SafeMobile

Radio Configuration

Contents

Configuring Connect Plus

Below is an edited screenshot highlighting the appropriate fields on the Configuration tab of the Connect Plus Controller:
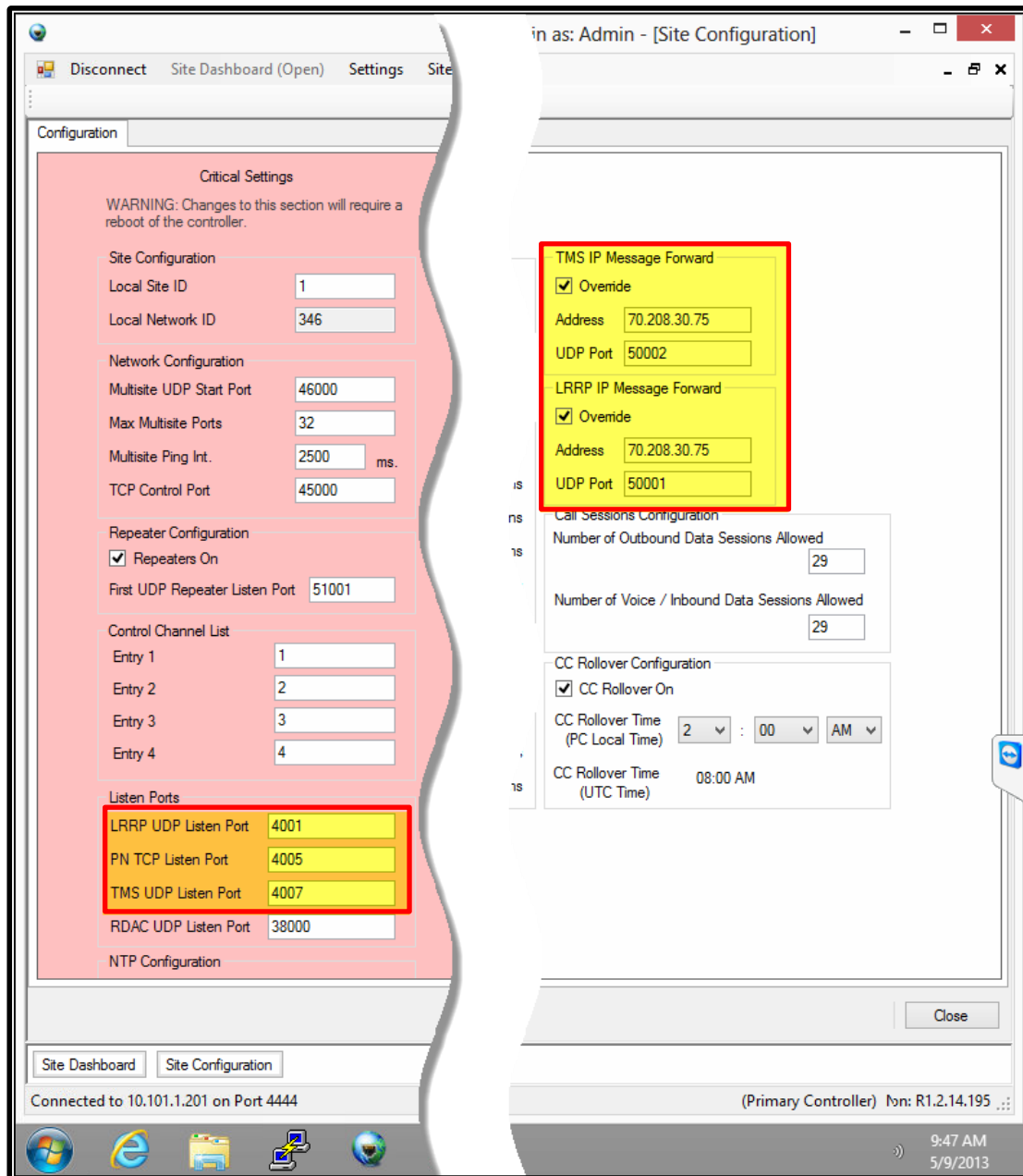
Figure 1 Connect Plus Gateway Configuration Checking

1.1 Install the Mototrbo USB drivers

Prior to connecting any MOTOTRBO radio to the PC(s), please be sure to install the Motorola MOTOTRBO Radio Drivers. This will ensure that the PC's operating system will recognize the control radio(s) when connected to the computer USB port(s). Contact SafeMobile Support to obtain the latest version of drivers.

⚠ Note: The drivers are automatically installed if you install the Mototrbo CPS on the computer.

SafeMobile Support

Email Support

Please email your technical support questions to support@safemobile.com.

SafeMobile Technical Support Online Forum

Please visit our SafeMobile Technical Support Online Forum for all your SafeMobile and Motorola questions at www.safemobile.com/forum.

Sales and Installation Support

Please contact your SafeMobile Channel Account Manager directly for assistance.

Appendix A

Configuring the MOTOTRBO system for SafeMobile

MOTOTRBO CPS Installation

To install MOTOTRBO Customer Programming Software (CPS):

⚠ **T**O CONFIGURE **MOTOTRBO** RADIOS, YOU NEED TO INSTALL **MOTOTRBO CPS.**

1. Run the installation of MOTOTRBO CPS (a copy of this application is available to your Motorola dealer)

2. Follow the onscreen installation.

Note: The CPS installer will also automatically install the MOTOTRBO drivers.

3. Launch MOTOTRBO CPS

    a. Set the view option to "Expert" mode to be able to access all CPS features
    b. Connect a radio to the PC using the corresponding programming cable
    c. Click "Read" button.
    d. The reading of your radio configuration will start.
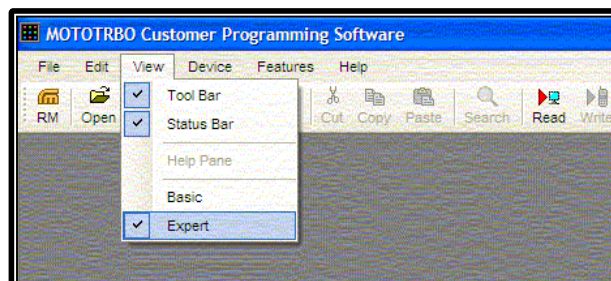
Figure 2 Setting the CPS view option to "Expert" mode

1.2 Configuration of MOTOTRBO Radios

1.2.1 General Considerations

Programming of the radios to work with SafeMobile depends on the radio system type and topology. Currently, the following MOTOTRBO system types are supported:

- Simplex
- Dual-Capacity Simplex
- Single Site Repeater(s)
- IP Site Connect
- Capacity Plus
- Linked Capacity Plus
- Connect Plus

Each of these systems needs customized programming, as described below.

For proper functionality of a MOTOTRBO based GPS location system the following must be considered:

- In a SafeMobile system the radios are automatically registering (when powered on or when changing channels) and (during this process) are instructed to send periodically their position. This time interval is set (for each individual radio) using the Administrative Module of the SafeMobile.
- In conventional systems the registrations are made on the voice channels, so the ARS control radio can also be used for dispatcher's voice communication but only if the dispatcher doesn't need to use different RF channels (defined by frequency & timeslot) – in the second case a configuration with separate ARS control radio and dispatcher voice radio must be used.
- MOTOTRBO voice calls have higher priority than GPS data transmissions – as a result, during a voice call the periodic transmissions are delayed until the call ends. This can cause collisions in sending the GPS data – mostly at the end of a group call, when more radios have to do that. To minimize this effect we recommend to avoid having large groups of radios. We also recommend to use short "RX Group Lists" or to avoid them completely, as the radios using such lists might be involved in too many calls to have time to send their GPS data.
- Depending on the radio system, the GPS data can be sent on the voice channel(s) or on dedicated GPS revert channels. We recommend to use, whenever possible, GPS revert channels – separating voice calls from the GPS traffic is a first step in increasing the reliability of GPS transmissions.
- In all systems that use repeaters the "Enhanced GPS" feature can be used, greatly improving the capacity of a GPS revert channel (as described below).

1.2.2 "Data Call Confirmed" Considerations

The "Data Call Confirmed" (DCC) feature of MOTOTRBO radios can be used in any data transmissions but here we are interested in the use of it for the radio registrations and GPS data sending. This feature can be enabled on each channel, by checking the *Data Call Confirmed* field in the TX section of the channel. If used, it will determine the radio to:

- Confirm any data messages that are successfully received
- Expect to receive confirmations for any transmitted data messages – if there is no confirmation the radio will repeat the data transmission

It's obvious that if the DCC feature is used, all the radios should be programmed to use it – otherwise, unnecessary re-sending of messages will occur. The problem of using it or not is that it adds some time to each data transmission, increasing the data load of the channel (and hence decreasing the data capacity). But because some data transmissions can be affected by RF propagation problems or by TX collisions, not using DCC will automatically lead to lost data – how acceptable is this?

In the case of radio registrations (made on the voice channels) a radio that misses to register will not send any GPS data (it will not be instructed how to do that) so it will also not appear on the SafeMobile map. This is not acceptable, so DCC should always be used on the voice channels.

If the GPS data is also sent on the voice channel then it will follow the same rule as the registration.

If the GPS data is sent on a data revert channel you can choose either to use or not the DCC on that channel. In the first case you will have a greater GPS traffic (not only because of the added confirmations but mainly because of the retrials) but more successfully sent GPS positions while in second case the traffic will be lower but the number of lost positions will be significantly higher.

If "Enhanced GPS" revert channels are used (available in all repeater systems) the GPS data is always sent unconfirmed (to save time and because the collisions are avoided) – this might however lead to some lost GPS data if RF propagation problems are present (but this is anyhow inevitable because re-sending the messages in such conditions will lead most probably to the same result).

1.2.3 Emergency Considerations

If the radio system uses Emergency then (regardless of how other Emergency features are programmed in the radios) when the radio user presses the Emergency button the radio will automatically send an "Emergency Alert" message. This type of message will be considered only by those radios that are programmed with the *Emergency Alarm Indication* field checked (in the RX section of the channel window). One (and ONLY one) of those radios must also be programmed to confirm the receiving of this alarm – by checking the *Emergency Alarm Ack* field (failing to do this will cause repeated alert messages). Note that this confirmation is not related to the above DCC feature. As the ARS control radio is also used by the dispatcher for voice communication, it is the best to use this radio to send

this type of confirmation (because it is always "on" and always present on the voice channel). In this case it must be an alphanumeric/graphic display radio.

1.2.4 Loading Considerations

Proper loading of the voice and GPS revert channels (if used) is very important. While overloading a voice channel will impact the radio users' experience and cause lower efficiency in using the radio system, any overload of the GPS transmissions will result in more and more collisions and loss of GPS data. To estimate the loading of a MOTOTRBO radio system, Motorola uses the concept of "radio user profile", based on specific average voice, GPS and SDS message traffic. The below table shows these profiles:

Profile Name	Traffic Type	Call Description	Traffic Per User Per Hour	
High Voice	Group Voice Call	10 second call, 2 transmissions per call	3.0 Calls per User per Hour	90%
	Individual Voice Call	20 second call, 4 transmissions per call		10%
Low Voice	Group Voice Call	10 second call, 2 transmissions per call	1.0 Calls per User per Hour	90%
	Individual Voice Call	20 second call, 4 transmissions per call		10%
High GPS	Location Updates	660 milliseconds (for Single Repeater and IP Site Connect) per transmission and 540 milliseconds (for Capacity Plus mode) per transmission	60 GPS Transmissions per User per Hour i.e. 1 Minute Update Period (Cadence)	
Low GPS	Location Updates	660 milliseconds per transmission	6 GPS Transmissions per User per Hour i.e. 10 Minute Update Period (Cadence)	
High Text Messaging	Text Messaging	100 characters per message	2.5 Text Messages per User per Hour	
Low Text Messaging	Text Messaging	100 characters per message	0.5 Text Messages per User per Hour	

Figure 3 Radio User Profiles

These profiles will be used to estimate the proper loading for each of the MOTOTRBO systems. Note that the impact of text messaging is minimal, so it can be almost neglected.

