3.5.9 DGNA

Dynamic Group Assignment (DGNA) is used to send Groups to radios that not already have these groups programmed.

3.5.9.1 Assigning subscribers to DGNA

1: Right click on a group to be assigned

- If it is not desirable to assign a group already programmed into the tetra terminals, a new group specific for DGNA should be defined in the Subscriber Register

2: Select function; “Add Group(s) to DGNA”

- This selects the parent group for the DGNA

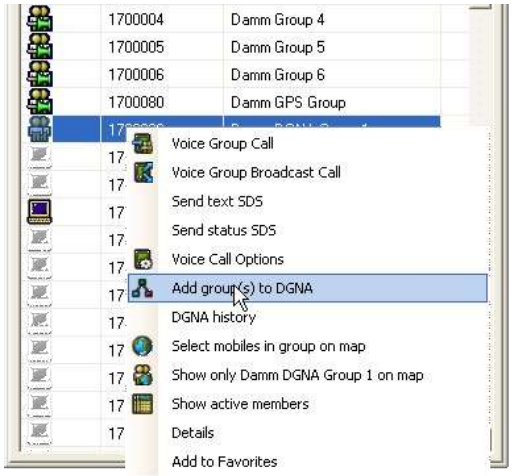


Figure 3-63: DGNA group Assignment

3: Right click on a subscriber(s) to be assigned to the DGNA group. More subscribers may be selected by holding down the <Shift> or <Ctrl> keys

4: Select “Add mobile(s) to DGNA)

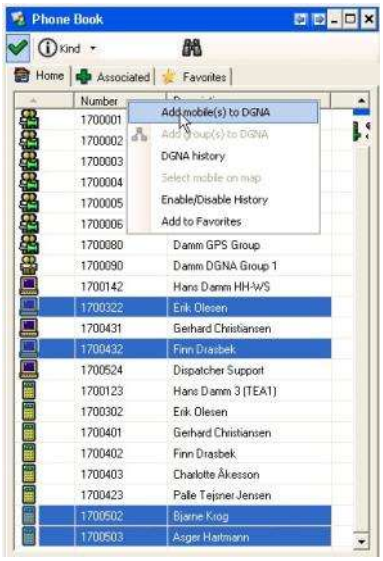


Figure 3-64: DGNA subscriber selection

5: Accept the selection

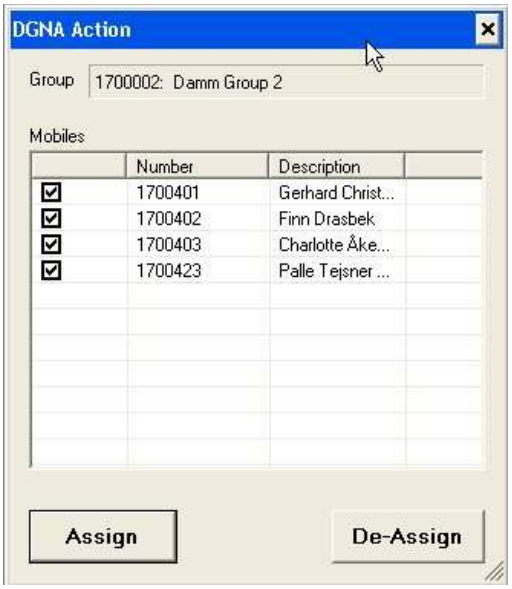


Figure 3-65: DGNA subscriber Assignment

Alternatively it is possible to drag and drop the selections to the DGNA group window

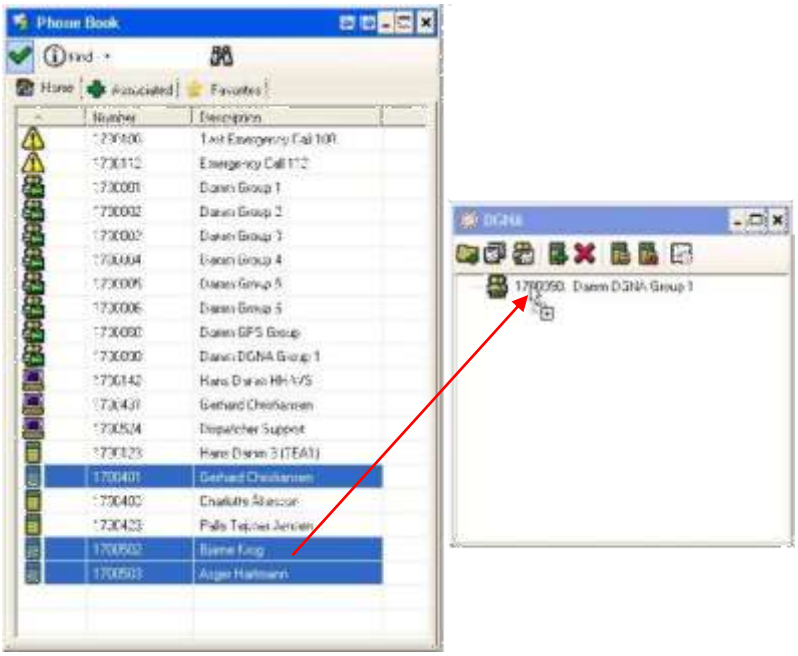


Figure 3-66: DGNA Drag and Drop Selection

6: Repeat 3 and 4 if more subscribers are to be assigned to the DGNA group

7: After assigning subscribers, the DGNA group is transferred to the mobile by selecting "Assign the parent group to the mobile"

Figure 3-67: DGNA Assignment

3.5.9.2 De-assigning subscribers to DGNA

1: Select group or subscriber to be de-assigned and press the  de-assign icon

Figure 3-68: DGNA de-assign

Figure 3-69: DGNA de-assigned terminals

3.5.9.3 Showing DGNA history

- Right click on the group or subscriber
- Select DGNA History

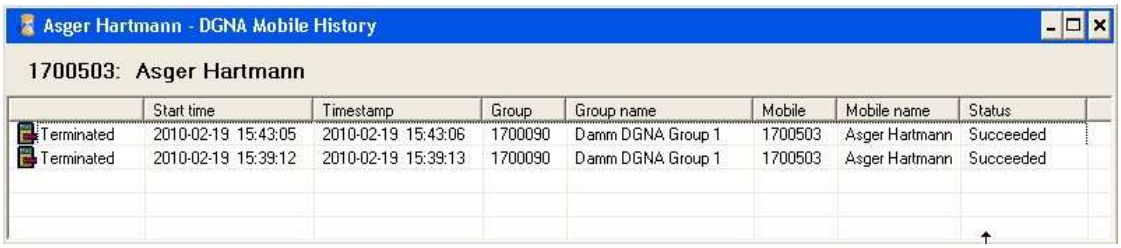


Figure 3-70: Individual Subscriber DGNA history

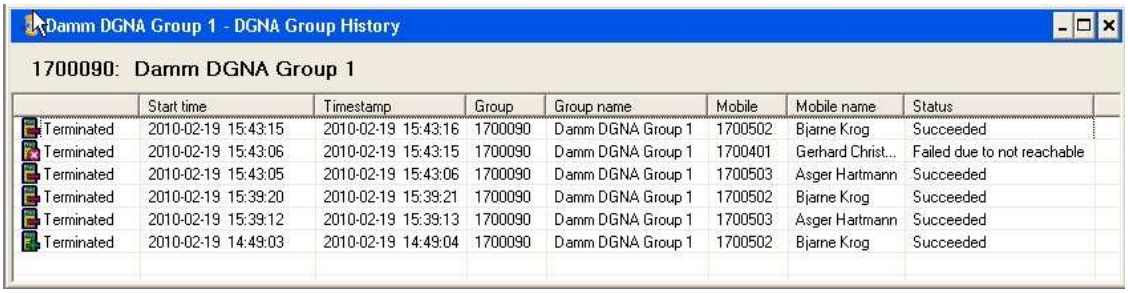


Figure 3-71: Group DGNA history

3.5.10 SDS Functionality

All outgoing SDS traffic from the Dispatcher is initiated from the Call Dialog which is available in the SDS and Phone Book windows. The predefined Status SDS's in the list are Organization in-depended, since they are completely transparent to the infrastructure. The predefined Status SDS list is located in a file named StatusSds.txt on the local dispatcher PC.

All incoming SDS traffic to the dispatcher is placed in the inbox; please see Figure 3-72. This includes both text and status SDS's.
An open or closed envelope indicates whether the SDS has been read or not

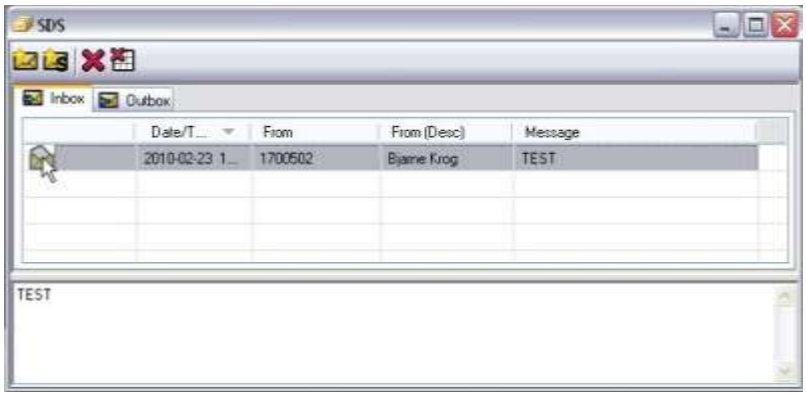


Figure 3-72: SDS Inbox

All outgoing SDS traffic from the Dispatcher are copied to the SDS Outbox, see Figure 3-73. This includes both text and status SDS's. The status of any requested SDS Reports is indicated here by icons.

The types of SDS reports which are supported are:

- **Delivery/consumed Report Request** 
  The receiving Terminal shall report when the SDS has been received.

- **Action accomplished** 
  The receiving Terminal has opened (read) the SDS.

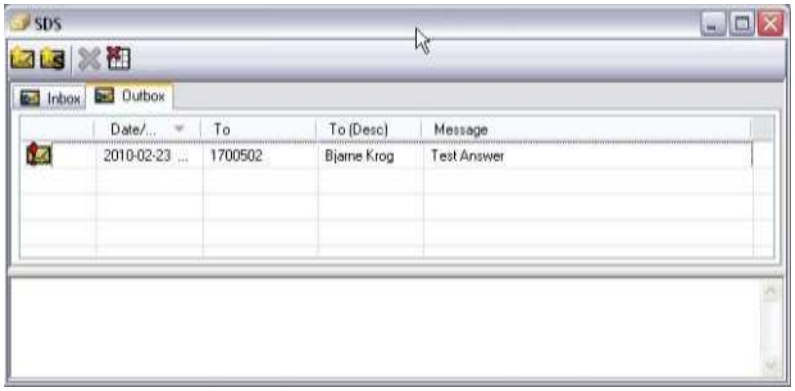


Figure 3-73: SDS Outbox

In the figure above, the left icon shows a SDS send with flag for Delivery- and Consumed Report set.

The figure changes to  when the SDS has been read / consumed

3.5.10.1 SDS details

SDS details may be displayed by right click on the specific SDS message and selecting "Details"

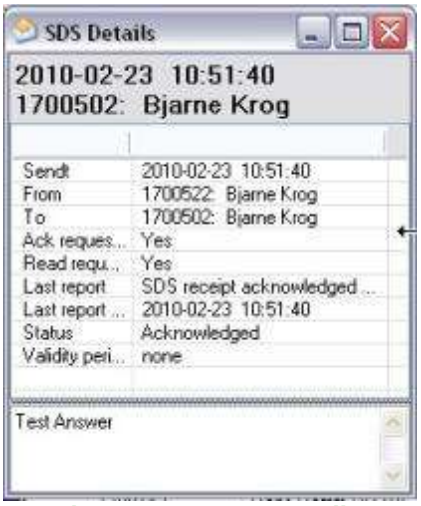


Figure 3-74: SDS Details

3.5.10.2 Receiving Emergency SDS

Emergency calls will be indicated in the SDS call window as a red bar containing the standard SDS options.

Also an alarm tone will be played and can be reset by answering / selecting the call

Figure 3-75: Emergency SDS

The icons associated with the emergency SDS are:

SDS received 

SDS answered 

3.5.10.3 ADU200 emergency alarm box

Please refer to the configuration section 3.5.3.2.6 external devices

3.5.11 Map

3.5.12 Detach Map

The map window may be detached from the main dispatcher window and placed anywhere on the PC monitor(s)

This detachment is accomplished by selecting the detach/attach  icon positioned in the upper right hand corner of the map window. To attach again, select the detach/attach icon once more

3.5.12.1 Positioning

The TetraFlex® dispatcher offers GPS positioning

Positions may be shown as a function of automatic positioning information send from the terminals or as a manual request from the dispatcher. This functionality uses WG84 map coordinates together with Google Maps or one of the other supported map formats.

It is also possible to add layers in ESRI Shapefile format on top of one of the supported maps (except the standard Goggle map format) e.g..for showing details that are not on standard maps.

Positions are shown as green circles and position history as yellow. When moving the mouse over the circle, the data and time for the subscriber is shown.

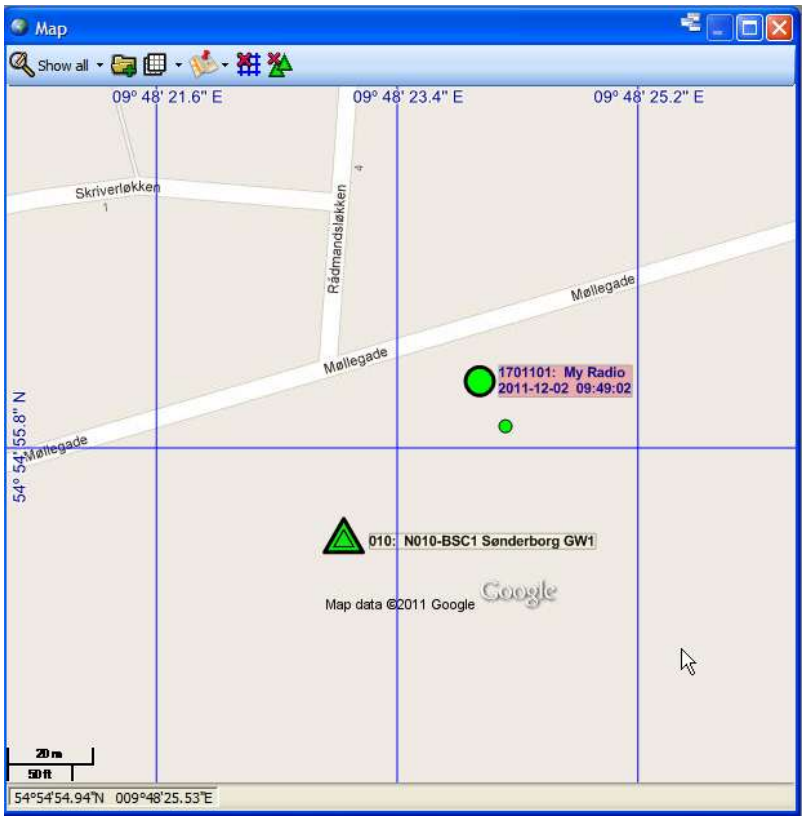
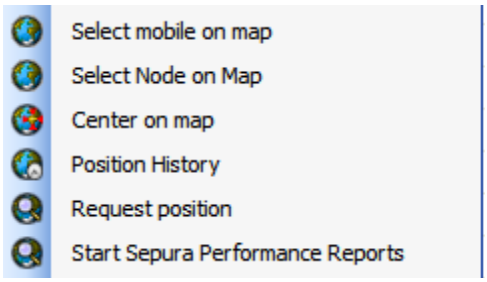
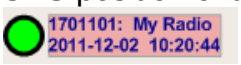


Figure 3-76: Positioning Google

To request the position of a subscriber, right click on the phonebook entry and select the option you want:



- Select mobile on map - This highlights the GPS position of the radio on the map with big green circle and subscriber details 

- Center on map – Center the GPS position on the map
- Position History – Shows the Position History window and the historic GPS position on the map as yellow circles
- Request position – This request the actual GPS position from the radio. This could be usefull when the radio has a long scan period for delivering GPS coordinates and you want a position here and now.
- Start Sepura Performance Reports – This function is at the moment only avaliable in Sepura radios and is use for getting the RSSI downlink measurment from the radio.

