Chapter 7

Radio Frequency Distribution System

The Radio Frequency Distribution System (RFDS) distributes and manages the communications network frequencies and mitigates interference between multiple radios, allowing them to operate simultaneously. This results in improved radio reception performance across the frequency ranges where multiple transmitters are broadcasting.

7.1 RFDS Theory of Operation

The RFDS module is made up of the following subcomponents:

- Preselector (MTS LiTE, MTS 2, and MTS 4)
- Duplexer (MTS LiTE, MTS 2, and MTS 4)
- Cavity Combiners (MTS 4 and Expansion Cabinet)
- Hybrid Combiner (MTS 2, MTS 4 uses either HC or CC)
- Post Filter (MTS 4 only)
- RX Splitter (Expansion Cabinet only)

The RFDS module supports the combining and filtering of multiple Base Radio transmitters to one or more antenna outputs. The RFDS module supports up to triple receive diversity. Signals are filtered by either the Duplexer or the Preselector, then amplified and distributed by the integrated Receiver Multicoupler (RMC). In configurations with an Expansion Cabinet, the RX-splitter is used to distribute the received signal.

The RFDS also conditions the transmit and receive signal using filters. After combining the Base Radio transmitters in the Hybrid Combiner (or in the Cavity Combiner in the case of the MTS 4), the transmit signals are filtered in the transmit path of the Duplexer, which supplies the antenna connector on the cabinet.

MTS LiTE, MTS 2 and MTS 4, with or without Expansion Cabinet configuration, use different types of RFDS modules. The following are the distinct differences:

- MTS 2 supports Hybrid Combiners
- MTS 4 supports Cavity Combiners or Hybrid Combiners
- MTS LiTE/MTS 2 and MTS 4 do not use the same filters and mechanics for the filter tray
- MTS LiTE support one RF channel
- MTS 2 supports up to two RF channels
- MTS 4 supports up to four RF channels
- Expansion Cabinet supports eight RF channels (four in MTS 4 Prime Cabinet and four in MTS 4 Expansion Cabinet)

MTS 2 only has up to two carriers (the frequency that it sends out) and, as a result there are no Post Filters for a non-duplexed operation. A non-duplexed operation is achieved using a Duplexer as the Post Filter and not using the receive path of the Duplexer. This configuration does not allow room for a third Preselector inside the cabinet; however, it is possible to situate one outside the cabinet, for example, on the wall.

7.1.1
CAN Bus

The intercommunication between the RFDS units (the Duplexers, Post Filters, and Cavity Combiners) and the Site Controller is carried out through the CAN Bus at 125 kB/second. The connectors for the CAN Bus are RJ45 connectors. The CAN Bus is terminated at each end, either by the Site Controller or by an RJ45 terminator.

Each device is registered at the Site Controller (SC), which specifies the particular channel for each unit. Every 30 seconds, each unit on the CAN Bus transmits status and alarm information. Alarms are triggered when any thresholds are exceeded, (failure alarms, software revisions, and so on). The following common information is available from the CAN Bus: serial number, TrackID, software revisions, and the Motorola Solutions kit number. For each unit, specific information is available, for example, voltage standing wave ratio (VSWR) for DPMs and tuning information for Cavity Combiners.

The receive path of the Preselector or Duplexer is not connected to the CAN Bus. Because the supply voltage is supplied from the Base Radio, the Base Radio can withstand a short or 50 ohms connection to the RX input without the Base Radio or the Power Supply Unit (PSU) being damaged.

For more information on CAN Bus, see Site Controller CAN Bus on page 303.

7.1.2
RFDS Frequency Band and Bandwidth

The following table contains all the frequency bands available in MTS LiTE, MTS 2, and MTS 4.

Table 81: RFDS Frequency Bands and Bandwidth

Frequency Band	MTS Version	Filter Bandwidth	Duplex Spacing
350 MHz – 470 MHz	• MTS LiTE • MTS 2 • MTS 4	5 MHz	10 MHz
260 MHz – 275 MHz	• MTS 2 • MTS 4	6 MHz	9 MHz
851 MHz – 870 MHz	• MTS LiTE • MTS 2 • MTS 4	19 MHz	45 MHz

7.2
MTS LiTE and MTS 2 RFDS

In terms of RFDS, MTS 2 uses a low-power, cost effective RFDS placed on top of a card cage, intended for up to 2 Base Radios. For MTS LiTE, the RFDS is placed beside the card cage intended for only 1 Base Radio.

The RFDS in MTS LiTE and MTS 2 is made up of the following:

- One or two Preselectors with integrated high performance low noise amplifier (LNA). The supply voltage for the LNA is supplied through the RX out connected to the Base Radios. The Preselector has two outlets for two Base Radios. The dimensions of the filter are: 85 x 280 x 70 mm, excluding connectors. The antenna connectors are DIN 7–16, the receive side is connected with QMA connectors. See the block schematic of the MTS LiTE/MTS 2 Preselector in Figure 142: Schematic Diagram of MTS LiTE / MTS 2 Preselector on page 265.

NOTICE: MTS LiTE supports up to one Preselector.

- One or two Duplexers rated for up to two TETRA modulated carriers. The antenna connectors are DIN 7–16, the transmit side is connected with QN connectors. The Duplexer has an integrated digital VSWR meter. The supply voltage for the digital VSWR meter is supplied through the CAN Bus interface. The receive side has integrated LNA as for the Preselector and two RX outputs (QMA). The supply voltage for the LNA is supplied through the RX ports. The filter dimensions are approximately: 170 x 280 x 70 mm excluding connectors. See the block schematic of the MTS LiTE/MTS 2 Duplexer in Figure 144: Schematic Diagram of MTS LiTE / MTS 2 Duplexer on page 268.

  NOTICE:
  MTS LiTE supports one Duplexer.

  Because the MTS 2 has only up to two carriers, there is no need for Post Filters for non-duplexed operation (you can achieve non-duplexed operation by using the Duplexer as the Post Filter and not using the receive path of the Duplexer).

- Hybrid Combiner. MTS 2 can have either a Hybrid Combiner for transmission on one antenna, or without combining for transmission on two separate antennas.

MTS 2 is equipped with a digital voltage standing wave ratio (VSWR) monitor to ensure site availability at remote low-traffic sites and for public safety customers. The digital VSWR monitor can make a quite accurate VSWR reading because the measurement is relative between the forward and reverse power.

The VSWR monitor does not have the same accuracy in power reading as the digital power monitor (DPM) in the MTS 4, but it still allows a cost-effective monitoring of the integrity of the antenna.

7.2.1
MTS LiTE and MTS 2 Filter Tray

The MTS LiTE filter tray can carry one Duplexer and one Preselector or one Duplexer and no Preselector. The antenna connectors from the Duplexer extend from the MTS LiTE junction panel while antenna connection from the Preselector is connected via the use of cable. Antenna cables are connected directly onto the filters.

NOTICE:
In Table 82: MTS LiTE RF Configurations on page 260, Low Power is valid for 400 MHz, while High Power is valid for 400 MHz, 800MHz and 900 MHz. The numbers illustrated are applicable for TETRA.

The MTS 2 filter tray can carry up to two Duplexers and one Preselector or one Duplexer and two Preselectors. There is also room for a Hybrid Combiner. The antenna connectors extend from the MTS 2 junction panel and antenna cables are connected directly onto the filters.

NOTICE: In Table 83: MTS 2 RF Configurations on page 261, *Low Power* is valid for 400 MHz and 260 MHz, while *High Power* is valid for 400 MHz, 800MHz and 900 MHz. The numbers illustrated are applicable for TETRA with TEDS numbers within parentheses.

Table 82: MTS LiTE RF Configurations on page 260 lists all filters configurations for MTS LiTE and Figure 135: MTS LiTE TX/RX on 1 ant. - Filter Configuration on page 260 and Figure 136: MTS LiTE

TX/RX on 1 ant., RX on 1 ant - Filter Configuration on page 261 show the positions of filters in the filter tray.

Table 82: MTS LiTE RF Configurations

RF Configuration	Max Power [W]		Duplexer	Preselector
	Low Pwr	High Pwr		
TX/RX on 1 ant.	25	40	1	-
TX/RX on 1 ant., RX on 1 ant.	25	40	1	1

Figure 135: MTS LiTE TX/RX on 1 ant. - Filter Configuration

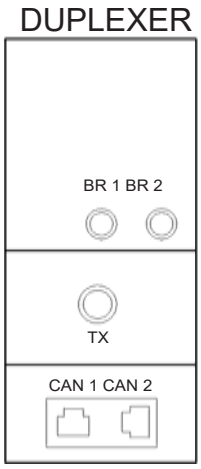


Figure 136: MTS LiTE TX/RX on 1 ant., RX on 1 ant - Filter Configuration

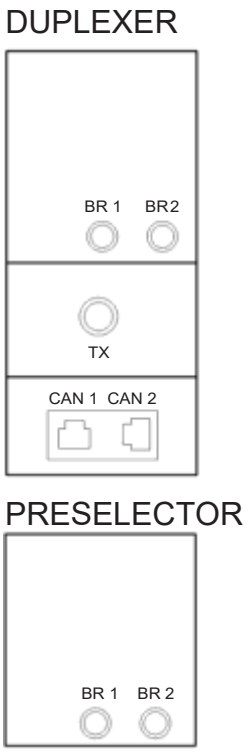


Table 83: MTS 2 RF Configurations on page 261 lists all filters configurations for MTS 2 and Figure 137: MTS 2 TX/RX on 2 ant. - Filter Configuration on page 262 to Figure 140: MTS 2 TX/RX on 1 ant., RX on 2 ant - Filter Configuration on page 263 show the positions of filters in the filter tray.