The loading provided by the radio registrations must also be considered. If the radio users work in shifts and switch on their radios in a short interval of time, a flood of registrations will result, with many collisions and retrials, having a great impact on the voice channel(s) for up to 15-30 minutes. To avoid this, the radio users must be instructed to switch on their radios at different moments of time (Motorola recommends not to exceed an average of 3 registrations per minute per RF channel).

1.2.5 GPS Revert and "Enhanced GPS" Considerations

As already mentioned, a first step in increasing the efficiency of sending the GPS data is the use of the "GPS Revert" feature of the Mototrbo radios, which allows to separate the voice and GPS traffic by using RF channels dedicated only for GPS transmissions. Even in this case, Motorola recommends not

to exceed 20 GPS updates per minute on such a channel – for High GPS usage this is equal to the number of radios that can use the channel. It's easy to notice that for systems that use many High GPS radios the number of needed GPS Revert channels can become unacceptable (for Low Voice and High GPS radios three GPS Revert channels are needed for each voice channel).

The above limitations in sending GPS data on a GPS revert channel are caused by the potential collisions and retrials made by the radios. In all systems that use repeaters, the "Enhanced GPS" feature of MOTOTRBO radios offers a synchronized manner of sending the GPS data by allocating to each radio a precise time window for doing that – after the radio registers, at the first attempt to send its position the repeater will reserve the time window (in an internal table) and all following GPS transmissions will be made in this reserved moment of time. This eliminates any collisions, allowing a much greater number of updates per minute.

Because not all transmissions can be made in this way (while the radios are involved in voice calls they might miss the reserved window moment) the repeater is programmed to reserve only a certain percentage of windows for periodic GPS updates – in the remaining time the radios can ask for extra windows to empty their GPS data queue. The available values are 90%, 75%, 60% and 45%.

The size of the window depends on what information is sent and if Enhanced Privacy is used – for SafeMobile systems the needed value (which covers all the cases) is 7. This value must be programmed both in the repeater and the radios.

The above 2 parameters give the maximum number of updates per minute. In most of the cases the 75% reservation time can be used – this will allow (for window size = 7) up to 107 periodic updates per minute. This reverses the need for GPS traffic versus voice traffic – for large number of radios only one Enhanced GPS channel can serve more voice channels (up to 6 with High Voice profile radios or up to 2 with Low Voice profile radios). But if large groups of radios are used (which increases the probability that many radios will miss their reserved windows due to the voice traffic) lower reservation percentages are needed and the maximum number of periodic updates per minute will also decrease: 86 for 60% and 64 for 45%.

Note that the percentage reserved for periodic updates can be also chosen based on real number of radios used in the system (considering also future growth). For example, if only one repeater is used and the radios are Low Voice & High GPS profiles ones then the repeater can be programmed with 45% (which allows up to 64 such radios, more than the 51 limit for voice traffic).

Finally, note that this system introduces a limitation in the allowed intervals for GPS transmissions – the only possible values are 30 sec, 1, 2, 4, 8 min.

⚠ ANY OTHER VALUE PROGRAMMED IN THE ADMINISTRATIVE MODULE WILL BE REJECTED BY THE RADIOS, CAUSING NO GPS DATA SENT.

Considering all the above, **we strongly recommend using the "Enhanced GPS" feature in all repeater systems**. In the below programing examples we indicate the use of this feature and give additional information to implement it efficiently.

1.3 Programming of Simplex Systems

In a simplex system the communication area is very limited, especially for the portable radios. As a result these systems are suitable only for limited perimeters or for radio-to-dispatcher communications. SafeMobile will need in this case only one control radio (used for voice, ARS and GPS data). Because voice and GPS data must coexist on the same channel the capacity can be very limited – the recommended limits are:

- 34 radios with Low Voice & Low GPS profiles
- 16 radios with High Voice & Low GPS profiles
- 12 radios with Low Voice & High GPS profiles
- 8 radios with High Voice & High GPS profiles

It's easy to see that simplex systems are totally unsuitable either for High Voice or for High GPS usage.
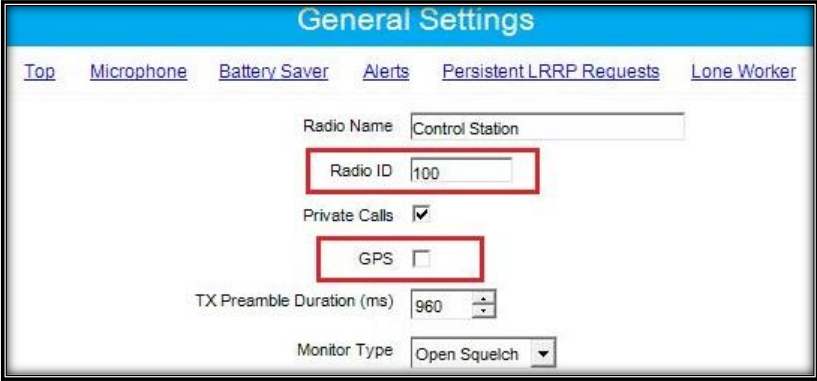
⚠ NOTE: We do not consider the use of simplex GPS revert channels – instead of using two simplex channels (frequencies) it is much more efficient to use a half-duplex frequency pair with a repeater, which offers a better coverage and the possibility to use the "Enhanced GPS" feature.

1.3.1 Programming of the control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

<u>General Settings</u>

A control radio must have a *Radio ID* – this ID will be used by the subscriber radios to register to the system and to send GPS data and will also be used to make private voice calls to the dispatcher – for this last reason we recommend to use an easy to remember value.

Figure 4 Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

We also recommend to change the *Talkaround Group Call Hang Time* and the *Talkaround Private Call Hang Time* (used by the radios on simplex channels) to lower values (1-2 seconds) to minimize the voice calls duration, allowing more time for registration and GPS traffic.
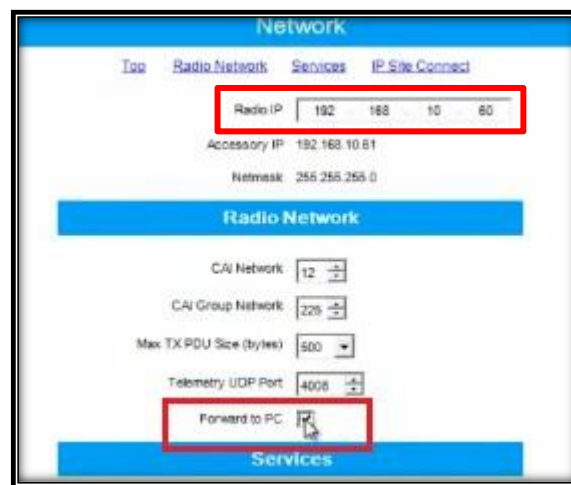
⚠ **ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUES FOR THESE TWO FIELDS.**

Network Settings

The network settings of the control radio should be configured as follows:

The control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. The below figure shows an IP address of 192.168.10.60, however this may be different, depending on your IT network settings.

Check the *Forward to PC* field – in this way all text messages this radio receives are passed to the connected PC.

Figure 5 Control Radio Network Settings

Channel Settings

Normally the control radio can have only one channel but if the dispatcher has to talk to different groups that use the same RF channel the radio can use more channel positions – but all should use the same settings (except the *Contact Name* field), as indicated below:

The *ARS* field should be set to *Disabled* as this radio will never register.

The frequency must be the same for both the RX (receive) and TX (transmit). Set the *Repeater/Time Slot* to *1.*

Figure 6 Set the RX and TX frequency

We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTING FOR THIS FIELD.

Program the radio not to transmit over a busy channel when starting a call or during a call.

Figure 7 Admit Criteria/In Call Criteria

Check the *Data Call Confirmed* field (to be sure that the subscriber radios will register).

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTING FOR THIS FIELD.

Write the configuration to the radio.

1.3.2 Programming of the subscriber radios

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A subscriber radio must have a *Radio ID*.

Fig. 8 shows a *Radio ID* of 101, however, this can be any number that you choose.

⚠ ALL SUBSCRIBER RADIOS MUST HAVE A UNIQUE RADIO ID.

The *GPS* field MUST be checked. The Subscriber radio must have GPS enabled in order to transmit location data.

Figure 8 Subscriber Radio General Settings

We also recommend to change the *Talkaround Group Call Hang Time* and the *Talkaround Private Call Hang Time* (used by the radios on simplex channels) to lower values (1-2 seconds) to minimize the voice calls duration, allowing more time for registration and GPS traffic.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUES FOR THESE TWO FIELDS.

Network Settings

The network settings of the subscriber radios should be configured as follows:

The *Radio IP* field can be left unmodified. The *Forward to PC* field should be set to *Disabled* as these radios do not connect to a PC.

In the *ARS Radio ID* field MUST be entered the ID of the control radio.

⚠ FAILING TO ENTER THE PROPER CONTROL RADIO ID WILL RESULT IN REPEATED UNSUCCESSFUL REGISTRATION ATTEMPTS.
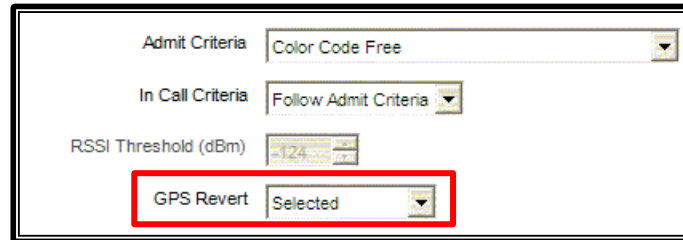
Figure 9 Subscriber Radio Network Settings

Channel Settings

The last important configuration for the subscriber radios takes place in the channel settings. All channel positions used in the radio system should be programmed as below:

⚠ The subscriber radios <u>MUST</u> have *ARS* enabled. This is responsible for transmitting presence notification to the MOTOTRBO Gateway Application.

Figure 10 ARS On System Change

Set the same frequency RX and TX frequency, timeslot, TX admit criteria and in call criteria as for the control radio.

Set the *GPS Revert* field to *Selected* to allow GPS updates transmitted on the current channel.

Figure 11 GPS Revert-Selected

Check the *Data Call Confirmed* field (to be sure that the radio will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠️ **ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.**

Write the configuration to the radio.

1.4 Programming of Dual-Capacity Simplex Systems

Dual-capacity simplex offers the possibility of using both timeslots on a simplex channel. This operation mode is available only for the second generation of MOTOTRBO radios and uses a special synchronizing mechanism performed by the radios (in the absence of a repeater). However this doesn't allow to separate the voice and GPS traffic by using each of them on different timeslots because dual-capacity channels cannot be used as GPS revert channels – the only advantage is that a double number of radios can be used on a single simplex frequency. In a dual-capacity simplex system the communication area is very limited, especially for the portable radios. As a result these systems are suitable only for limited perimeters or for radio-to-dispatcher communications. SafeMobile will need in this case two control radios (each one used on one of the timeslots for voice, ARS and GPS data) – so two dispatchers will be used. Because voice and GPS data are on the same channels the capacity per timeslot is the same as for the simplex channels:

- 34 radios with Low Voice & Low GPS profiles
- 16 radios with High Voice & Low GPS profiles
- 12 radios with Low Voice & High GPS profiles
- 8 radios with High Voice & High GPS profiles

1.4.1 Programming of the control radios

Read each radio codeplug and make the needed changes in the following CPS windows:

General Settings

A control radio must have a *Radio ID* – this ID will be used by the subscriber radios to register to the system and to send GPS data and will also be used to make private voice calls to the dispatcher – for this last reason we recommend to use an easy to remember value.

Figure 12 Control Radios Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

For the second control radio we recommend to use the same Radio ID (there will be no conflict as they will use different timeslots) – this becomes mandatory if there are subscriber radios that have to work on both timeslots.