3.5.12.2 Configuring positioning

At present the TetraFlex® relies on the mobile to send positioning to a group.
Any group may be used, but it is recommended to create a specific positioning group. This GPS to Group assignment must be set from the radio programming tool.

The position information SDS from the mobile is send to the group. The dispatcher is as rule “member” of all groups, so the dispatcher will pick up the SDS information, process and show it as a position on the map.

Positioning SDS’s are filtered out and will not be shown in the dispatcher SDS inbox

3.5.12.3 Overlay file in ESRI map (.shp) format

NOTE: The use of overlay files in ESRI format is dongle controlled.

You can use ESRI overlay maps on top Google premier maps, OpenStreet maps, Raster maps and the Empty map option. Standard Google maps are not supported with overlay maps. The Dispatcher uses a flag in the Dongle in order to enable and disable the ESRI shape file view.

The current used overlay files are saved together with the used map and will be re-loaded when the map view / dispatcher is started again.

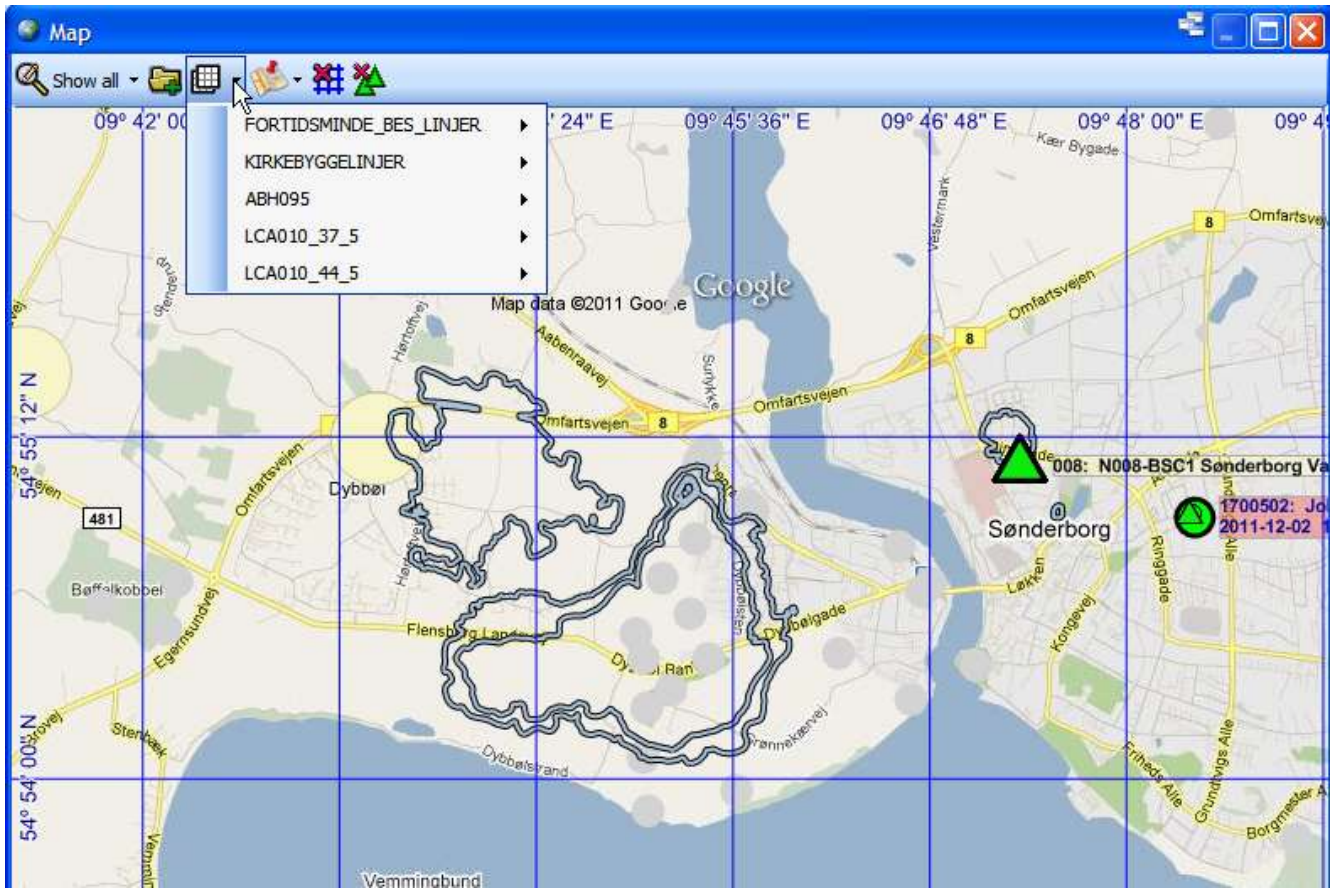
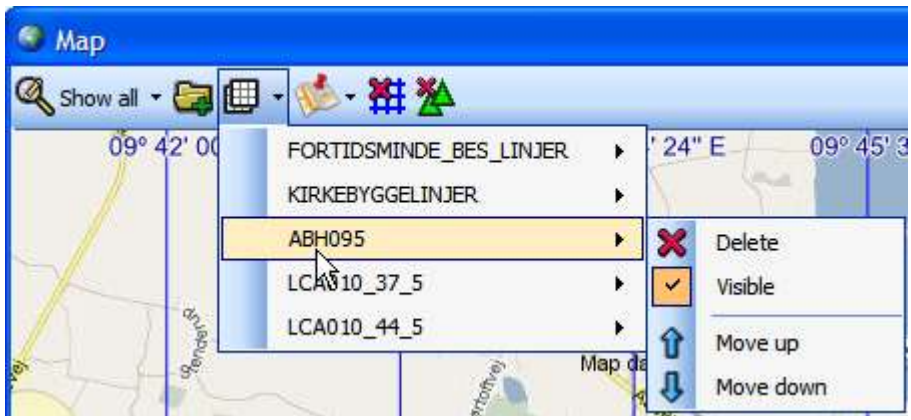


Figure 3-77: Overlay on Google map

To load a new overlay file use the folder icon. When loaded it will be available in the overlay list



By Right clicking on the overlay in the menu, you get the possibility to **Delete** them again, make them **Visible** or not Visible and to move the layer up and down (**Move up, Move down**) in the different layers on the map e.g. if two layers are overlaying each other you can change which one should be in front.

3.5.12.4 Other map options

The **Show (all)** menu makes it possible to select what GPS coordinates you want to show on the map:

- Show all – Shows the GPS coordinates for all radios, registered and not registered (not registered are shown with a dark green color).
- Show registered – Shows only the registered radios. If a Radio comes out of coverage, the battery is removed or in another way comes unavailable without de-registering is will still be shown on the map as registered.
- Show history – Shows the historical plot of GPS coordinates for the selected radio.

With the  icon you can change the map view between Road map, Satellite or Hybrid This option is only available in Google premier maps and on Google standard map (map and satellite).

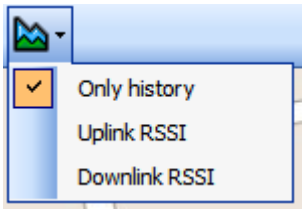
 Toggles between showing grid line on the map and no grid lines (not available on Google standard map)

 Toggles between showing the nodes on the map or not. (not available on Google standard map)

 Show / hides lines between history points on the map. (not available on Google standard map)

3.5.12.5 RSSI measurement plot

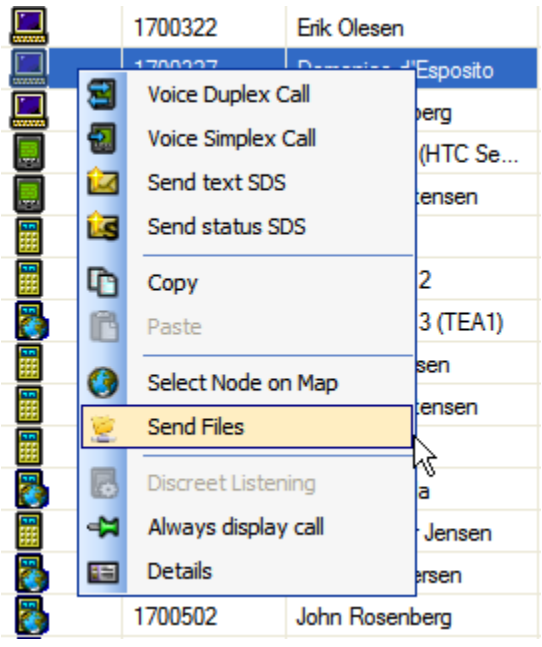
(not available on Google standard map)
When changing the map view to History view you get the option to plot RSSI measurement on the map as different colors depending on the RSSI level. This can be used for making a coverage map or just to see the RSSI levels of a radio on the map.



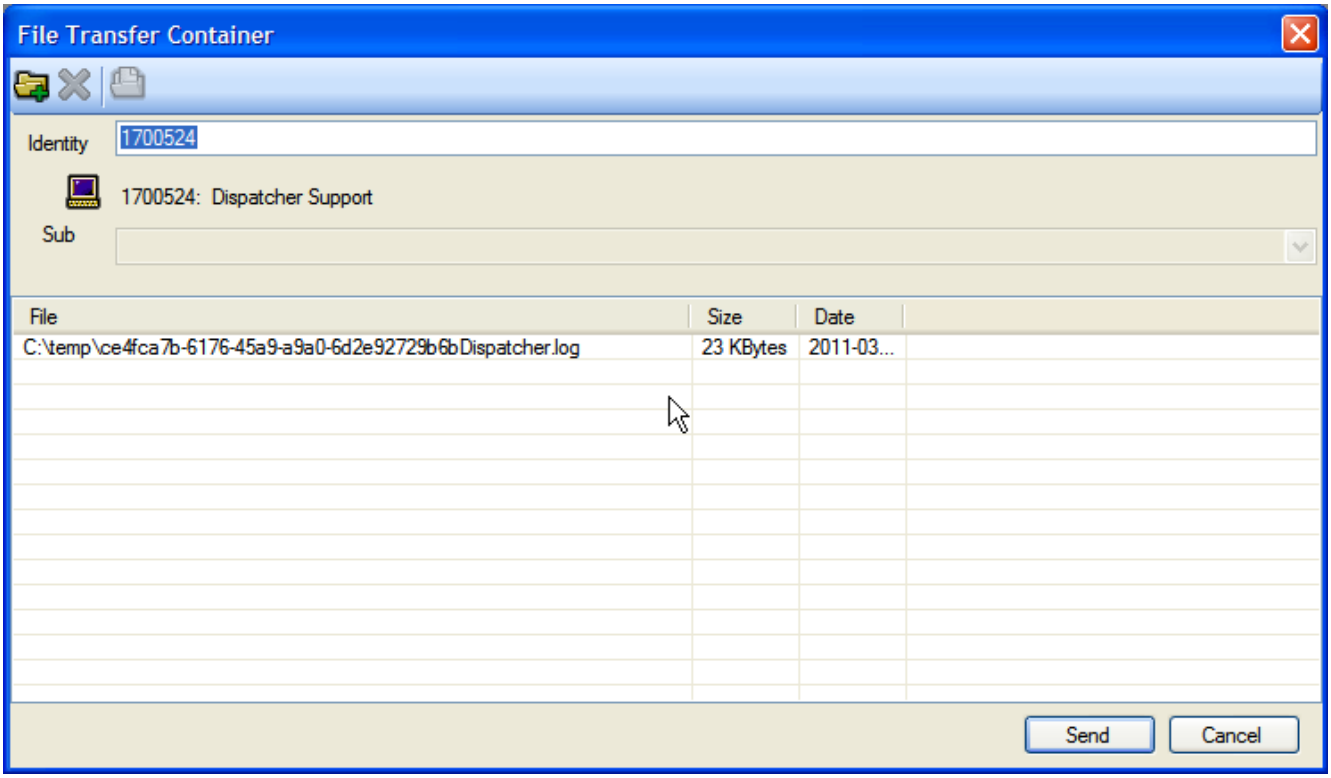
- Only history – shows only the historical GPS positions
- Uplink RSSI – Shows the RSSI level the actual node measures for a given radio
- Downlink RSSI – Shows the RSSI level the radio measures to the connected node (only possible on Sepura radios with the Sepura Performance Report enabled)

3.5.12.6 Send file

It is possible to send files between two dispatchers by clicking the on the dispatcher you want to send the file to in the Phone book list:

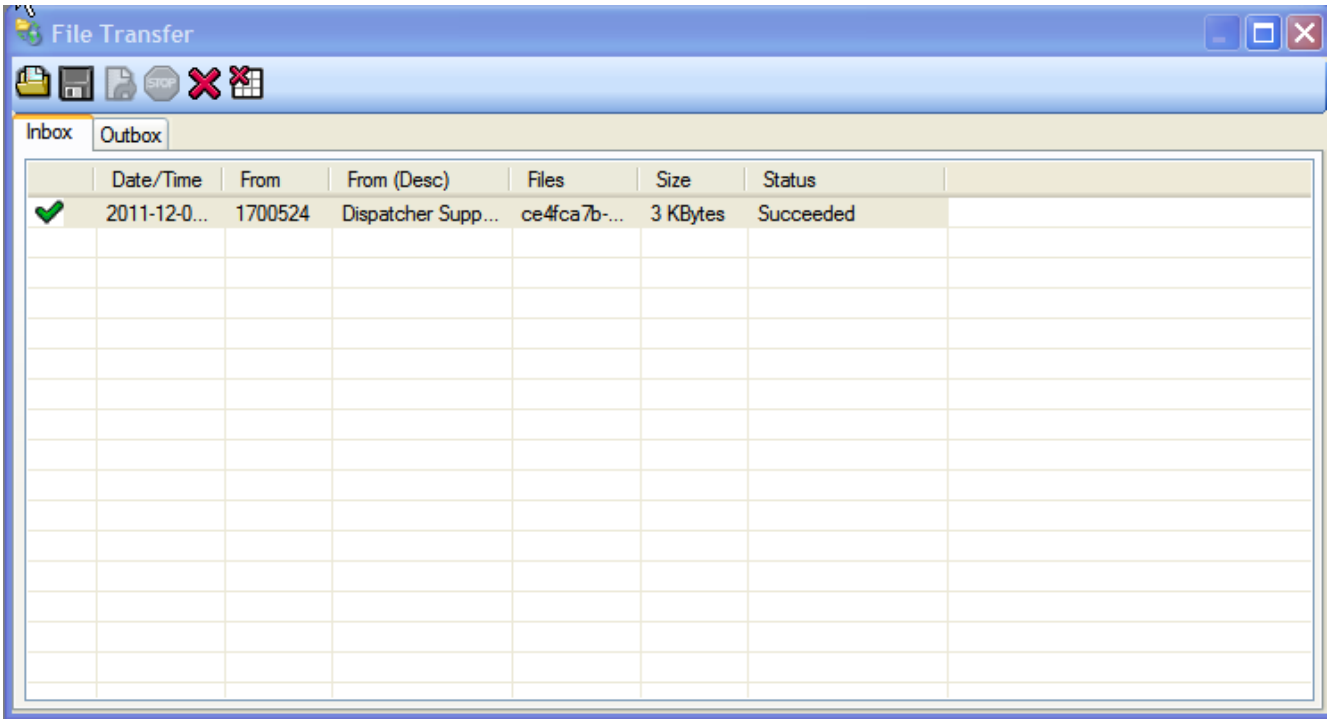


When selecting Send Files you get the file transfer container:



Here you can either drag and drop the files you want to send from e.g.. the file manger or you can use the file menu  to get the open dialog from where you can select the files you want to send.

