



## MWL-RADIOUNIT 900MHz RF Tunup Procedure

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# 1 CONFIGURATION, CONTROL AND MONITORING SYSTEM

## 1.1 OVERVIEW OF THE CCMS

- CCMS stands for **C**onfiguration, **C**ontrol and **M**onitoring **S**ystem
- It is a web based configuration, requiring only a web browser (Internet Explorer or Mozilla Firefox)
- No “service kit” software is required
- CCMS is used to configure radio, perform software updates etc.
- CCMS has levels of access such as: user and tech
- The radio has a database which contains all settings; these are manipulated with the CCMS web application.

## 1.2 TASKS THAT CAN BE PERFORMED VIA THE CCMS

- Monitoring radio link performance
- Radio link configuration
- Changing passwords
- Changing RF parameters (Power and Frequency)
- Changing a radio's IP address
- Configuring Serial parameters (Synchronous, Asynchronous and Submux)
- Configuring M-SEC
- Configuring M-DNP3
- Performing software upgrades
- Backing up radio settings
- Activating software feature enables
- Configuring SNMP
- Configuring M-RAP
- Configuring M-DAP
- Configuring M-PoD

## 1.3 LOGGING INTO CCMS

MiMOMax radios use a built in web configuration package called CCMS. To access the CCMS, point a web browser to the radio's IP address (see Figure 1). MiMOMax radios are often preconfigured with an IP address specified by the customer when the radio is ordered. If no IP address has been assigned, the default is 192.168.0.1/24 for Tx-High radios and 192.168.0.2/24 for Tx-Low radios. Additionally MiMOMax radios will broadcast 3 gratuitous ARPs to advertise the IP address when the radio boots up.



Figure 1: MiMOMax logon

To logon to the radio, press the “log into System” button. MiMOMax radios have two levels of access (user and tech). The default login credentials are:

Username	Default password
user	user
tech	tech

Figure 2: Default login credentials

## 1.4 RF SETTINGS

MiMOMax radios include the ability to set frequency and output power level for the tech login. They also have a range of options for advanced configuration and debugging.

The current transmit and receive frequencies can be viewed on the RF Tx and Rx page (see Figure 3). The procedure to change the operating frequencies of the unit is covered in section 2. Output power can be set on the RF Tx and Rx page, see Figure 3. Its range is between 0 and +30 dBm. The power can be specified in either dBm or mW, by selecting either dBm or mW as the transmitter power unit.

A number of other options are available on this page such as three advanced parameters that are used to optimise the radio’s behaviour in challenging RF conditions. These parameters should only be changed under the direction of MiMOMax support.

As with all options, to save changes press the “Save” button and then to activate the changes, click “Apply changes” in the control panel.

Figure 3: RF Configuration Page

## 2 SETTING OPERATING FREQUENCY & TRANSMITTER CALIBRATION

### 2.1 INTRODUCTION

Setting operating frequencies of a MiMOMax radio is done via the CCMS. The radio's internal duplexers also may need to be re-tuned. This is covered in section 3. The tech and factory use the same process with the factory being able to perform the additional step of saving the current settings as "factory default".

### 2.2 EQUIPMENT REQUIRED: POWER METER & POWER ATTENUATORS

For accurate measurement of average power from MiMOMax transmitters a thermocouple sensor type of power meter (e.g. HP8482A sensor with HP435B meter and 30dB power attenuators) is required. Other types of power meter may give inaccurate average power readings when used with MiMOMax transmitters, and may be suitable only for relative power measurement.

The transmitters are set up in the factory to produce 1W average power output with tolerance of +/-1dB over the operating range. If retuning transmitters to a different frequency is required, and a suitable power meter is not available to accurately set the average power to 1W after retuning, then the power output of each transmitter channel should be measured using the available power indicator BEFORE any retuning is carried out. The values obtained can then be used as reference points to reset the final power for each channel after retuning.

### 2.3 PROCESS OVERVIEW

The process of changing frequencies and transmitter calibration can be seen in Figure 4.

