

Adjustment Description

Required Test Instruments

1. Radio communication test set 1 set
2. Digital radio test set(Aeroflex 3920) 1 set
3. Scanner 1 set
4. 20A/30V power supply 1 set
5. Digital voltmeter 1 set
6. 20A Ammeter 1 set
7. DMR Tuner Tool Software in PC for RD980

Adjustment Procedures

1. Frequencies table for test

Channel	Rx frequency (MHz)	Tx frequency (MHz)	Mode	Power	Channel spacing
1	400.025	400.025	Analog	High	25KHZ
2	435	435	Analog	High	25KHZ
3	469.975	469.975	Analog	High	25KHZ
4	400.025	400.025	Analog	High	20KHZ
5	435	435	Analog	High	20KHZ
6	469.975	469.975	Analog	High	20KHZ
7	400.025	400.025	Analog	High	12.5KHZ
8	435	435	Analog	High	12.5KHZ
9	469.975	469.975	Analog	High	12.5KHZ
10	400.025	400.025	Digital	Low	12.5KHZ
11	435	435	Digital	Low	12.5KHZ
12	469.975	469.975	Digital	Low	12.5KHZ
13	403	413	RMO Digital	Low	12.5KHZ
14	403	413	RMO Analog	Low	25KHZ
15	null	null	null	null	null
16	null	null	null	null	null

2. Adjustment Items

2.1 Procedure before adjustment

Before the radio set adjustment there should be the board test like below which is for the manufacture only.

Check Name	Test Equipments	Test Conditions	Test Points	Specs	Note
Transmit					
FGU Lock Detect	Communication Test Set(CTS) or Frequency Counter	1.Analog mode 2.No signaling 3.SPK ON 4.MIC OFF 5.Low power	8 points, Wideband Tx 400M/434.9875M/435M/470 MHz Rx 400.075M/434.975M/435.075 M/469.975MHz	1. No unlock alarm in receive and transmit state. 2. Correct CV voltages are observed.(TBD)	Manufacture only To test the unit is programmed to the correct frequency range.
Transmit Path	CTS / Frequency Counter & Power Meter	1.Analog mode 2.TX standby 3.No Signaling 4.SPK OFF 5.MIC ON 6.Low power	1 point, Wideband(e.g.470MHz)	Correct frequency, modulation and power output are observed.	Manufacture only To test the transmitter path is ok.
Receive					
Receive Path	CTS / Signal Generator & AC Voltmeter	1.Analog mode 2.Receive standby 3.No signaling 4.SPK ON 5.MIC OFF	1 point, Wideband(e.g.469.975MHz)	Receiver PLL locked and output 1kHz single-tone audio.	Manufacture only To test the receiver and audio processing is ok.
2nd Lo CV	DC Voltmeter	1.Analog mode 2.Receive standby 3.No signaling 4.SPK ON 5.MIC OFF	1 point, Wideband(e.g.469.975MHz)	Correct DC voltage (TBD)	Manufacture only
Receiver Reference Oscillator Warp	Communication Test Set(CTS) or Frequency Counter	1.Analog mode 2.No signaling 3.Both SPK ON 4.Both MIC OFF	1 point Wideband(e.g.469.975MHz)	$\pm 40\text{Hz}$	Repeater only

2.2 Tuner items

Enter the DMR Tuner Tool software of MD782 you can see tuner items as shown in table below. Select the item to be tuned and drag the moving beam to change the tuning value till getting the proper ones. And then do save the tuning value by clicking the “save” button.

Tuning Name	Tuning Equipments	Test Conditions	Tuning Points	Specs	Note
Transmit					
Reference Oscillator Warp	Communication Test Set(CTS) or Frequency Counter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Both Mic OFF 5.Low power	1 point Wideband(e.g.470 MHz)	$\pm 40\text{Hz}$	In the process of frequency error tuning, no modulation is allowed. Hence, the DSP signal consists only DC offset with no audio carrier.
Transmit High Power Calibration	CTS or Power Meter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on	8 points, Wideband, only High Power for manufacture	$45\pm 0.2\text{W(UHF)}$	/
Transmit Low Power Calibration	CTS or Power Meter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on	8 points, Wideband, only High Power for manufacture	$1\pm 0.05\text{W(UHF)}$	/
Transmit M Power Calibration	CTS or Power Meter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on	8 points, Wideband, only High Power for manufacture	$10\pm 0.2\text{W(UHF)}$	
DSP-to-Deviation Conversion	CTS or Frequency Counter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Both Mic OFF 5.Low power	1 point, Wideband, Low-end frequency(e.g.400 MHz)	5K	HW team will need to determine if this step is required. If the Max deviation error is small, it can be hard coded and thus will not need this extra step in determining the max deviation.

