATOR FREQUENCY ADJUST

If your lowband radio has reference oscillator adjustment potentiometer R120, return to and perform step 7 of the GENERAL procedure. If your lowband radio has a two-pin connector in place of R120, perform the following alternate procedure.

**ALTERNATE TEST SETUP**




| **PRESET:** | **Communications Analyzer to:** | | **Portable Test Box to:** | |
|---|---|---|---|---|
| | • MODE- | Monitor | MT PL- | Off |
| | • MONITOR- | Frequency | PTT switch- | Continuous |

**RESULT:** Read frequency error on Service Monitor. Desired result is nominal frequency ±300 Hz.

**PROCEDURE:** With the Alternate Test Setup above, use the UP/DOWN and COARSE/FINE switches on the Tuner Box to bring the measurement within tolerance (300 Hz). Adjust by holding the POWER button depressed and simultaneously pressing and releasing the TUNE button. Adjust to nominal frequency +50 Hz to allow for drift.

*Table 2. Power Output Adjustment*

| STEP | ADJUST | FOR | USING | NOTE |
|---|---|---|---|---|
| 1 | Check power output of all channels. NOTE: You must dekey before changing channels for the synthesizer to change frequencies. Set the frequency switch to the channel with the lowest output power. | | | |
| 2 | C159 TRIMMER CAPACITOR | Maximum power output with least current drain | RF Wattmeter and Amplifier | Use wide end of tuning tool. |
| 3 | *C115 TRIMMER CAPACITOR | Maximum power output with least current drain | RF Wattmeter and Amplifier | Use narrow end of tuning tool. If the power exceeds 7.8 W, tune C115 to 7.8 W. |
| 4 | *C159 TRIMMER CAPACITOR | Power output of 6.8 to 7.0 W | RF Wattmeter and Amplifier | If power does not make the 6.8 to 7.0 W window, peak C159. |
| 5 | C115 TRIMMER CAPACITOR | Power output of 6.2 to 6.4 W | RF Wattmeter and Amplifier | Two possible peaks: choose peak with least current drain. Adjust from component side. |
| 6 | Check both ends of the customer frequency to ensure a minimum power output of 6.2 W. | | RF Wattmeter and Amplifier | Maximum frequency separation is 1 MHz. |

*When tuning capacitor C115, be careful not to touch the leg of C115 and the heatsink with a metal tuning tool. Refer to the Alignment and Metering Point Locations.

## 3. TRANSMITTER ALIGNMENT

**Review "GENERAL" information paragraph before performing TRANSMITTER ALIGNMENT**

Preliminary Adjustments:

1. Terminate the program/test cable, RF lines (pins 10 and 12), to a power meter through a 30-dB pad.
2. Make all measurements at the Universal Interface Connector (pins 10 and 12), with radio keyed through the external PTT switch.
3. Program new customer frequencies (if necessary).

DEVIATION CHECK:

1. Terminate the program/test cable through a 30-dB pad to a service monitor or deviation meter.
2. Place the **METER SELECTOR** switch on the test box (RTK-4005) to the MIC position. Insert a 1-kHz tone at the **AUDIO IN** port of the test box. Use an ac voltmeter to monitor the voltage at the **AC/DC METER** port of the test box. Using the PTT switch on the RTX box to key the radio, adjust the level of the 1-kHz tone until 45 millivolts RMS is present at the **AC/DC METER** port. Dekey the radio.
3. If the radio requires a change in frequency or options, make the appropriate changes to the work space and program the radio.

**NOTE**

The RTK-4000 test box has a resistive divider between the **AUDIO IN** port and the **AC/DC METER** port. To accurately set deviation, 45 mV must be present at the the **AC/DC METER** port. This means that approximately 450 VRMS must be applied to the **AUDIO IN** port.

4. With the 1-kHz tone applied, check the total transmit deviation. It should be greater than 4.0 kHz but less than 5.0 kHz. If any of the deviations are not in the proper range, perform the **Radio Wide Deviation Alignment.**
5. For channels with Transmit PL, remove the 1-kHz tone from the **AUDIO IN** port of the test box. Check the deviation of the PL signal; it should be greater than 500 Hz but less than 1000 Hz. If any of the deviations are not in the proper range, perform the **Radio Wide Deviation Alignment.**

**Channel Deviation Alignment:**

ONLY PERFORM CHANNEL DEVIATION ALIGNMENT ON THOSE CHANNELS THAT FAILED THE RADIO DEVIATION ALIGNMENT.