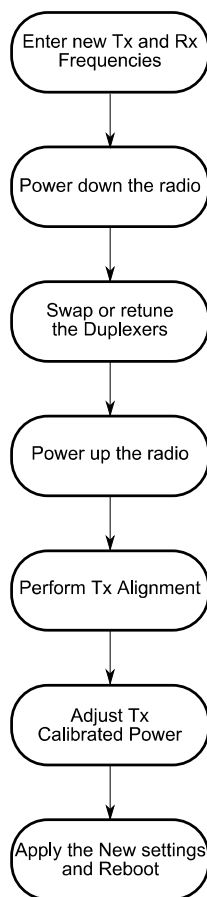


Figure 4: Frequency change flow chart

### 2.4 CCMS PAGES

To start the process, click on "RF Tx and Rx", see Figure 5. This page displays the transmitter power level, Tx and Rx frequencies. The output power can be re-adjusted once the Radio Units are operating on the new frequency. Note that it is strongly advised to set the unit to 30dBm output power and to measure the transmit power before starting the process. (The output power can be re-adjusted once the Radio Units are operating on the new frequency.) Click on "Retune Frequencies" to start the frequency change procedure.

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**Configure RF Transmitter & Receiver**

Transmitter frequency (MHz)

Transmitter power

Transmitter power unit

Duplexers

Receiver frequency (MHz)

Rx 1 20dB attenuator

Rx 2 20dB attenuator

**Advanced Configuration**

Tracking algorithm rate of adaptation

Tracking algorithm adaptation delay

Retrain detection time (ms)

**RF Transmitter & Receiver**

*This MIMO radio has 2 transmitters and 2 receivers, operating on common Tx and Rx frequencies.*

**Transmitter power** can be set in dBm or mW. This is the average power level at each antenna connector. Tx modules that have been factory calibrated for low power will cause a **Low power operation** option to appear. **Mode 1** reduces the input power down to approx 54W (max Tx power +26dBm), **Mode 2** reduces the input power down to approx 40W (+23dBm Tx).

**20dB attenuator** (400MHz only) can be used to reduce the receive signal level when operating in very high signal level conditions.

**Retune Frequencies** enters the process of changing the radio's operating frequencies.

**Advanced Configuration** These parameters alter how the radio tracks errors and determines when it will retrain. They should only be altered under the guidance from MiMOMax support personnel.

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**Figure 5: Configure RF CCMS Page**

This will display the page shown in Figure 6. From here on, no other CCMS pages will be accessible. One has to press the Abort button if one wants to leave the retune process. Enter the desired frequencies and press Next.



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Diagnostics	<b>Retune Frequencies: Enter new frequencies</b>		<b>Retuning Frequencies</b>
System	<b>Please ensure the radio is connected to RF loads &amp; not to the antenna.</b>		The transmitters will operate during retuning requiring RF loads of at least 25W rating to be connected to each antenna port. Alternatively 30dB 25watt attenuators can be used to allow connection of a power sensor for transmit power measurement and calibration.
Calibration			
RF Tx and Rx			New frequencies can be entered, then when "Next" is selected the frequencies are checked to be within the valid range of the radio hardware including the correct raster of 5 or 6.25kHz.
Network	<b>Current frequencies</b>		
MSEC	Transmitter frequency (MHz)	928.0125	Duplexers may need to be physically swapped and/or retuned during the process.
MRAP	Receiver frequency (MHz)	952.0125	
MDAP	<b>New frequencies</b>		Selecting "Abort" at any stage will return the radio to the previous frequencies and restore normal operation.
DNP3	New transmitter frequency (MHz)	<input type="text" value="928.0125"/>	
Serial Interfaces	New receiver frequency (MHz)	<input type="text" value="952.0125"/>	
Control Panel	<input type="button" value="Next"/> <input type="button" value="Abort"/>		
SFE			
Log out			
<b>Logged in as factory</b>			

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**Figure 6: Enter New Frequencies Page**

The new frequencies will be checked to ensure that they are supported by the hardware. A message saying that the frequency check passes will be displayed if the check is successful, see Figure 7.

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Diagnostics	<b>Retune Frequencies: Check Frequencies</b>		<b>Retuning Frequencies</b>
System	<b>Press Next to decommission the radio unit.</b>		A check is made of the new frequencies for possible self interference. Certain combinations of Tx & Rx frequencies may result in a warning message. If this happens the user can select the Tx IF for best performance. If impaired link performance is seen on both IF settings, contact MiMoMax product support for guidance.
Calibration			
RF Tx and Rx	Tx and Rx frequency check -- PASSED		
Network	New transmitter frequency (MHz)	928.0125	
MSEC	New receiver frequency (MHz)	952.0125	
MRAP	<input type="button" value="Next"/> <input type="button" value="Abort"/>		
MDAP			
DNP3			
Serial Interfaces			
Control Panel			
SFE			
Log out			
<b>Logged in as factory</b>			

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**Figure 7: Frequency Check Page**

Next, the radio checks that the VCOs lock. The user will also be prompted to power the radio down, retune the duplexers, and attach attenuators before powering back up again. See Figure 8. It is crucial that the radio is connected to loads or attenuators and the duplexers are tuned appropriately! See section 3 for more information on duplexer tuning.

