CODAN
RADIO COMMUNICATIONS

TN900
Codan MT-3 and IFR 1200 by Aeroflex Test Procedures

Technical Note for Tuning, Testing, Maintaining and Servicing MT-3 FM Analog Radio Systems with the IFR 1200 by Aeroflex

Codan Radio Communications
43 Erie Street
Victoria, British Columbia
Canada V8V 1P8

International
Phone: **250-382-8268**
Fax: **250-382-6139**

Email: **LMRsales@codanradio.com**
Web: **www.codanradio.com**

Toll Free Canada and U.S.A.
Phone: **1-800-664-4066**
Fax: **1-877-750-0004**

TN900 Codan MT-3 and IFR 1200 Test Procedures

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Important Information

This Technical Note is intended as an aid to configuring and testing Codan MT-3 radios using an IFR 1200 Service Monitor by Aeroflex. Neither Codan Limited or Aeroflex Inc. assume responsibility for damage caused to either unit as a result of misinterpretation or misuse of this procedure. Codan manufactured Products are warranted against defective materials and workmanship. This warranty does not extend to damage due to misuse, neglect, accident, improper configuration or installation. Codan and Aeroflex shall be released from all obligations under its respective warranty in the event the Products are subject to misuse, neglect, alteration, accident, improper installation or testing, or if un-authorized repairs are performed by the Customer or others. These procedures can be modified, changed and altered at any time to better suit your specific needs and requirements.

43 Erie Street
Victoria, B.C.
Canada V8V 1P8

Toll Free Canada & U.S.A.
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Fax: 1-877-750-0004

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General Set-Up and Connections

Frequencies and Bandwidths:

The receiver and transmitter modules are individually programmed with RF frequencies and are also designed for wideband or narrowband operation. Familiarize yourself with all of the transmitter and receiver settings before testing or tuning the Codan radio system.

Typical Specifications:

This document refers to some TYPICAL receiver and transmitter specifications. Refer to the Instruction Manuals for complete radio system specifications.

Adapters, Cables and Extender Cards:

Various adapters, cables and extender cards are required for the different radio tests. Extender cards and adapters are available from Codan Radio Communications. The receiver front end filter tuning requires an SMB - BNC adapter (5192-WJ01BJ01) that is available from Codan Radio Communications.

Control Cards:

Most Codan MT-3 radio systems have an AC-3E or AC-3L-96 Audio Control Card for use in the radio system. The Control Cards connect to the receiver and transmitter balanced audio lines with an unbalanced load, which could cause some measurements to be in error. If the radio system includes an Audio Control Card, remove the control card from the rack for the individual receiver and transmitter tests unless otherwise noted.

Audio Connections:

The Receiver, Transmitter and Auxiliary Balanced audio lines are available for connection on Codan extender cards or by connecting to the optional back panel A-PNL-AUX96-3 screw-type terminal connector. The extender cards have solder points available on each signal line that can have a small test point, (5059-TP110300) that is supplied with the extender card, soldered to them for easy connection with clip-on type clips. Recommended Test Points are:

Audio Control Card Extender Card pins (EC-96D1 and EC-96K-1.22):

Auxiliary 1 Audio Output = B11 & A11

Auxiliary 2 Audio Output = C1 & C3

Auxiliary 1 Audio Input = C19 & C20

Auxiliary 2 Audio Input = B14 & A14

Receiver and Transmitter Extender Card pins (EC-48RD and EC-48RK-1.22):

Rx Balanced Audio Output = B26 & Z26

Tx Balanced Audio Input = B18 & Z18

Tx Subtone Input = B22 & Ground (B32)

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System Regulator Testing

System Voltage Testing

The first stage of testing a Codan MT-4E radio system is to perform a basic system check on the supply and regulated voltages. The System Regulator module is designed with a convenient and easy test point built in to the front panel. This test point allows a technician access to the DC supply and regulated voltages. Simply connect a standard Digital Volt Meter (DVM) to the METER jacks on the front panel of the System Regulator as shown in Figure 1.