We also recommend to change the *Talkaround Group Call Hang Time* and the *Talkaround Private Call Hang Time* (used by the radios on simplex channels) to lower values (1-2 seconds) to minimize the voice calls duration, allowing more time for registration and GPS traffic.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUES FOR THESE TWO FIELDS.

Network Settings

The network settings of the control radios should be configured as follows:

The control radios must have a *Radio IP* address – this is used for the USB connection between the radio and the PC. The below figure shows an IP address of 192.168.10.60, however this may be different, depending on your IT network settings. Although the two control radios are connected in this case to different computers, we recommend to use different IP addresses – for the second control radio use a value similar to the one used for the first control radio by changing the second byte value (for example, if the first control radio IP address is set to 192.168.10.60, then use for the second control radio the value 192.168.20.60).

Check the *Forward to PC* field – in this way all text messages these radios receive are passed to the connected PC.

Figure 13 Control Radios Network Settings

Channel Settings

Normally a control radio can have only one channel but if the dispatcher has to talk to different groups that use the same RF channel the radio can use more channel positions – but all should use the same settings (except the *Contact Name* field), as indicated below:

Check the *Dual Capacity Direct Mode* field and set the *Timing Leader Preference* field to *Preferred* (as these radios are fixed ones, they have a good RF coverage and they also will be always "on" – both make them the ideal radios for synchronizing the timeslots in the radio system).

The *ARS* field should be set to *Disabled* as these radios will never register.

Figure 14 Control Radios Channel Settings

Set the same frequency for both RX (receive) and TX (transmit). Set the *Repeater/Time Slot* to *1* for the first control radio and *2* for the second one.

Check the *Data Call Confirmed* field (to be sure that the subscriber radios will register).

We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ **ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.**

Figure 15 Set the RX and TX frequency

Program the radios not to transmit over a busy channel when starting a call or during a call.

Figure 16 Admit Criteria / In Call Criteria

Write the corresponding configuration to each radio.

1.4.2 Programming of the subscriber radios

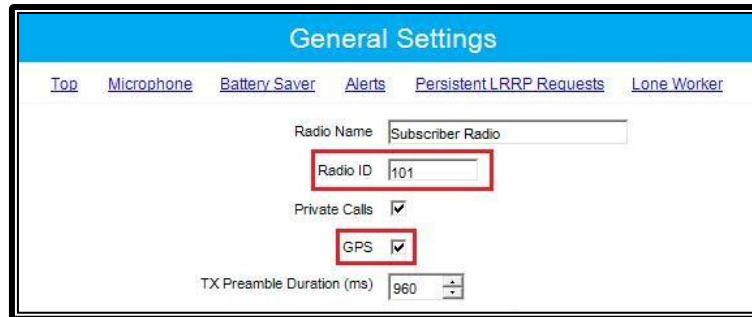Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A subscriber radio must have a *Radio ID*. Fig. 15 shows a *Radio ID* of 101, however, this can be any number that you choose.

⚠ **ALL** SUBSCRIBER RADIOS MUST HAVE A UNIQUE **RADIO ID.**

The *GPS* field MUST be checked. The Subscriber radio must have GPS enabled in order to transmit location data.

Figure 17 Subscriber Radios General Settings

We also recommend to change the *Talkaround Group Call Hang Time* and the *Talkaround Private Call Hang Time* (used by the radios on simplex channels) to lower values (1-2 seconds) to minimize the voice calls duration, allowing more time for registration and GPS traffic.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUES FOR THESE TWO FIELDS.

Network Settings

The network settings of the subscriber radios should be configured as follows:

The *Radio IP* field can be left unmodified. The *Forward to PC* field should be set to *Disabled* as these radios do not connect to a PC.

In the *ARS Radio ID* field MUST be entered the ID of the control radio.

⚠ FAILING TO ENTER THE PROPER CONTROL RADIO ID WILL RESULT IN REPEATED UNSUCCESSFUL REGISTRATION ATTEMPTS.

Figure 18 Subscriber Radios Network Settings

Channel Settings

The last important configuration for the subscriber radios takes place in the channel settings. All channel positions used in the radio system should be programmed as below:
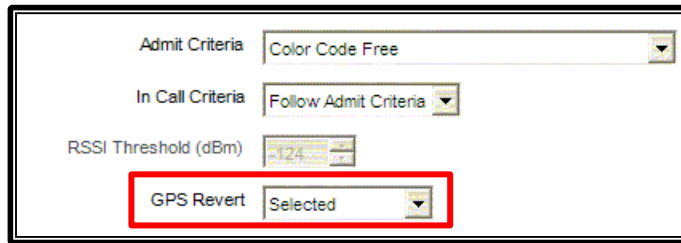
⚠ The subscriber radios <u>MUST</u> have *ARS* enabled. This is responsible for transmitting presence notification to the MOTOTRBO Gateway Application.

Figure 19 ARS On System Change

Check the *Dual Capacity Direct Mode* field and set the *Timing Leader Preference* field to *Eligible* (so that these radios can be used for synchronizing the timeslots outside the coverage area of the control radios).

Set the same frequency RX and TX frequency, timeslot, TX admit criteria and in call criteria as for the corresponding control radio.

Set the *GPS Revert* field to *Selected* to allow GPS updates transmitted on the current channel.

Figure 20 GPS Revert- Selected

Check the *Data Call Confirmed* field (to be sure that the radio will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

Write the configuration to the radio.

1.5 Programming of Single-Site Repeater Systems

Using a repeater offers great advantages. First, it offers a much wider communication area as compared to a simplex system. Second, it always transmits continuously (not on one timeslot) and offers the synchronization information to the subscriber radios, enabling the full use of two timeslots. This allows to separate the voice and GPS traffic by using each of them on different timeslots, through the GPS revert feature of the radios. SafeMobile will need in this case two control radios (one used on one of the timeslots for voice and ARS and one used on the other timeslot for GPS data). Because voice and GPS data are on different channels the capacity can be limited by either of the two types of traffic – the recommended limits per timeslot are in this case:

- 51 radios with Low Voice profile
- 18 radios with High Voice profile
- 20 GPS updates per minute

As a result, a repeater system can use up to 18 High Voice & High GPS radios or up to 51 Low Voice & Low GPS radios (in this case the GPS interval can be in fact lowered to 153 sec. (2.55 min.) per radio).
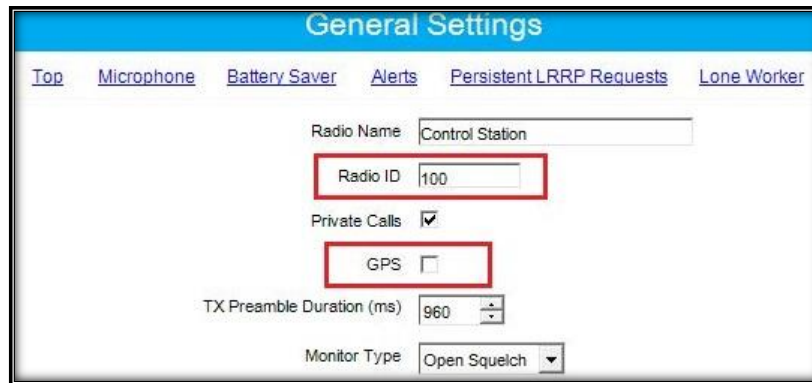
However, if High GPS profile is needed, you should either limit the number of radios to 20 or use more repeaters (for Low Voice & High GPS you should use 2 repeaters with up to 51 radios – one timeslot for voice and 3 timeslots for GPS – a costly and low efficiency solution). The real solution is to use the "Enhanced GPS" feature (for Low Voice & High GPS this will allow to use only one repeater, with 45% reserved windows on the Enhanced GPS timeslot).

1.5.1 Programming of the ARS control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A control radio must have a *Radio ID* – this ID will be used by the subscriber radios to register to the system and to send GPS data and will also be used to make private voice calls to the dispatcher – for this last reason we recommend to use an easy to remember value.
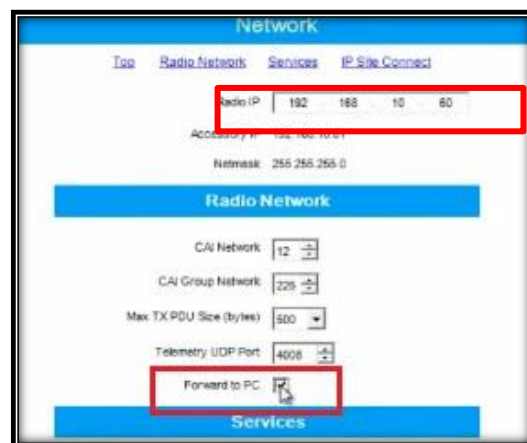
Figure 21 ARS Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

Network Settings

The network settings of the ARS control radio should be configured as follows:

The control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. The below figure shows an IP address of 192.168.10.60, however this may be different, depending on your IT network settings.

Check the *Forward to PC* field – in this way all text messages this radio receives are passed to the connected PC.

Figure 22 ARS Control Radio Network Settings

Channel Settings

Normally the control radio can have only one channel but if the dispatcher has to talk to different groups that use the same RF channel the radio can use more channel positions – but all should use the same settings (except the *Contact Name* field), as indicated below:

The *ARS* field should be set to *Disabled* as this radio will never register.

Figure 23 ARS Control Radio Channel Settings

Set the frequencies for RX (receive) and TX (transmit). Set the *Repeater/Time Slot* to *1.*

Check the *Data Call Confirmed* field (to be sure that the subscriber radios will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

Figure 24 Set the RX and TX frequency

Program the radio not to transmit over a busy channel when starting a call or during a call.

Figure 25 Admit Criteria / In Call Criteria

Write the configuration to the radio.

1.5.2 Programming of the GPS control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

Set the *Radio ID* field with the same value as the ARS control radio – this ID will be used by the subscriber radios to send GPS data on the GPS revert channel.

Figure 26 GPS Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.
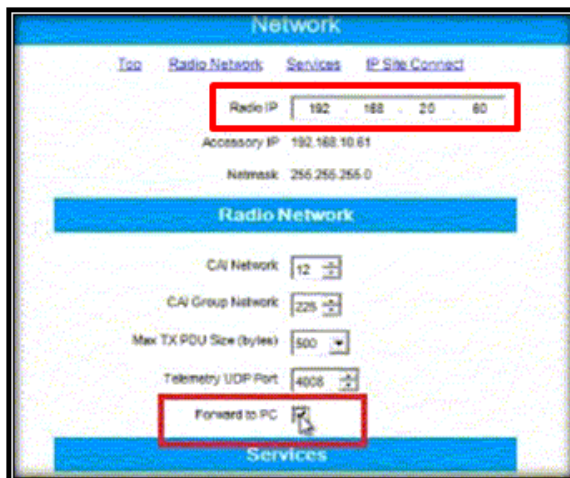
⚠ THE ARS CONTROL RADIO AND GPS CONTROL RADIO MUST HAVE THE SAME ID OTHERWISE THE GPS DATA WILL BE LOST.

Network Settings

The network settings of the GPS control radio should be configured as follows:

The GPS control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. To avoid any potential IP address conflicts while keeping an easy to manage value we recommend to use a value similar to the one used for the ARS control radio by changing the second byte value – for example, if the ARS control radio IP address is set to 192.168.10.60, then use for the GPS control radio the value 192.168.20.60.
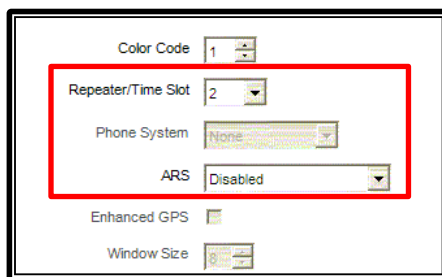
Check the *Forward to PC* field – in this way all GPS messages this radio receives are passed to the connected PC.