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Diagnostics	<b>Retune Frequencies: Decommission &amp; VCO Check</b>	<b>Retuning Frequencies</b>
System	<b>Prepare radio for transmitter operation.</b>	<i>The radio is now in a decommissioned state. A check is made to ensure that both Tx and Rx can lock to the new frequencies. If either the Tx or Rx fails to lock, the retuning process cannot be completed.</i>
Calibration		
RF Tx and Rx	Decommission -- DONE	<i>It is important to make sure the duplexers are tuned and installed to match the Tx &amp; Rx frequencies, otherwise damage may occur to the hardware.</i>
Network	RX VCO locked -- PASSED	
MSEC	TX VCO locked -- PASSED	
MRAP	<b>DC power to the radio must now be removed and then reinstated before proceeding.</b>	
MDAP	<b>If it is necessary to swap and/or retune the duplexers, this must be done at this stage whilst DC power is removed.</b>	
DNP3	Please ensure RF power loads or attenuators are connected when power is restored to the radio.	
Serial Interfaces	Please <b>Refresh</b> this page and re-login when the radio is back up and running again approx. 2 minutes after reapplying the power.	
Control Panel		
SFE		
Log out		
Logged in as factory	<b>New frequencies</b>	
	New transmitter frequency (MHz) 928.0125	
	New receiver frequency (MHz) 952.0125	
	<input type="button" value="Abort"/>	

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**Figure 8: Decommission and VCO Check Page**

Once the radio has powered up again, refresh the page and log back into the CCMS. The VCOs will be checked once again, then press Next to start the auto alignment process. See Figure 9.



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Diagnostics	<b>Retune Frequencies: Power Cycle Status</b>	<b>Retuning Frequencies</b>
System	<b>ATTENTION! Please ensure the radio is connected to RF loads &amp; not to the antenna. Press Next to start auto-alignment of Tx1 (see picture).</b>	Provided both VCOs are locked, pressing Next will initiate auto-alignment of Tx1. Note: RF loads or attenuators <b>must</b> be attached to the antenna ports.
Calibration		
RF Tx and Rx		The auto-alignment of each Tx takes approximately 15 seconds to complete.
Network	RX VCO locked -- PASSED	<b>Antenna connectors</b> 
MSEC	TX VCO locked -- PASSED	
MRAP	<input type="button" value="Next"/> <input type="button" value="Abort"/>	
MDAP		
DNP3		
Serial Interfaces		
Control Panel		
SFE		
Log out		
<b>Logged in as factory</b>		


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**Figure 9: Page after Powering Up**

Next, the radio will execute its auto alignment procedure before displaying the results, see Figure 10. The auto alignment process is then repeated for transmitter two.

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Diagnostics	<b>Retune Frequencies: Tx1 Auto Alignment</b>	<b>Retuning Frequencies</b>
System	<b>Auto-alignment PASSED. Press Next to start auto-alignment of Tx2 (see picture).</b>	If the final measured level shows [Normal] the auto-alignment has been successful. If [Abnormal], press Retry to try again.
Calibration		
RF Tx and Rx	Tx1 auto-tune -- PASS	<b>Antenna connectors</b> 
Network	Tx1 filter voltages and measured level:	
MSEC	Level=-5.98 dBFS [Normal]	
MRAP	IF=12.00 V UpConv=2.96 V DownConv=7.95 V	
MDAP	<input type="button" value="Next"/> <input type="button" value="Retry"/> <input type="button" value="Abort"/>	
DNP3		
Serial Interfaces		
Control Panel		
SFE		
Log out		
<b>Logged in as factory</b>		

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**Figure 10: Tx Auto Alignment Result Page**

The radio will then initialise the transmitter, see Figure 11. The user is then required to calibrate the output power. This is done by adjusting the loop attenuation and clicking “Apply” (see Figure 11). While measuring the output power on a power meter, adjust the loop attenuation until +30dBm is measured. If a thermocouple sensor type power meter is not available, then adjust the loop attenuation until the power measure is the same as when operating on the original frequencies.