Table 83: MTS 2 RF Configurations

RF Configuration	Max Power [W]		Hybrid Combiner	Duplexer	Preselector
	Low Pwr	High Pwr			
TX/RX on 2 ant.	25	40 (20)	-	2	-
TX/RX on 2 ant., RX on 1 ant.	25	40 (20)	-	2	1
TX/RX on 1 ant., RX on 1 ant.	10	25 (10)	1	1	1
TX/RX on 1 ant., RX on 2 ant.	10	25 (10)	1	1	2

Figure 137: MTS 2 TX/RX on 2 ant. - Filter Configuration

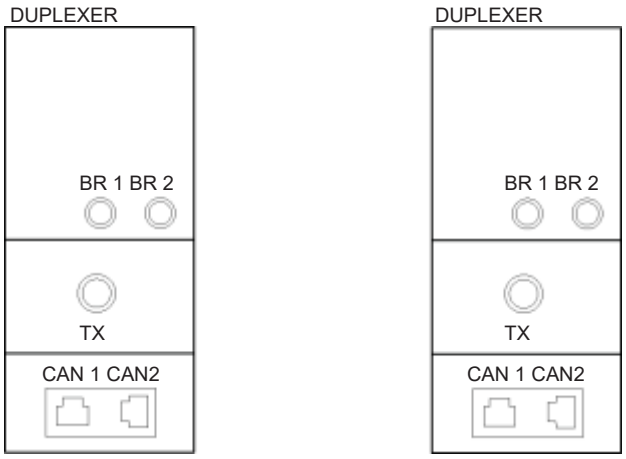


Figure 138: MTS 2 TX/RX on 2 ant., RX on 1 ant - Filter Configuration

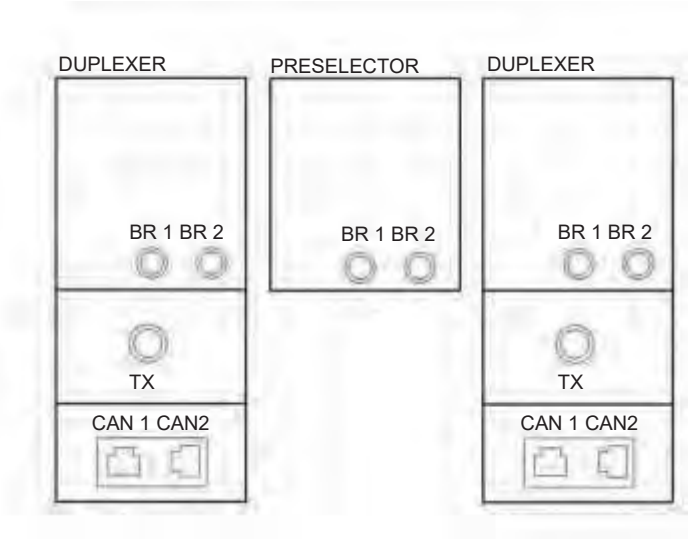


Figure 139: MTS 2 TX/RX on 1 ant., RX on 1 ant - Filter Configuration

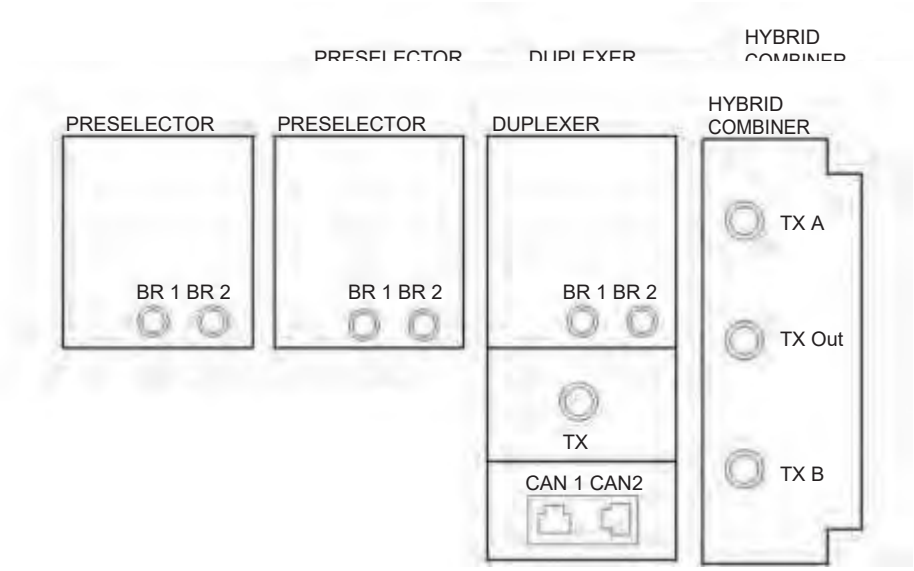


Figure 140: MTS 2 TX/RX on 1 ant., RX on 2 ant - Filter Configuration

7.2.2
MTS LiTE / MTS 2 Preselector

The MTS LiTE/MTS 2 Preselector is a bandpass filter, which only allows the receiver signals to pass. With a bandwidth of:

- 5 MHz for 400 MHz version
- 6 MHz for 260 MHz version (MTS 2 only)
- 19 MHz for 800 MHz version
- 5 MHz for 900 MHz version

The filters bandwidth is designed to block transmitter frequencies. The receive and transmit bandpass are 10 MHz apart for 400 MHz, 45 MHz apart for 800 MHz and 15 MHz apart for 900 MHz. The Preselector incorporates an LNA followed by an RMC.

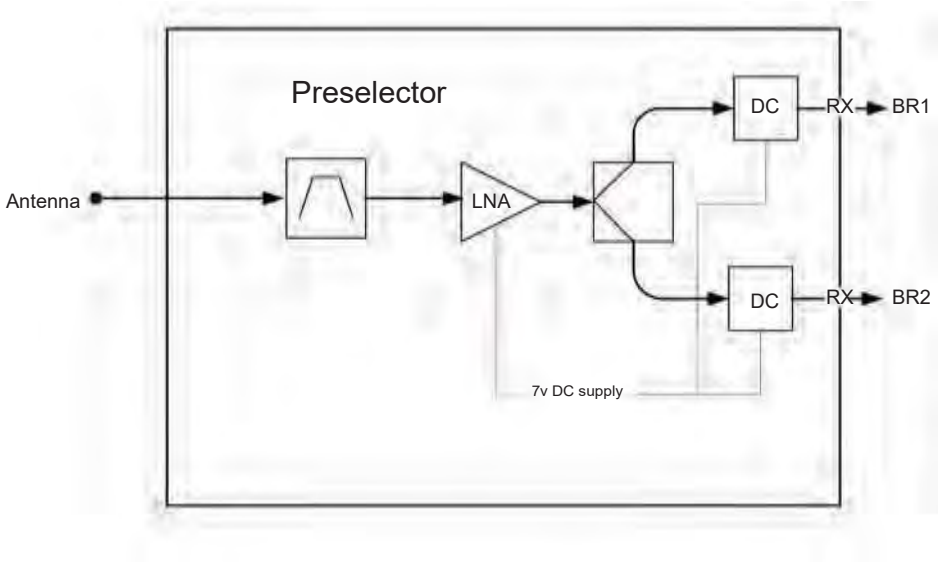
NOTICE: The MTS LiTE Preselector FRU is common with the MTS 2 Preselector.

Figure 141: MTS LiTE / MTS 2 Preselector

NOTICE: Unused RX outputs should be terminated.

The MTS LiTE/MTS 2 Preselector only has two RX outputs and no expansion output. In MTS LiTE/MTS 2 the Preselector has an integrated high performance low noise amplifier (LNA). The supply voltage for the LNA is supplied through the RX out connected to the Base Radios. The Preselector has two outlets for two Base Radios. The antenna connectors are DIN 7–16, the receive side is connected with QMA connectors. See the block schematic of the MTS LiTE/MTS 2 Preselector in the following figure.

Figure 142: Schematic Diagram of MTS LiTE / MTS 2 Preselector



NOTICE: Unused RX outputs should be terminated.

7.2.2.1

Replacing the MTS LiTE / MTS 2 Preselector

For a list of available FRUs, see Field Replaceable Units (FRUs) on page 446.