When the receiving dispatcher receives the file(s) a notice will come in the mail box icon in the process line and the file(s) will be shown in the File Transfer window that you can choose from the menu:



3.6 LOG SERVER

3.6.1 Description

A TetraFlex® Log Server is a network component that can be placed anywhere in the TetraFlex® Network's infrastructure. Once connected, it will automatically start to record the status of all Nodes in the TetraFlex® network, without any configuration. Furthermore it can be setup to log statistics (default, always present), SDS, Call records and Voice Communication, or a combination of these functions (dongle controlled)

The TetraFlex® system supports the attachment of one or more Log Servers to the system. The Log Server is developed to run on a Windows platform.

For single-site and small systems the Log Server can be installed on and run from the BSC412 or BSC421.

For bigger systems the Log Server must run on DAMM Log Work Station or on a DAMM Log Server Station.

3.6.2 General Description

3.6.2.1 The TetraFlex® Network and the Log Server

The TetraFlex® network infrastructure consists of TetraFlex® Nodes which are connected through a backbone IP net as illustrated in Figure 3-78
Log Servers are passive network elements that can be attached anywhere in the infrastructure, only requirement is IP connectivity to the backbone network. When attached the LogServer will automatically be joining a specific log server IP multicast address on which all Nodes send status and call information.

The Log Server is capable of:

- Logging the status from all Nodes in the TetraFlex® network.
- Logging Call information (Call Data Records) for all mobiles.
- Logging Voice Communication for selected mobiles.
- Logging the mobiles Node location and on/off state for selected mobiles.

The Log Server automatically starts to log the status from the TetraFlex® Nodes. In addition, it can be setup to log all calls (CDR without voice) and SDS on the system, and optionally log Voice Communication and Node location for selected mobiles. The Log Server logs all data to a database, managed by a SQL Server.
In Figure 3-78 TetraFlex® Network with Log Server, the SQL Server and the Log Server are running on the TetraFlex® Log Server machine.

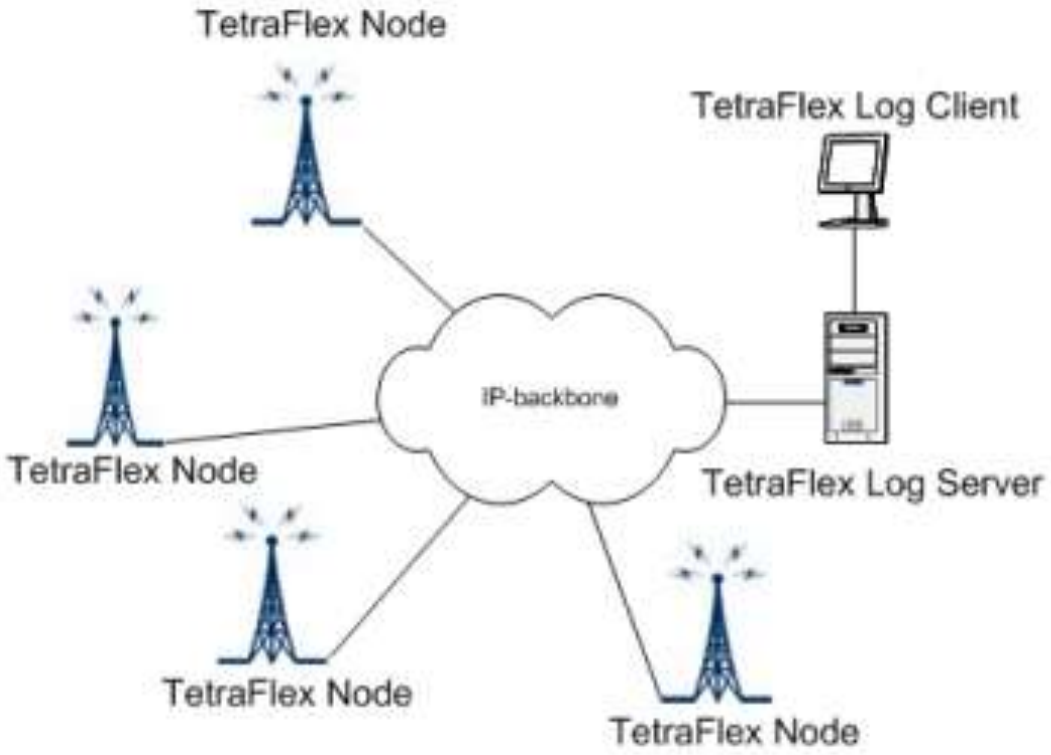


Figure 3-78 TetraFlex® Network with Log Server

It is possible to attach one or more TetraFlex® Log Servers to the infrastructure, either on dedicated Log Server machines or on a BSC412 or BSC421, all depending on the network load.

3.6.3 Log Server Maintenance

The database should be backed up on a daily basis; the backup should be saved to an external media, such as Tape, external disk, and network server or similar.

The Log server can be setup to perform a scheduled maintenance, which can run on specified interval. It is also possible to make the “Maintenance now”.

The Maintenance parameters are setup via the LogClient, but the LogClient itself has nothing to do with the execution of the maintenance this is totally done by the log server based on the settings made by the client.

The maintenance is performed by the LogServer, which executes 2 steps: An optional backup of the database files to a network share, and an optional cleanup old data. Each of these steps can be disabled independently of each other.

It is recommended to enable the scheduled maintenance with backup and automatic cleanup enabled. There are several of good reasons for this:

- Keep the database from running out of disk space.
- backup the database to an external disk to ensure data in case of disk crash.
- Keep high performance when querying data from the database.

3.6.3.1 Scheduled Maintenance

The scheduled maintenance parameters are set up via the LogClient. Open the settings view and select the database tab.

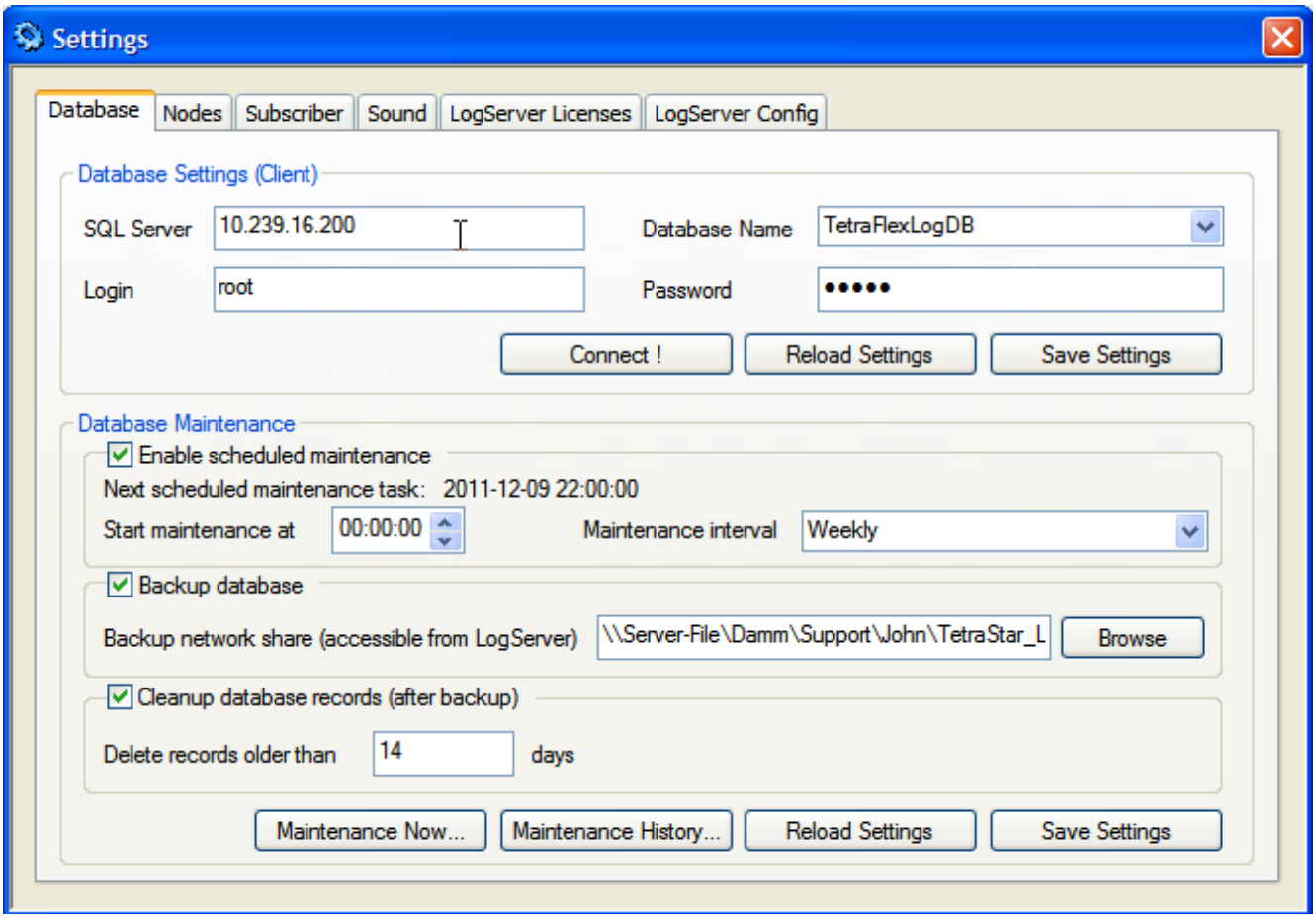


Figure 3-79 Log Client Setting view –Database tab

1. In the Database maintenance group box, you can enable/disable “scheduled maintenance”, “database backup” and “Cleanup database records”.
2. To set up scheduled maintenance set a check mark in “Enable scheduled maintenance”.
3. Now set the start time to a time where the TetraFlex traffic load possibly is low, i.e. midnight.
4. Finally set how often this operation should be performed in “Maintenance interval”. The Maintenance task can be executed each day, every week, every 2nd week, or every 4th week, depending on the selected “Maintenance interval”.

To enable backup of database put a check mark in the “Backup database” checkbox.
Now you must supply a fully qualified network path to the backup share you are using. This must be on the form \\<BackupServer-IP>\<Share> seen from the LogServer; local drives and mapped drives are not allowed because they are not available when the LogServer is running with no one logged in. Login credentials must have write permissions in the supplied destination share.
E.g.:Figure 3-79 the Backup network share is set to:

\\Server-File\Damm\Support\John\TetraStar_Logserver_Backup this is a network destination where the log server has access.

To enable the scheduled database maintenance settings you have to click the “Save settings” button. When you do this, you will be requested to enter the login credentials for the Backup Destination Login.

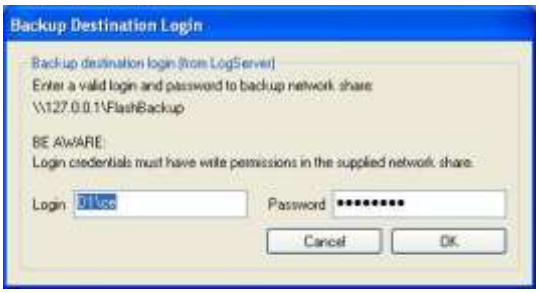


Figure 3-80 Backup destination login credentials

When the scheduled maintenance is saved and enabled, you can see when the next scheduled maintenance task is executed in the Next scheduled maintenance task field, see **Error! Reference source not found.**.

Figure 3-81 next scheduled maintenance task

To enable or disable cleanup of old database records set or remove the check mark in “Cleanup database records (after backup)”, and specify the cleanup threshold in the “Delete record older than” edit box. The scheduled maintenance executes the database backup as the first step (if selected), when this succeeds it continues to clean up the old database records from database.

3.6.3.2 Maintenance Now

The LogClient offers the possibility to check/test your database maintenance settings by initiating the database maintenance immediately. Be aware that the “Maintenance now” is executed with the saved “Backup database” and “Cleanup database records” settings. These settings are shown in the confirm dialog, see **Error! Reference source not found.**.

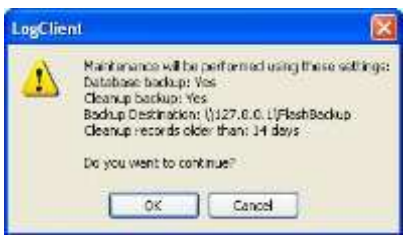


Figure 3-82 Confirm manual maintenance

When accepting the settings by clicking OK, the maintenance is initiated by the LogClient, and will be executed by the LogServer within the next minute. It is possible to follow the maintenance progress by accepting this, see fig.3.82.

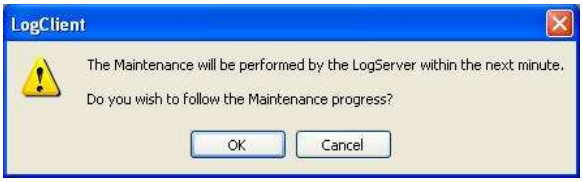


Figure 3-83 Follow maintenance progress

The Maintenance progress is shown in the “Additional info maintenance” dialog, see Fig. 3.83. The rows and fields in this dialog are filled as the progress information becomes available.

3.6.3.3 Maintenance History

Once the maintenance has finished, the result of the maintenance can be found in the Maintenance history. Open the “Maintenance History” dialog to see the list of executed maintenance jobs. Each maintenance job has a row containing info about: start- and end time, the result (OK or Error), the type of maintenance executed, backup destination and cleanup of old records. See Maintenance history in **Error! Reference source not found.** below.