The screenshot shows the MiMoMax wireless management interface. At the top, the logo 'mimo|Max wireless' is displayed with the tagline 'maximizing the potential of advanced wireless communications'. Below the logo, the status bar shows 'NDL\_E Site 2 Link Inactive Tue Dec 11 10:55:40 UTC 2012'. The main content area is titled 'Retune Frequencies: Tx1 Check & Adjust Cal Power'. A prominent red box contains the following text: 'Tx1 is now operating. Press Next to continue or, if fine adjustment of calibration power is required, adjust the value up or down as required using the Apply button then when the correct calibration power is obtained press Next to continue.' Below this, a note states: 'Note: This adjustment is critical to correct operation. DO NOT attempt it unless you have an accurately-calibrated power meter of the correct type (thermistor bolometer or similar) to measure true average power! For further information on this please refer to manual.' The interface includes two input fields: 'Tx1 loop attenuation setting (dB)' with the value '0.7' and 'New transmitter frequency (MHz)' with the value '928.0125'. Below these fields are three buttons: 'Next', 'Abort', and 'Apply'. On the right side, there is a section titled 'Retuning Frequencies' with explanatory text: 'The transmitter is now operating with a 256QAM modulated test carrier and the lineariser is active.' and 'The calibration power is the maximum operating power of the radio, normally +30dBm with internal duplexers. This should not be confused with the user set power which is the actual power used in normal operation and is a separate setting.' Below this text is a diagram titled 'Antenna connectors' showing two antenna ports labeled 'ANT 2' and 'ANT 1' with green indicator lights. The footer of the interface reads 'Copyright © 2011 MiMoMax Wireless Ltd.' and the user is logged in as 'factory'.

**Figure 11: Tx Fine Power Adjustment**

This alignment and power adjustment process is then repeated again for transmitter 2. Once transmitter 2 is complete, a success screen is shown, see Figure 12.

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Diagnostics	<b>Retune Frequencies: Confirmation to Apply Changes</b>		<b>Retuning Frequencies</b>
System	<b>CONGRATULATIONS! Retuning is complete. Press Apply to save the new settings or Abort to return to the previous settings.</b>		The new settings can be saved by pressing Apply. The radio will then reconfigure itself and return to normal operation on the new frequencies.
Calibration			
RF Tx and Rx			
Network	<b>Current frequencies</b>		
MSEC	Transmitter frequency (MHz)	928.0125	Before deploying this unit in the field we recommend that you bench test it off-air (i.e. connected to its partner via suitable coax cables and attenuators) to confirm that a reliable link can be established.
MRAP	Receiver frequency (MHz)	952.0125	
MDAP			
DNP3	<b>New frequencies</b>		
Serial Interfaces	New transmitter frequency (MHz)	928.0125	
Control Panel	New receiver frequency (MHz)	952.0125	
SFE	<input type="button" value="Apply"/> <input type="button" value="Abort"/>		
Log out			
<b>Logged in as factory</b>			

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**Figure 12: Success Page**

Once apply is clicked, the radio will reboot and can be put back into service, see Figure 13. If the process is aborted, then please ensure that the duplexers are retuned to the original frequencies, see Figure 14.

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Diagnostics	<b>Retune Frequencies: Applying Changes</b>		<b>Retuning Frequencies</b>
System	<b>The radio will now reboot and the new settings will be applied. Please allow up to 2 minutes for the radio to come back up. Please Refresh this page and re-login when the radio is back up.</b>		The new frequencies are being saved and the radio will now return to normal operation.
Calibration			
RF Tx and Rx			
Network			
MSEC			
MRAP			
MDAP			
DNP3			
Serial Interfaces			
Control Panel			
SFE			
Log out			
<b>Logged in as factory</b>			

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**Figure 13: Application of New Settings and Reboot**