Prerequisites:

WARNING: RF energy burn hazard. Disconnect power in the cabinet to prevent injury and equipment damage while disconnecting and connecting antennas.

Process:

1. Remove the Preselector, see Removing the Preselector – MTS LiTE on page 265 or Removing the Preselector – MTS 2 on page 266.
2. Reinstall the Preselector, see Reinstalling the Preselector – MTS LiTE on page 266 or Reinstalling the Preselector – MTS 2 on page 266.

7.2.2.1.1

Removing the Preselector – MTS LiTE

Procedure:

1. Remove the door of the cabinet completely.
2. Unscrew the antenna cable on the Preselector.
3. Remove the two fastening screws behind the antenna.
4. Loosen the two fastening screws at the front enough to free the center tab.

   CAUTION: Do not remove the screws entirely because the filter will drop.

5 Slide the Preselector out of the cabinet.
6 Remove all RX cable connections on the Preselector.
7 Remove and keep the RF Terminator from the BR2 connector.
8 Remove and keep the bracket at the front.

7.2.2.1.2
Removing the Preselector – MTS 2

Procedure:

1 Remove the door of the cabinet completely.
2 Unscrew the antenna cable. Remove all RX cables connected to the Preselector.
3 Remove the fastening screw behind the antenna.
4 Loosen the two fastening screws at the front enough to free the center tab.

CAUTION: Do not remove the screws entirely because the filter will drop.

5 Slide the Preselector out of the cabinet.

7.2.2.1.3
Reinstalling the Preselector – MTS LiTE

Procedure:

1 Assemble the rear bracket at the Preselector.
2 Assemble the front bracket at the antenna connector with a screw.
3 Connect the RF Terminator to the BR2 output of the Preselector.
4 Connect the RX cable to the BR1 connector of the Preselector.
5 Slide the Preselector into the filter tray in the cabinet.
6 While supporting the Preselector fasten the screws at the front bracket.
7 Attach the RF cable on the Preselector antenna connector.
8 Switch ON the Power Supply Unit.

7.2.2.1.4
Reinstalling the Preselector – MTS 2

Procedure:

1 Slide the Preselector into the filter tray in the cabinet. Make sure the rear center tab fits into the appropriate slot.
2 While supporting the Preselector fasten the two screws at the front.
3 Fasten the screw in the center tab behind the antenna.
4 Attach all RX, TX and signal cables to the Preselector. Fasten the antenna cable.
5 Switch ON the Power Supply Unit.

7.2.3

MTS LiTE / MTS 2 Duplexer

The Duplexer is a Preselector with Integrated Receiver Multicoupler (RMC) and a Post Filter with a digital power monitor (DPM) combined into one unit. These form the two bandpass filters that make up the Duplexer; one is a receive filter and the other a transmit filter.

NOTICE: The MTS LiTE Duplexer is common with the MTS 2 Duplexer.

Figure 143: MTS 2 Duplexer

NOTICE: Unused RX outputs should be terminated.

The duplex spacing between a transmit frequency and the corresponding receive frequency is 10 MHz, with the transmit frequency highest. This leaves a 5 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency.

For MTS 2 260 MHz, the duplex spacing between a transmit frequency and the corresponding receive frequency is 9 MHz, and leaves a 3 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency.

For 800 MHz, the duplex spacing between a transmit frequency and the corresponding receive frequency is 45 MHz, and leaves a 19 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency in each duplexer.

For 900 MHz, the duplex spacing between a transmit frequency and the corresponding receive frequency is 15 MHz, and leaves a 10 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency.

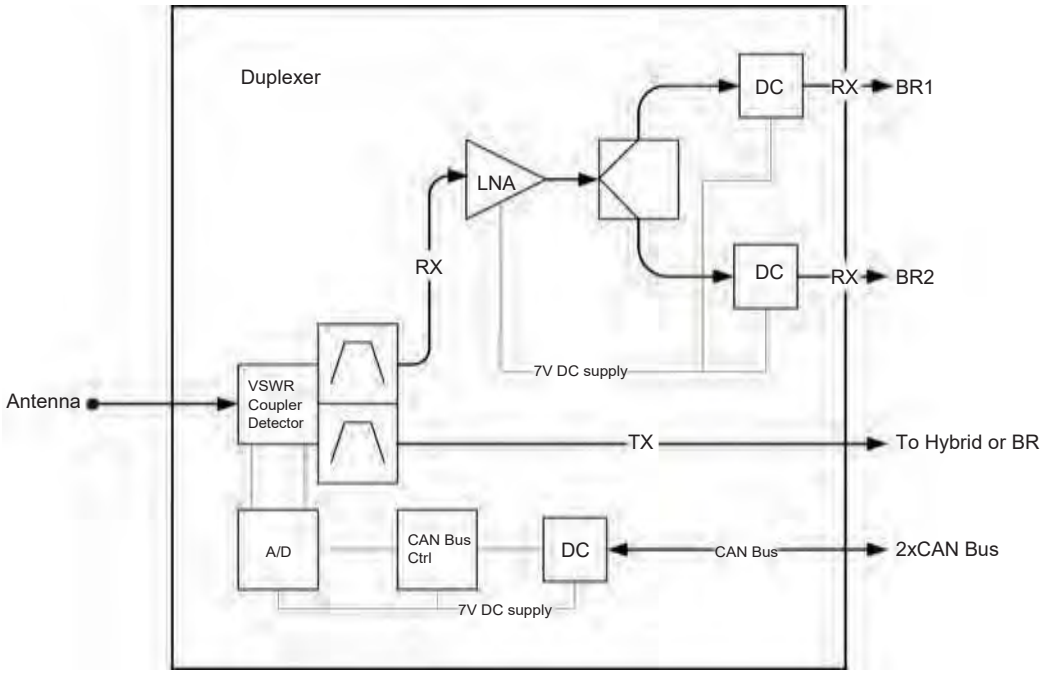
The MTS LiTE/MTS 2 Duplexer has 2 RX outputs and can handle a maximum power of 60 watts.

NOTICE: Unused RX outputs should be terminated.

The receiver LNA and splitter provides multiple receive signal ports. An amplified output is provided for connection to the other cabinet in an expansion configuration.

The digital power monitor (DPM) is a directional coupler that measures forward and reverse Power. Power and VSWR information can be read through the CAN bus.

Figure 144: Schematic Diagram of MTS LiTE / MTS 2 Duplexer



NOTICE: Unused RX outputs should be terminated.

7.2.3.1 Replacing the MTS LiTE / MTS 2 Duplexer

For a list of available FRUs, see Field Replaceable Units (FRUs) on page 446.

Process:

1. Remove the Duplexer, see Removing the MTS LiTE / MTS 2 Duplexer on page 269.
2. Insert the Duplexer into the filter tray, see Inserting the MTS LiTE / MTS 2 Duplexer into the Filter Tray on page 269.
3. Update the mapping list with the new unit TrackID, see Updating the Mapping List with the New Unit TrackID on page 269.

7.2.3.1.1

Removing the MTS LiTE / MTS 2 Duplexer

WARNING: RF energy hazard and potential equipment damage precaution: Turn off all power to the Power Supply Unit before performing the following procedures to prevent accidental contact with high energy and injury to personnel.

Procedure:

1. Switch OFF the Power Supply Unit.
2. Unscrew the antenna cable. Remove all RX, TX and signal cables connected to the Duplexer.
3. Remove the fastening screw behind the antenna.
4. Loosen the two fastening screws at the front enough to free the center tab.

   CAUTION: Do not remove the screws entirely because the filter will drop.
5. Slide the Duplexer out of the cabinet.

7.2.3.1.2

Reinstalling the MTS LiTE / MTS 2 Duplexer

Procedure:

1. Insert the Duplexer into the filter tray.

   See Inserting the MTS LiTE / MTS 2 Duplexer into the Filter Tray on page 269.
2. Update the mapping list with the new unit TrackID.

   See Updating the Mapping List with the New Unit TrackID on page 269.

7.2.3.1.3

Inserting the MTS LiTE / MTS 2 Duplexer into the Filter Tray

Procedure:

1. Slide the Duplexer into the filter tray in the cabinet. Make sure the rear center tab fits in the appropriate slot.
2. While supporting the Duplexer fasten the two screws at the front.
3. Fasten screw in the center tab behind the antenna.
4. Attach all RX, TX and signal cables to be connected to the Duplexer. Fasten the antenna cable.
5. Switch ON the Power Supply Unit.

7.2.3.1.4

Updating the Mapping List with the New Unit TrackID

Procedure:

1. Log on to the Site Controller.
2. View the mapping list by entering: `can check_mapping`.

   Step example:

```
Units are present:
Device Track ID
DPM 1 JTH0500101
PSU 1 JTH0500200
```

```
Units are not present:
DPM 2 JTH0500105
Track ID not mapped:
JTH0500102
```

3 On the mapping list, locate the removed unit indicated as `Units are not present`.

4 Delete the old CAN Bus unit from the CAN Bus unit mapping list by entering: `can remove_mapping` ***<X>***.

<X> identifies the old unit name and is digit between 0 and 3.