1. Press the **F7** key in the MAIN/SERVICE menu to enter the CHANNEL DEVIATION Alignment menu to realign an individual channel. The cursor will be at TRANSMIT DEV position.
2. Set the radio on the channel to be aligned.
3. Set the service monitor(or deviation meter) to the transmit frequency (displayed in the upper right-hand

corner of the screen) of the channel to be aligned. Press and hold down the PTT switch on the test box to continuously key the radio.

4. Withe the 1-kHz tone applied, use the up/down arrow keys to adjust the peak deviation to the limits displayed on the screen. Release the PTT switch on the test box to dekey the radio. Press the **ENTER** key to move the cursor to the REFERENCE DEV position.

5. Disconnect the 1-kHz tone from the **AUDIO IN** port of the test box.

6. Press and hold down the PTT switch on the test box to continuously key the radio.

7. Use the up/down arrow keys to adjust the peak deviation to the limits displayed on the screen. Release the PTT switch on the test box to dekey the radio.

8. Press **F8** to program the deviation values for this channel into the radio.

9. Press F10 to exit the menu.

10. With the 1-kHz tone applied, check the peak deviation for this channel. It should be greater than 4 kHz but less than 5 kHz.

11. For channels with Transmit PL, remove the 1-kHz tone from the **AUDIO IN** port of the test box. Check the deviation of the PL signal. It should be greater than 500 Hz but less than 1000 Hz.

12. Repeat steps 1 through 11 for all channels that failed the deviation check in the **Radio Wide Deviation Alignment** procedure

Deviation Adjustment for DTMF Radios:

1. Follow the deviation procedure detailed above.

2. Press the number **1** key on the DTMF pad and continuously key the radio's PTT switch. Adjust R709 for 3.0 to 3.2 kHz deviation.

**NOTE**

DTMF memory is volatile. If the battery is left off for more than 2 minutes, the memory will be erased.

## 4. RECEIVER ALIGNMENT

**Review "GENERAL" information paragraph before performing RECEIVER ALIGNMENT.**

Preliminary Adjustments:

1. The receiver is factory-tuned to operate over the entire bandsplit and should not need retuning. Perform the "Receiver Check" to determine if "RECEIVER ALIGNMENT" (tuning any portion of the receiver) is necessary.

2. Connect the program/test cable (RTK-4205A) to the Radio Interface Box (RIB). Use the radio service software to read the radio.

3. When using the RTX-4005 test box, place the **AUDIO OUT** switch in the **B** position to set for proper speaker loading. Place the meter selector in the **AUDIO PA** position for receiver tests.

4. Connect the rf cable of the test cable to an rf generator or service monitor.

**NOTE**

Some interference conditions can be eliminated by changing the second injection. The second injection can be changed using the radio service software. Refer to the RSS manual for more details.

Receiver Check:

1. Use the radio service software to program for new customer frequencies, if necessary.

2. Set the rf generator (or service monitor) for the appropriate frequency at a 1-mV level with a 1-kHz tone modulated at 3-kHz deviation.

3. Connect the **AC/DC METER** port of the RTX-4005 to an ac voltmeter. Adjust the volume potentiometer (R140) for an ac voltmeter reading of 4.47 Vrms.

4. Connect a SINAD meter to the **AC/DC METER** port of the RTX-4005.

5. Reduce the rf level until 12 dB of SINAD is obtained; record the rf level reading. Depress the monitor button while taking this measurement to ensure that the radio is not squelched. Also, temporarily disconnect the test cable from the RIB to ensure that computer noise does not affect the measurement.

6. Perform SINAD measurements on all channels.

7. If the rf level required to produce 12-dB SINAD is 0.25 µV or less, DO NOT REALIGN THE RECEIVER; instead, proceed directly to "Squelch Sensitivity/ Check Adjustment." If the rf level required to produce 12-dB SINAD is greater than 0.25 µV, perform the "Receiver Alignment."

**DO NOT PERFORM RECEIVER ALIGNMENT UNTIL THE "RECEIVER CHECK" HAS BEEN PERFORMED.**

**NOTE**

The receiver back end coils (L12 and L13) and the receiver front end coil L2 are factory tuned to cover the entire bandsplit and should not need retuning. Should the rf amp, mixer, crystal filters, i-f module, or accompanying parts need replacing, it may be necessary to perform the following tuning procedure.