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Diagnostics	<b>Retune Frequencies: Abort</b>		<i>Retuning Frequencies</i>
System	<p><b>Please ensure the duplexers are configured for the original frequencies. If they already are press Proceed to reboot the system or remove power to swap and/or retune them.</b></p>		<p><i>It is important to make sure the duplexers are tuned and installed to match the Tx &amp; Rx frequencies, otherwise damage may occur to the hardware.</i></p>
Calibration			
RF Tx and Rx	Transmitter frequency (MHz)	<input type="text" value="928.0125"/>	
Network	Receiver frequency (MHz)	<input type="text" value="952.0125"/>	
MSEC	<input type="button" value="Proceed"/>		
MRAP			
MDAP			
DNP3			
Serial Interfaces			
Control Panel			
SFE			
Log out			
<b>Logged in as factory</b>			

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**Figure 14: Returning to the Original Frequencies**



### 3 DUPLEXERS

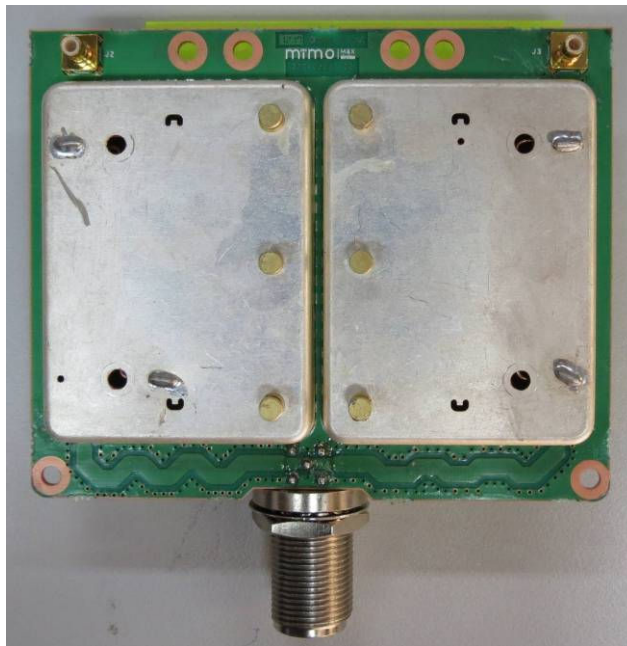
The MiMOMax radio unit has 2 transmitters and 2 receivers; these connect to 2 antenna ports via 2 duplexers.

The duplexer serves 2 primary functions:

- 1) It allows one transmitter and one receiver to be connected to a single antenna port.
- 2) It reduces the high power transmitter signal and noise getting into the sensitive receiver, and the received signal getting into the transmitter.

It does this by putting a very sharp and deep notch on each of the Tx and Rx signal paths whilst providing a low loss pass response to the desired signal. The transmitter path will have a notch filter tuned to the receiver frequency. The receiver path will have a notch filter tuned to the transmitter frequency. Each of these notch filters are made up of 3 tunable elements, these groups of three are called filter banks, and are covered by a single shield (note 2 silver shields as seen in