Figure 27 GPS Control Radio Network Settings

Channel Settings

The GPS control radio must have only one channel, using the settings indicated below:

Figure 28 GPS Control Radio Channel Settings

The *ARS* field should be set to *Disabled* as this radio will never register. Set the frequencies for RX (receive) and TX (transmit). Set the *Repeater/Time Slot* to *2.*

We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUE FOR THIS FIELD.

Program the radio not to transmit over a busy channel when starting a call or during a call.

DO NOT check the *Data Call Confirmed* field (DCC is not used on Enhanced GPS revert channels).

⚠ NOTE: As the only task for the GPS control radio is to receive the GPS messages, this radio will never transmit. You can even check the *RX Only* field to prevent any accidental transmission but this is not mandatory (you can keep its TX capability for RF testing).

Write the configuration to the radio.

1.5.3 Programming of the subscriber radios

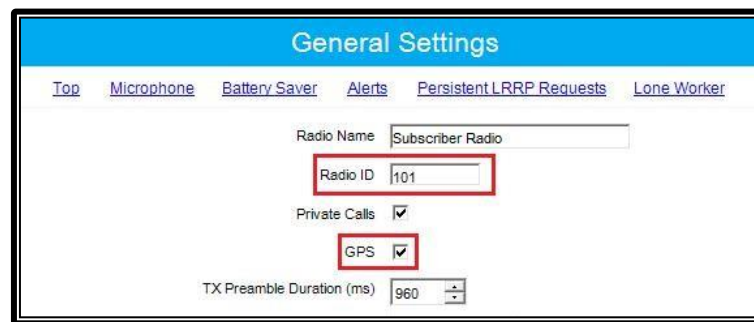Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A subscriber radio must have a *Radio ID*.

Fig. 27 shows a *Radio ID* of 101, however, this can be any number that you choose.

⚠ **ALL** SUBSCRIBER RADIOS MUST HAVE A UNIQUE **RADIO ID.**

The *GPS* field <u>MUST</u> be checked. The Subscriber radio must have GPS enabled in order to transmit location data.

Figure 29 Subscriber Radios General Settings

Network Settings

The network settings of the subscriber radios should be configured as follows:

The *Radio IP* field can be left unmodified. The *Forward to PC* field should be set to *Disabled* as these radios do not connect to a PC.

In the *ARS Radio ID* field <u>MUST</u> be entered the ID of the ARS control radio.

⚠ FAILING TO ENTER THE PROPER CONTROL RADIO ID WILL RESULT IN REPEATED UNSUCCESSFUL REGISTRATION ATTEMPTS.

Figure 30 Subscriber Radios Network Settings

Channel Settings

Program at least two digital channels in the radio (one for voice and one for GPS revert). The voice channel should be present in *Zone 1* while the GPS revert channel must be added to the *Channel Pool* (so that the user cannot select it).

For the voice channel:

- The subscriber radios <u>MUST</u> have *ARS* enabled on the voice channels. This is responsible for transmitting presence notification to the MOTOTRBO Gateway Application.

Figure 31 ARS On System Change

- Set the same RX and TX frequencies, timeslot, TX admit criteria and in call criteria as for the ARS control radio. Select for the *GPS Revert* field the GPS revert channel to allow GPS updates transmitted on that channel.

Figure 32 GPS Revert

- Check the *Data Call Confirmed* field (to be sure that the radio will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

For the GPS revert channel:

- Set the *ARS* field to *Disabled*.
- Check the *Enhanced GPS* field and set the *Window Size* to *7*.

Figure 33 GPS Revert Channel Settings

- Program the GPS revert channel with the same frequencies as the voice channel (you can use copy/paste) but use Timeslot 2.
- Set the same TX admit criteria and in call criteria as on the voice channel
- Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages, allowing to use the *Window Size* of *7*.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTING FOR THIS FIELD.

Write the configuration to the radio.

1.5.4 Programming of the repeater

Read the repeater codeplug and make the needed changes in the following CPS windows:

<u>General Settings</u>

In this case you can ignore the *Radio ID* (it is not used). We recommend to change the *Group Call Hang Time,* the *Private Call Hang Time* and the *Emergency Call Hang Time* fields to lower values (1-2 seconds) to minimize the voice calls duration, allowing more time for voice, registration and GPS traffic.

Figure 34 Repeater General Settings

<u>Channel Settings</u>

Program the repeater with only one digital channel, having the following settings:

- In the *Enhanced GPS* section check the *Enable* field for *Slot 2* and set the *Window Size* to *7*.
- Change (only if needed) the *Periodic Window Reservation (%)* field to the desired value (the default value is 75%).
- Set the TX and RX frequencies (according to the frequency license).

Figure 35 Repeater Channel Settings

Write the configuration to the repeater.

1.6 Programming of IP Site Connect Systems

An IP Site Connect (IPSC) system offers a much wider communication area as compared to a single-site repeater system. Generally, it offers the possibility to use any of the 2 repeater timeslots either in local mode or in wide-area mode. It also allows to separate the voice and GPS traffic by using each of them on different timeslots, using the GPS revert feature of the radios. Here we will consider only the case when both timeslots are used in wide-area mode – for any local use you can read and program (for each site) according to the single-site repeater case. SafeMobile will need in this case 2 control radios (one used on the timeslot for voice and ARS and one used on the timeslot for GPS data). As voice and GPS data are on different channels the capacity can be limited by either of the two types of traffic – the recommended limits per timeslot are the same as for the single-site repeater case:

- 51 radios with Low Voice profile
- 18 radios with High Voice profile
- 20 GPS updates per minute

As a result, an IPSC system can use up to 18 High Voice & High GPS radios or up to 51 Low Voice & Low GPS radios (in this case the GPS interval can be in fact lowered to 153 sec. (2.55 min.) per radio).
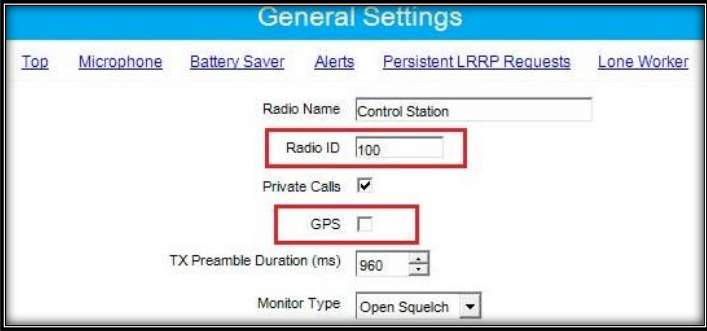
However, if High GPS profile is needed, you should either limit the number of radios to 20 or use more repeaters (for Low Voice & High GPS you should use 2 systems with up to 51 radios – one timeslot for voice and 3 timeslots for GPS – a costly and low efficiency solution). The real solution is to use the "Enhanced GPS" feature (for Low Voice & High GPS this will allow to use only one system, with 45% reserved windows on the Enhanced GPS timeslot).

1.6.1 Programming of the ARS control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A control radio must have a *Radio ID* – this ID will be used by the subscriber radios to register to the system and to send GPS data and will also be used to make private voice calls to the dispatcher – for this last reason we recommend to use an easy to remember value.

Figure 36 ARS Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

Network Settings

The network settings of the ARS control radio should be configured as follows:

The control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. The below figure shows an IP address of 192.168.10.60, however this may be different, depending on your IT network settings.

Check the *Forward to PC* field – in this way all text messages this radio receives are passed to the connected PC.

Figure 37 ARS Control Radio Network Settings

Channel Settings

Normally the control radio can have only one channel but if the dispatcher has to talk to different groups that use the same RF channel the radio can use more channel

---

positions – but all should use the same settings (except the *Contact Name* field), as indicated below:

The *ARS* field should be set to *Disabled* as this radio will never register.

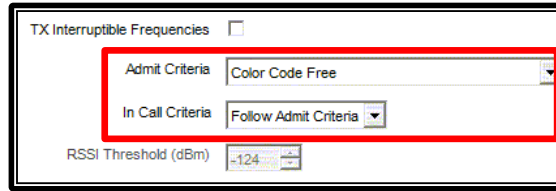**Figure 38 ARS Control Radio Channel Settings**

Set the frequencies for RX (receive) and TX (transmit) corresponding to the local repeater. Set the *Repeater/Time Slot* to *1.*

Figure 39 Set the RX and TX frequency

Check the *Data Call Confirmed* field (to be sure that the subscriber radios will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

Program the radio not to transmit over a busy channel when starting a call or during a call.

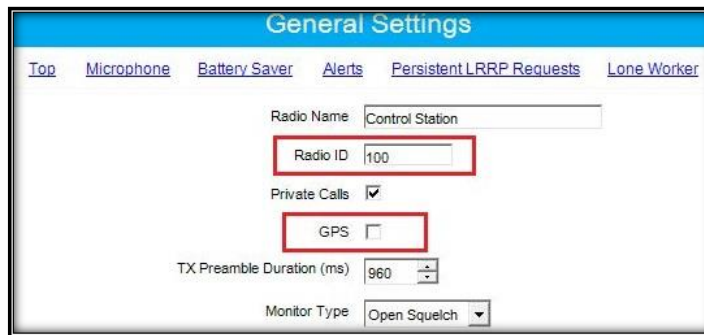**Figure 40 Admit Criteria / In Call Criteria**

Write the configuration to the radio.

1.6.2 Programming of the GPS control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

Set the *Radio ID* field with the same value as the ARS control radio – this ID will be used by the subscriber radios to send GPS data on the GPS revert channel.

Figure 41 GPS Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

⚠ THE ARS CONTROL RADIO AND GPS CONTROL RADIO MUST HAVE THE SAME ID OTHERWISE THE GPS DATA WILL BE LOST.

Network Settings

The network settings of the GPS control radio should be configured as follows:

The GPS control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. To avoid any potential IP address conflicts while keeping an easy to manage value we recommend to use a value similar to the one used for the ARS control radio by changing the second byte value – for example, if the ARS control radio IP address is set to 192.168.10.60, then use for the GPS control radio the value 192.168.20.60.

Check the *Forward to PC* field – in this way all GPS messages this radio receives are passed to the connected PC.

Figure 42 GPS Control Radio Network Settings

Channel Settings

The GPS control radio must have only one channel, using the settings indicated below:
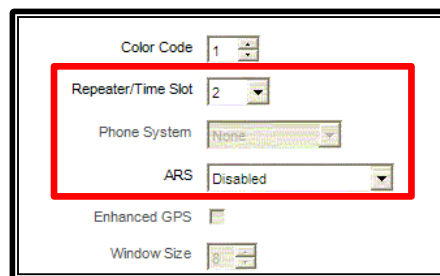
Figure 43 GPS Control Radio Channel Settings

The *ARS* field should be set to *Disabled* as this radio will never register. Set the frequencies for RX (receive) and TX (transmit) corresponding to the local repeater. Set the *Repeater/Time Slot* to *2.*

Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUE FOR THIS FIELD ON THE GPS REVERT CHANNEL.

Program the radio not to transmit over a busy channel when starting a call or during a call.

DO NOT check the *Data Call Confirmed* field (DCC is not used on Enhanced GPS revert channels).

⚠ NOTE: As the only task for the GPS control radio is to receive the GPS messages, this radio will never transmit. You can even check the *RX Only* field to prevent any accidental transmission but this is not mandatory (you can keep its TX capability for RF testing).

Write the configuration to the radio.

1.6.3 Programming of the subscriber radios

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A subscriber radio must have a *Radio ID*.

Fig. 42 shows a *Radio ID* of 101, however, this can be any number that you choose.