Modulation Balance (Low Port)	CTS	1.Analog mode 2.Single Tone: 1point, 100Hz 3.No signaling 4.Both SPK OFF 5.Both MIC OFF 6.Low power	Single Tone: 1 point — 100Hz Carrier Frequency: 8 points, from low to high band.	5kHz±20Hz	1.MOD_L_RFCS contributes major deviation at low port (100Hz) while MOD_H contributes major deviation at high port (1kHz~7kHz). 2. The points of single tone is subject to increase depending on the VCO characteristics. 3. Reserve the delay tuning capability in case we need it.
Modulation Balance (High Port)	CTS	1.Analog mode 2.Single Tone: 1point, 6kHz3.No signaling4.Both SPK OFF5.Both MIC OFF6.Low power	Single Tone: 1 point — 6kHzCarrier Frequency: 8 points, from low to high band.	5kHz±20Hz	/
Modulation Balance (Delay) Developme nt only	CTS	1.Analog mode 2.Single Tone: random points, 100Hz - 6kHz, 100Hz step 3.No signaling 4.Both SPK OFF 5.Both MIC OFF 6.Low power	400M	/	/
Modulation flat checking (Research only)	CTS	1.Analog mode 2.Single Tone: random points, 100Hz - 6kHz, 100Hz step 3.No signaling 4.Both SPK OFF 5.Both MIC OFF 6.Low power	Single Tone: random points, 100Hz - 6kHz, 100Hz step Carrier Frequency: 8 points, from low to high band.	5kHz±20Hz	
TX CV synthesize for quick locked	multimeter	1.Analog mode 2.No signaling3.Both SPK OFF4.Both Mic OFF5.Low power6.TX ON	1 pointTX 470MHz	radix point 3 for △CV	/
Receive					

Front-end Filter	CTS / Signal Generator & Spectrum Analyzer & SINAD Meter	1. Analog mode 2. No signaling 3. Int. SPK ON, internal speaker gain set to Rated Audio (Portable, Mobile & Repeater) 4. Both MIC OFF 5. RX ON 6. Squelch open 7. rate Audio volume	8 points, Wideband	SINAD > 14dB @ -118dBm input	/
Rx Front-end Gain	CTS / Signal Generator	1. Analog mode 2. No signaling 3. Int. SPK ON, internal speaker gain set to Rated Audio (Mobile & portable only) / Repeater Ext SPK on 4. Both MIC OFF 5. RX ON 6. Squelch open 7. rate Audio volume	8 points, Wideband	RF input = -70dBm	Pump in known signal level to the radio. Need to tune this parameter for RSSI calculation.
Rated Audio	CTS / Signal Generator & AC Voltmeter	1. Analog mode 2. No signaling 3. Int. SPK ON, internal speaker gain set to Rated Audio (Portable, Mobile & Repeater) 4. Both MIC OFF 5. RX ON	2 points, wideband and narrowband @ 430.075MHz	Rated Voltage $\pm 0.1V$	/

Accessory Audio Output Gain	CTS	1.Analog mode 2.No signaling 3.Int. SPK ON, internal speaker gain set to Rated Audio(Mobile & portable only) /Repeter Ext SPK on 4.Both MIC OFF 5.RX ON	2 points, wideband and narrowband @ 430.075MHz	Filtered Output: 700~1000mV RMS Flat Output: 300~1000mV RMS Slot1/Slot2 Output:700~ 1000mV RMS	/
RX CV synthesize for quick locked	multimeter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Both Mic OFF 5.Low power 6.RX ON	1 point RX 469.975MHz	radix point 3 for Δ CV	/

2.3 Test items

2.3.1 Transmitter

The transmitter testing can be done in radio communication test set (for analog) and digital radio test set (for digital). The items are shown in table below.