Step example: `can remove_mapping dpm 2`.

5 Add the new CAN Bus unit to the CAN Bus unit mapping list by entering: `add_mapping dpm`***<X><track ID>***.

<track ID> is a Track ID of the new unit.

<X> identifies the new unit name and is a digit between 0 and 3.

NOTICE: The new unit Track ID is present on the replaced unit label and indicated as `Track ID not mapped`.

Step example: `can add_mapping dpm 2 JTH0500102`

6 View the updated mapping list by entering: `can check_mapping`.

7 On the mapping list, check that there are no units labeled as `Track ID not mapped` or `Units are not present`.

7.2.4
Hybrid Combiner

The Hybrid Combiner is a part of the transmitter path in the RF Distribution System. The Hybrid Combiner provides very reliable combining of up to two transmitters. The Hybrid Combiner has no limitations in respect to channel spacing of the TX channels; however, for frequency planning and interference reasons, at least 50 kHz is recommended.

Figure 145: Hybrid Combiner

The TX signals from two Base Radios are attached to the respective Hybrid Combiner inputs. The combined signal at the Hybrid Combiner out port is then applied to the Duplexer.

The Hybrid Combiner contains one printed circuit board.

7.2.4.1
Replacing the Hybrid Combiner

Process:

1. Remove the Hybrid Combiner.

   See Removing the Hybrid Combiner on page 271.
2. Reinstall the Hybrid Combiner.

   See Reinstalling the Hybrid Combiner on page 272.

7.2.4.1.1
Removing the Hybrid Combiner

Procedure:

1. **WARNING:** RF energy hazard and potential equipment damage.

   Switch OFF the Power Supply Unit to prevent accidental contact with high energy and injury to personnel.
2. **WARNING:** The Hybrid Combiner may be hot.

To avoid injury, allow the Hybrid Combiner to cool down before servicing.

3 Remove the TX and antenna cables.

4 Loosen the two screws that secure the Hybrid Combiner onto the bracket.

5 Slide the Hybrid Combiner forward and pull free from the screws. Slide it out from the bracket.

7.2.4.1.2
Reinstalling the Hybrid Combiner

Procedure:

1 Place the Hybrid Combiner on the bracket of the cabinet with the heat sink facing the side of the cabinet.

NOTICE: In the MTS 2, the heat sink should face inwards towards the center of the cabinet.

2 Slide in the Hybrid Combiner at an angle.

3 Secure the lip at the back of the Hybrid Combiner behind the bracket.

4 Fasten the screws to the bracket.

5 Attach the TX and antenna cables.

6 Switch ON the Power Supply Unit.

7.3
MTS 4 RFDS

The MTS 4 uses a high-power RFDS intended for up to 4 high power Base Radios. The RFDS in MTS 4 is made up of the following:

- Up to three Preselectors low-loss Preselectors with integrated high performance LNA and RMC. The supply voltage for the LNA is supplied through the RX out connected to the Base Radios. The Preselectors have outputs for four Base Radios. Dimensions of the filter are 90 x 180 x 200 mm excluding connectors. The antenna connectors are DIN 7–16. The RX signals from Base Radios are connected with QMA connectors.
- Up to two Post Filters low-loss Post Filters rated for up to 8 TETRA modulated carriers. The antenna connectors are DIN 7–16, the TX signals to Cavity Combiners are connected with QN connectors.
- Up to two Duplexers Preselectors with an integrated receiver multicoupler (RMC) and a Post Filter with a digital power monitor (DPM) combined into one unit. Duplexer is rated for up to four TETRA modulated carriers. The antenna connectors are DIN 7–16, the transmit site is connected with QN connectors. The receive side has integrated LNA as for the Preselector and four RX outputs (QMA). The supply voltage for the LNA is supplied through the RX ports.
- Hybrid Combiner – combining of four carriers on 2 TX antennas. Cavity Combiners - combining of four carriers on 1 TX antenna.

MTS 4 is equipped with a digital power monitor to ensure diagnostic availability. The digital interface has the same benefits as described for the MTS 2 digital VSWR monitor.

7.3.1
MTS 4 Filter Tray

The MTS 4 filter tray can carry different filter configurations. The antenna connectors extend from the cabinet top cover and antenna cables connect directly onto the filters.

The following table lists all configurations for MTS 4.

NOTICE: The numbers illustrated are applicable for TETRA with TEDS numbers within parentheses.
Low Power is valid for 400 MHz and 260 MHz, while High Power is valid for both 400 MHz and 800 MHz.

Table 84: MTS 4 RF Configurations

RF Configuration	Max Power [W]		Combin-er	Duplex-er	Pre se-lector	Post Filter
	Low Pwr	High Pwr				
1 - 2 BRs						
TX/RX on 2 ant.	25	40 (20)	-	2	-	-
TX/RX on 2 ant., RX on 1 ant.	25	40 (20)	-	2	1	-
TX on 2 ant., RX on 2 ant.	25	40 (20)	-	-	2	2
TX on 2 ant., RX on 3 ant.	25	40 (20)	-	-	3	2
TX/RX on 1 ant., RX on 1 ant.	10	25 (10)	1	1	1	-
TX/RX on 1 ant., RX on 2 ant.	10	25 (10)	1	1	2	-
TX on 1 ant., RX on 2 ant.	10	25 (10)	1	-	2	1
TX on 1 ant., RX on 3 ant.	10	25 (10)	1	-	3	1
3 - 4 BRs						
TX/RX on 2 ant.	10	25 (10)	2	2	-	-
TX/RX on 2 ant., RX on 1 ant.	10	25 (10)	2	2	1	-
TX on 2 ant., RX on 2 ant.	10	25 (10)	2	-	2	2
TX on 2 ant., RX on 3 ant.	10	25 (10)	2	-	3	2
TX/RX on 1 ant., RX on 1 ant.	10	25 (10)	2 (comb)	1	1	-
TX/RX on 1 ant., RX on 2 ant.	10	25 (10)	2 (comb)	1	2	-
TX on 1 ant., RX on 2 ant.	10	25 (10)	2 (comb)	-	2	1
TX on 1 ant., RX on 3 ant.	10	25 (10)	2 (comb)	-	3	1

The following figures show the positions of filters in the filter tray.

Figure 146: MTS 4 TX/RX on one Antenna and up to two RX Antennas Filter Configuration

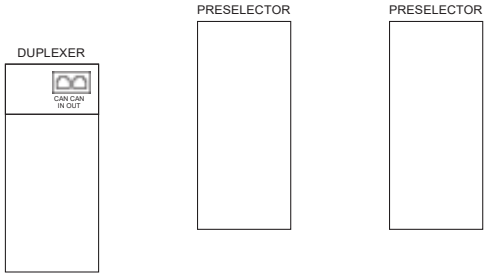


Figure 147: MTS 4 TX/RX on two Antennas and up to one RX Antenna Filter Configuration

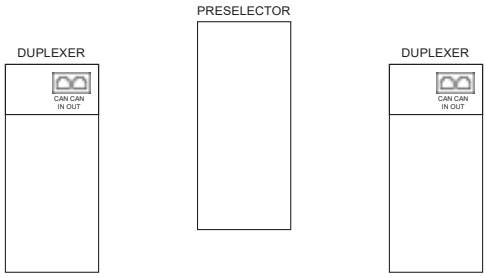


Figure 148: MTS 4 TX on one Antenna and up to three RX Antennas Filter Configuration

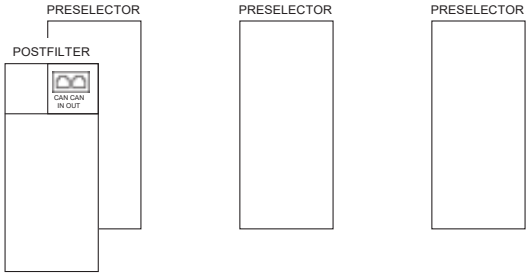


Figure 149: MTS 4 TX on one Antenna and two RX Antennas Filter Configuration

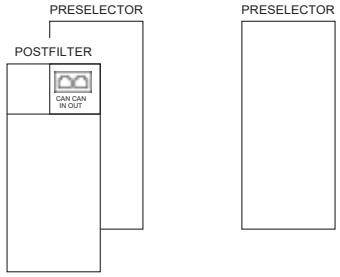
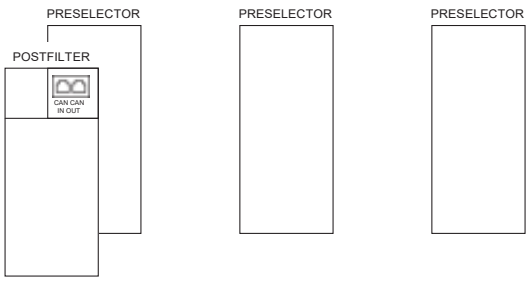


Figure 150: MTS 4 TX on one Antenna and three RX Antennas Filter Configuration



7.3.2
MTS 4 Preselector

The MTS 4 Preselector is a bandpass filter, which only allows the receiver signals to pass.