⚠ **ALL** SUBSCRIBER RADIOS MUST HAVE A UNIQUE **RADIO ID.**
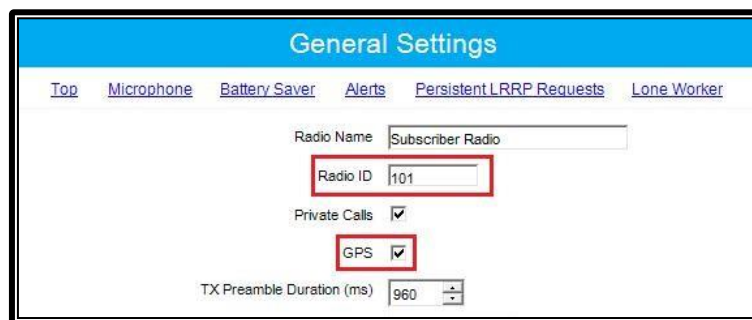
The *GPS* field MUST be checked. The Subscriber radio must have GPS enabled in order to transmit location data.

Figure 44 Subscriber Radios General Settings
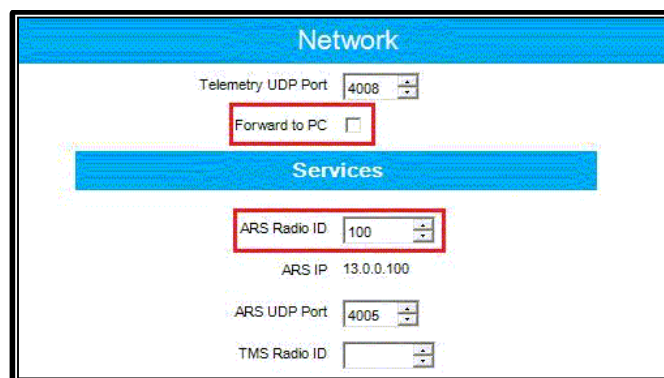
Network Settings

The network settings of the subscriber radios should be configured as follows:

The *Radio IP* field can be left unmodified. The *Forward to PC* field should be set to *Disabled* as these radios do not connect to a PC.

In the *ARS Radio ID* field MUST be entered the ID of the ARS control radio.

⚠ **FAILING TO ENTER THE PROPER CONTROL RADIO ID WILL RESULT IN REPEATED UNSUCCESSFUL REGISTRATION ATTEMPTS.**

Figure 45 Subscriber Radios Network Settings

Channel Settings

Program at least two digital channels in the radio (one for voice and one for GPS revert) for each repeater site. The voice channels should be present in *Zone 1* while the GPS revert channels must be added to the *Channel Pool* (so that the user cannot select them).

For the voice channels:

- The subscriber radios <u>MUST</u> have *ARS* enabled on the voice channels. This is responsible for transmitting presence notification to the MOTOTRBO Gateway Application.

Figure 46 ARS and Roam List

- Check the *IP Site Connect* field and set the *Scan/Roam List* field to *Roam List 1*.
- Set the RX and TX frequencies corresponding to each repeater site, using Timeslot 1.

Figure 47 IP Site Connect Channel

- Set the same TX admit criteria and in call criteria as for the ARS control radio.

- Select for each voice channel (in the *GPS Revert* field) the corresponding GPS revert channel to allow GPS updates transmitted on that channel.

Figure 48 GPS Revert Selection

Check the *Data Call Confirmed* field (to be sure that the radio will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

For the GPS revert channels:
- Set the *ARS* field to *Disabled*.
- Check the *Enhanced GPS* field and set the *Window Size* to *7*.

Figure 49 GPS Revert Channel Settings-1

- Do not check the *IP Site Connect* field
- Program each GPS revert channel with the same frequencies as the corresponding voice channel (you can use copy/paste) but use Timeslot 2.
- Set the same TX admit criteria and in call criteria as on the voice channels

- Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages, allowing to use the *Window Size* of *7*.

⚠ **ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTING FOR THIS FIELD.**

Figure 50 GPS Revert Channel Settings - 2

Roam Settings

The set of corresponding voice channels (one for each site) uses a Roam List (if there are more channel sets (using for example another *Contact Name* in the TX section) each will use a separate list). The list is defined by selecting (with the mouse) a channel in the *Available* table and clicking on the *Add>>* button – the channel will move to the *Members* table.

Figure 51 Roam List
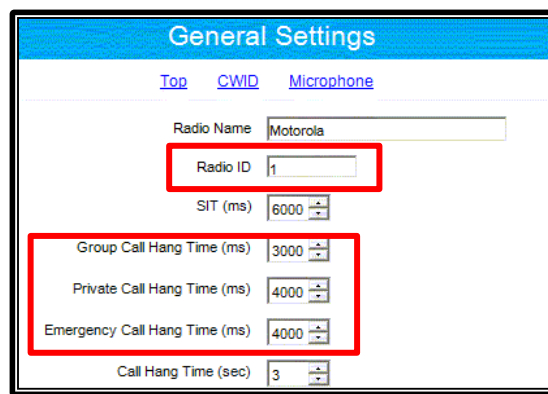
Write the configuration to the radio.

1.6.4 Programming of the repeaters

Read the repeater codeplug and make the needed changes in the following CPS windows:

General Settings

⚠ IN THIS CASE THE RADIO ID IS USED IN THE REPEATER IP NETWORK TO IDENTIFY EACH REPEATER, SO EACH REPEATER MUST HAVE A DIFFERENT ID.

Figure 52 IPSC Repeaters General Settings

We recommend to change the *Group Call Hang Time,* the *Private Call Hang Time* and the *Emergency Call Hang Time* fields to lower values (1-2 seconds) to minimize the voice calls duration, allowing more time for voice, registration and GPS traffic.

Network Settings

In an IPSC system all repeaters are connected together via Ethernet connections. As each repeater is in a different site, the most common case is the general Internet connection type via an Internet Service Provider (ISP) – other cases like a customer WAN are also possible but less probable. To allow maximum flexibility (towards the ISP) the system doesn't use multicast data packets – each repeater will send in turn the data packets (that can correspond to voice or data radio transmissions) to each of the other repeaters present in the system. While this leads to a limit in the maximum number of repeaters (currently 15) it avoids the problem of the multicast data packets that most ISP are blocking. But it also means that each repeater must know the IP address of all the other repeaters in the system. To provide flexibility in the system topology (capability to add new repeaters or to adapt to the change of the IP address of the repeaters) without the need to reprogram the repeaters for every change Motorola has implemented the following mechanism: one repeater will be programmed to be a "Master" while the others will be programmed to be "Peers". The "Master" is the only repeater that must have a fixed IP address (provided by the ISP)

while the "Peers" can have a variable IP address (using DHCP). The "Peers" are programmed with the "Master"'s IP address and (when switched on) they will register to the "Master" with their IP address – the "Master" keeps a

table of existing repeaters and for each change (new registration) will update the table and resend it to all the other repeaters ("Peers").

⚠ Note that the DHCP mechanism will create anyhow short communication interruptions when a "Peer"'s IP address is changed, so we recommend to avoid (if possible) the use of DHCP and to set all repeaters to fixed IP addresses – or to discuss with the ISP the possibility to perform the IP address changes during a low traffic moment of time (like during night).

To secure the repeater IP communication an authentication key is used (it is an up to 40 digits hexa number value) – for more security you can use VPN connections between repeaters (with additional hardware).

For the "Master" repeater use the following network settings in the *Link Establishment* section:
- Select for the *Link Type* field the value *Master.*
- Enter an *Authentication Key* value (the same value must be used for all repeaters – keep it also saved in a separate secure place as you cannot see it in a read or opened codeplug)
- Enter the *Ethernet IP* value (the fixed address provided by the ISP)
- Enter the *Gateway IP* and the *Gateway Netmask* values (also provided by the ISP)

For the "Peer" repeaters use the following network settings in the *Link Establishment* section:
- Select for the *Link Type* field the value *Peer.*
- Enter the *Authentication Key* value (the same value as used for the "Master")
- Enter the Master IP value (the fixed address provided for the "Master" by the ISP)
- Check the *DHCP* box (if DHCP is used for the "Peers") or (if DHCP is not used) Enter the *Ethernet IP* value (the fixed address provided by the ISP for this repeater)
- Enter (if DHCP is not used) the *Gateway IP* and the *Gateway Netmask* values (also provided by the ISP)

Figure 53 IPSC Repeaters Network Settings

Master   Peer

Channel Settings

Program the repeaters with only one digital channel, having the following settings:

Figure 54 IPSC Repeaters Channel Settings

Master   Peer

- For the *IP Site Connect* field select the value *Slot 1 & Slot 2* (this sets both timeslots to be used in wide-area mode).

- In the *Enhanced GPS* section check the *Enable* field for *Slot 2* and set the *Window Size* to *7*.

- For the "Master" repeater change (only if needed) the *Periodic Window Reservation (%)* field to the desired value (the default value is 75%).
- For the "Peer" repeaters change the *Periodic Window Reservation (%)* field to *None.*
- Set the TX and RX frequencies (according to the frequency license for each repeater).

Write the configuration to the repeater.

1.7 Programming of Capacity Plus Systems

A Capacity Plus system is a single-site trunking system that offers a much greater communication capacity as compared to a single repeater system. Generally, it consists in a number of voice/data repeaters (maximum 6) that work in trunking mode and a number of data revert repeaters (maximum 12) that work in conventional mode – both timeslots of either type of repeater are of the same type. Alhough the GPS data can also be sent on the trunking channels we do not recommend this (unless only a limited number of Low GPS profile radios are used) – the normal way of sending the GPS data is on a data revert repeater timeslot, using the GPS revert feature of the radios.

In Capacity Plus (unless there are no data revert repeaters) the radios register on the data revert channels (and not on the trunking channels) – even if they are Enhanced GPS ones. SafeMobile will need in this case more control radios – one used in trunking mode (only for data information sent to the subscriber radios and also for dispatcher's voice communication) and at least two (or multiple of two) used in conventional mode (one on each GPS data revert timeslot).

If the GPS data is sent on the trunking channels (no data revert repeaters) the trunking control radio must also be used for registrations. This creates an additional problem: while it is used by the dispatcher for voice calls no radios can register – the only solution is to use two separate radios (one used for ARS, GPS data and data sent to the subscriber radios and one used for dispatcher's voice communication). In this case the following limits in the number of radios per system apply:

Number of trunking repeaters / (channels)	Maximum no. of High Voice/Low GPS radios	Maximum no/ of Low Voice/Low GPS radios
1 / (2)	10	30
2 / (4)	30	50
3 / (6)	100	230
4 / (8)	210	470
5 / (10)	330	740
6 / (12)	460	1020

Note that to handle the GPS traffic a separate trunking control radio will be needed for every 200-250 Low GPS radios.

If the GPS data is sent on the data revert channels the following limits in the number of radios per system apply:

- For the trunking channels:

Number of trunking repeaters / (channels)	Maximum number of High Voice radios	Maximum number of Low Voice radios
1 / (2)	25	75
2 / (4)	120	360
3 / (6)	245	735
4 / (8)	390	1170
5 / (10)	545	1635

6 / (12)	710	2130

You can compare the above two tables and notice the impact of even Low GPS data sending on trunking channels.

- For the GPS data revert channels (because they work in conventional mode) the same number of 20 updates per minute per timeslot is supported as in the conventional repeater systems:

Number of data revert repeaters / (channels)	Maximum number of High GPS radios	Maximum number of Low GPS radios
1 / (2)	40	400
2 / (4)	80	800
3 / (6)	120	1200
4 / (8)	160	1600
5 / (10)	200	2000
6 / (12)	240	2400
⋮	⋮	⋮
12 / (24)	480	4800

It's easy to see that if using High GPS radios more data revert repeaters are needed than voice repeaters, even if the radios are also High Voice profile ones – a costly and low efficiency solution. The real solution is to use the "Enhanced GPS" feature – this will allow to use the following number of High GPS radios per system (for Low GPS radios multiply the below values by 10):

Number of "Enhanced GPS" data revert repeaters / (channels)	Maximum number of High GPS radios – 75% reserved windows	Maximum number of High GPS radios – 60% reserved windows	Maximum number of High GPS radios – 45% reserved windows
1 / (2)	214	172	128
2 / (4)	428	344	256
3 / (6)	642	516	384
4 / (8)	856	688	512
5 / (10)	1070	860	640
6 / (12)	1284	1032	768
⋮	⋮	⋮	⋮
12 / (24)	2568	2064	1536

1.7.1 Programming of the trunking control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A control radio must have a *Radio ID* – this ID will be used by the subscriber radios to register to the system and to send GPS data:

Figure 55 Trunking Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose.