Receiver Alignment (Back End):

1. Remove the radio from its housing as described in the "DISASSEMBLY" paragraphs located in the maintenance section of this manual, then remove the backplane shield.
2. Attach the battery adapter to the radio frame, then attach the battery eliminator to the battery adapter.
3. Selecting any one of the customer frequencies, adjust the rf generator or service monitor for the appropriate frequency. Then, place the radio front side down so that the solder side (side 2) of the PC board is facing up.
4. Tune coils L12 and L13 flush with the solder side of the PC board.
5. With an ac voltmeter, monitor **M1** on the solder side of the PC board. Set the ac voltmeter to the –40 dB scale and adjust the rf level so that the voltage can be monitored at M1. During the following procedure, adjust the rf level to keep the ac voltage at M1 within the –40 dB scale.
6. Peak coils L12 and L13 (in that order) for maximum ac voltage at M1.
7. Perform the "Receiver Check" procedure, then repeat Steps 4–6 of the "Back End" procedure, if necessary.

Receiver Alignment (Front End):

**NOTE**

Perform the following procedure only if the radio fails the "Receiver Check" and the "Receiver Back End Alignment" tests. The radio should already have been removed from the housing.

1. Tune coil L2 flush with the solder side (side 2) of the PC board.
2. Program the radio to a frequency centered between the highest and lowest customer frequencies. Then adjust coil L2 for the maximum ac voltage level at M1. Select the peak where the slug of the coil is closest to the solder side of the PC board.
3. Program the radio back to the original customer frequency.
4. Perform the "Receiver Alignment (Back End)" procedure and then the "Receiver Check."

Squelch Sensitivity Check/Adjustment:

1. Set the radio frequency to the channel determined to have the poorest sensitivity on the "Receiver Check." Place the PL/SCAN switch in the carrier squelch position ( ⊳ ).
2. Connect an ac voltmeter to the **AC/DC METER** port of the test box (RTX-4005).
3. Set the rf generator or service monitor for the appropriate frequency and no modulation. Reduce the rf level to a minimum.
4. Depress the monitor button on the side of the radio and adjust the noise level for 2.2 Vrms. Make a note of the level on the dB scale; this will be the reference level for quieting measurements.
5. Press the **F3** key in the MAIN/SERVICE menu to enter the SQUELCH and VOLUME Alignment menu. The cursor will be at the CARRIER SQUELCH position. Increase the rf level until squelch break occurs. Note the quieting level at squelch break. If squelch break occurs between 8 and 18 dB of quieting, proceed directly to step 8. If the quieting level is not within the 7- to 16-dB range, proceed to step 6.
6. Press the up/down arrow keys to adjust the CARRIER SQUELCH setting to 0. Adjust the rf level for 8 dB of quieting.
7. Holding the rf level constant, press the up arrow key to increment the CARRIER SQUELCH setting one step at a time until the radio squelches. This will be the CARRIER SQUELCH setting.
8. Reduce the rf level to a minimum. The radio should be squelched.
9. Press the **ENTER** key to proceed to the TONE SQUELCH position on the menu.
10. The TONE SQUELCH setting should be the same as the CARRIER SQUELCH setting. If not, use the up/down arrows to set the TONE SQUELCH setting to the same value as the CARRIER SQUELCH setting.
11. Press the **ENTER** key to proceed to the SCAN SQUELCH position on the menu.
12. The SCAN SQUELCH setting should be the same as the CARRIER SQUELCH setting. If not, use the up/

down arrows to set the SCAN SQUELCH setting to the same value as the CARRIER SQUELCH setting.