MTS 4 Preselector bandwidth is:

- 5 MHz for 400 MHz version
- 6 MHz for 260 MHz version
- 19 MHz for 800 MHz version

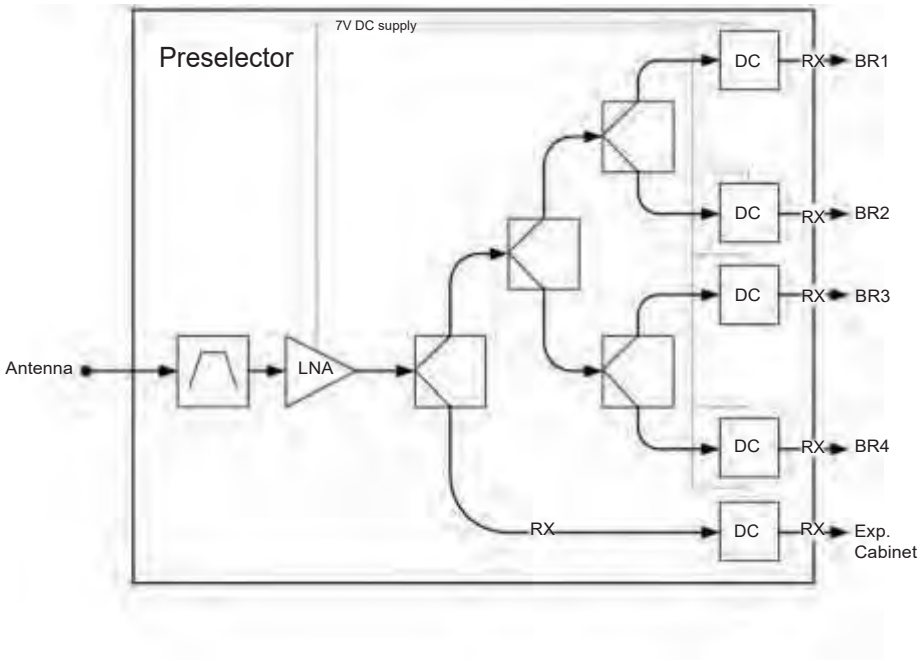
The filter's bandwidth is designed to block transmitter frequencies. The receive and transmit bandpass are 10 MHz apart for 400 MHz, 9 MHz apart for 260 MHz, and 45 MHz apart for 800 MHz. The Preselector incorporates an LNA followed by an RMC.

The MTS 4 Preselector has four RX outputs and one expansion output.

Figure 151: MTS 4 Preselector

In the MTS 4, the Preselector has an integrated high performance LNA and RMC. The supply voltage for the LNA is supplied through the RX out connected to the Base Radios. The Preselector has outputs for four Base Radios The antenna connector is DIN 7–16. The receive side is connected by QMA connectors.

Figure 152: Schematic Diagram of MTS 4 Preselector



7.3.2.1

Replacing the MTS 4 Preselector

WARNING: RF energy burn hazard. Disconnect power in the cabinet to prevent injury and equipment damage while disconnecting and connecting antennas.

Process:

1. Remove the Preselector.

   See Removing the MTS 4 Preselector on page 276.
2. Reinstall the Preselector.

   See Reinstalling the MTS 4 Preselector on page 277.

7.3.2.1.1

Removing the MTS 4 Preselector

Procedure:

1. Remove the door of the cabinet completely.
2. Remove the four screws holding the front panel.
3. Loosen the two screws holding the front section of the top panel and slide off the panel.
4. Loosen the screws fastening the rear section of the top panel and slide off the panel.
5. Unscrew the antenna cable and remove the RX cables connected to the back of the Preselector.
6. Loosen the two fastening screws at the front enough to free the mounting bracket.
7. Slide the Preselector out of the cabinet.
8. Remove the Preselector from the bracket and replace with the new unit.

7.3.2.1.2
Reinstalling the MTS 4 Preselector

Procedure:

1. Fasten the Preselector onto the bracket.
2. Slide the Preselector into the cabinet.
3. Tighten the two fastening screws at the front.
4. Screw on the antenna cable and connect the RX cables to the back of the Preselector.
5. Slide on the top rear and front panels and fasten these with screws.
6. Put the front panel back on and screw this into place.
7. Put the door of the cabinet back on.

7.3.3
MTS 4 Duplexer

The Duplexer is a Preselector with an integrated receiver multicoupler (RMC) and a Post Filter with a digital power monitor (DPM) combined into one unit. These form the two bandpass filters that make up the Duplexer; one is a receive filter and the other a transmit filter. See the block schematic of the MTS 4 Duplexer in Figure 154: Schematic Diagram of MTS 4 Duplexer on page 278

For 400 MHz, the duplex spacing between a transmitter frequency and the corresponding receive frequency is 10 MHz, with the transmitter frequency highest. This leaves a 5 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency.

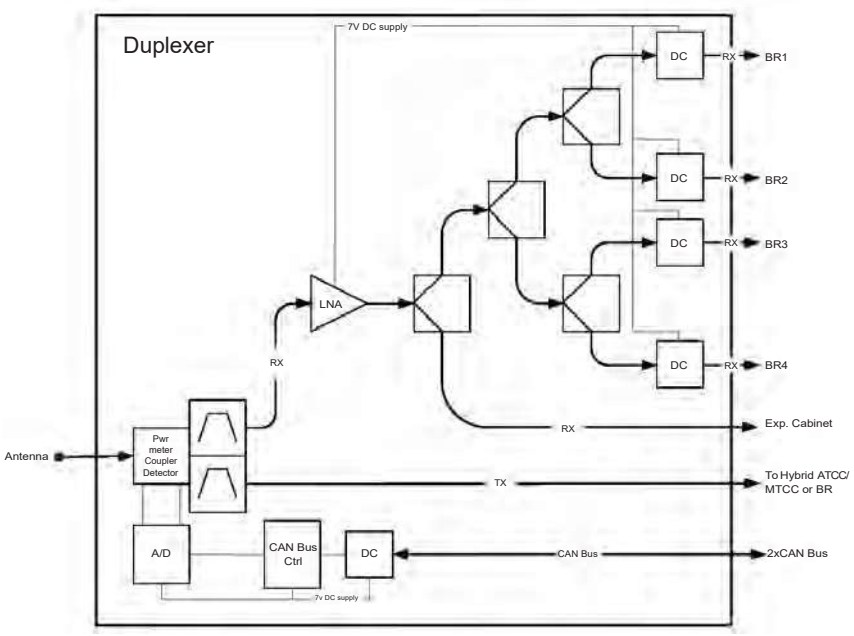
For 260 MHz, the duplex spacing between a transmit frequency and the corresponding receive frequency is 9 MHz, and leaves a 3 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency.

For 800 MHz, the duplex spacing between a transmit frequency and the corresponding receive frequency is 45 MHz, and leaves a 19 MHz spacing between the lowest possible transmit frequency and the highest possible receive frequency.

The MTS 4 Duplexer has 4 RX outputs and one expansion output. It can handle a maximum power 180 Watts.

Figure 153: MTS 4 Duplexer

Figure 154: Schematic Diagram of MTS 4 Duplexer



7.3.3.1
Replacing the MTS 4 Duplexer

Process:

1 Remove the Duplexer.

See Removing the MTS 4 Duplexer on page 279.

2 Insert the Duplexer into the filter tray.

See Inserting the MTS 4 Duplexer into the Cabinet on page 279.

3 Update the mapping list with the new unit TrackID.

See Updating the Mapping List with the New Unit TrackID on page 280.

7.3.3.1.1

Removing the MTS 4 Duplexer

Procedure:

1 **WARNING:** RF energy hazard and potential equipment damage precaution.

To prevent accidental contact with high energy and injury to personnel, switch ff all power to the Power Supply Unit.

2 Remove the four screws holding the front panel.

3 Loosen the two screws holding the front section of the top panel and slide off the panel.

4 Loosen the screws fastening the rear section of the top panel and slide off the panel.

5 Unscrew the antenna cable and remove the RX, TX and signal cables.

6 Loosen the two fastening screws at the front enough to free the mounting bracket.

7 Slide the Duplexer out of the cabinet.

8 Remove the Duplexer from the bracket and replace.

7.3.3.1.2

Reinstalling the MTS 4 Duplexer

Procedure:

1 Insert the Duplexer into the cabinet.

See Inserting the MTS 4 Duplexer into the Cabinet on page 279.

2 Update the mapping list with the new unit TrackID.

See Updating the Mapping List with the New Unit TrackID on page 280.