As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

Network Settings

The network settings of the trunking control radio should be configured as follows:

The control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. The below figure shows an IP address of 192.168.10.60, however this may be different, depending on your IT network settings.

Check the *Forward to PC* field – in this way all text messages this radio receives are passed to the connected PC.

Figure 56 Trunking Control Radio Network Settings

Personality / Channel Settings

The trunking control radio will have only one Capacity Plus personality, using the settings indicated below:

- The *ARS* field should be set to *Disabled* as this radio will never register.

Figure 57 Trunking Control Radio ARS Settings

- Select for the *Voice List* field the *List 1* value (it contains the RF trunking channels from the *Channel Pool* – see below).

Figure 58 Trunking Control Radio Personality Settings

- Check the *Data Call Confirmed* field (to be sure that no data messages are lost). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

- Program the radio not to transmit over a busy channel when starting a call or during a call.

Figure 59 Admit Criteria / In Call Criteria

Add in the *Channel Pool* the number of *Capacity Plus Voice Channels* that corresponds to the number of voice (trunking) repeaters in the system. For each voice channel set the frequencies for RX (receive) and TX (transmit) corresponding to each repeater.

Voice List Settings

The set of corresponding voice channels determines a *Voice List* – this list is used by the radio for all trunking communication. The list is defined by selecting (with the mouse) a channel in the "*Available*" table and clicking on the "*Add>>*" button – the channel will move to the "*Members*" table.

Go to *Voice List 1* and add all the corresponding voice channels from the *Channel Pool* – take care to use the same order in the list as the numbering order used in the repeater programming (see below).

⚠ **A WRONG ORDER IN THE LIST WILL DETERMINE THE RADIO NOT TO WORK WITH SOME OR ALL OF THE REPEATERS.**

Figure 60 Capacity Plus Voice List

Write the configuration to the radio.

1.7.2 Programming of the GPS control radios

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

Set the *Radio ID* field with the same value as the trunking control radio – this ID will be used by the subscriber radios to send GPS data on the GPS revert channels.

Figure 61 GPS Control Radios ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

⚠️ THE TRUNKING CONTROL RADIO AND THE GPS CONTROL RADIOS MUST HAVE THE SAME ID OTHERWISE THE GPS DATA WILL BE LOST.

Network Settings

The network settings of the GPS control radios should be configured as follows:

The GPS control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. To avoid any potential IP address conflicts while keeping an easy to manage value we recommend to use a value similar to the one used for the ARS control radio by changing the third byte value – for example, if the ARS control radio IP address is 192.168.10.60, then use for the first GPS control radio the value 192.168.20.60, for the second one 192.168.30.60 and so on.

Check the *Forward to PC* field – in this way all GPS messages this radio receives are passed to the connected PC.

Figure 62 GPS Control Radios Network Settings

Channel Settings

The GPS control radio must have only one digital conventional channel, using the settings indicated below:

- The *ARS* field should be set to *Disabled* as this radio will never register. Set the frequencies for RX (receive) and TX (transmit) corresponding to the proper data revert repeater. Set the *Repeater/Time Slot* to *1* for the first control radio using that repeater and to *2* for the second one.
- Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages.

⚠ **ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUE FOR THIS FIELD ON THE GPS REVERT CHANNEL.**
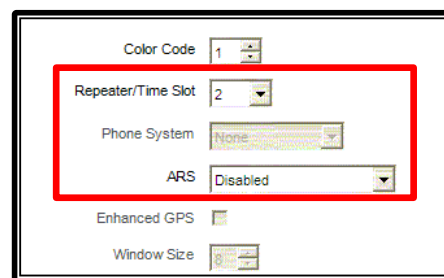
Figure 63 GPS Control Radios Channel Settings

- Program the radio not to transmit over a busy channel when starting a call or during a call.
- DO NOT check the *Data Call Confirmed* field (DCC is not used on Enhanced GPS channels).

Write the configuration to the radio.

1.7.3 Programming of the subscriber radios

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A subscriber radio must have a *Radio ID*.

Fig. 62 shows a *Radio ID* of 101, however, this can be any number that you choose.

⚠ **ALL SUBSCRIBER RADIOS MUST HAVE A UNIQUE RADIO ID.**

The *GPS* field MUST be checked. The Subscriber radio must have GPS enabled in order to transmit location data.

Figure 64 Subscriber Radios General Settings

Network Settings

The network settings of the subscriber radios should be configured as follows:

The *Radio IP* field can be left unmodified. The *Forward to PC* field should be set to *Disabled* as these radios do not connect to a PC.

In the *ARS Radio ID* field <u>MUST</u> be entered the ID of the ARS control radio.

⚠ **FAILING TO ENTER THE PROPER CONTROL RADIO ID WILL RESULT IN REPEATED UNSUCCESSFUL REGISTRATION ATTEMPTS.**

If more ARS control radios are used (for systems with many registrations), as each must have a different *Radio ID*, the subscriber radios must also be equally "allocated" to each of them, using the corresponding ID (for example, for two ARS control radios half of the subscriber radios will use the ID of the first ARS control radio and half will use the ID of the second one).

Figure 65 Subscriber Radios Network Settings

Personality / Channel Settings

Program in the radio at least one Capacity Plus personality using the following settings:

- The subscriber radios <u>MUST</u> have *ARS* enabled. This is responsible for transmitting presence notification to the MOTOTRBO Gateway Application.
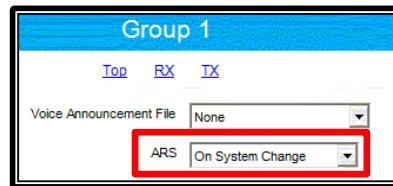
Figure 66 Subscriber Radios ARS Setting

- Check the *Data Call Confirmed* field (to be sure that the radio will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ <u>**ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.**</u>
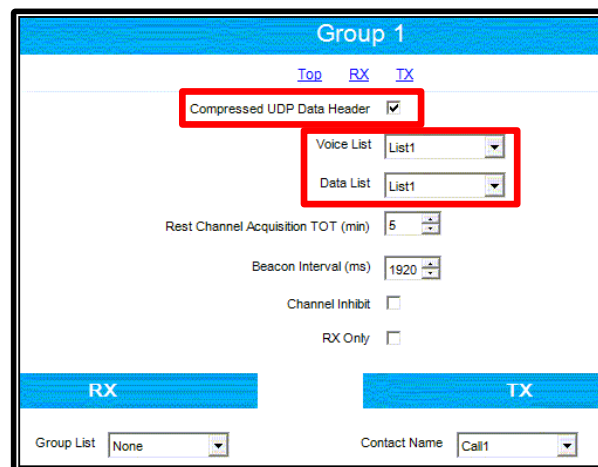
Figure 67 Subscriber Radios Personality Settings

- Select for the *Voice List* field the *List 1* value (it contains the RF trunking channels from the *Channel Pool* – see below) and for the *Data List* field the *List 1* value (it contains the GPS revert channel from the *Channel Pool* – see also below).
- Set the same TX admit criteria and in call criteria as for the ARS control radio.
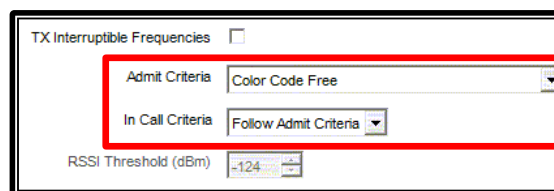
Figure 68 Admit Criteria / In Call Criteria

Add in the *Channel Pool* the number of *Capacity Plus Voice Channels* that corresponds to the number of voice (trunking) repeaters in the system. For each voice channel set the frequencies for RX (receive) and TX (transmit) corresponding to each repeater.

The GPS revert channel must be also added (as a conventional digital channel) to the *Channel Pool* (so that the user cannot select it).

For the GPS revert channel use the following settings:

- Set the *ARS* field to *Disabled*.
- Check the *Enhanced GPS* field and set the *Window Size* to *7*.

Figure 69 GPS Revert Channel Settings - 1

- Program the GPS revert channel with the frequencies and the timeslot corresponding to the used repeater channel (the subscriber radios should be equally "allocated" to the existing data revert channels)
- Set the same TX admit criteria and in call criteria as on the trunking personality
- Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages, allowing to use the *Window Size* of *7*.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUE FOR THIS FIELD.

Figure 70 GPS Revert Channel Settings - 2

<u>Voice and Data Lists Settings</u>

The set of corresponding voice channels determines a *Voice List* – this list is used by the radio for all trunking communication. The list is defined by selecting (with the mouse) a channel in the *"Available"* table and clicking on the *"Add>>"* button – the channel will move to the *"Members"* table.

Go to *Voice List 1* and add all the corresponding voice channels from the *Channel Pool* – take care to use the same order in the list as the numbering order used in the repeater programming (see below).

⚠ **A WRONG ORDER IN THE LIST WILL DETERMINE THE RADIO NOT TO WORK WITH SOME OR ALL OF THE REPEATERS.**
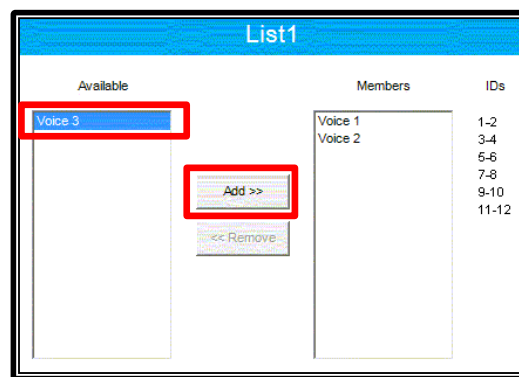
Figure 71 Voice List

Go to the *Data List 1* and add (using the same procedure as above) the GPS revert channel from the *Channel Pool.*
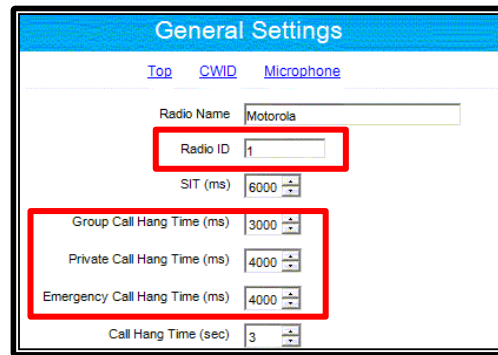
Write the configuration to the radio.

1.7.4 Programming of the repeaters

Read the repeater codeplug and make the needed changes in the following CPS windows:

<u>General Settings</u>

⚠ **IN THIS CASE THE RADIO ID IS USED IN THE REPEATER IP NETWORK TO IDENTIFY EACH REPEATER, SO EACH REPEATER MUST HAVE A DIFFERENT ID.**

Figure 72 Capacity Plus Repeaters General Settings

For the voice repeaters we recommend to change the *Group Call Hang Time,* the *Private Call Hang Time* and the *Emergency Call Hang Time* to lower values (1-2 seconds) to minimize the voice calls duration, allowing a more efficient voice traffic.

Network Settings

In a Capacity Plus system all repeaters are connected together via an Ethernet switch. As for the IPSC systems one repeater will be programmed to be a "Master" while the others will be programmed to be "Peers". Although the "Master" is the only repeater that must have a fixed IP address while the "Peers" can have a variable IP address (using DHCP), in this case (because all repeaters are in the same LAN) the "Peers" should also be programmed with fixed IP addresses. The "Peers" are programmed with the "Master"'s IP address and (when switched on) they will register to the "Master" with their IP address – the "Master" keeps a table of existing repeaters and for each change (new registration) will update the table and resend it to all the other repeaters ("Peers").