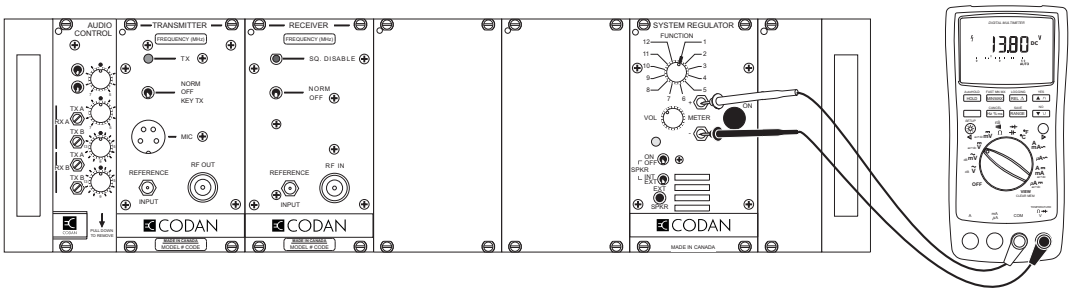

Figure 1: System Regulator Voltage Testing

The FUNCTION rotary switch on the front panel of the System Regulator will allow you to test various points in the radio system. Following is a list of System Regulator rotary switch positions, the functions they measure and the parameters measured:

1	Supply Voltage	+10 Vdc to +17 Vdc (+13.8 Vdc nominal)
2	+9.5 Volts Regulated	+9.5 Vdc (± 0.1 Vdc)
3	Rx A Audio	Receiver A Audio (NOT Rx Balanced Output)
4	Rx A Carrier Strength	0 Vdc to +5.0 Vdc based on received signal strength (0 Vdc is a low RF signal level, +5.0 Vdc is high)
5	Rx B Audio	Receiver B Audio (NOT Rx Balanced Output)
6	Rx B Carrier Strength	0 Vdc to +5.0 Vdc based on received signal strength (0 Vdc is a low RF signal level, +5.0 Vdc is high)

The standby current draw of the radio system should be measured for battery / solar powered systems. Connect an ammeter to the power input line and measure the standby current draw and transmit current draw of the system. The maximum standby and transmit current draw is dependant on the radio system (number and class of receivers, transmitter output power, amplifiers, auxiliary equipment, etc.).

Backwards Compatibility

The SM-3 System Regulator is a direct replacement for the SM-3 System Monitor, however, the rotary switch positions for the front panel test points have been changed.

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Receiver Testing

Connect the IFR 1200 and Codan radio as shown in Figure 2:

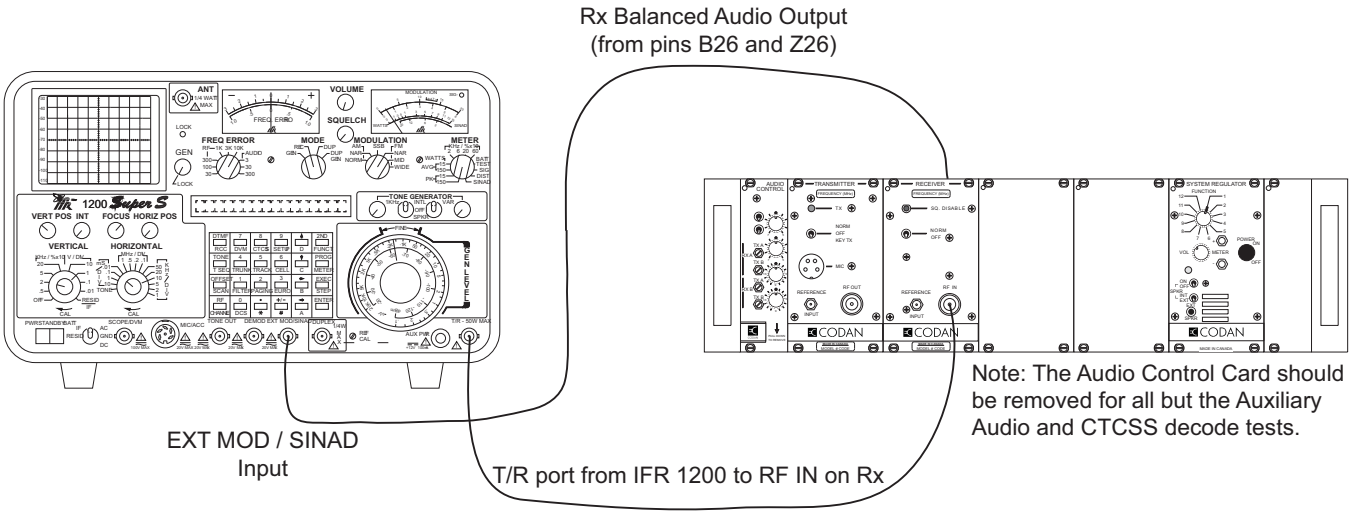

Figure 2: Receiver Testing

Set up the IFR 1200 as follows:

1. Temporarily unplug the EXT MOD / SINAD input.
2. Set the MODE switch to GEN.
3. Set the MODULATION switch to FM NAR.
4. Set the METER switch to 6 (Khz/%x10).
5. Set the GEN LEVEL dial to -70 dBm.
6. Push the RF button on the keypad and input the Receiver RF frequency.
7. Push 2ND FUNCT then METER (PROG) on the keypad.
8. On the TONE GENERATOR area turn the 1 KHz tone ON (up).
9. Adjust the 1 KHz variable level knob until the meter reads ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow).

On the Codan Radio system, ensure the receiver is turned on and turn the System Regulator Speaker switch ON. Ensure the rotary select switch is set to the correct Receiver Audio (depending on the receiver being tested), then turn the volume up until the 1 KHz tone is audible.

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Distortion:

To check the receiver distortion, set the METER switch to DIST. Plug the EXT MOD / SINAD input back into the IFR 1200. Please note that the IFR 1200 does not have the proper bandpass filter for a true Audio Distortion measurement according to TIA-603-C. The distortion will read slightly higher than normal when read using an IFR 1200. Receiver audio distortion is typically less than 3.0 %.

Sensitivity (12 dB SINAD):

To check the receiver sensitivity, set the METER switch to SINAD. If not done already, plug the EXT MOD / SINAD input back into the IFR 1200. Slowly turn the GEN LEVEL dial down to lower RF generator levels while monitoring the SINAD meter. The receiver sensitivity point is where the RF generator level is for a 12 dB SINAD reading (The SINAD meter tends to jump around; look for the closest RF level for an average of 12 dB SINAD). Receiver sensitivity is typically -116 dBm to -118 dBm, depending on the receiver model.

If the Distortion or SINAD measurements are not within Codan published specifications, the Front End may need re-alignment. Refer to the Receiver Front End Alignment and Tuning section.

Squelch:

To check the receiver squelch points, adjust the RF carrier level up and down with the GEN LEVEL dial until the receiver squelches and unsquelches. There should be approximately 6 dBm of hysteresis (centered around the sensitivity point) on MT-3 receivers. The squelch and unsquelch point can be adjusted on the receiver mainboard (R88 & R115). Refer to the Instruction Manual or Technical Note for squelch setting procedures.

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Receiver and Auxiliary (AC-3E) Output Audio Levels:

The audio level adjustment can be done on both the Rx Balanced Audio Output and the Auxiliary Balanced Output (1 and 2). The Auxiliary Balanced Output is only available on the AC-3E Control Card. The Receiver and Auxiliary Balanced Audio Outputs are 600 ohm balanced audio outputs and will require an external 600 ohm matching load before an accurate measurement of the audio level can be performed by the IFR 1200. Some connections may need to be changed from Figure 2.

1. Set the GEN LEVEL dial to -70 dBm.
2. Set the METER switch to 6 (Khz/%x10).
3. Push 2ND FUNCT then METER (PROG) on the keypad.
4. On the TONE GENERATOR area, turn the 1 KHz tone ON (up).
5. Adjust the 1 KHz variable level knob until the meter reads ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow).

Rx Balanced Output:

1. Ensure the receiver is turned on and the Audio Control Card is NOT plugged into the subrack.
2. Disconnect the Rx Balanced Audio Output from the EXT MOD/SINAD connector and connect it to the SCOPE/DVM input on the IFR 1200.
3. Push 2ND FUNCT, then DVM (7) on the IFR 1200 keypad.
4. If the DVM meter is reading a DC voltage, push ± on the keypad to toggle between DC and AC Voltmeter.
5. Adjust the Rx Balanced Audio level adjustment (R64 the High Level Drive Adjust) for -8.0 dBm audio level (308 mVrms @ 600 ohms). If no external 600 ohm load is available, the audio level could be adjusted for approximately 585 mVrms in the IFR 1200.