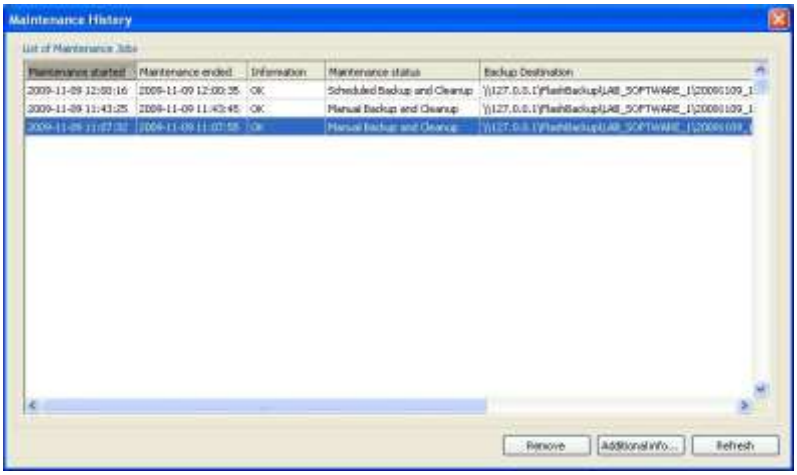


Figure 3-84 Maintenance history

To remove an old Maintenance job choose the row, then press the remove button. The Maintenance registration and the corresponding backup files will be removed and deleted. To get additional info about a specific maintenance job, select a job and press the button “Additional info”, see fig. 3.84

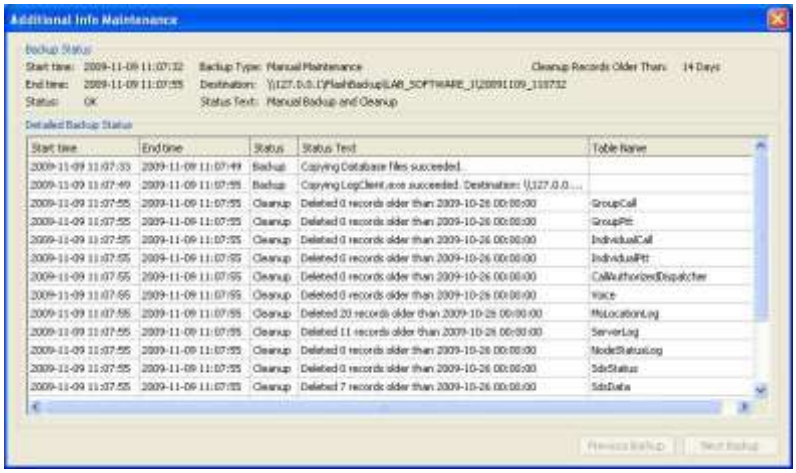


Figure 3-85 Additional info maintenance

In the Additional info maintenance dialog each action performed in the maintenance job is listed.

3.6.3.4 Manual backup of the database

The MySql Server is set up to use the MyISAM storage engine. MyISAM manages non-transactional tables which provides high-speed storage and retrieval of data.
The database can be backed up simply by copying the database files. Don't forget to backup (copy) the logClient executable which is located at:
\\<logServer>\Tetraflex\LogClient\Files\LogClient.exe.

The TetraFlexLogDb database is stored either under the default MySql data path:

C:\Program Files\MySQL\MySQL Server 5.0\data\tetraflexlogdb

or on systems with more partitions:

E:\Tetra\Applications\LogServer\Database\ tetraflexlogdb

Copy this folder and the LogClient executable to an external storage to make your manual backup.

To find the physical database files location look in the MySql configuration file:
C:\Program Files\MySQL\MySQL Server 5.0\my.ini find the following line starting with datadir, i.e: datadir="C:/Program Files/MySQL/MySQL Server 5.0/Data/"

3.6.3.5 Restoring a database

The scheduled maintenance backup files are stored under the supplied path entered in Scheduled maintenance; see section 3-98 Scheduled Maintenance for further info. The backup contains the database files as well as the LogClient which is able to read it.

Figure 3-86 Backed up files

Copy the backup directory which is named with the timestamp on the form <YYYY-MM-DD_hhmmss> to the MySql database directory.

Important: When the copy has finished, the MySql Server locks the files and you will no longer be able to rename or delete the database files. The MySql service has to be stopped to delete or rename a database folder.

It should now be possible to connect to the MySql server and select the database with the LogClient, see fig. 3.87. To restore the backup press the connect button. On success you will get a “Connect to database succeeded” dialog, see fig. 3.88.

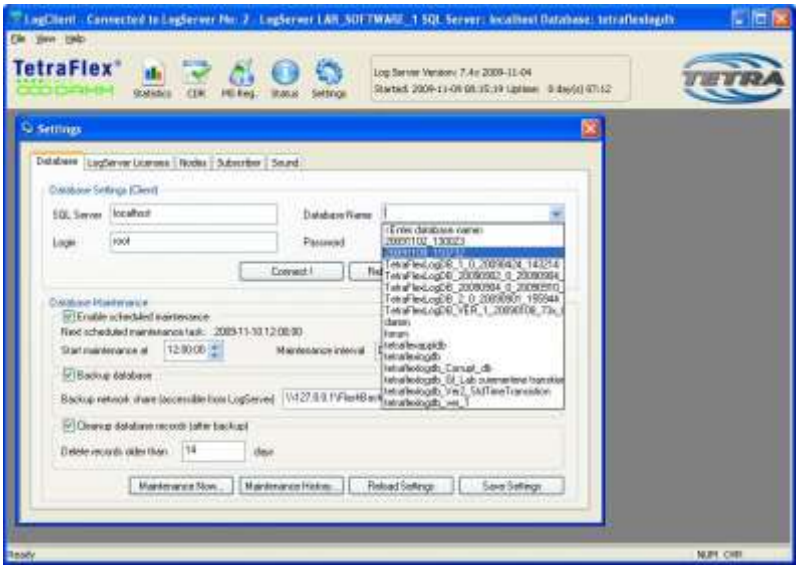


Figure 3-87 Selection the database backup

Figure 3-88 Backup restored

The LogClient is now connected to the restored database and you can only browse through the “old” data till you select the active running database named “TetraFlexLogDb”.

Note: if you have not saved the “database settings (Client)”, then a restart of the LogClient will make the LogClient connect to the previous selected database.

3.7 TETRAFLEX® LOG CLIENT

3.7.1 Description

The TetraFlex® Log Client application is developed to run on a Windows XP or Win7 platform or a Terminal Server where multiple users can run their own instance of the TetraFlex® Log Client at a time.

The TetraFlex® Log Client application requires access to the SQL-Server and has the following properties:

- There is no user validation. Dongle configuration controls the level of database query
- Hardware Dongle required.
- It is able to query CDR records from the database for:
  - Group- and individual calls
  - SDS Status
  - SDS TL
  - SDS Data
  - SDS Application

Queries can be made for a specified time interval as well as “Only from”, “Only to” and combination of this.

- Set up query and replay Voice data from the database for voice logged group- and individual calls for a specified call.
- Set up the latest MS Registrations, and also historical registration data for the mobiles.
- Set up to monitor the status of the Tetra network.
- Set up to present statistical data showing the performance of the TetraFlex® Network.
- Set up the Subscriber configuration, meaning setting up which mobiles should be "location and voice logged", and which groups should be voice logged.
- Set up the logging priority for the selected individual and groups
- It is able to switch database without restart of the application.
- Selecting temporary storage for voice playback files

3.7.2 Functionality

When the TetraFlex® Log Client application is launched the main window appears:

Figure 3-89: Log Client - Main window

From the Log Client toolbar it is possible to open the Statistics-, CDR-, MS Reg.-, Status- and the Settings view.
Note that the title bar indicates which SQL Server and database the application is connected to.

3.7.3 Statistics View

The Statistics view has five tabs

On the statistics window of each tab it is possible to right click to open the configuration dialogue. The configuration dialogue also includes export options

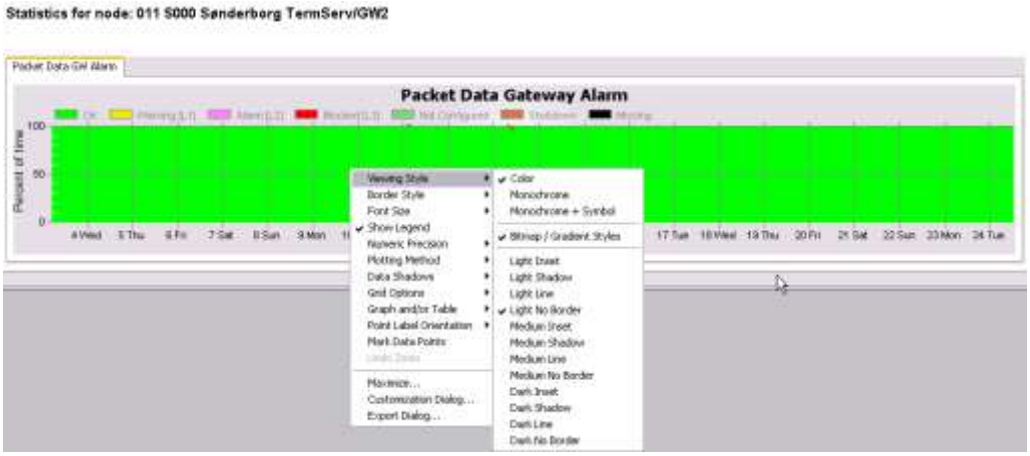


Figure 3-90: Configuration Dialog example

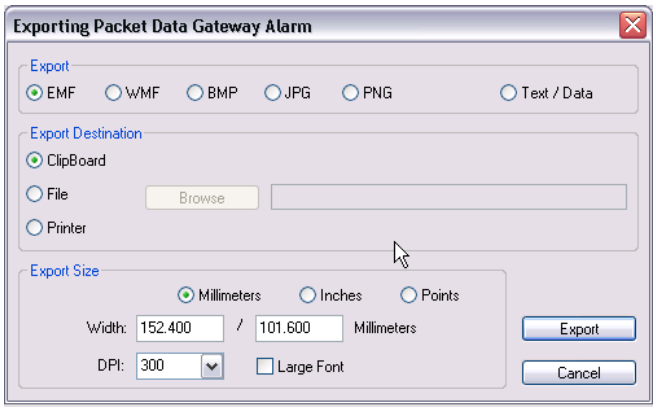


Figure 3-91: Export Dialog example

3.7.3.1 Node

Shows the Node Alarm as percentage of time

Indications are

- OK
- Warning (L1)
- Alarm (L2)
- Blocked (L3)
- Shutdown
- Missing

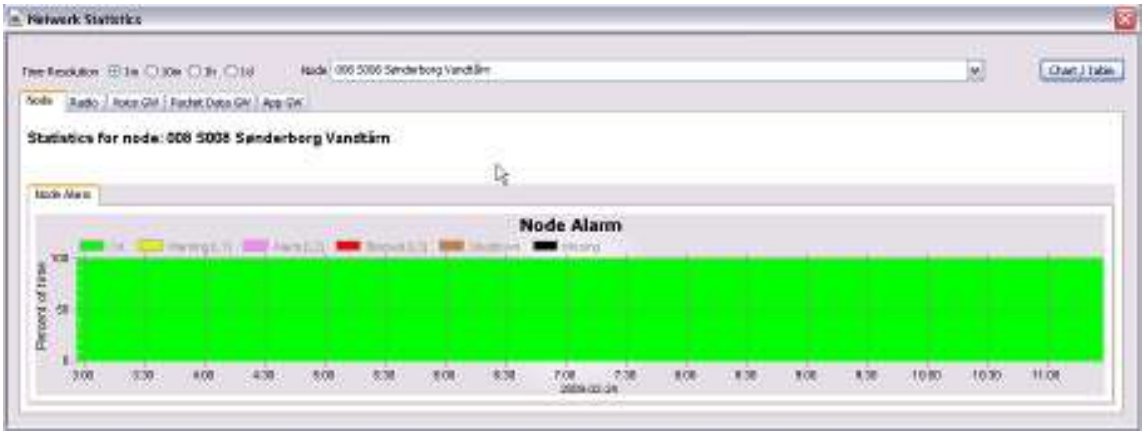


Figure 3-92: Node

3.7.3.2 Radio

The Radio tab has 3 sub-tabs
All tabs has a selection of resolution to 1 minute, 10 minutes, 1 hour or 1 day
All tabs has the selection of table or graphic view

3.7.4 Radio Cell Alarm

Shows alarms as percentage of time

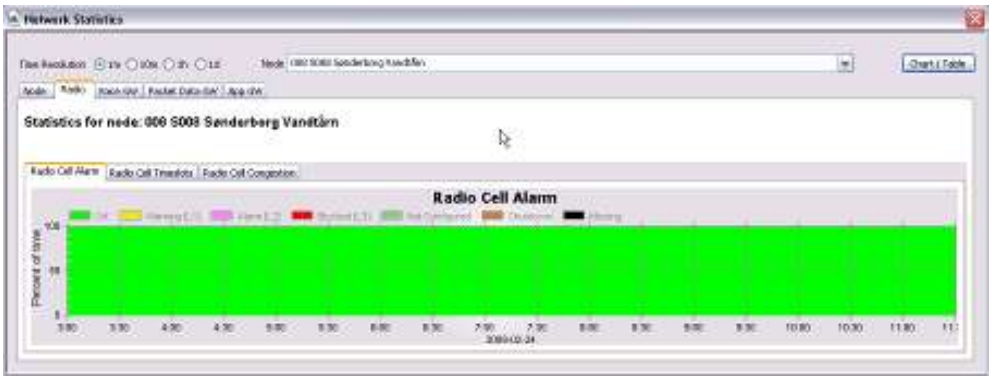


Figure 3-93: Radio, Alarm

3.7.4.1 Radio Cell Timeslot

Shows timeslots as function of Erlang

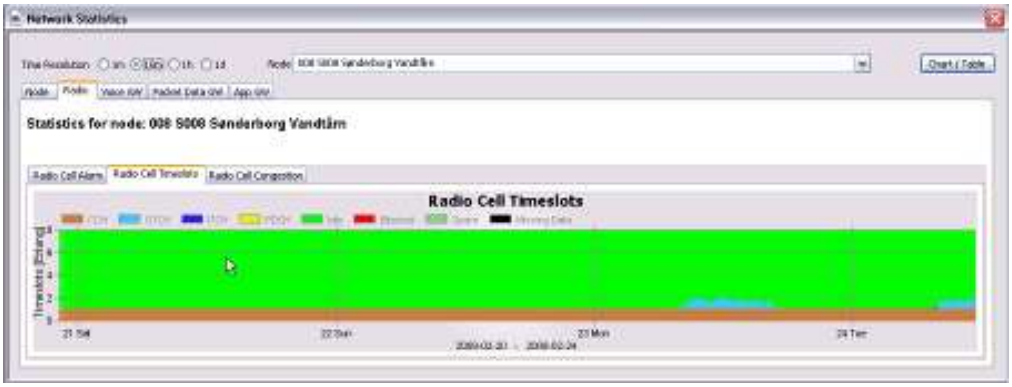


Figure 3-94: Radio, Timeslot

Congestion shows the traffic load in percentage, and Timeslot showing the average timeslot distribution for a specific node. The user has to enter resolution time and specify a Node.