7.3.3.1.3

Inserting the MTS 4 Duplexer into the Cabinet

Procedure:

1 Fasten the Duplexer onto the bracket with screws.

2 Slide the Duplexer into the cabinet.

3 Tighten the two fastening screws at the front to secure the mounting bracket

4 Attach the antenna cable and the RX, TX and signal cables.

5 Slide on the top rear and front panels and fasten these with screws.

6 Put the front panel back on and screw this into place.

7 Put the door of the cabinet back on.

7.3.3.1.4
Updating the Mapping List with the New Unit TrackID

Procedure:

1. Log on to the Site Controller.
2. View the mapping list by entering: `can check_mapping`.

   Step example:

   ```
   Units are present:
   Device Track ID
   DPM 1 JTH0500101
   PSU 1 JTH0500200
   Units are not present:
   DPM 2 JTH0500105
   Track ID not mapped:
   JTH0500102
   ```
3. On the mapping list, locate the removed unit indicated as `Units are not present`.
4. Delete the old CAN Bus unit from the CAN Bus unit mapping list by entering: `can remove_mapping` ***<X>***.

   <X> identifies the old unit name and is digit between 0 and 3.

   Step example: `can remove_mapping dpm 2`.
5. Add the new CAN Bus unit to the CAN Bus unit mapping list by entering: `add_mapping dpm`***<X><track ID>***.

   <track ID> is a Track ID of the new unit.

   <X> identifies the new unit name and is a digit between 0 and 3.

   NOTICE: The new unit Track ID is present on the replaced unit label and indicated as `Track ID not mapped`.

   Step example: `can add_mapping dpm 2 JTH0500102`
6. View the updated mapping list by entering: `can check_mapping`.
7. On the mapping list, check that there are no units labeled as `Track ID not mapped` or `Units are not present`.

7.3.4
Hybrid Combiner in MTS 4

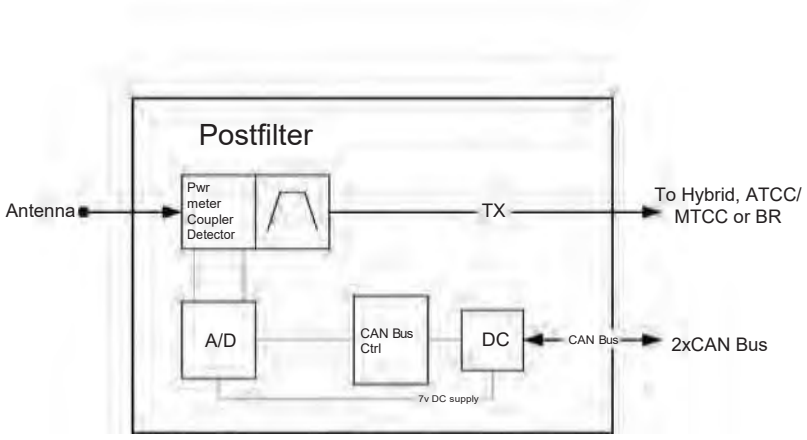
For details about the Hybrid Combiner (HC), see Hybrid Combiner on page 270.

7.3.5
Post Filter

The Post Filter supports non-duplexed configurations. The Post Filter incorporates a DPM. A Post Filter is only available for the MTS 4 because the MTS 2 does not support non-duplexed configurations. The bandwidth is 5 MHz on 400 MHz, 6 MHz on 260 MHz, and 19 MHz on 800 MHz.

Figure 155: Post Filter

Figure 156: Schematic Diagram of Post Filter



7.3.5.1

Replacing the Post Filter

For a list of available FRUs, see Field Replaceable Units (FRUs) on page 446.

Process:

1. Remove the Post Filter, see Removing the Post Filter on page 282.
2. Install the Post Filter into the cabinet, see Inserting the Post Filter into the Cabinet on page 282.
3. Update the mapping list with the new unit TrackID, see Updating the Mapping List with the New Unit TrackID on page 283.

7.3.5.1.1
Removing the Post Filter

Procedure:

1. **WARNING:** RF energy hazard and potential equipment damage precaution.

   To prevent accidental contact with high energy and injury to personnel, switch off the Power Supply Unit.
2. Remove the four screws holding the front panel.
3. Loosen the two screws holding the front section of the top panel and slide off the panel.
4. Loosen the screws fastening the rear section of the top panel and slide off the panel.
5. Unscrew the antenna cable and remove the TX and signal cables.
6. Loosen the two fastening screws at the front enough to free the mounting bracket.

   NOTICE: If a Preselector is mounted on the same bracket, remove the Preselector to slide out the filter bracket. See Removing the MTS 4 Preselector on page 276.
7. Slide the Post Filter out of the cabinet.
8. Remove the Post Filter from the bracket and replace with the new unit.

7.3.5.1.2
Reinstalling the Post Filter

Procedure:

1. Insert the Post Filter into the cabinet.

   See Inserting the Post Filter into the Cabinet on page 282.
2. Update the mapping list with the new unit TrackID.

   See Updating the Mapping List with the New Unit TrackID on page 283.

7.3.5.1.3
Inserting the Post Filter into the Cabinet

Procedure:

1. Fasten the Post Filter onto the bracket with screws.
2. Slide the Post Filter into the cabinet.
3. Tighten the two fastening screws at the front to secure the mounting bracket.
4. Attach the antenna and the TX and signal cables.
5. Slide on the top rear and front panels and fasten these with screws.
6. Put the front panel back on and screw this into place.
7. Put the door of the cabinet back on.

7.3.5.1.4
Updating the Mapping List with the New Unit TrackID

Procedure:

1. Log on to the Site Controller.
2. View the mapping list by entering: `can check_mapping`.

   Step example:

   ```
   Units are present:
   Device Track ID
   DPM 1 JTH0500101
   PSU 1 JTH0500200
   Units are not present:
   DPM 2 JTH0500105
   Track ID not mapped:
   JTH0500102
   ```
3. On the mapping list, locate the removed unit indicated as `Units are not present`.
4. Delete the old CAN Bus unit from the CAN Bus unit mapping list by entering: `can remove_mapping` ***<X>***.

   <X> identifies the old unit name and is digit between 0 and 3.

   Step example: `can remove_mapping dpm 2`.
5. Add the new CAN Bus unit to the CAN Bus unit mapping list by entering: `add_mapping dpm`***<X><track ID>***.

   <track ID> is a Track ID of the new unit.

   <X> identifies the new unit name and is a digit between 0 and 3.

   NOTICE: The new unit Track ID is present on the replaced unit label and indicated as `Track ID not mapped`.

   Step example: `can add_mapping dpm 2 JTH0500102`
6. View the updated mapping list by entering: `can check_mapping`.
7. On the mapping list, check that there are no units labeled as `Track ID not mapped` or `Units are not present`.

7.3.6
Cavity Combiner

NOTICE: MTS 2 does not support Cavity Combiners.

There are two types of Cavity Combiners available:

- Auto Tune Cavity Combiners (ATCC)
- Manual Tune Cavity Combiners (MTCC)

  MTCCs are functionally the same as ATCCs except that they are tuned manually instead of electronically.

  NOTICE: 260 MHz configurations does not support MTCC.

Minimum channel spacing of the TX channels is 150 kHz while the recommended channel spacing is 250 kHz. This limitation applies to all Cavity Combiners in all cabinets connected to the same transmit antenna.

Figure 157: Auto Tune Cavity Combiner

7.3.6.1
Cavity Combiner - Theory of Operation

A minimum of 2 watts is needed at a cavity input. The ATCC will automatically tune in 40 seconds maximum. For more detail, see the ATCC specification.

Once an RF signal greater than 2 watts is detected, the ATCC tunes the cavity and continuously keeps it tuned over humidity, temperature and changing transmit frequency, so long as it does not sense one of the following alarm conditions:

- Channel Spacing alarm
- VSWR alarm
- Failure to Tune alarm

Being tuned means that a cavity is within the insertion loss specification at the frequency of the applied PI/4DQPSK or QAM4,16,64 signal that is within the average input power range specified above. Being tuned also means that the cavity peak response is no greater than 25 kHz away from the TX carrier center frequency. If the TX carrier does not change channel or average power level, the auto tune algorithm will not initiate a re-tuning on its own which exceeds +/- 300 kHz from the carrier frequency. The only exception occurs when the fine tune timer event happens. The fine tune timer is used to compensate for large variations in humidity and is default set to 480 Minutes. The Cavity Combiner is temperature compensated but large variations in humidity can de-tune the cavities up to 150 kHz with the result of an increasing insertion loss.

When the fine tune timer event occurs, all cavities with RF applied will be re-tuned for maximum output power of each TX carrier. The fine tune timer can be adjusted to compensate for fast humidity variations; for instance if the MTS 4 is installed in outdoor sites without air-conditioning. The recommended setting of the fine tune timer, if the MTS 4 is installed in a controlled environment, is 480 Minutes. For sites where the MTS 4 is exposed to more than +/- 20% variation in RH, the recommended setting of the fine tune timer is 60-200 minutes depending on the speed of the variation.