Auxiliary Balanced Output (1 & 2):

1. Ensure the receiver is turned on and the Audio Control Card IS plugged into the subrack.
2. Connect the Auxiliary Balanced Audio Output (1 or 2) from the AC-3E to the SCOPE/DVM input on the IFR 1200.
3. Push 2ND FUNCT then DVM (7) on the IFR 1200 keypad.
4. If the DVM meter is reading a DC voltage, push ± on the keypad to toggle between DC and AC Voltmeter.
5. Adjust the Auxiliary Balanced Audio level adjustment (R13 for Aux Out 1, R56 for Aux Out 2) for 0.0 dBm audio level (775 mVrms @ 600 ohms). If no external 600 ohm load is available, the audio level could be adjusted for approximately 2.50 Vrms in the IFR 1200.

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CTCSS Decode:

To check the CTCSS decode of the receiver, plug the Audio Control Card into the subrack and ensure that the CTCSS decode switch is turned ON (if applicable). When the decoder is turned ON, the receiver will mute and audio will no longer be audible at the System Regulator speaker.

1. Set the GEN LEVEL dial to -70 dBm.
2. Set the METER switch to 6 (Khz/%x10).
3. Push 2ND FUNCT, then METER (PROG) on the keypad.
4. On the TONE GENERATOR area, turn the 1 KHz tone ON (up).
5. Adjust the 1 KHz variable level knob until the meter reads ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow).
6. On the TONE GENERATOR area, turn the 1 KHz tone OFF (down) and turn the VAR tone ON (up).
7. Push TONE and enter the CTCSS decode tone, then ENTER on the keypad.
8. Push 2ND FUNCT, then METER (PROG) on the keypad.
9. Adjust the VAR variable level knob until the meter reads a deviation of ±0.50 KHz wide / ±0.35 KHz narrow.
10. On the TONE GENERATOR area, turn the 1 KHz tone ON (up).

The receiver will now un-mute and the 1 KHz tone (and possibly the CTCSS tone) will be audible on the System Regulator speaker. If the receiver does not un-mute, check that the correct CTCSS tone is entered in the IFR 1200.

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Receiver Front End Alignment and Tuning:

Tuning of the Front End filter is typically only required when the Sensitivity or Distortion does not meet published specifications, or when the receiver RF frequency is changed beyond the band pass of the filter (typically 5 - 7 MHz). Some IFR 1200 models may not have the required tracking generator option installed. Push 2ND FUNCT, then TRACK (5) on the keypad. Push the UP ARROW key until TRACK LOW appears on the display, then push the ENTER key. If TRACK LOW does not appear on the display, then the IFR 1200 does not have tracking generator capability.

Connect the IFR 1200 and Codan radio as shown in Figure 3:

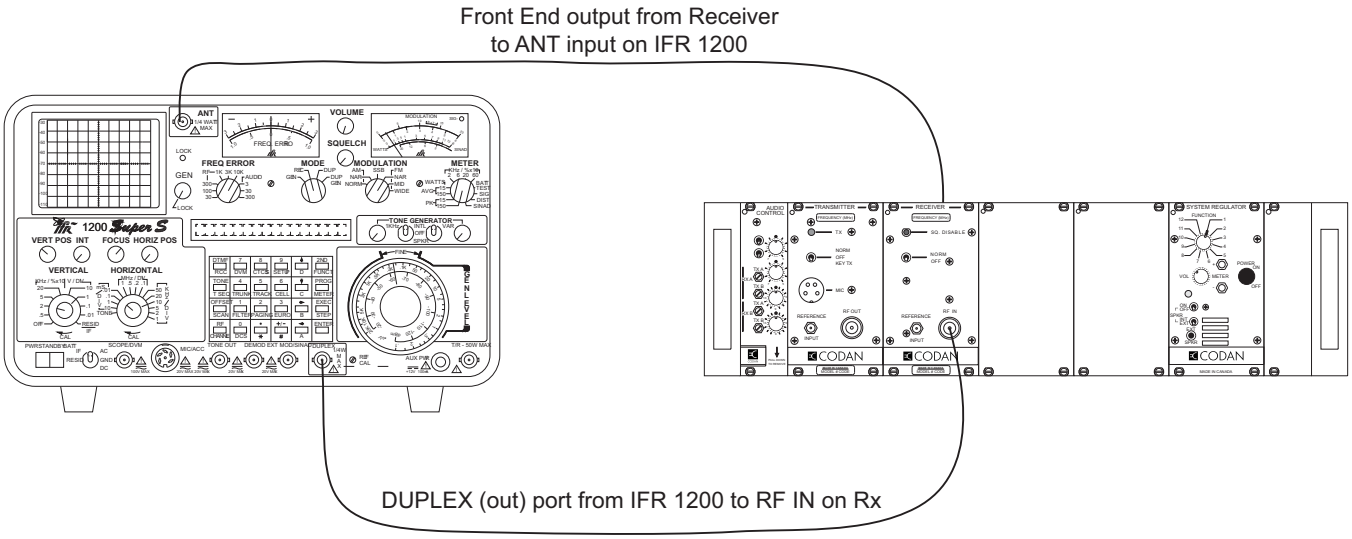

Figure 3: Receiver Front End Alignment and Tuning

The internal cable in the receiver from the output of the front end terminates in an SMB connector. The SMB plugs directly into the Receiver 21.4 MHz IF / Audio Main Board. Disconnect the SMB cable from the Mainboard connector and use the SMB-BNC adapter to connect this point to the ANT input on the IFR 1200.

Set up the IFR 1200 as follows:

1. Set the IFR 1200 in TRACK LOW as described above.
2. Set the MODE switch to DUP.
3. Set the VERTICAL to .5 (Khz/%x10).
4. Set the HORIZONTAL to 1 (MHz/DIV).
5. Push the RF button on the keypad and input the Receiver RF frequency.

Ensure the receiver is turned on. The filter waveform will appear on the scope display. To tune the Front End filter, remove the dust caps on the variable capacitors and, starting from the capacitor closest to the front panel of the receiver and moving back, tune the filter to its new frequency.

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Transmitter Testing

Connect the IFR 1200 and Codan radio as shown in Figure 4:

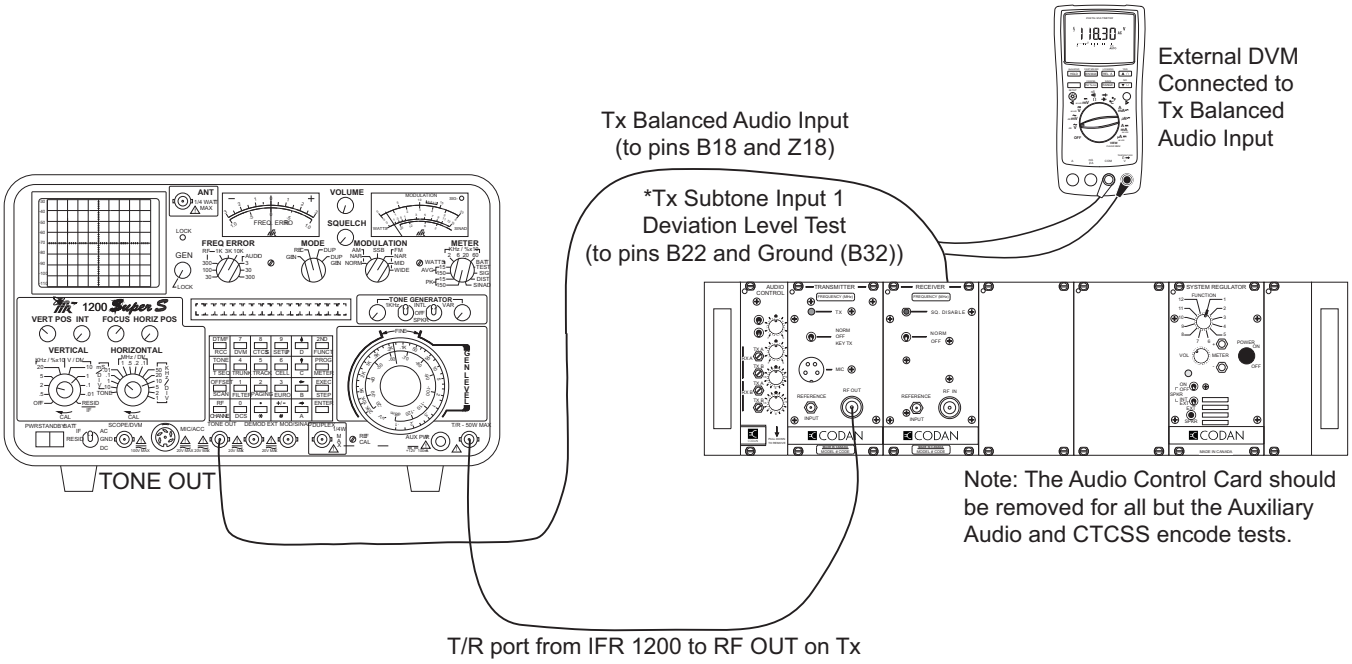

Figure 4: Transmitter Testing

Set up the IFR 1200 as follows:

1. Set the MODE switch to REC.
2. Set the MODULATION switch to FM NAR.
3. Set the VERTICAL to 2 (Khz/%x10).
4. Set the HORIZONTAL to 1 (ms/DIV)
5. Push the RF button on the keypad and input the Transmitter RF frequency.
6. Push 2ND FUNCT, then METER (PROG) on the keypad.
7. On the TONE GENERATOR area, turn the 1 KHz tone ON (up).
8. Adjust the 1 KHz variable level knob until the external DVM meter reads -8.0 dBm (308 mVrms).

On the Codan Radio system, ensure the transmitter is set to KEY TX and the Audio Control Card is NOT plugged into the subrack.

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Distortion:

Connect a jumper cable from DEMOD (out) to EXT MOD / SINAD (in). To check the transmitter distortion, set the METER switch to DIST. Transmitter audio distortion is typically less than 2.0 %. If transmitter distortion is greater than 2.0%, the transmitter Audio Processor may need re-tuning. Refer to the Instruction Manual or Technical Note for audio processor tuning procedures.

If the IFR 1200 reads a much higher distortion than normal (eg. 20%), the internal demod level in the IFR 1200 may not be high enough for the distortion meter (this is more likely to occur in a narrowband transmitter). Increase the 1 KHz variable level knob slightly until the distortion meter becomes active.

Disconnect the jumper cable from DEMOD (out) to EXT MOD / SINAD (in).

RF Power:

To check the RF power output, set the METER switch to 15 WATTS AVG. RF power output should typically be between 0.5 to 3.0 Watts (Lowband VHF), 2.0 to 8.0 Watts (Highband VHF) or 0.5 to 8.0 or 2.0 to 8.0 Watts (UHF 400 MHz). Adjust R48 (Lowband VHF) or R7 (VHF/UHF) in the Transmitter Amplifier section to change the RF output power. High Power Amplifiers can also be checked by setting the METER switch to 150 WATTS AVG. Transmitter RF power output will vary slightly with the +10 - +17 Vdc input. Do not exceed power amplifier input levels.

Connect the transmitter to the power amplifier (if used) and measure the RF power output of the amplifier. The Codan 30 Watt Amplifier's RF power output can be changed by adjusting the transmitter (exciter) RF power output. Do not exceed power amplifier input levels. Higher power amplifiers typically have a fixed RF power input level and RF power output level.

Frequency Stability:

To check the transmitter frequency stability, set the FREQ ERROR switch to RF 1 KHz. Transmitter frequency stability is typically ± 1 ppm.

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Transmitter Deviation Levels:

To check the transmitter deviation level, set the METER switch to 6 (Khz/%x10). Transmitter deviation is typically ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow) for an audio frequency of 1.0 KHz at -8.0 dBm audio level input.

To check the transmitter maximum deviation level, set the METER switch to 6 (Khz/%x10). On the TONE GENERATOR area turn the 1 KHz tone OFF (down) and turn the VAR tone ON (up). Push TONE and enter 300.0, then ENTER on the keypad. Adjust the VAR variable level knob until the external DVM meter reads +10.0 dBm (2.50 Vrms). Increase the 300.0 Hz sine wave up to 3400.0 Hz in increments of 100.0 Hz using the keypad (push TONE and the RIGHT arrow key until the 100 position is flashing, then use the UP arrow key on the keypad). Monitor the analog meter in the top right corner and check that the transmitter deviation does not rise above ± 5.0 KHz wide or ± 2.5 KHz narrow at any time.