The timeslot types displayed are:

Timeslot table	
Timeslot type	Description
CCH	Control Channel. (MCCH and SCCH)
Group Call TS (GTCH)	Timeslots used for group calls.
Individual Call TS (ITCH)	Timeslots used for individual calls.
Packet Data TS (PDCH)	Timeslots used for packet data.
Idle TS	Unused/Idle timeslots ready for traffic.
Blocked TS	Blocked timeslots which cannot be used for traffic.
Spare TS	Spare timeslots used for redundancy if a transceiver drops out.
Missing Data	No connection between node and log server

3.7.4.2 Radio Cell Congestion

Shows timeslot usage as percentage of time

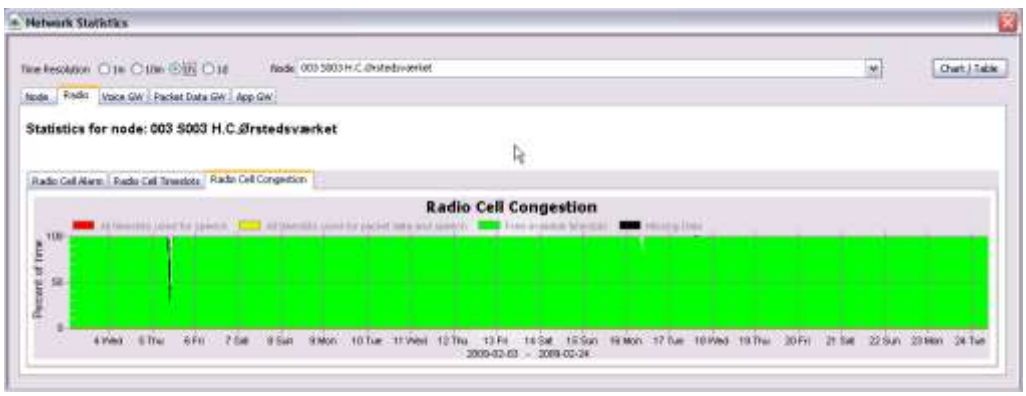


Figure 3-95: Radio, Congestion

3.7.5 Voice GW

Voice GW tab has 3 sub-tabs

3.7.5.1 Voice GW Alarm

Shows alarms as percentage of time

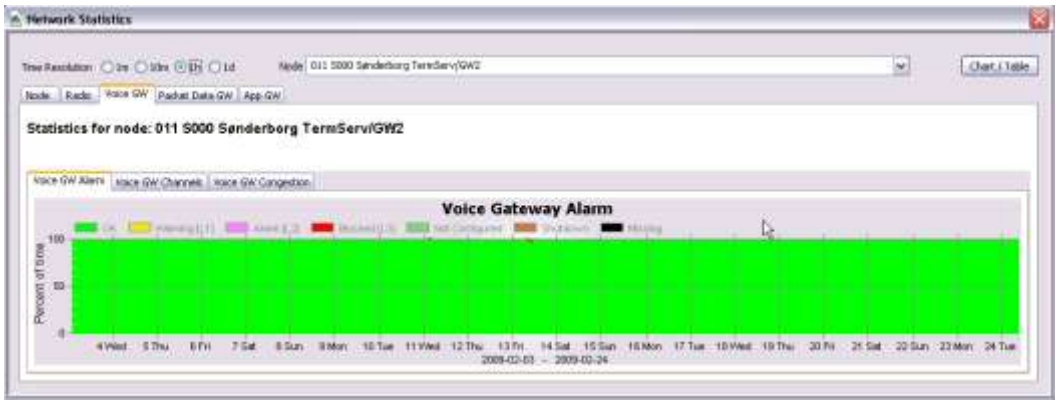


Figure 3-96: Voice GW, Alarms

3.7.5.2 Voice GW Channels

Shows GW channels related to Erlang

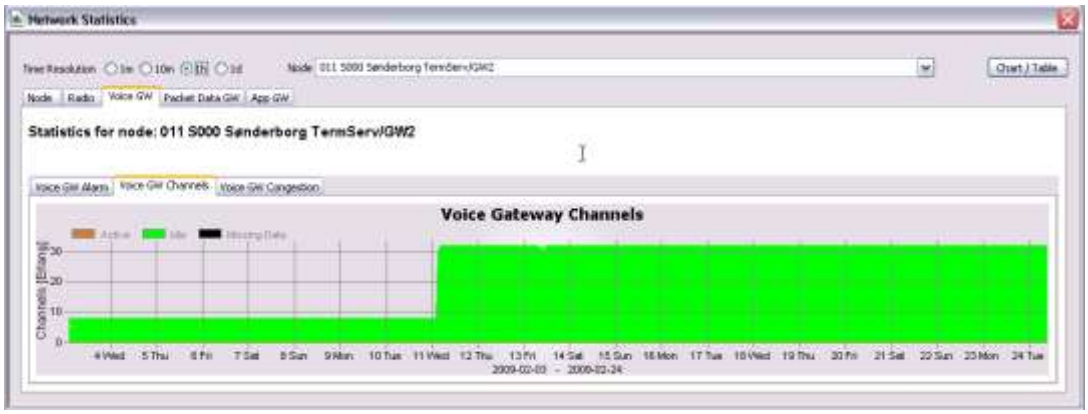


Figure 3-97: Voice GW, Channels

3.7.5.3 Voice GW Congestion

Shows GW congestion related to percent of time

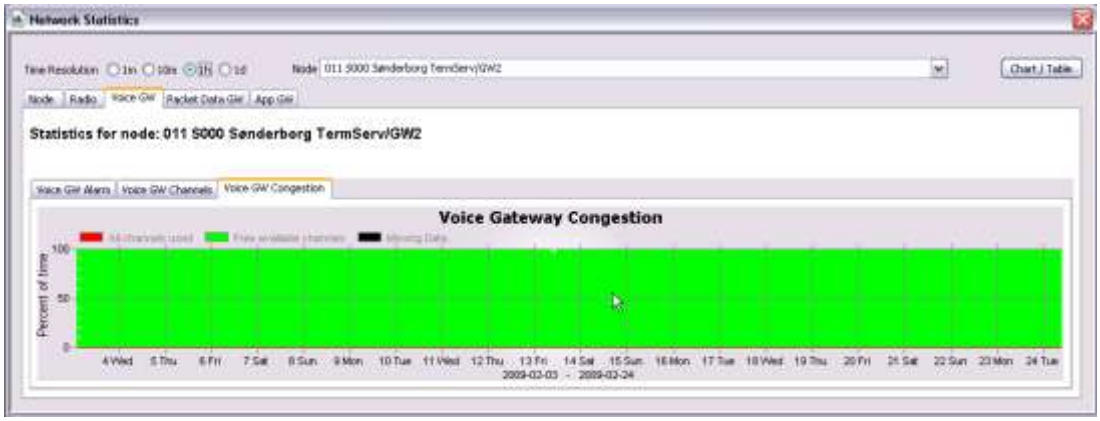


Figure 3-98: Voice GW, Congestion

3.7.6 Packet Data GW

Shows GW alarms related to percent of time

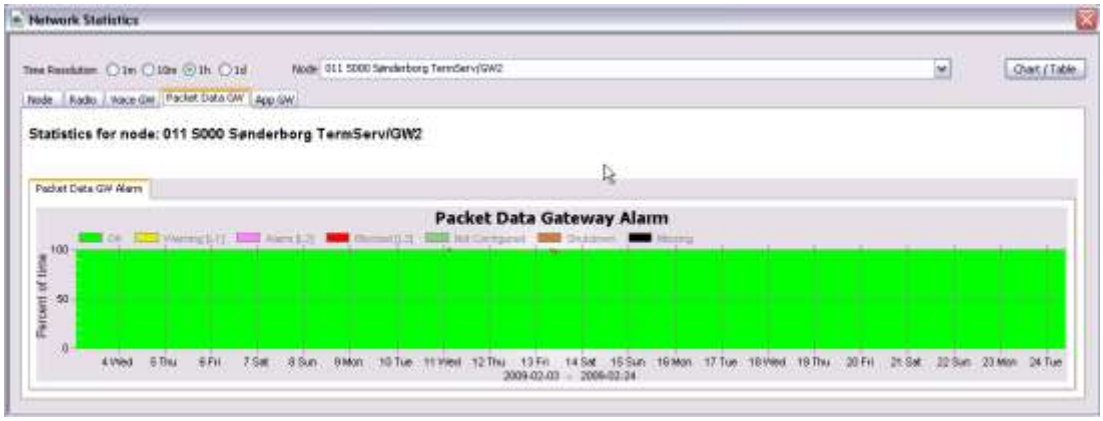


Figure 3-99: Packet Data GW, Alarms

3.7.7 Application GW

Application GW has 2 sub-tabs

3.7.7.1 Application GW alarms

Shows GW alarms related to percentage of time

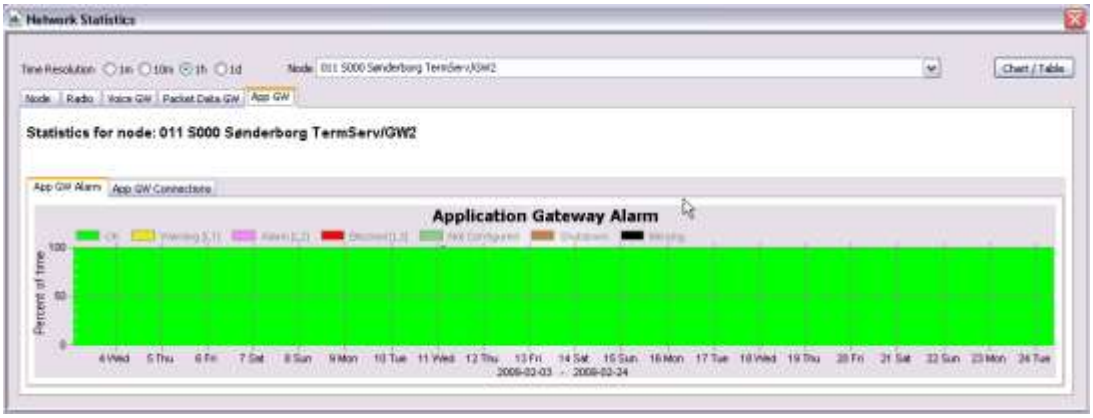


Figure 3-100: Application GW, Alarms

3.7.7.2 Application GW congestion

Shows GW channels related to Erlang

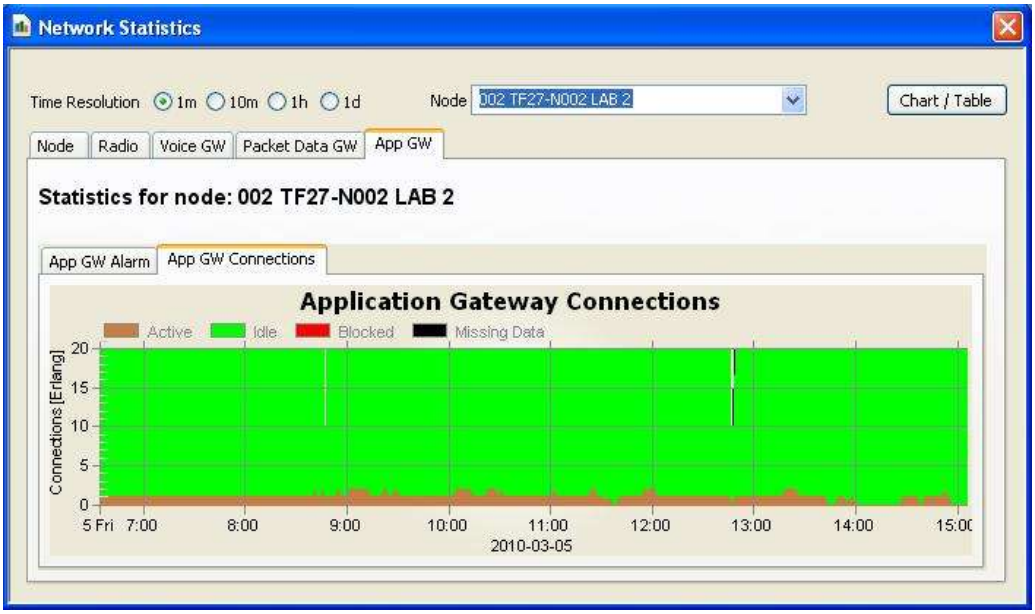


Figure 3-101: Application GW, Connections

3.7.8 CDR View

In the CDR View the Call Data Records are presented. The user must enter Search Criterion as the time period and specify whether it is group-, individual- or SDS type- calls to narrow the number of hits. It is also possible to specify a single From and/or To subscriber. When Search Criterion is entered, press Search button to load the Search Results from the SQL Server.

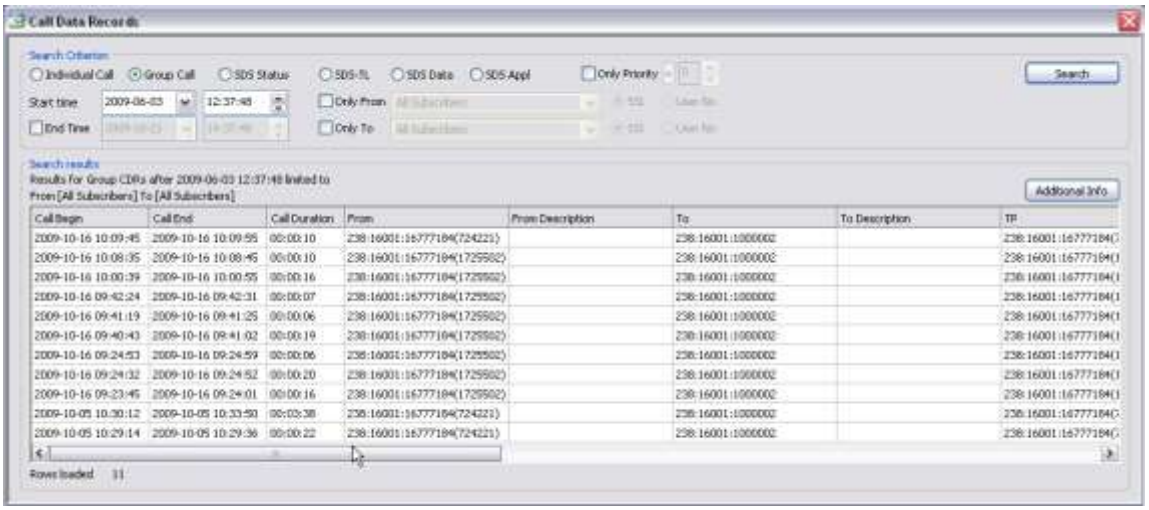


Figure 3-102: Log Client, Call Data Records

The Search Result lists all the calls matching the Search Criterion, and it contains the relevant call information like Call Begin, Call End, From, To, From Node, Call Priority etc. One row in the result grid reflects one call.
When the Search Result is loaded it is possible to get additional information on a single call, either by double clicking on a single row or by selecting a row and press the Additional Info button.

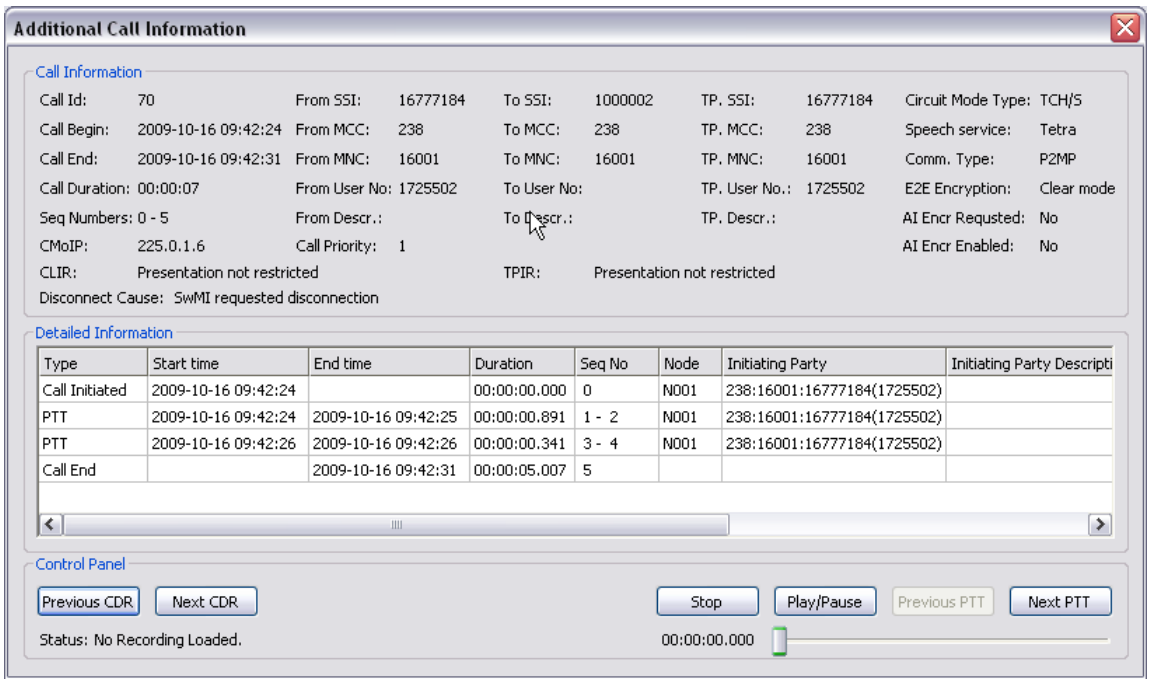


Figure 3-103: Log Client. Additional Call Info

In the Additional Call Information view, the Talking Parties in simplex calls are listed. It is also indicated whether the Talking Party has preemptive rights and which node the MS is located under.
From this view it will also be possible (if client dongle allows this) to load and playback calls that have been recorded.