Testing Name	Mode	Test Equipments	Test Conditions	Testing Points	Specs
Frequency Error	Test	CTS or Frequency Counter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Both MIC OFF 5.Low power	1 point, Wideband(e.g .470MHz)	$\leq 100\text{Hz}$
Transmit High Power	Test	CTS or Power Meter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.High power	3 points, Wideband(e.g . 400/430/470 MHz)	47.75-52.25W

Transmit Low Power	Test	CTS or Power Meter	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	4.5~5.5W
Transmit 4FSK Max. Deviation	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	±3.7kHz
Transmit 4FSK Modulation(Modulation Accuracy)	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	Deviation of four sequence of 4FSK ① +1.944kHz+/-10%; ② +0.648kHz+/-10%; ③ -0.648kHz+/-10%; ④ -1.944kHz+/-10%.
Transmit FSK and Magnitude Error	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	FSK Error ≤5% Magnitude Error ≤1%
Transmit BER(0.153)	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	<0.01%
Transmit BER(1031)	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	<0.01%

Transmit BER(Silence)	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	<0.01%
Transmit BER (4FSK Sine)	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	<0.01%
Transmit BER	Digital Test	VSA E89441A	1.Digital mode 2.No signaling 3.Both SPK OFF 4..Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	3 points, Wideband(e.g 400/430/470 MHz)	<0.01%
Maximum Analog Transmit Deviation w/o subtone	Analog Test	CTS -- TX TEST HPF:20Hz LPF:15kHz	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Both MIC ON 5.Low power	6 points (3 points H/M/L for W/N respectively)	Wideband: 4.8kHz Narrowband: 2.4kHz
Modulation Sensitivity	Analog Test	CTS -- TX TEST HPF:20Hz LPF:15kHz	1.Analog mode 2.No signaling 3.Both SPK OFF 4..Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	6 points (3 points H/M/L for W/N respectively)	
PL Deviation	Analog Test	CTS -- TX TEST HPF:20Hz LPF:300Hz	1.Analog mode 2.Signaling:PL 3.Both SPK OFF 4.Both MIC OFF 5.Low power	6 points (3 points H/M/L for W/N respectively)	Wideband: 500~1000Hz Narrowband: 00~600 Hz
DPL Deviation	Analog Test	CTS -- TX TEST HPF:20Hz LPF:300Hz	1.Analog mode 2.Signaling:DPL 3.Both SPK OFF 4.Both MIC OFF 5.Low power	6 points (3 points H/M/L for W/N respectively)	Wideband: 500~1000Hz Narrowband: 00~600 Hz
Maximum Transmit Deviation w/ PL	Analog Test	CTS -- TX TEST HPF:20Hz LPF:15KHz	1.Analog mode 2.Signaling:PL 3.Both SPK OFF 4..Int. Mic on(Mobile & portable)	6 points (3 points H/M/L for W/N respectively)	Wideband: ≤5kHz Narrowband: ≤2.5kHz

			/repeater Ext. mic on 5.Low power		
Maximum Transmit Deviation w/ DPL	Analog Test	CTS -- TX TEST HPF:20Hz LPF:15kHz	1.Analog mode 2.Signaling:DPL 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	6 points (3 points H/M/L for W/N respectively)	Wideband: ≤5kHz Narrowband: ≤2.5kHz
2(5)-Tone Deviation	Analog Test	CTS -- TX TEST HPF:20Hz LPF:15kHz	1.Analog mode 2.Signaling:2(5)-Tone 3.Both SPK OFF 4.Both MIC OFF 5.Low power	6 points (3 points H/M/L for W/N respectively)	Wideband: 3.2±0.1kHz Narrowband: 1.8±0.1kHz
MSK Deviation	Analog Test	CTS -- TX TEST HPF:20Hz LPF:15kHz	1.Analog mode 2.Signaling:MSK 3.Both SPK OFF 4.Both MIC OFF 5.Low power	6 points (3 points H/M/L for W/N respectively)	Wideband: 3.2±0.1kHz Narrowband: 1.8±0.1kHz
Transmit S/N ratio	Analog Test	CTS -- TX TEST HPF:300Hz LPF:3kHz	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	6 points (3 points H/M/L for W/N respectively)	3K\1.5K(W\N) ≥45dB(W)/40dB(N)
Modulation Distortion	Analog Test	CTS -- TX TEST HPF:300Hz LPF:3kHz	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	2 points, W/N, 430MHz	3K\1.5K(W\N) ≤3%
Mic Gain (Level 1 to 10)	Test	CTS -- TX TEST HPF:20Hz LPF:15kHz	1.Analog mode 2.No signaling 3.Both SPK OFF 4.Int. Mic on(Mobile & portable) /repeater Ext. mic on 5.Low power	1 point, Wideband(e.g .430MHz)	/
Repeater Audio Gain Balance	CTS	1.Analog mode 2.No signaling 3.Ext.SPK on 4.Both MIC OFF	2 points, wideband and narrowband @ 430.075MHz		/

2.2 Receiver

The receiver test can be done in radio test set as used in the transmitter test for both analog and digital.