Having a second cavity tune up and pass through the desired channel, the desired channels insertion loss dips no more than 3 dB more than the max insertion spec for a period of 0.25 seconds. The cavity tuning rate should be faster than 1 MHz per second.

The following list contains control and monitoring features available through the CAN Bus:

- Request current tuned position/frequency of a specific cavity.
- Fine tune time feature, to re-tune each cavity with a specified interval.
- Park an individual cavity, but if RF power is still present, cavity will park and then retune again.
- Input power: request current measured input reflected power of a specific cavity.
- VSWR: request input VSWR of an individual cavity.
- Tuning status of each cavity; parked, tuning, tuned, and parking.
- Alarm conditions of each cavity are reported when requested, including : VSWR, subband, channel spacing and failure to tune.

7.3.6.2
Replacing the Cavity Combiner

Process:

1 Remove the Cavity Combiner.

See Removing the Cavity Combiner on page 285.

2 Reinstall the Cavity Combiner.

See Reinstalling the Cavity Combiner on page 285.

7.3.6.2.1
Removing the Cavity Combiner

Procedure:

1 **WARNING:** RF energy hazard and potential equipment damage precaution.

To prevent accidental contact with high energy and injury to personnel, switch off the Power Supply Unit.

2 Remove the door of the cabinet completely.

3 Remove the three screws fastening the Cavity Combiner to the brackets of the cabinet.

Two screws are on the left and one is on the right side of the Cavity Combiner.

4 Remove all TX and signal cables.

5 **CAUTION:** The Cavity Combiner can weigh up to 11.8 kg (26 lbs.). Use caution when removing or installing Cavity Combiner into the equipment rack. To avoid injury to personnel and equipment damage, ensure that the combiner is fully supported when free from mounting rails.

Slide out the Cavity Combiner.

7.3.6.2.2
Reinstalling the Cavity Combiner

Procedure:

1 **CAUTION:** The Cavity Combiner can weigh up to 11.8 kg (26 lbs.). Use caution when removing or installing Cavity Combiner into the equipment rack. To avoid injury to personnel and equipment damage, ensure that the combiner is fully supported when free from mounting rails.

Insert the Cavity Combiner into the cabinet.

See Inserting the Cavity Combiner into the Cabinet on page 286.

2 **For redundant ATCC only:** Upgrade the redundant ATCC firmware.

See Upgrading the Redundant ATCC Firmware on page 286.

3 **For ATCC only:** Update the mapping list with the new unit TrackID.

See Updating the Mapping List with the New TrackID on page 286.

7.3.6.2.3
Inserting the Cavity Combiner into the Cabinet

Procedure:

1 Slide the Cavity Combiner into the cabinet.

2 Attach the TX and signal cables.

3 Fasten the three screws that hold the Cavity Combiner onto the brackets of the cabinet.

Two screws are on the left and one is on the right side of the Cavity Combiner.

4 Put the door of the cabinet back on.

5 Switch on the Power Supply Unit.

7.3.6.2.4
Upgrading the Redundant ATCC Firmware

Procedure:

1 Connect a PC with the TFTP server to the Base Station.

2 Place the new firmware on the TFTP server.

3 Log on to the Site Controller.

4 At the command prompt, enter:
`tftp` ***`<IP address>`*** `get` ***`<tftp server directory>`***`\SU11075-15.a90 /ffx/SU11075-15.a90`

The firmware is transferred from the PC to the Base station.

5 Load the file into the ATCC by entering `atc 1 load_program /ffx/SU11075-15.a90`.

The firmware is loaded to the ATCC and the upload status displays.

6 Verify the successful upgrade by entering `atc 1 get device_id`.

The device ID matches the firmware version.

7.3.6.2.5
Updating the Mapping List with the New TrackID

Procedure:

1 Log on to the Site Controller.

2 View the mapping list by entering: `can check_mapping`.

Step example:

```
Units are present:

DPM 1 JTH0500101
DPM 2 JTH0500105
PSU 1 JTH0500200
Units are not present:
ATCC 1 JTH0500201
Track ID not mapped:
JTH0500102
```

3 On the mapping list, locate the removed unit indicated as `Units are not present`.

4 Delete the old CAN Bus unit from the CAN Bus unit mapping list by entering: `can remove_mapping attc`***<X>***.

<X> identifies the new unit name and is a digit between 0 and 2.

Step example: `can remove_mapping atcc 1`

5 Add the new CAN Bus unit to the CAN Bus unit mapping list by entering: `add_mapping attc`***<X><track ID>***.

<track ID> is a Track ID of the new unit.

<X> identifies the new unit name and is a digit between 0 and 2.

NOTICE: The new unit Track ID is present on the replaced unit label as `Track ID not mapped`.

Step example: `can add_mapping atcc 1 JTH0500102`

6 View the updated mapping list by entering: `can check_mapping`.

7 On the mapping list, check that there are no units labeled as `Track ID not mapped` or `Units are not present`.

7.3.6.3 Tuning the MTCC in a BTS in Tetra Application Mode

The Manually Tuned Cavity Combiner (MTCC) can have 2 or 4 inputs. The TX output of each BR is connected to an input on the MTCC. The output of the MTCC is connected to the Antenna Port of the BTS via the TX-path of a duplex filter. A configuration file has been uploaded to the Site Controller, defining the TX frequencies of all the BRs.

Equipment: High Power Power Meter (PM) like Stabilock 4032, which can handle up to 120W. Service computer.

Procedure:

1 Calibrate the PM and set the frequency to the center frequency of the duplex filter. Set the PM to display Watts.

2 Connect the PM to the TX antenna connector of the BTS.

3 Loosen the all the locking knobs of the MTCC, see the figure below (the design of the MTCC may look slightly different), and turn the tuning knobs counter clock wise as many turns as possible.

Figure 158: Tuning Knob and Locking Knob

4 Power up the BTS and let all BRs key up. Observe that the TX LEDs of all BRs shine.

5 Connect the service computer to the service port of Base Radio 1 and log on. The service port connector is located on the front panel of the Base Radio module. The default password is `motorola`.

6 At the `BR)` prompt, type: `dekey` This command stops all RF transmission.

7 Repeat step 5 and 6 for all BRs.

8 Observe on the power meter that all BRs have dekeyed and that all TX LEDs are off.

9 Connect the service computer to the service port of Base Radio 1.

10 At the `BR)` prompt, type: `key`. After a while the TX LED of the BR will turn on and the power meter will show the BR output power minus the loss of the MTCC and the duplex filter.

11 Slowly turn the tuning knob of the cavity to be tuned, until the power level displayed at the power meter is at its absolute maximum.

12 Tighten the locking knob.

13 Repeat step 11 and 12 until the power level is still at its absolute maximum with the locking knob firmly tightened.

14 Dekey the BR.

15 Repeat step 9 to 14 for all remaining BRs connected to the MTCC.

7.4 Expansion Cabinet RFDS

The Expansion Cabinet uses a high-power RFDS intended for up to four high power Base Radios in addition to the Base Radios in the MTS 4 Prime cabinet. The RFDS in the Expansion Cabinet is made up of the following:

- Up to three RX Splitters – a passive device functioning as an extension for the Receiver Multi Coupler function of the Duplexer/Preselector in MTS 4 to support eight Base Radios. It is connected to the Exp Cabinet connector on the Duplexer/Preselector present in the MTS 4 Prime Cabinet giving the right signal level for the RX-Splitter.
- Cavity Combiners – combining of eight carriers on 1 TX antenna.

Table 85: MTS 4 Expansion Cabinet RF Configurations on page 289 lists the RF configurations of the MTS 4 Expansion Cabinet. In the table, *Low Power* is valid for both 400 MHz and 260 MHz versions of the Expansion Cabinet, while *High Power* is valid for both 400 MHz and 800 MHz versions of the Expansion Cabinet.

Table 85: MTS 4 Expansion Cabinet RF Configurations

RF Configuration	Max Power (W)		Cavity Combiner	RX Splitter
	Low Pwr	High Pwr		
1 – 2 BRs				
TX/RX on 2 ant.	10	25	1	2
TX/RX on 2 ant., RX on 1 ant.	10	25	1	3
TX on 2 ant., RX on 2 ant.	10	25	1	2
TX on 2 ant., RX on 3 ant.	10	25	1	3
TX/RX on 1 ant., RX on 1 ant	8	20	1 + phasing harness	2
TX/RX on 1 ant., RX on 2 ant.	8	20	1 + phasing harness	3
TX on 1 ant., RX on 2 ant.	10	20	1 + phasing harness	2
TX on 1 ant., RX on 3 ant.	10	20	1 + phasing harness	3
3 – 4 BRs				
TX/RX on 2 ant.	10	25	2 (comb)	2
TX/RX on 2 ant., RX on 1 ant.	10	25	2 (comb)	3
TX on 2 ant., RX on 2 ant.	10	25	2 (comb)	2
TX on 2 ant., RX on 3 ant.	10	25	2 (comb)	3
TX/RX on 1 ant., RX on 1 ant.	8	20	2 (comb) + phasing harness	2
TX/RX on 1 ant., RX on 2 ant.	8	20	2 (comb) + phasing harness	3
TX on 1 ant., RX on 2 ant.	8	20	2 (comb) + phasing harness	2
TX on 1 ant., RX on 3 ant.	8	20	2 (comb) + phasing harness	3

NOTICE: For 260 MHz version of MTS there are no phasing harness configurations, so please disregard from these in Table 85: MTS 4 Expansion Cabinet RF Configurations on page 289.