⚠ Note that the DHCP mechanism will create anyhow short communication interruptions when a "Peer"'s IP address is changed, so we recommend to set all repeaters to fixed IP addresses. Even more, the LAN of the repeaters should not include any other device – if an external RDAC is used, a router should isolate the LAN from the external environment.

To secure the repeater IP communication an authentication key is used – it is an up to 40 digits hexa number value that is programmed in all repeaters.

Figure 73 Capacity Plus Repeaters Network Settings

Master   Peer

For the "Master" repeater use the following network settings in the *Link Establishment* section:

- Select for the *Link Type* field the value *Master.*
- Enter an *Authentication Key* value (the same value must be used for all repeaters – keep it also saved in a separate secure place as you cannot see it in a read or opened codeplug)
- Enter the *Ethernet IP* value (the fixed address used in the repeater LAN)
- Enter the *Gateway IP* and the *Gateway Netmask* values (if a router is used)

For the "Peer" repeaters use the following network settings in the *Link Establishment* section:

- Select for the *Link Type* field the value *Peer.*
- Enter the *Authentication Key* value (the same value as used for the "Master")
- Enter the Master IP value (the fixed address provided for the "Master")
- Do not check the *DHCP* field and enter the *Ethernet IP* value (the fixed address provided for this repeater in the LAN)
- Enter the *Gateway IP* and the *Gateway Netmask* values (if a router is used)

For all the repeaters use the following network settings in the *Capacity Plus* section:

- Enter the *Rest Channel/Site IP* value – an address inside the site's LAN range

Channel Settings

Program the voice (trunking) repeaters with only one *Capacity Plus Voice Channel*, having the following settings:

- For the *Slot 1 Channel ID* field select the value corresponding for each repeater – so that it matches the trunking channels order in the radios' *Voice List*.

⚠ <u>A WRONG SELECTION WILL DETERMINE THE RADIOS NOT TO WORK WITH SOME OR ALL OF THE REPEATERS.</u>

- Set the TX and RX frequencies (according to the frequency license for each repeater).

Figure 74 Capacity Plus Repeaters Channel Settings

Voice Repeater   **Data Revert Repeater**

Program the data revert repeaters with only one *Capacity Plus Data Channel*, having the following settings:

- In the *Enhanced GPS* section check the *Enable* fields for both slots and set the *Window Size* to *7*.
- Change (only if needed) the *Periodic Window Reservation (%)* field to the desired value (the default value is 75%).
- Set the TX and RX frequencies (according to the frequency license for each repeater).

Write the configuration to the repeater.

1.8 Programming of Linked Capacity Plus Systems

A Linked Capacity Plus system is a multi-site trunking system that combines the greater communication capacity of trunking with the greater coverage of multi-site. Generally, it consists in a number of voice/data repeaters (maximum 6 per site) that work in trunking mode and a number of data revert repeaters (maximum 3 per site) that work in conventional mode – both timeslots of either type of repeater are of the same type. Alhough the GPS data can also be sent on the trunking channels we do not recommend this (unless only a limited number of Low GPS profile radios are used) – the normal

way of sending the GPS data is on a data revert repeater timeslot, using the GPS revert feature of the radios.

In Linked Capacity Plus (unless there are no data revert repeaters) the radios register on the data revert channels (and not on the trunking channels) – even if they are Enhanced GPS ones. SafeMobile will need in this case more control radios – one used in trunking mode (only for data information sent to the subscriber radios and also for dispatcher's voice communication) and at least two (or multiple of two) used in conventional mode (one on each GPS data revert timeslot).

If the GPS data is sent on the trunking channels (no data revert repeaters) the trunking control radio must also be used for registrations. This creates an additional problem: while it is used by the dispatcher for voice calls no radios can register – the only solution is to use two separate radios (one used for ARS, GPS data and data sent to the subscriber radios and one used for dispatcher's voice communication).

Estimating the LCP capacity is difficult because it is a multi-site system and its flexibility in allocating the groups to different sites will give specific values for each case. But (when not using data revert repeaters) the dispatcher site is a critical one because all GPS traffic (from all sites) will load this site. So, while other sites can handle additional traffic, there are the the following limits in the number of radios that use this site (for voice and/or GPS):

Number of trunking repeaters / (channels)	Maximum no. of High Voice/Low GPS radios	Maximum no/ of Low Voice/Low GPS radios
1 / (2)	10	30
2 / (4)	30	50
3 / (6)	100	230
4 / (8)	210	470
5 / (10)	330	740
6 / (12)	460	1020

Note that to handle the ARS and GPS traffic a separate trunking control radio will be needed for every 200-250 Low GPS radios.

If the GPS data is sent on data revert channels the following limits in the number of radios per system apply for the GPS data revert channels (because they work in conventional mode the same number of 20 updates per minute per timeslot is supported as in the conventional repeater systems):

Number of data revert repeaters / (channels)	Maximum number of High GPS radios	Maximum number of Low GPS radios
1 / (2)	40	400
2 / (4)	80	800
3 / (6)	120	1200

It's easy to see that the data revert repeaters can handle only a very limited number of High GPS radios. The solution to use more High GPS radios is to use the "Enhanced

GPS" feature. The below table sumarizes the capacity of "Enhanced GPS" data revert channels for High GPS profile radios (for Low GPS radios multiply the below values by 10):

Number of Enhanced GPS data revert repeaters / (channels)	Maximum number of High GPS radios for 75% reservation	Maximum number of High GPS radios for 60% reservation	Maximum number of High GPS radios for 45% reservation
1 / (2)	214	172	128
2 / (4)	428	344	256
3 / (6)	642	516	384

1.8.1 Programming of the trunking control radio

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A control radio must have a *Radio ID* – this ID will be used by the subscriber radios to register to the system and to send GPS data:

Figure 75 Trunking Control Radio ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.

Network Settings

The network settings of the trunking control radio should be configured as follows:

Figure 76 Trunking Control Radio Network Settings

The control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. The below figure shows an IP address of 192.168.10.60, however this may be different, depending on your IT network settings.

Check the *Forward to PC* field – in this way all text messages this radio receives are passed to the connected PC.

Personality / Channel Settings

The trunking control radio will have only one LCP personality using the settings indicated below:

- The *ARS* field should be set to *Disabled* as this radio will never register.

Figure 77 Trunking Control Radio ARS Setting

- Select for the *Site List* field the *List 1* value (it contains the RF trunking channels from the *Channel Pool* – see below).
- Check the *Data Call Confirmed* field (to be sure that no data messages are lost). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

Figure 78 Trunking Control Radio Personality Settings

- Program the radio not to transmit over a busy channel when starting a call or during a call.

Figure 79 Admit Criteria / In Call Criteria

Add in the *Channel Pool* the number of *Capacity Plus Voice Channels* that corresponds to the number of voice (trunking) repeaters in the used site. For each voice channel set the frequencies for RX (receive) and TX (transmit) corresponding to each repeater.

Voice List Settings

The set of corresponding voice channels determines a *Voice List* – this list is used by the radio for all trunking communication. The list is defined by selecting (with the mouse) a channel in the "*Available*" table and clicking on the "*Add>>*" button – the channel will move to the "*Members*" table.

Figure 80 (Linked) Capacity Plus Voice List

Go to *Voice List 1* and add all the corresponding voice channels from the *Channel Pool* – take care to use the same order in the list as the numbering order used in the repeater programming (see below).

⚠ **A WRONG ORDER IN THE LIST WILL DETERMINE THE RADIO NOT TO WORK WITH SOME OR ALL OF THE REPEATERS.**

Site List Settings

In LCP the set of corresponding sites determines a *Site List* – this list is used by a radio for all multi-site trunking communication. The list is defined by adding the corresponding number of sites and selecting each site's voice list and data list. In our case (the trunking control radio is a fixed one) the list will contain only one site.

Figure 81 Linked Capacity Plus Site List

Select *Voice List 1* and no data list (this radio is used only on trunking channels).

Write the configuration to the radio.

1.8.2 Programming of the GPS control radios

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

Set the *Radio ID* field with the same value as the trunking control radio – this ID will be used by the subscriber radios to send GPS data on the GPS revert channels.

Figure 82 GPS Control Radios ID

The above figure shows a *Radio ID* of 100, however, this can be any number that you choose. As this is a base radio (that will never send GPS data) the *GPS* field should be left unchecked.
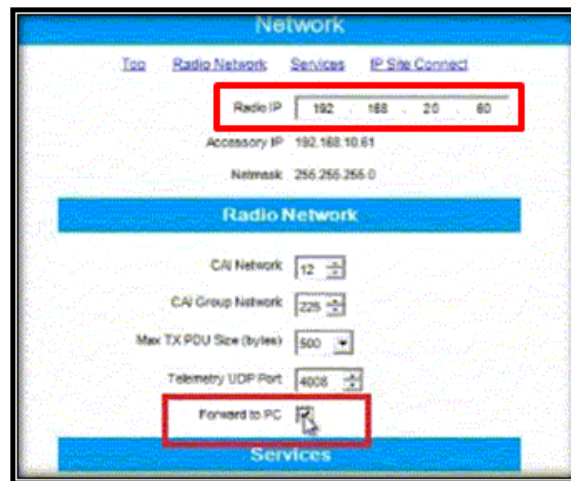
⚠ THE TRUNKING CONTROL RADIO AND THE GPS CONTROL RADIOS MUST HAVE THE SAME ID OTHERWISE THE GPS DATA WILL BE LOST.

Network Settings

The network settings of the GPS control radios should be configured as follows:

The GPS control radio must have a *Radio IP* address – this is used for the USB connection between this radio and the PC. To avoid any potential IP address conflicts while keeping an easy to manage value we recommend to use a value similar to the one used for the ARS control radio by changing the second byte value – for example, if the ARS control radio IP address is 192.168.10.60, then use for the first GPS control radio the value 192.168.20.60, for the second one 192.168.30.60 and so on.

Check the *Forward to PC* field – in this way all GPS messages this radio receives are passed to the connected PC.
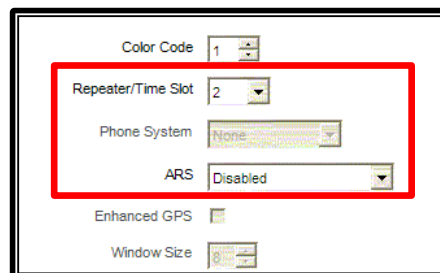

Figure 83 GPS Control Radios Network Settings

Channel Settings

The GPS control radio must have only one digital conventional channel, using the settings indicated below:

- The *ARS* field should be set to *Disabled* as this radio will never register. Set the frequencies for RX and TX corresponding to the proper data revert repeater. Set the *Repeater/Time Slot* to *1* for the first control radio using that repeater and to *2* for the second one.

Figure 84 GPS Control Radios Channel Settings

- Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages.

⚠ **ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUE FOR THIS FIELD ON THE GPS REVERT CHANNEL.**

- Program the radio not to transmit over a busy channel when starting a call or during a call.
- <u>DO NOT</u> check the *Data Call Confirmed* field (DCC is not used on Enhanced GPS channels).

Write the configuration to the radio.

1.8.3 Programming of the subscriber radios

Read the radio codeplug and make the needed changes in the following CPS windows:

General Settings

A subscriber radio must have a *Radio ID*.

Fig. 83 shows a *Radio ID* of 101, however, this can be any number that you choose.

⚠ **ALL SUBSCRIBER RADIOS MUST HAVE A UNIQUE RADIO ID.**

The *GPS* field <u>MUST</u> be checked. The Subscriber radio must have GPS enabled in order to transmit location data.

Figure 85 Subscriber Radios General Settings

Network Settings

The network settings of the subscriber radios should be configured as follows:

The *Radio IP* field can be left unmodified. The *Forward to PC* field should be set to *Disabled* as these radios do not connect to a PC.