Testing Name	Mode	Test Equipments	Test Conditions	Testing Points	Specs
Receiver Sensitivity - Analog	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1.Analog mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON 6.Squelch open 7.rate Audio volume	6 points (3 points H/M/L for W/N respectively)	SINAD>14dB @ ≤-118dBm
Receiver BER(0.153)	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	3 points H/M/L	5% BER: ≤ -116dBm 1% BER: ≤ -110dBm
Receiver BER (Silence)	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	3 points H/M/L	5% BER: ≤ -116dBm 1% BER: ≤ -110dBm
Receiver BER (1031)	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	3 points H/M/L	5% BER: ≤ -116dBm 1% BER: ≤ -110dBm

Receiver Maximum Usable Sensitivity - Digital	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	3 points H/M/L	5% BER: \leq -116dBm 1% BER: \leq -110dBm
High RF Input BER	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable /repeater Ext.SPK on) 4.Both MIC OFF 5.RX ON	3 points H/M/L	BER=0% @ +10dBm
Receiver Ultimate (BER) Sensitivity	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable /repeater Ext.SPK on) 4.Both MIC OFF 5.RX ON	3 points H/M/L	BER=0% @ -85dBm
Dynamic Faded (BER) Sensitivity	Digital Test	ESG signal generator with 0.153 voice super frame burst test pattern	1.Digital mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	3 points H/M/L	5% BER @ \leq -108dBm(for 8 and 100Km/hr Rayleigh Fading)
Receiver S/N radio	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1.Analog mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	6 points (3 points H/M/L for W/N respectively)	\geq 45dB(W)/40dB (N)
Receiver Audio Distortion	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1.Analog mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF	2 points (1 pointfor W/N respectively)	<3%

			5. RX ON		
Maximum Audio Output Power	Test	CTS -- RX TEST HPF:20Hz LPF:15kHz	1. Analog mode 2. No signaling 3. Int. SPK on (Mobile & portable) /repeater Ext. SPK on 4. Both MIC OFF 5. RX ON	2 points (1 point for W/N respectively)	7.5W
Normal Level Squelch Open	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1. Analog mode 2. No signaling 3. Int. SPK on (Mobile & portable) /repeater Ext. SPK on 4. Both MIC OFF 5. RX ON	6 points (3 points H/M/L for W/N respectively)	HP8921 RF Output = -118dBm
Normal Level Squelch Off	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1. Analog mode 2. No signaling 3. Int. SPK on (Mobile & portable) /repeater Ext. SPK on 4. Both MIC OFF 5. RX ON	6 points (3 points H/M/L for W/N respectively)	HP8921 RF Output = -120dBm
Tight Level Squelch Open	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1. Analog mode 2. No signaling 3. Int. SPK on (Mobile & portable) /repeater Ext. SPK on 4. Both MIC OFF 5. RX ON	6 points (3 points H/M/L for W/N respectively)	HP8921 RF Output = -112dBm

Tight Level Squelch Off	Analog Test	CTS -- RX TEST HPF:300Hz LPF:3kHz	1.Analog mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	6 points (3 points H/M/L for W/N respectively)	HP8921 RF Output = -114dBm
Receive PL/DPL Decode	Analog Test	CTS -- RX TEST HPF:50Hz LPF:15kHz	1.Analog mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	1 point, Narrowband (e.g.470MHz)	/
Receive PL/DPL Decode Time	Analog Software Test	CTS -- RX TEST, Oscilloscope	1.Analog mode 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	6 points, Wideband and Narrowband, 3 PL with each carrier frequency.	TPL Decode Time \leq 240ms DPL Decode Time \leq 275ms
5Tone Decode	Analog Test	CTS -- RX TEST, Oscilloscope	1.Analog mode 2.Signaling: 5-Tone 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	1 point, Narrowband (e.g.470MHz)	/
MDC1200 Decode	Analog Test	CTS -- RX TEST, Oscilloscope	1.Analog mode 2.Signaling: 5-Tone 3.Int.SPK on(Mobile & portable) 4.Both MIC OFF 5.RX ON	1 point, Narrowband (e.g.470MHz)	/

RX standby current	Test	Ampere Meter	1.Analog & Digital mode respectively 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	1 point, Narrowband (e.g.470MHz)	/
RX current drain	Test	Ampere Meter	1.Analog & Digital mode respectively 2.No signaling 3.Int.SPK on(Mobile & portable) /repeater Ext.SPK on 4.Both MIC OFF 5.RX ON	2 points, wideband and narrowband @ 430.075MHz	/