Figure 159: Expansion Cabinet with Single Diversity

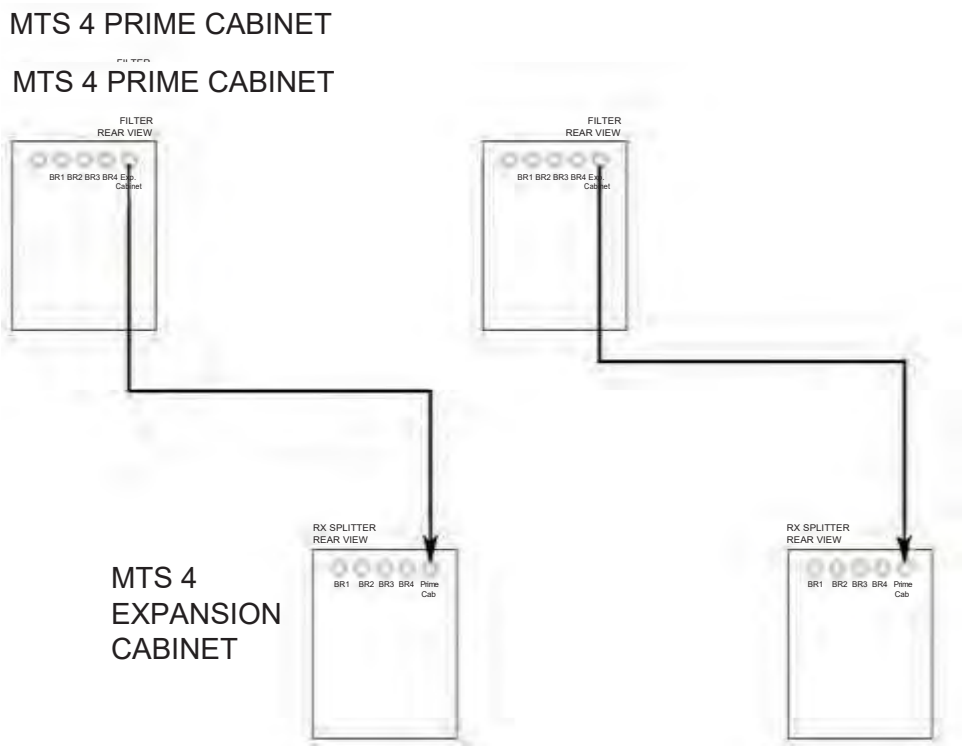
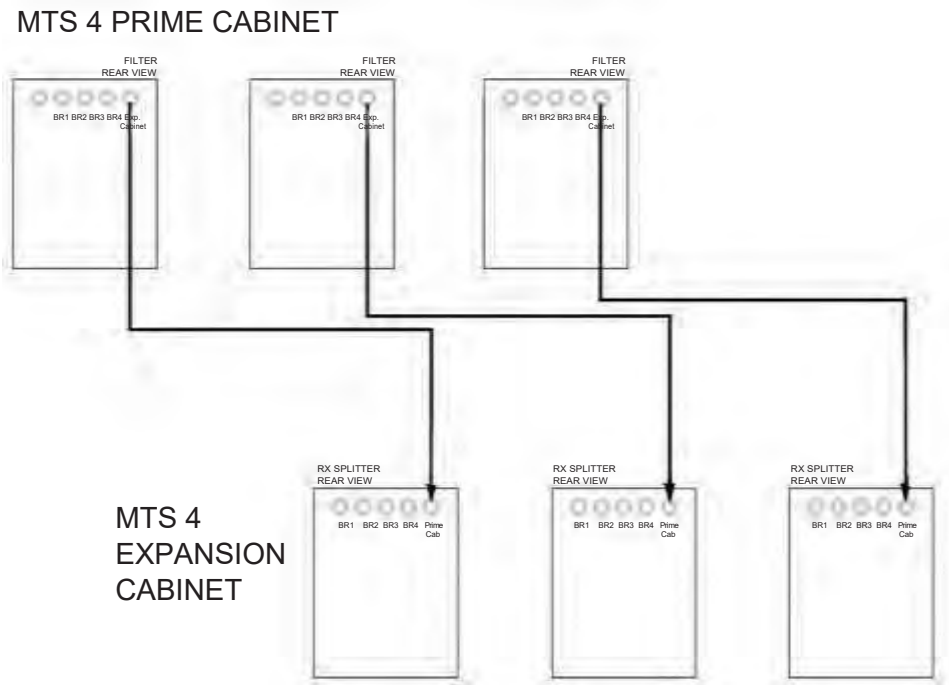


Figure 160: Expansion Cabinet with Dual Diversity

Figure 161: Expansion Cabinet with Triple Diversity



7.4.1
RX Splitter

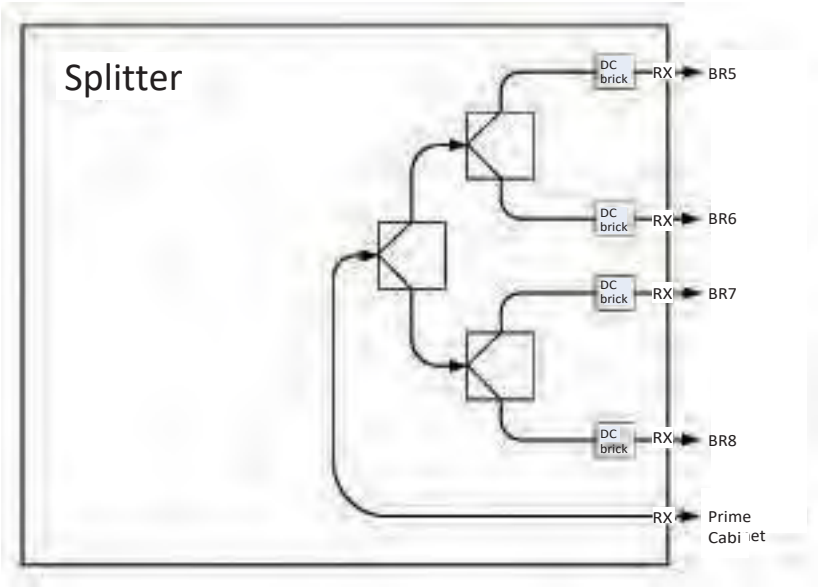
The RX Splitter is a passive device functioning as an extension for the Receiver Multi Coupler function of the Duplexer/Preselector in MTS 4 to support eight Base Radios. It is connected to the Exp Cabinet connector on the Duplexer/Preselector present in the MTS 4 Prime Cabinet giving the right signal level for the RX-Splitter.

There are two types of RX splitters covering the 260 MHz range and the 350–825 MHz range.

The following figure displays the Expansion Cabinet RX Splitter.

Figure 162: Expansion Cabinet RX Splitter

Figure 163: Schematic Diagram of RX Splitter



7.4.1.1

Replacing the Expansion Cabinet RX Splitter

This process outlines the recommended tasks to be performed to replace the Expansion Cabinet RX Splitter. For a list of available FRUs, see Field Replaceable Units (FRUs) on page 446.

Process:

1. Remove the RX splitter, see Removing the RX Splitter on page 292.
2. Reinstall the RX splitter, see Reinstalling the RX Splitter on page 293.

7.4.1.1.1

Removing the RX Splitter

This procedure describes how to remove the RX Splitter.

Procedure:

1. Remove the door of the cabinet completely.
2. Remove the four screws holding the front panel.
3. Loosen the two screws holding the front section of the top panel and slide off the panel.
4. Loosen the screws fastening the rear section of the top panel and slide off the panel.
5. Remove the RX cables connected to the back of the RX Splitter.
6. Loosen the two fastening screws at the front enough to free the mounting bracket.
7. Slide the RX Splitter out of the cabinet.
8. Remove the RX Splitter from the bracket and replace with the new unit.

7.4.1.1.2

Reinstalling the RX Splitter

This procedure describes how to reinstall the RX Splitter.

Procedure:

1. Fasten the RX Splitter onto the bracket.
2. Slide the RX Splitter into the cabinet.
3. Tighten the two fastening screws at the front.
4. Connect the RX cables to the back of the RX Splitter.
5. Slide on the top rear and front panels and fasten these with screws.
6. Place the front panel back on and screw this into place.
7. Put the door of the cabinet back on.

7.4.2

Cavity Combiner

See Cavity Combiner on page 283.