3.7.9 MS Registration View

The MS Registration view has tree tabs, the Latest MS Registration, the MS Registration History tab and the MS RSSI history tab. When a mobile registers it indicates an Update Type to the Node.

There are 3 Update Types:

Update Type Table	
Update Type	Description
ITSI Attach (Power on)	The mobile has been turned on.
Roaming	The mobile has moved and is covered by a new Node.
ITSI Detach (Power off)	The mobile has been switched off.

3.7.9.1 Latest MS Registrations

The Latest MS Registrations tab shows a live view of the mobiles and their Node location. The list contains one entry pr MS, showing its current Update Type state and which Node that has received it.

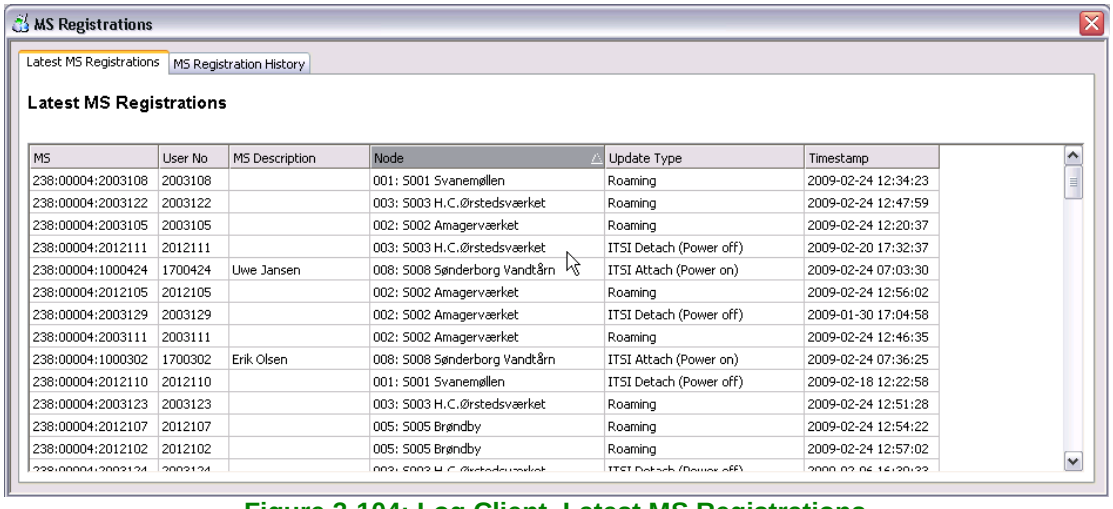


Figure 3-104: Log Client, Latest MS Registrations

3.7.9.2 MS Registration History

The MS Registration History tab shows the historical registration data. The user must enter the Search Criterion such as time interval and specify mobiles and Nodes of interest. It is possible to exclude roaming registrations.
The list might contain the same mobile several times.

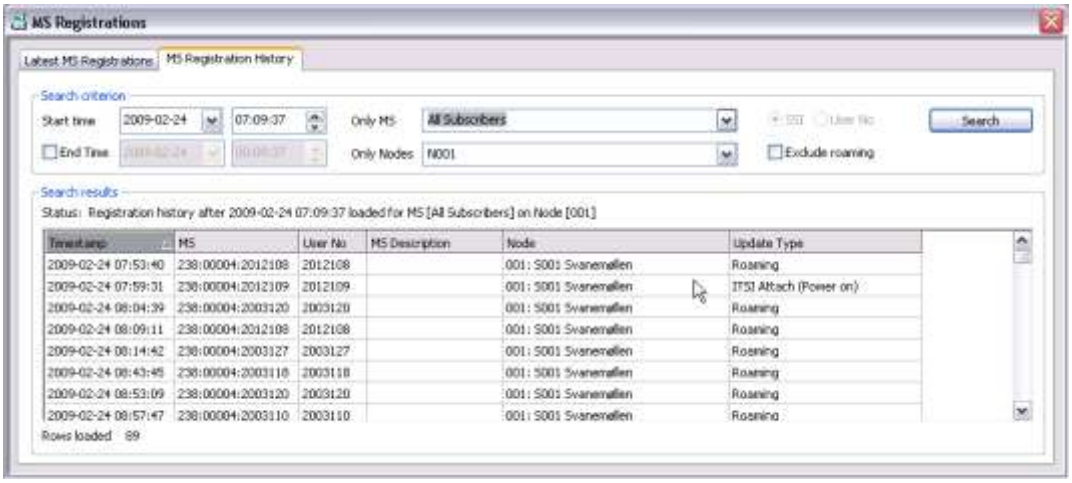


Figure 3-105: Log Client, MS Registration History

3.7.9.3 MS RSSI History

The MS RSSI history view shows the uplink RSSI values in dBm for the different calls made.

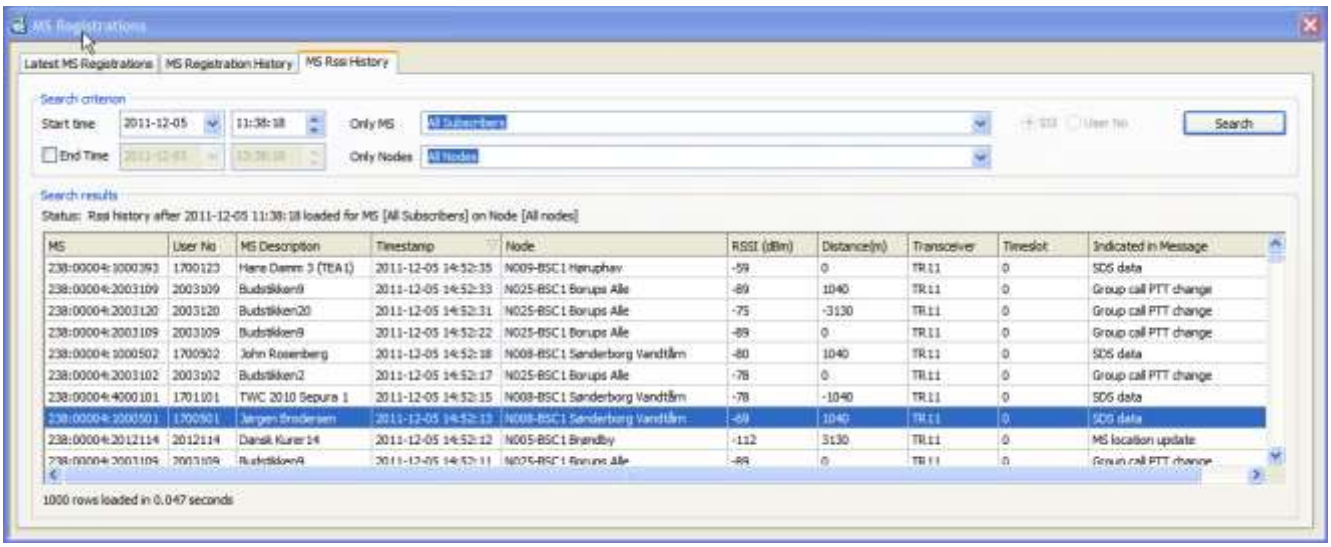


Figure 3-106: Log Client, MS RSSI History

It is also possible to the approximately distance to the node and what Transceiver there was used for the call.

NB: MS RSSI history data older than 24 hours will be deleted in ver. 7.52

3.7.10 Status View

The status view shows the latest received Status messages of the TetraFlex® Node. Each TetraFlex® node in the network reports its status on regular interval (default interval is 10 seconds). This means that the Status view should always have status messages no older than the interval.

On each status tab the nodes in the TetraFlex® network are listed including the reception timestamp of the TetrtaFlexLogServer and their latest status.

The Status tab gives an overview of the nodes and their status. Each Status generally has these states:

Status Table	
Status type	Description
OK	Everything in perfect order.
Warning [L1]	Level 1 warning, informational only.
Alarm [L2]	Level 2 Alarm, reduced functionality of component.
Blocked [L3]	Level 3 Blocking Alarm, dropout of component.
Start-up	The component is starting up.
Not Alive	The component is not responding.
[BLANK]	The component is not configured on this node.

The list can be refreshed manually by pressing **Refresh**.

3.7.10.1 Status

The Status tab shown below gives an overview of the status window.
The view is essential the same as shown in the Network Management, so refer to the Network Management Manual for detailed description of the tabs

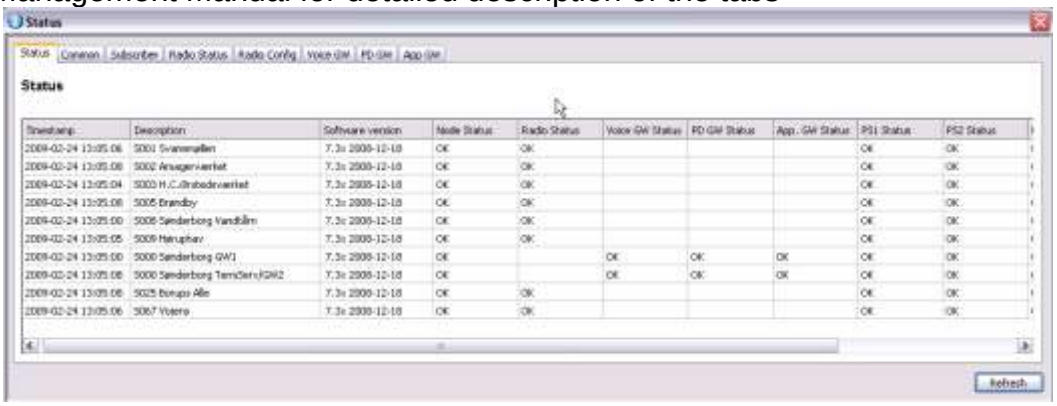


Figure 3-107: Log Client, Status view

3.7.10.2 Common

On the Common tab it is possible to see the Repetition time interval, which the node uses for sending its status message.

3.7.10.3 Subscriber

On the Subscriber Register tab it is possible to see which node is Master, and the subscriber counts and checksums which should be the same for all Nodes.

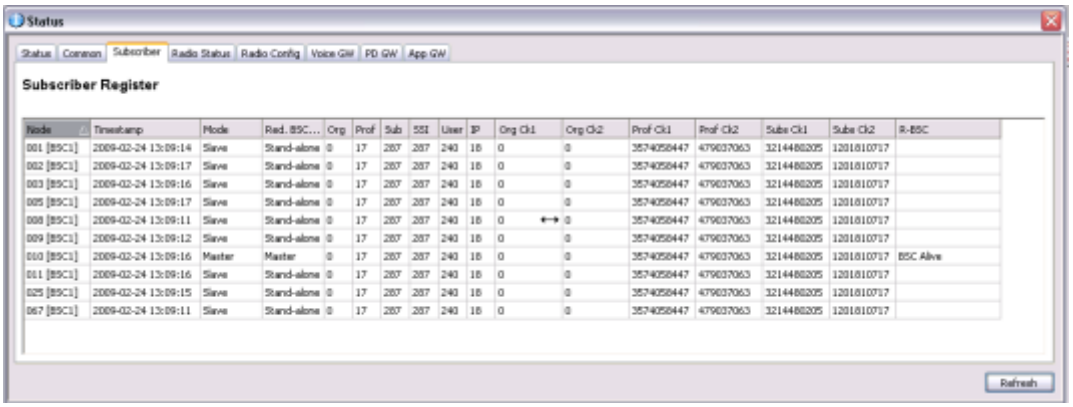


Figure 3-108: Log Client, Status Subscriber Register

3.7.10.4 Radio Status

On the Radio Status tab it is possible in real time to see active time slots.

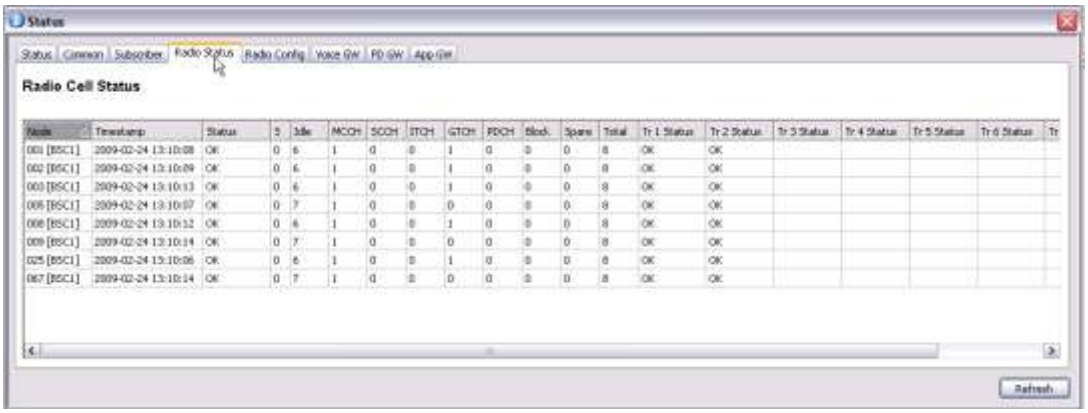


Figure 3-109: Log Client, Radio Status

3.7.10.5 Radio Config

On the Radio Config tab it is possible see how frequencies are configured.

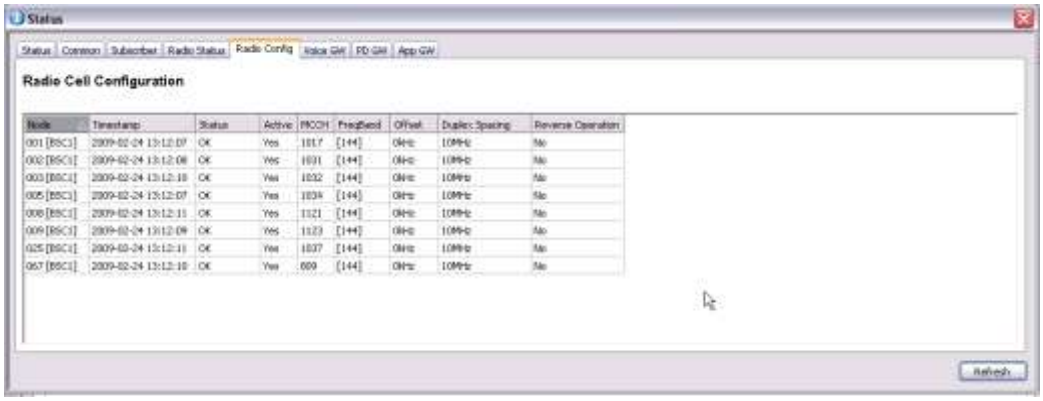


Figure 3-110: Log Client, Radio Config

3.7.10.6 Voice GW

On the Voice GW tab the status for the Voice Gateway can be seen, including number of active and idle calls.