**Figure 15).**

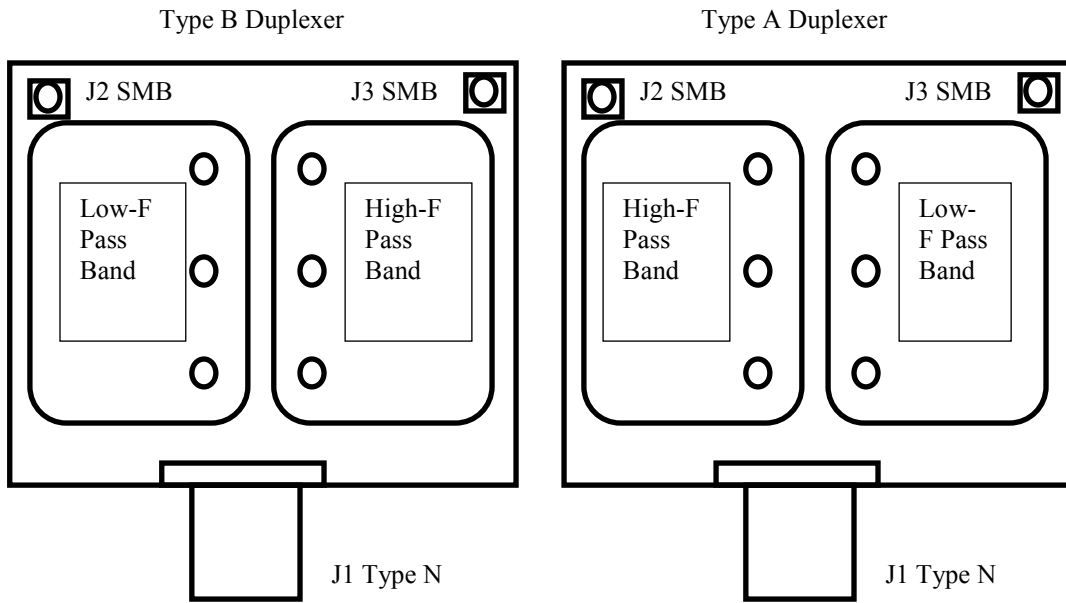


**Figure 15: MiMOMax Duplexer**

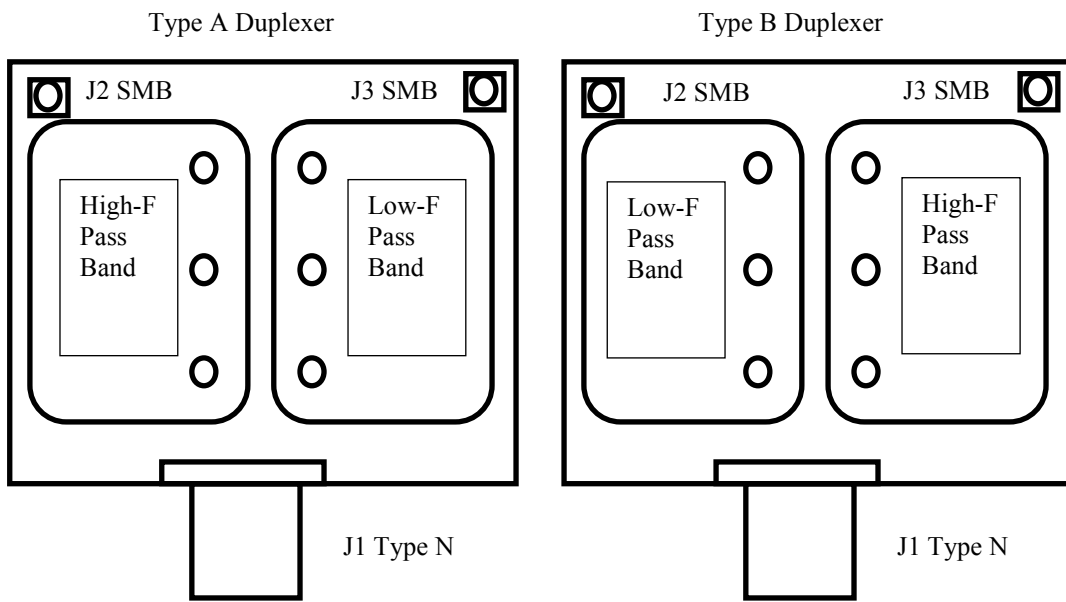
The duplexers are designed for a Tx to Rx frequency difference of 24MHz or more. To achieve optimum performance the filters are asymmetric - that is, the filter will have a notch on one side of the pass-band. As such each filter bank is considered to be a bandpass filter with low side notch or a bandpass filter with high side notch.

There are two 'types' of duplexers (aside from frequency bands), 'Type A' and 'Type B' (See **Figure 16**). The type can be read off the label on the duplexers. The code on them should read "XMWL-DPLXR-Axxx" or "XMWL-DPLXR-Bxxx", the first letter in the suffix is either A or B referring to type A or type B.