In the *ARS Radio ID* field <u>MUST</u> be entered the ID of the ARS control radio.

⚠ **FAILING TO ENTER THE PROPER CONTROL RADIO ID WILL RESULT IN REPEATED UNSUCCESSFUL REGISTRATION ATTEMPTS.**

If more ARS control radios are used (for systems with many registrations), as each must have a different *Radio ID*, the subscriber radios must also be equally "allocated"

to each of them, using the corresponding ID (for example, for two ARS control radios half of the subscriber radios will use the ID of the first ARS control radio and half will use the ID of the second one).

Figure 86 Subscriber Radios Network Settings

Personality / Channel Settings

Program in the radio at least one Linked Capacity Plus personality using the following settings:

- The subscriber radios <u>MUST</u> have *ARS* enabled. This is responsible for transmitting presence notification to the MOTOTRBO Gateway Application.

Figure 87 Subscriber Radios ARS Setting

- Select for the *Site List* field the *List 1* value (it contains the LCP sites – see below).
- Check the *Auto Roam* field (to be sure that the radio will roam between sites).
- Check the *Data Call Confirmed* field (to be sure that the radio will register). We also recommend to check the *Compressed UDP Data Header* field – using this feature will reduce the duration of all data messages.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME SETTINGS FOR THESE TWO FIELDS.

Figure 88 Subscriber Radios Personality Settings

- Set the same TX admit criteria and in call criteria as for the ARS control radio.

Figure 89 Admit Criteria / In Call Criteria

Add in the *Channel Pool* the number of *Capacity Plus Voice Channels* that corresponds to the number of voice (trunking) repeaters in the system. For each voice channel set the frequencies for RX (receive) and TX (transmit) corresponding to each repeater.

The GPS revert channels must be also added (as conventional digital channels) to the *Channel Pool* (so that the user cannot select them).

For the GPS revert channels use the following settings:

- Set the *ARS* field to *Disabled*.
- Check the *Enhanced GPS* field and set the *Window Size* to *7*.

Figure 90 GPS Revert Channel Setting - 1

- Program the GPS revert channels with the frequencies and the timeslot corresponding to the used repeater channels in each site (the subscriber radios should be equally "allocated" to the existing revert channels)

- Set the same TX admit criteria and in call criteria as on the trunking personality
- Check the *Compressed UDP Data Header* field – using this feature will reduce the duration of the GPS data messages, allowing to use the *Window Size* of *7*.

⚠ ALL THE RADIOS IN THE SYSTEM SHOULD BE PROGRAMMED WITH THE SAME VALUE FOR THIS FIELD.

Figure 91 GPS Revert Channel Settings- 2

Voice and Data Lists Settings

The set of corresponding voice channels of a site determines a *Voice List* – this list is used by the radio for all trunking communication in that site. The list is defined by selecting (with the mouse) a channel in the "*Available*" table and clicking on the "*Add>>*" button – the channel will move to the "*Members*" table.

For Site 1 go to *Voice List 1* and add all the corresponding voice channels from the *Channel Pool* – take care to use the same order in the list as the numbering order used in the repeater programming (see below).

⚠ A WRONG ORDER IN THE LIST WILL DETERMINE THE RADIO NOT TO WORK WITH SOME OR ALL OF THE REPEATERS.

Go to the *Data List 1* and add (using the same procedure as above) the corresponding GPS revert channel from the *Channel Pool.*
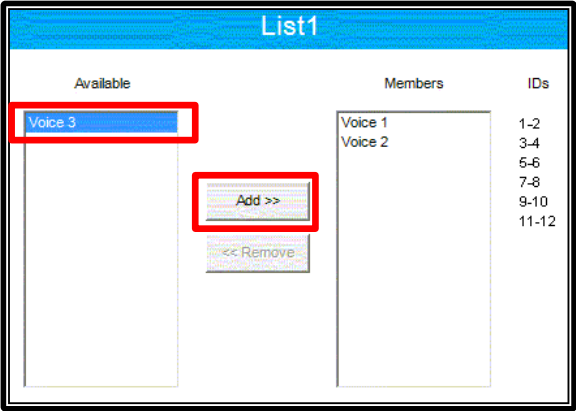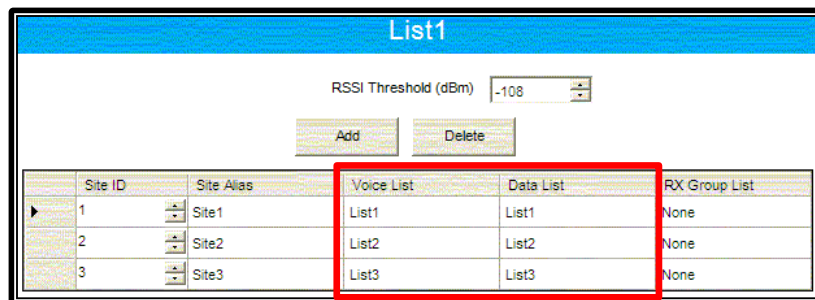
Figure 92 Voice List

Add a new voice list and data list for each LCP site and repeat the above procedure for all the other sites.

<u>Site List Settings</u>

In LCP the set of corresponding sites determines a *Site List* – this list is used by a radio for all multi-site trunking communication. The list is defined by adding the corresponding number of sites and selecting each site's voice list and data list. For the mobile/portable subscriber radios the list will contain all LCP sites.

Figure 93 Linked Capacity Plus Site List

Select for each site the corresponding voice and data lists.

⚠ **A WRONG SETTING IN THE SITE LIST WILL DETERMINE THE RADIO NOT TO WORK WITH SOME OR ALL OF THE SITES.**
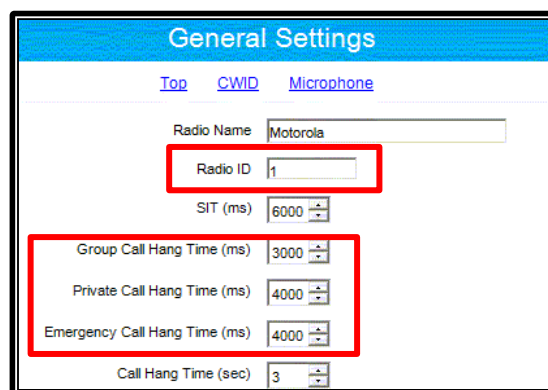
Write the configuration to the radio.

1.8.4 Programming of the repeaters

Read the repeater codeplug and make the needed changes in the following CPS windows:

<u>General Settings</u>

⚠ IN THIS CASE THE RADIO ID IS USED IN THE REPEATER IP NETWORK TO IDENTIFY EACH REPEATER, SO EACH REPEATER MUST HAVE A DIFFERENT ID.

Figure 94 LCP Repeaters General Settings

For the voice repeaters we recommend to change the *Group Call Hang Time,* the *Private Call Hang Time* and the *Emergency Call Hang Time* to lower values (1-2 seconds) to minimize the voice calls duration, allowing a more efficient voice traffic.

Network Settings

In a Linked Capacity Plus system all repeaters of a site are connected together in a LAN via an Ethernet switch and a router is added to connect to the other sites – this LAN should not include any other device.

For intersite connections the most common case is the general Internet connection type via an Internet Service Provider (ISP) – other cases like a customer WAN are also possible but less probable. To allow maximum flexibility (towards the ISP) the system doesn't use multicast data packets – during a call, each repeater will send in turn the data packets (that can correspond to voice or data radio transmissions) to the corresponding repeaters present in the other sites of the system. While this leads to a limit in the maximum number of sites (currently 15) it avoids the problem of the multicast data packets that most ISP are blocking. But it also means that each repeater must know the IP address of all the other repeaters in the system. To provide flexibility in the system topology (capability to add new repeaters or to adapt to the change of the IP address of the repeaters) without the need to reprogram the repeaters for every change Motorola has implemented the following mechanism: one repeater will be programmed to be a "Master" while the others will be programmed to be "Peers". The "Master" is the only repeater that must have a fixed IP address (provided by the ISP) while the "Peers" can have a variable IP address (using DHCP). Also, in LCP each repeater must use a different UDP port.

The "Peers" are programmed with the "Master"'s IP address / UDP port and (when switched on) they will register to the "Master" with their IP address and UDP port – the "Master" keeps a table of existing repeaters and for each change (new registration) will update the table and resend it to all the other repeaters ("Peers"). Note that what has to be programmed in the "Peer" repeaters as the "Master" IP address is in fact the WAN IP address of the router (of the site containing the "Master").

⚠ Note the DHCP mechanism will create anyhow short communication interruptions when a "Peer"'s IP address is changed, so we recommend to set all repeaters to fixed IP addresses inside each site's LAN. We also recommend (if possible) to set fixed IP addresses for all sites (routers) to avoide the above described interruptions when a router IP address changes – or to discuss with the ISP the possibility to perform the IP address changes during a low traffic moment of time (like during night).

To secure the repeater IP communication an authentication key is used – it is an up to 40 digits hexa number value that is programmed in all repeaters.

Figure 95 Linked Capacity Plus Repeaters Network Settings

Master   Peer (from another
site)

For the "Master" repeater use the following network settings in the *Link Establishment* section:

- Select for the *Link Type* field the value *Master.*
- Enter an *Authentication Key* value (the same value must be used for all repeaters – keep it also saved in a separate secure place as you cannot see it in a read or opened codeplug)
- Enter the *Ethernet IP* value (the fixed address used in the repeater LAN)
- Enter the *Gateway IP* (the LAN IP address of the router) and the *Gateway Netmask* values
- Enter the *UDP Port* value (different for each repeater in the LCP system)

For the "Peer" repeaters use the following network settings in the *Link Establishment* section:

- Select for the *Link Type* field the value *Peer.*
- Enter the *Authentication Key* value (the same value as used for the "Master")
- Enter the *Master IP* value (the fixed address provided by the ISP for the "Master"'s router)
- Enter the *Master UDP Port* value (the same value as used for the "Master"'s *UDP Port*)
- Do not check the *DHCP* field and enter the *Ethernet IP* value (the fixed address provided for this repeater in the LAN)
- Enter the *Gateway IP* (the LAN address of the site's router) and the *Gateway Netmask* values
- Enter the *UDP Port* value (different for each repeater in the LCP system)

For all the repeaters use the following network settings in the *Capacity Plus* section:

- Enter the *Rest Channel/Site IP* value – an address inside the site's LAN (different for each site)
- Enter the *Rest Channel/Site UDP port* value – a separate port value (different for each site)

Channel Settings

Program the voice (trunking) repeaters with only one *Capacity Plus Voice Channel (Linked)*, having the following settings:

- For the *Slot 1 Channel ID* field select the value corresponding for each repeater from that site – so that it matches the trunking channels order in the radios' *Voice List* for that site.

⚠ **A WRONG SELECTION WILL DETERMINE THE RADIOS NOT TO WORK WITH SOME OR ALL OF THE REPEATERS.**

- Set the TX and RX frequencies (according to the frequency license for each repeater).

Figure 96 Linked Capacity Plus Repeaters Channel Settings

Voice Repeater　　　　　　　　　　**Data Revert Repeater**

Program the data revert repeaters with only one *Capacity Plus Data Channel (Linked)*, having the following settings:

- Check the *Wide Area* box – this will allow the GPS data sent from any site to arrive to the GPS control radios
- Select the *Slot 1 Channel ID* value – for the first data revert repeater in each site choose the value *33*, for the second set of repeaters (if used) choose the value *35* and so on

- In the *Enhanced GPS* section check the *Enable* fields for both slots and set the *Window Size* to *7*.
- For one of the Data Revert repeaters change (only if needed) the *Periodic Window Reservation (%)* field to the desired value (the default value is 75%).
- For all the other Data Revert repeaters change the *Periodic Window Reservation (%)* field to *None.*
- Set the TX and RX frequencies (according to the frequency license for each repeater).

Write the configuration to the repeater.