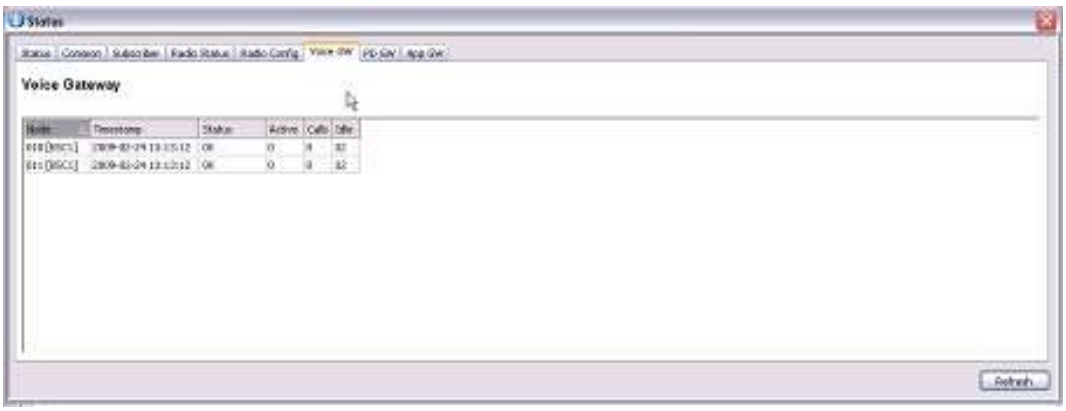


Figure 3-111: Log Client, Voice GW

3.7.10.7 PD-GW

Figure 3-112: Log Client, Status Packet Data GW

3.7.10.8 App-GW

Figure 3-113: Log Client. Status App GW

3.7.11 Settings View

The Settings view has six sections: Database, nodes, subscriber, sound, logserver licenses and log server config.

3.7.11.1 Database

Database settings used by the TetraFlex® Log Client is shown.
It is possible to replace SQL Server by specifying the IP address and login credentials.
By pressing the **Connect to Database!** Button the client establishes the connection to the SQL Server and database specified. This can be done on the fly.
The **Reload Database Settings**- and **Save Database Settings** respectively load and save the database settings to a local file Log Client.ini located in the same folder as the Log Client executable.

In the maintenance section it is possible to setup backup and cleanup intervals (please see the section 3.6.3 Log Server Maintenance)

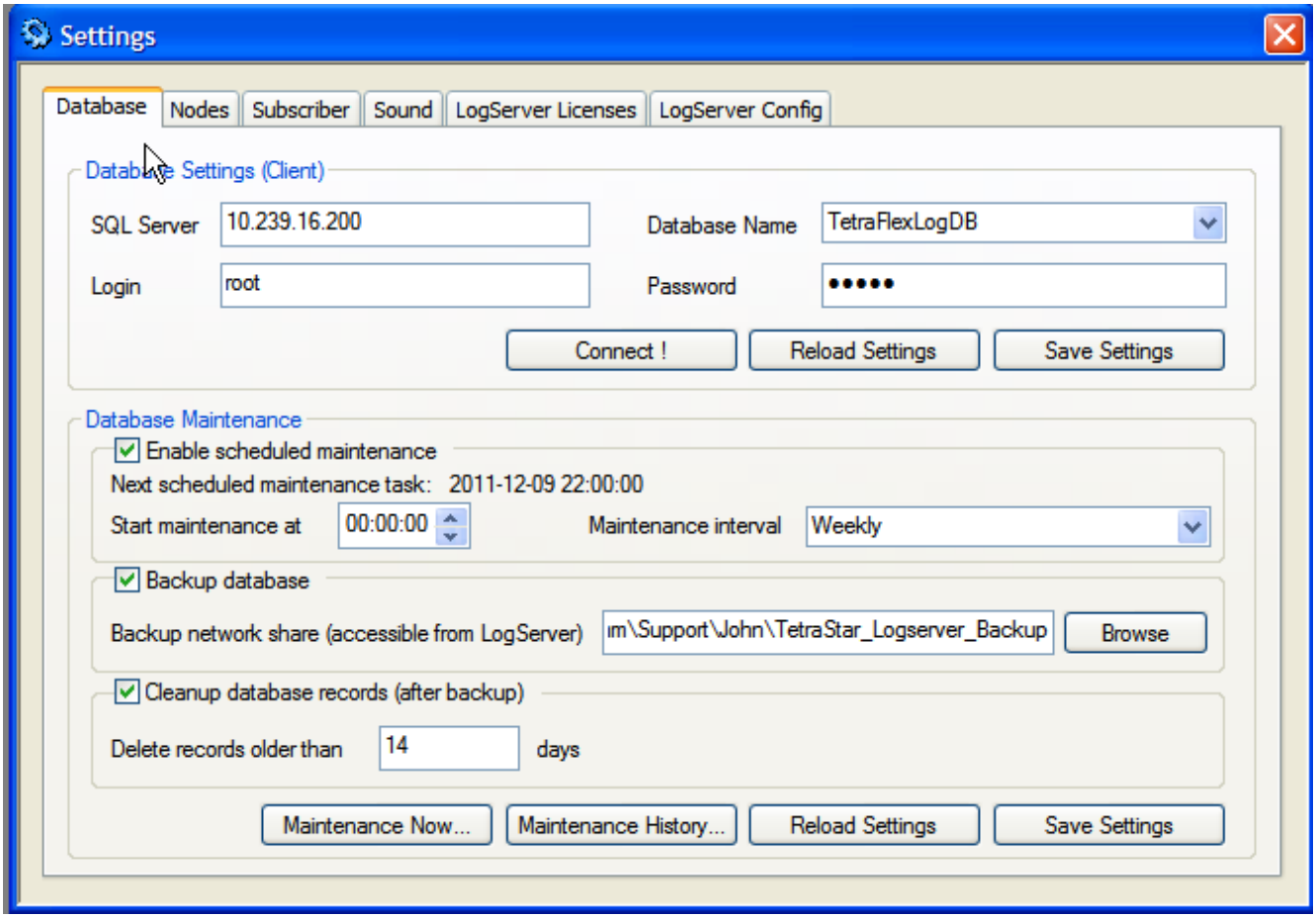


Figure 3-114: Log Client, Settings database

3.7.11.2 Nodes

Node descriptions and last status received information

- If a node has managed to send status messages prior to the node being configured with the correct node number etc. the node may be deleted here and will reappear with the correct settings at the next status message (10 sec.)
- A deleted node will be removed from node status and node statistics views and database.

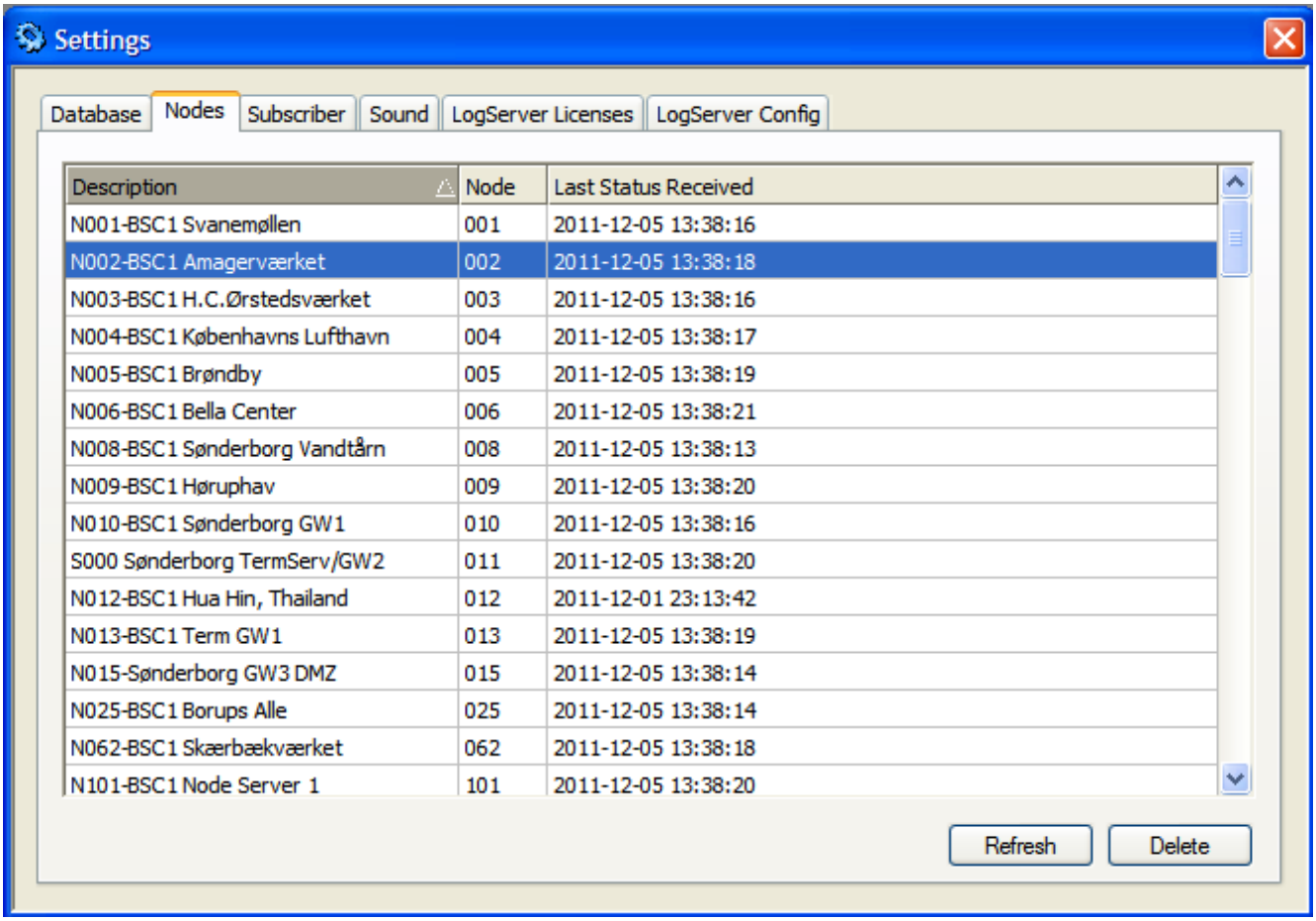


Figure 3-115: Log Client, Node information

3.7.11.3 Subscriber

The configured subscribers are listed. The list is a positive list, meaning that subscribers not in the list will be treated as subscribers with Voice- and Location Logging disabled.

NOTE: In case the Log Server settings has a selection “Log all MS by default”, then subscribers which has NOT been added to the list will be voice and location logged

The Voice Logging Priority only applies to the subscribers where Voice Logging is enabled. In this view it is possible to add, edit, or delete subscribers.

Note that the LogServer hardware Dongle settings can override the Voice- and Location Logging settings.

Note Voice Logging:
For individual calls the following rule applies: If either the calling or the called party is on the positive list, the call is voice logged otherwise not.
For group calls the following rule applies: If the called group TSI appears in the positive list, then the group call is voice logged otherwise not.
If all voice logging channels are occupied (number of voice logging channels is defined by LogServer dongle), then the priority is used to interrupt and stop voice logging for lower priority calls. If no voice logging channel is free when a new call is established, then the lowest priority ongoing voice logged channel is freed for the new higher priority call.