13. If the squelch settings require modification, program the radio.

Cloning procedure:

(The content of radio A is to be duplicated into radio B)

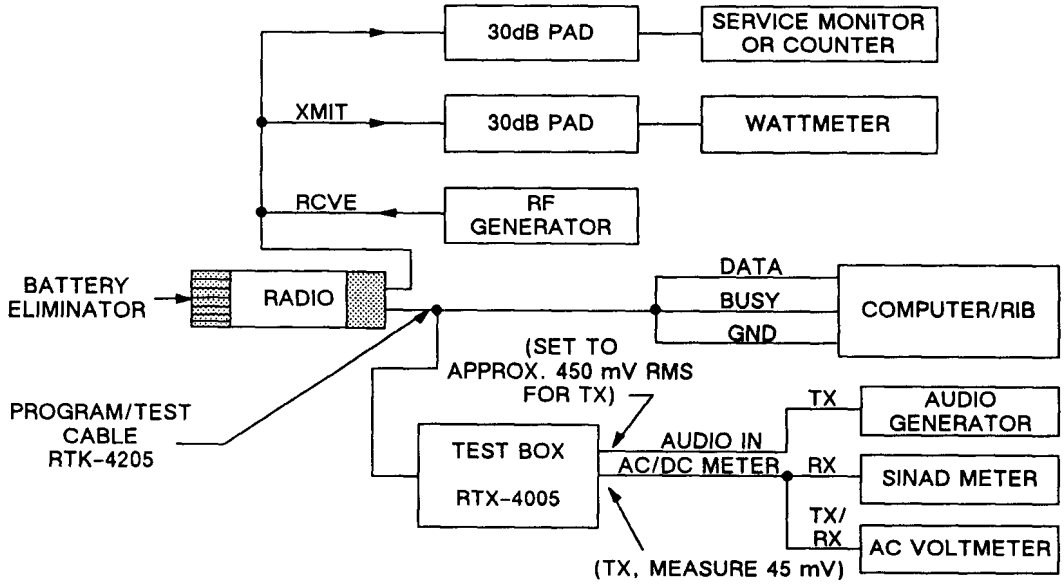
1. Turn off radio A and turn on radio B.
2. Connect the cloning cable (NKN6376A to the Universal Connector of both radio A and radio B.
3. Simultaneously depress the PTT and either monitor button on radio A and hold.
4. Turn on radio A. The green LED on radio B will flash, indicating that cloning is in progress.
5. Cloning is complete once the green LED turns off. Release both the PTT and the monitor buttons on radio A. Turn radio A off and on to reset.

**NOTE**

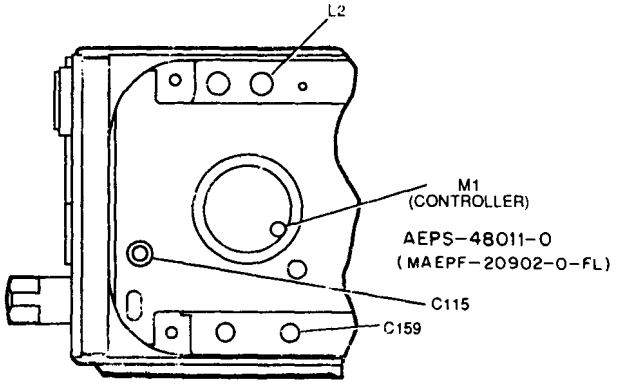
Cloning procedure does not duplicate the deviation and squelch settings.

6. Disconnect the cloning cable and turn on both radios to resume normal operation

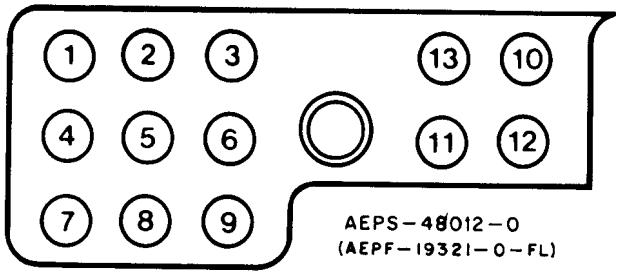
## TEST SETUP DETAIL




## ALIGNMENT AND METERING POINT LOCATION (CONTROLLER)



## UNIVERSAL CONNECTOR DETAIL AND PIN NUMBER ASSIGNMENT




| | |
|---|---|
| 1 | EXTERNAL MICROPHONE |
| 2 | EXTERNAL SPEAKER |
| 3 | OPTION B+ |
| 4 | EXTERNAL PTT |
| 5 | GROUND (to controller board) |
| 6 | DATA |
| 7 | EXTERNAL SPEAKER SELECT |
| 8 | SPEAKER COMMON |
| 9 | BUSY |
| 10 | REMOTE ANTENNA |
| 11 | CVC SENSE |
| 12 | RF GROUND (to mother board) |
| 13 | SENSE |

## ALIGNMENT ADJUSTMENT LOCATIONS