**Figure 16: Tx High configuration as arranged in the chassis**



**Figure 17: Tx Low configuration arranged in the chassis**

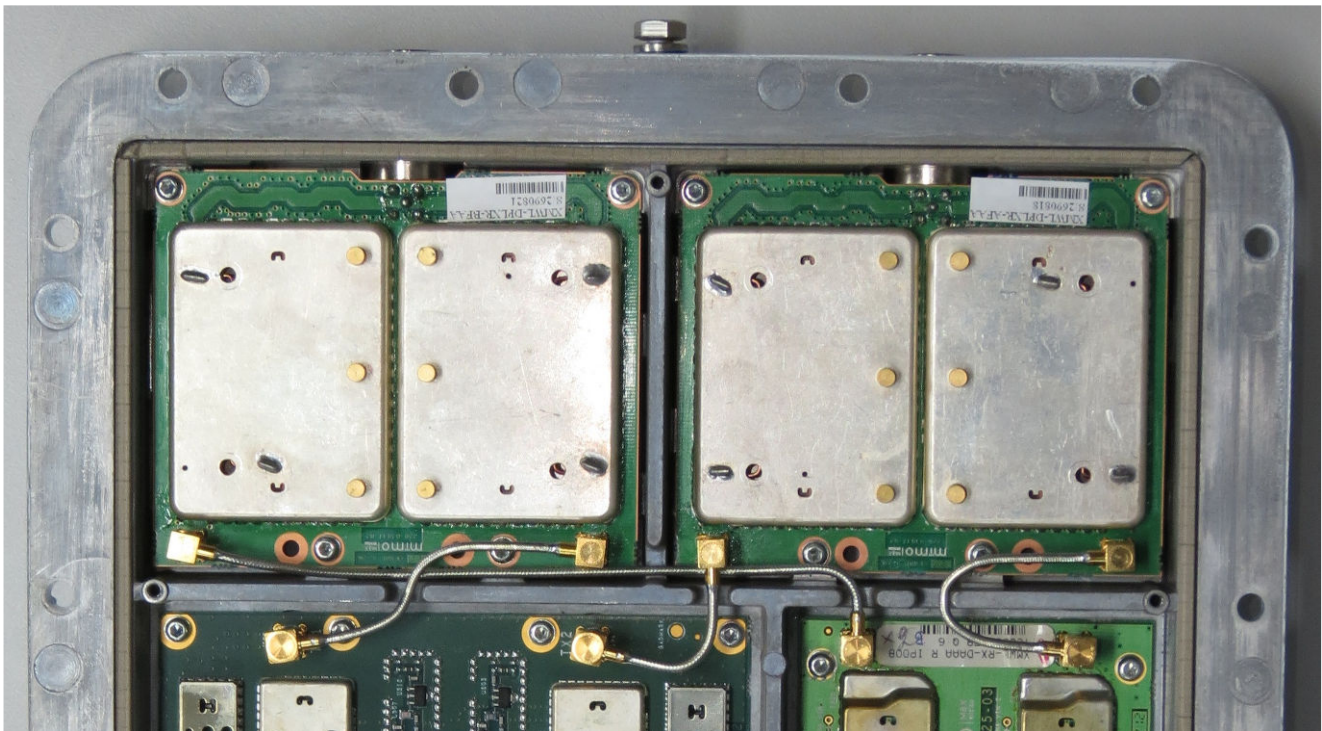


Figure 18: Duplexers & coax cables mounted in the chassis

By swapping the duplexer positions the radio unit is changed from Tx high to Tx low or vice versa.

Note: Tx high means the transmitter frequency is above the receive frequency. Tx low means the transmitter frequency is below the receive frequency. A point-to-point link will have a Tx high unit at one end and a Tx low at the other.

### 3.1 DUPLEXER TUNING GUIDE

#### 3.1.1 Tools/Equipment Required

- Network analyser, Spectrum analyser with tracking generator or other suitable frequency sweeping set up covering 800~960MHz
- Leads and adaptors to connect measuring equipment to type N female and type N Male and the load to SMB male
- 50ohm SMB load
- Fine blade tuning tool 1.5 to 2mm x 0.35mm e.g. Goot CD-15
- T10 screwdriver
- T25 screwdriver