To check the transmitter subtone input level set the METER switch to 2 (Khz/%x10). Disconnect the TONE OUT from the Tx Balanced Audio Input connector and connect it to the Tx Subtone Input 1 connector. On the TONE GENERATOR area turn the 1 KHz tone OFF (down) and turn the VAR tone ON (up). Push TONE and enter 100.0, then ENTER on the keypad. Adjust the VAR variable level knob until the external DVM meter reads -18.0 dBm (98 mVrms). Push 2ND FUNCT then METER (PROG) on the keypad. Transmitter subtone deviation is typically ±0.50 KHz wide / ±0.35 KHz narrow for -18.0 dBm audio level input.

If transmitter deviation is off by more than ± 0.15 KHz deviation, the transmitter over-deviates, or the subtone deviation is off by more than ± 0.10 KHz, the transmitter Audio Processor may need re-tuning. Refer to the Instruction Manual or Technical Note for audio processor tuning procedures.

Auxiliary (AC-3E) Input Audio Levels:

The auxiliary audio input level is set while measuring the transmitter deviation. Some connections need to be changed from Figure 4.

1. Ensure the transmitter is set to KEY TX and the Audio Control Card IS plugged into the subrack.
2. Connect TONE OUT on the IFR 1200 to the Auxiliary Balanced Audio Input (1 or 2).
3. Adjust the 1 KHz variable level knob until the external DVM meter reads 0.0 dBm (775 mVrms).
4. Adjust the Auxiliary Balanced Audio level adjustment (R120 for Aux In 1, R123 for Aux In 2) for a transmitter deviation of ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow)

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CTCSS Encode:

The CTCSS encode tone can be supplied from a CTCSS decoder (encode is same tone as decode) or a separate CTCSS encoder; or some base stations may be configured for the tone remote adapter to supply the CTCSS encode tone. These procedures are for use when the audio control card supplies the CTCSS encode tone (with a decoder or encoder).

1. Connect a jumper cable from DEMOD (out) to EXT MOD / SINAD (in).
2. Ensure the transmitter is set to KEY TX and the Audio Control Card IS plugged into the subrack.
3. Ensure that the CTCSS encode switch is turned ON (if applicable).
4. Set the METER switch to 2 (Khz/%x10).
5. Set the VERTICAL to 2 (Khz/%x10).
6. Set the HORIZONTAL to TONE.
7. Disconnect the Tx Balanced Audio Input from the TONE OUT connector on the IFR 1200.
8. On the TONE GENERATOR area, turn the 1 KHz tone OFF (down) and turn the VAR tone ON (up).
9. Push TONE and enter the CTCSS encode tone, then ENTER on the keypad.
10. Push 2ND FUNCT, then METER (PROG) on the keypad.

Adjust the Transmitter CTCSS deviation for ±0.50 KHz wide / ±0.35 KHz narrow (the adjustment pot is located directly on the CTCSS module in the audio control card). If the proper CTCSS tone was entered in the IFR 1200, a small stable oval shape will appear on the IFR 1200 scope (the oval shape may sometimes look like a straight line, simply re-enter the tone until a more oval shape appears). If a different tone was entered than the CTCSS encode tone, the oval shape will fluctuate or become distorted.

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Duplex Testing

Some IFR 1200 models may not have the required duplex option installed. Push 2ND FUNCT, then TRACK (5) on the keypad. Push the UP ARROW key until DUPLEX LOW appears on the display, then push the ENTER key. If DUPLEX LOW does not appear on the display, then the IFR 1200 does not have duplex capability.

Connect the IFR 1200 and Codan radio as shown in Figure 5:

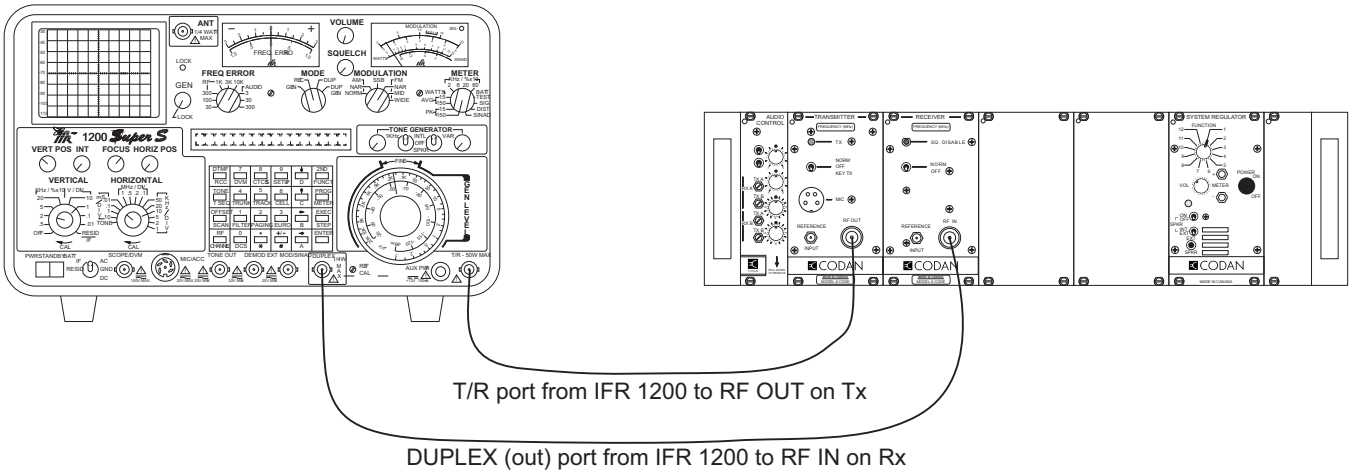

Figure 5: Duplex Testing

Set up the IFR 1200 as follows:

1. Set the IFR 1200 in DUPLEX LOW as described above.
2. Set the MODULATION switch to FM NAR.
3. Set the METER switch to 6 (Khz/%x10).
4. Push the RF button on the keypad and input the Transmitter RF frequency.
5. Push the OFFSET button on the keypad and input the difference between the Receiver and Transmitter RF frequencies. If the Rx frequency is higher than the Tx frequency, the + sign should be shown, and the - sign if the Rx frequency is lower than the Tx frequency.
6. Push 2ND FUNCT, then METER (PROG) on the keypad.
7. Set the MODE switch to DUP GEN.
8. On the TONE GENERATOR area, turn the 1 KHz tone ON (up).
9. Adjust the 1 KHz variable level knob until the meter reads ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow).
10. Set the MODE switch to DUP.

On the Codan Radio system, ensure the transmitter and receiver are set to NORM. Ensure the Audio Control Card IS plugged into the subrack and the CTCSS decode and encode are turned OFF.

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Distortion:

Connect a jumper cable from DEMOD (out) to EXT MOD / SINAD (in). To check the repeater system distortion, set the METER switch to DIST. Complete radio system audio distortion is typically less than 5.0 %. If the radio system distortion is greater than 5.0%, the transmitter or receiver may need re-tuning. Refer to the Instruction Manual or Technical Note for tuning procedures.

If the IFR 1200 reads a much higher distortion than normal (eg. 20%), the internal demod level in the IFR 1200 may not be high enough for the distortion meter (this is more likely to occur in a narrowband transmitter). Increase the 1 KHz variable level knob slightly until the distortion meter becomes active.

Disconnect the jumper cable from DEMOD (out) to EXT MOD / SINAD (in).

Repeater Deviation Levels:

Ensure the deviation into the receiver is set at ± 60% maximum deviation (±3.0 KHz wide / ±1.5 KHz narrow). To check the repeater input and output deviation level matching, set the METER switch to 6 (Khz/%x10). The transmitter deviation into the IFR 1200 should read within ± 0.15 KHz of the input deviation.

AC-3E Audio Control Cards:
If transmitter deviation is off by more than ± 0.15 KHz deviation from the input deviation of ± 60%, adjust the audio level matching pot on the front panel (RXA to TXA, RXA to TXB, RXB to TXA or RXB to TXB) of the Audio Control Card until the deviation levels match.

AC-3L-96 Audio Control Cards:
If transmitter deviation is off by more than ± 0.15 KHz deviation from the input deviation of ± 60%, check the receiver audio level and transmitter deviation level individually in the Rx and Tx modules.

43 Erie Street
Victoria, B.C.
Canada V8V 1P8

Toll Free Canada & U.S.A.
Phone: 1-800-664-4066
Fax: 1-877-750-0004

International
Phone: 250-382-8268
Fax: 250-382-6139

Internet
Email: LMRsales@codanradio.com
Web: www.codanradio.com

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