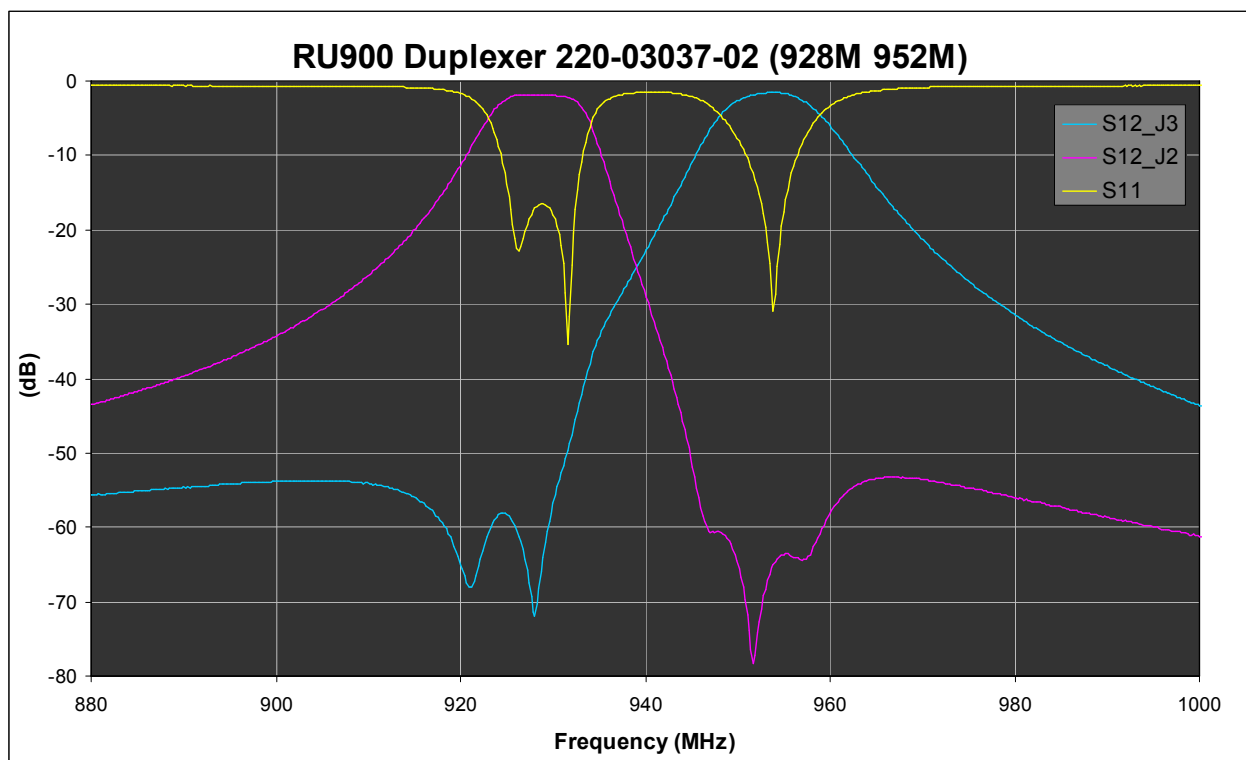
**NB: full anti-static precautions are to be taken**

#### 3.1.2 Procedure

- 1) Remove the 18x T25 screws from the perimeter of the radio.
- 2) Pull the 2 clamshell halves away from each other, separating them at the connector end and pivoting at the other end. Do not unplug the multi-way cables between clamshell halves.
- 3) Remove the 4x T10 screws securing the separating plate.
- 4) Remove the 4x semi rigid coax assemblies. **Note: gently unclip each SMB connector but don't fully remove it, then remove both ends of each cable assembly at the same time, this prevents damaging the cable assembly by twisting it.**
- 5) Remove the trimmer capacitor covers from the Type B duplexer.
- 6) Calibrate/set up the measuring equipment to the desired frequency band.
- 7) Set markers to the desired Tx and Rx frequencies to aid tuning.
- 8) Connect the measuring equipment to antenna port J1 and J2 of the Type B duplexer, and place the 50ohm load on J3.
- 9) Using the tuning tool, tune the 3 left hand trimmers to maximise the pass band response at the lower desired frequency.
- 10) Swap the 50 Ohm load to J2 and the measuring equipment to J3.

- 11) Tune the 3 right hand trimmers to maximise the response at the higher desired frequency. A small amount of iteration between the left and right hand sides may be required to get best pass band responses.
- 12) Refit the trimmer covers.
- 13) Remove the trimmer capacitor covers from the Type A duplexer.
- 14) Connect the measuring equipment to antenna port J1 and J3 of the Type B duplexer, and place the 50ohm load on J2.
- 15) Using the tuning tool, tune the 3 right hand trimmers to maximise the pass band response at the lower desired frequency.
- 16) Swap the 50 Ohm load to J3 and the measuring equipment to J2.
- 17) Tune the 3 left hand trimmers to maximise the response at the higher desired frequency. A small amount of iteration between the left and right hand sides may be required to get best pass band responses.
- 18) Refit the trimmer covers and coax assemblies.
- 19) The pass-band loss should be less than 2.5dB and the loss at the stop frequency should be greater than 65dB. Typical response curves are shown below.
- 20) Reassemble the dividing plate and clamshell halves back together ensuring weather seal O-ring is seated and multi-way cables are plugged in and not pinched.

See Figure 19 for a plot of the final tuned filter characteristic as seen on the Network Analyser



**Figure 19: Filter Characteristic as Seen on Network Analyser**