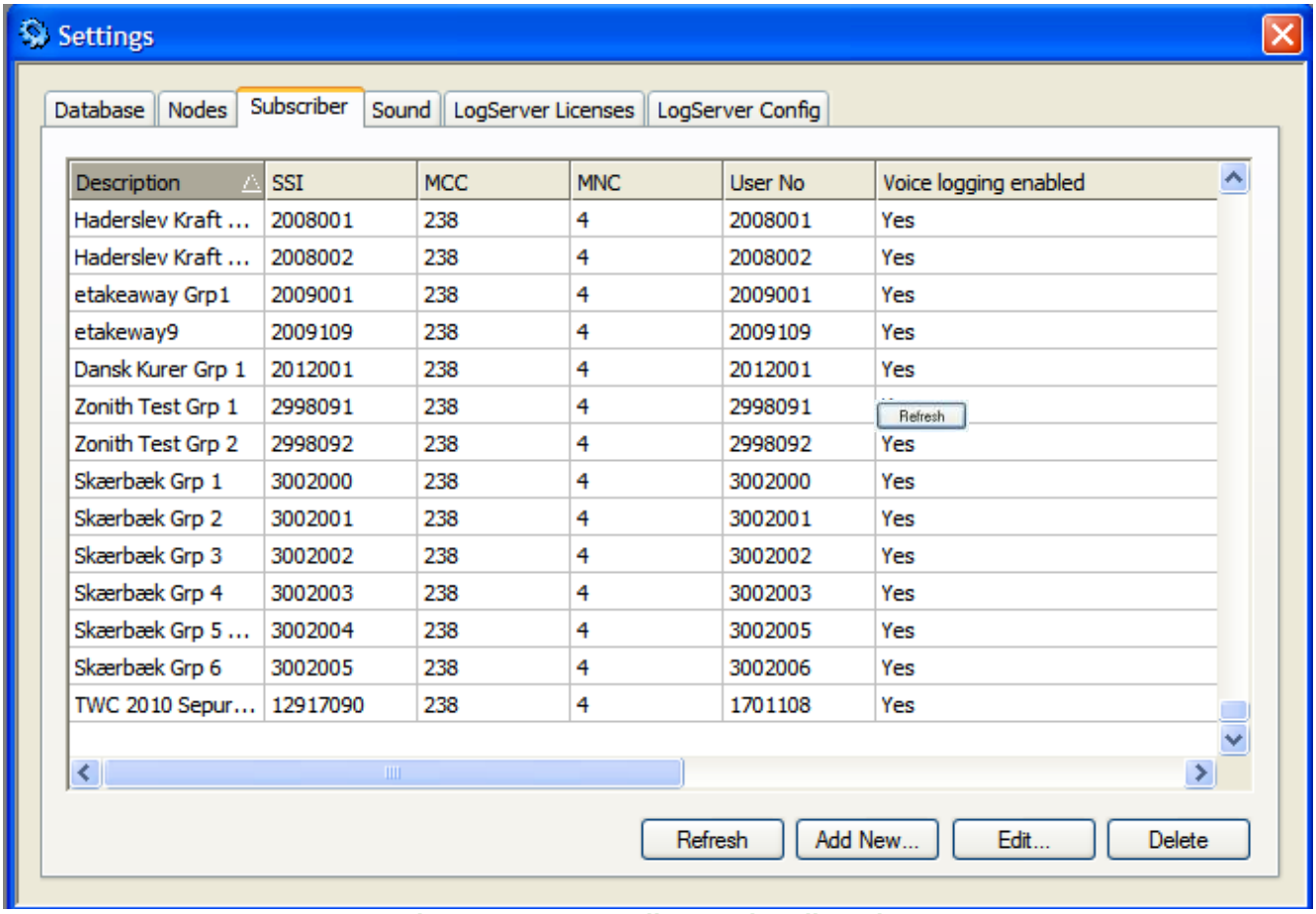


Figure 3-116: Log Client, Subscriber List

3.7.11.4 Sound

This setting are for the voice recording playback

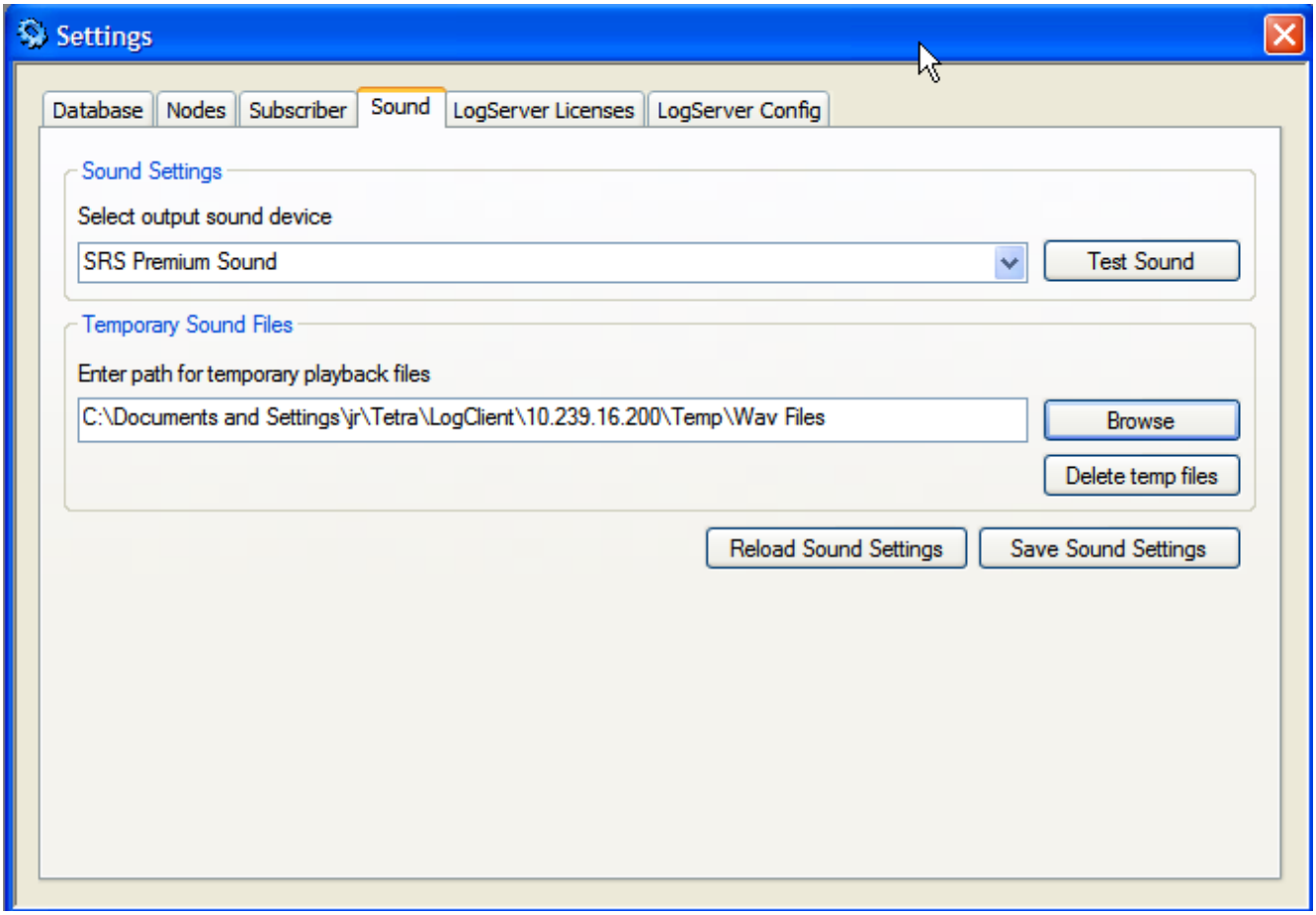


Figure 3-117: Log Client, Sound settings

- Sound Settings - Setup and test of output sound device

- Temporary Sound Files:
  - Setup, save/reload and deletion of the path to the temporary sound files saved whenever a CDR is played
  - Standard setting %USERPROFILE%\Tetra\LogClient\<LogServer name>\Wav Files

3.7.11.5 LogServer Licens

License dongle information shows the license dongle settings for the Log Server

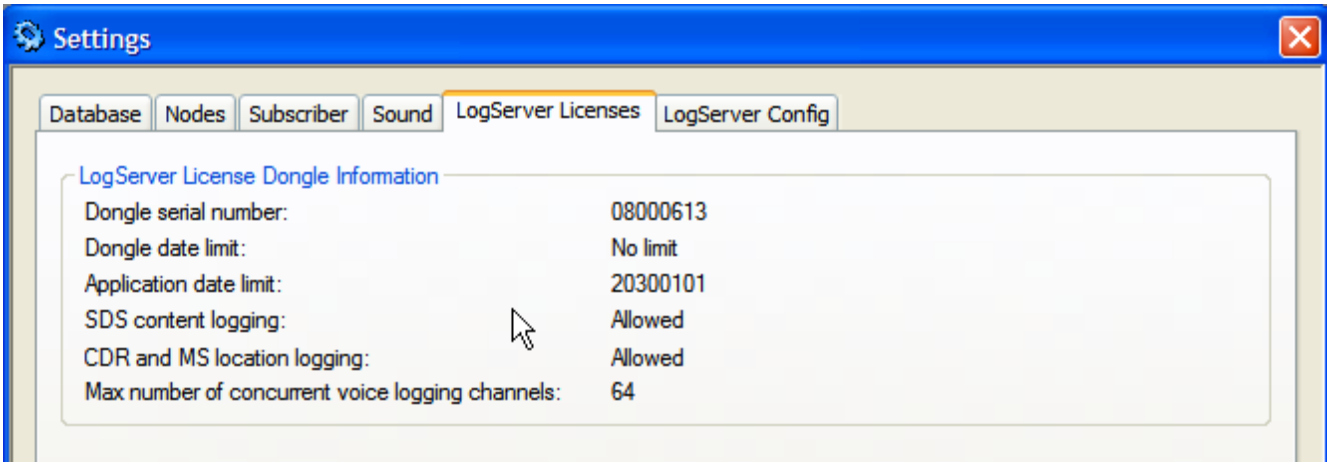


Figure 3-118: LogServer Licenses

3.7.11.6 LogServer Config

This shows how the log server is configured. It is not possible to make changes to the settings from here. Please see the chapter 2.10.3 for setting the parameters.

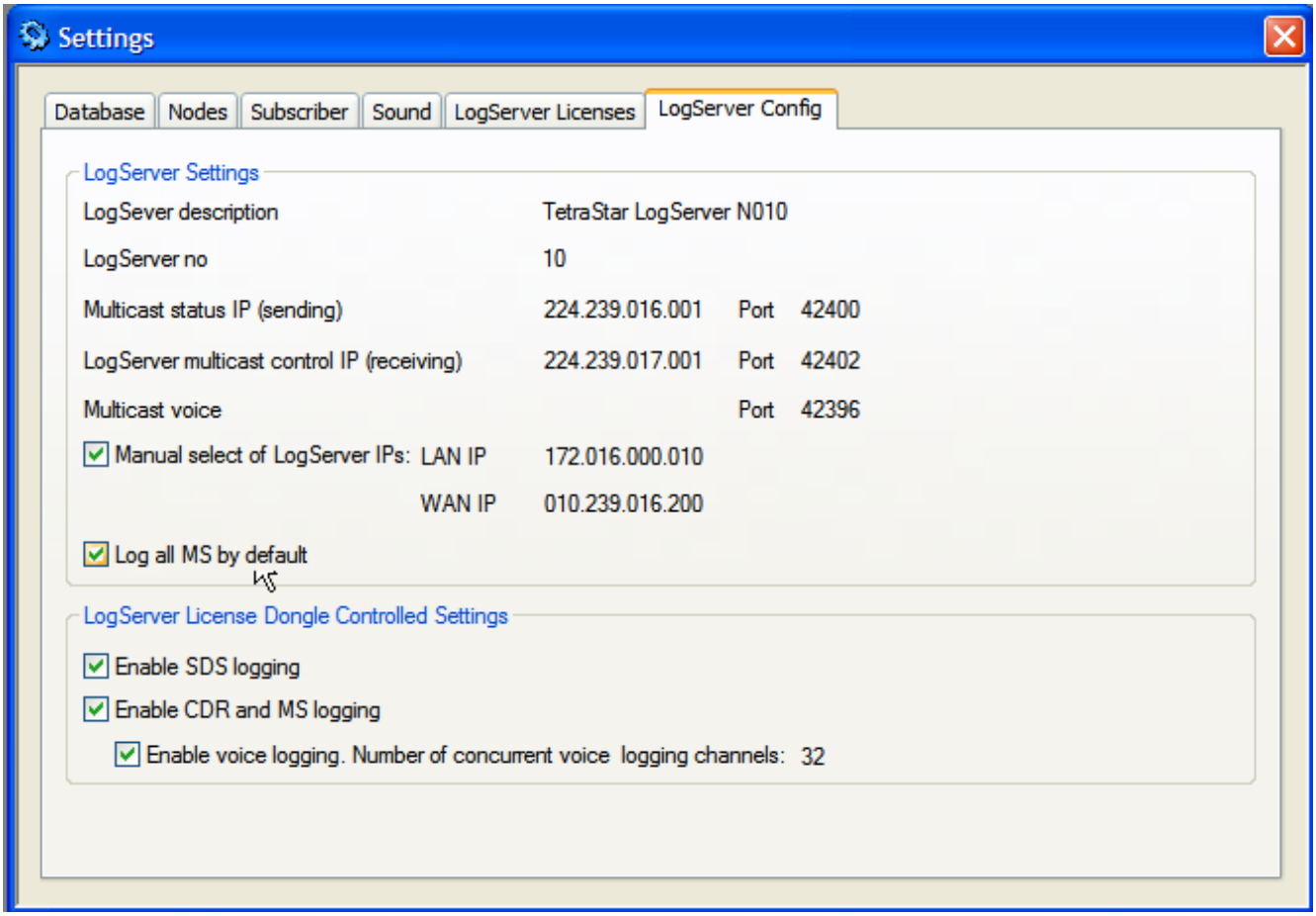


Figure 3-119: LogServer config

Log Server Settings may be overruled by the dongle configuration. Logging selection may be set equal or less than the settings in the license dongle. As an example license dongle settings gives privilege to do SDS Content Logging (=Allowed) but if the flag “Enable SDS Logging” is not set, the SDS content is not logged, i.e. log server settings overrules dongle settings.

PART-4: Technical References

4.1 ANTENNA SYSTEM FOR BS41X

4.1.1 Introduction

This application note describes the recommended antenna configuration for the BS41x Tetra Base station.

The BS41x Tetra BS includes either the TMA412 Tower Mounted Amplifier or the TMD412 Tower Mounted Amplifier and Duplexer. The use of the RX amplifier section in the TMA/TMD is mandatory. It shall preferably be mounted in the top of the mast as close as possible to the RX antennas or alternatively ground mounted at the BS rack.

The TMD412 in addition contains a Duplex Filter, which optionally can combine the TX and one RX to run on same antenna.

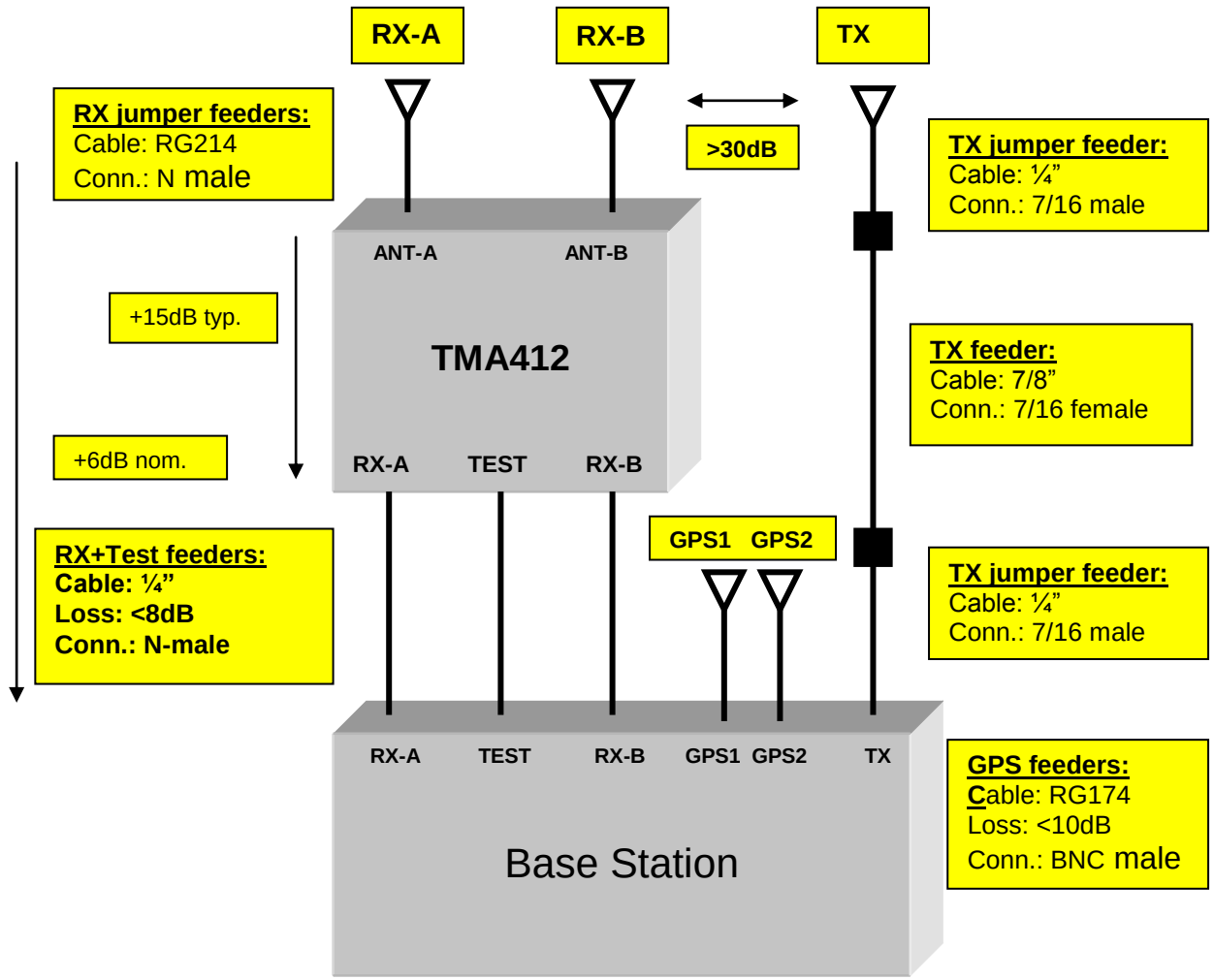
Whenever possible it is however recommended to run with two separate RX antennas and one TX antenna.

When using the TMD412 Tower Mounted Amplifier/Duplexer it is recommended not to use the duplex filter option for more than 1 carrier, as the usage of the duplex filter may increase disturbances in the receiver i.e. reduced sensitivity.
When using the duplex filter option, care shall be taken not to use TX frequencies generating 5th order IM products on the used RX frequencies

The antenna system shall in addition contain one GPS antennas for each installed BSC.

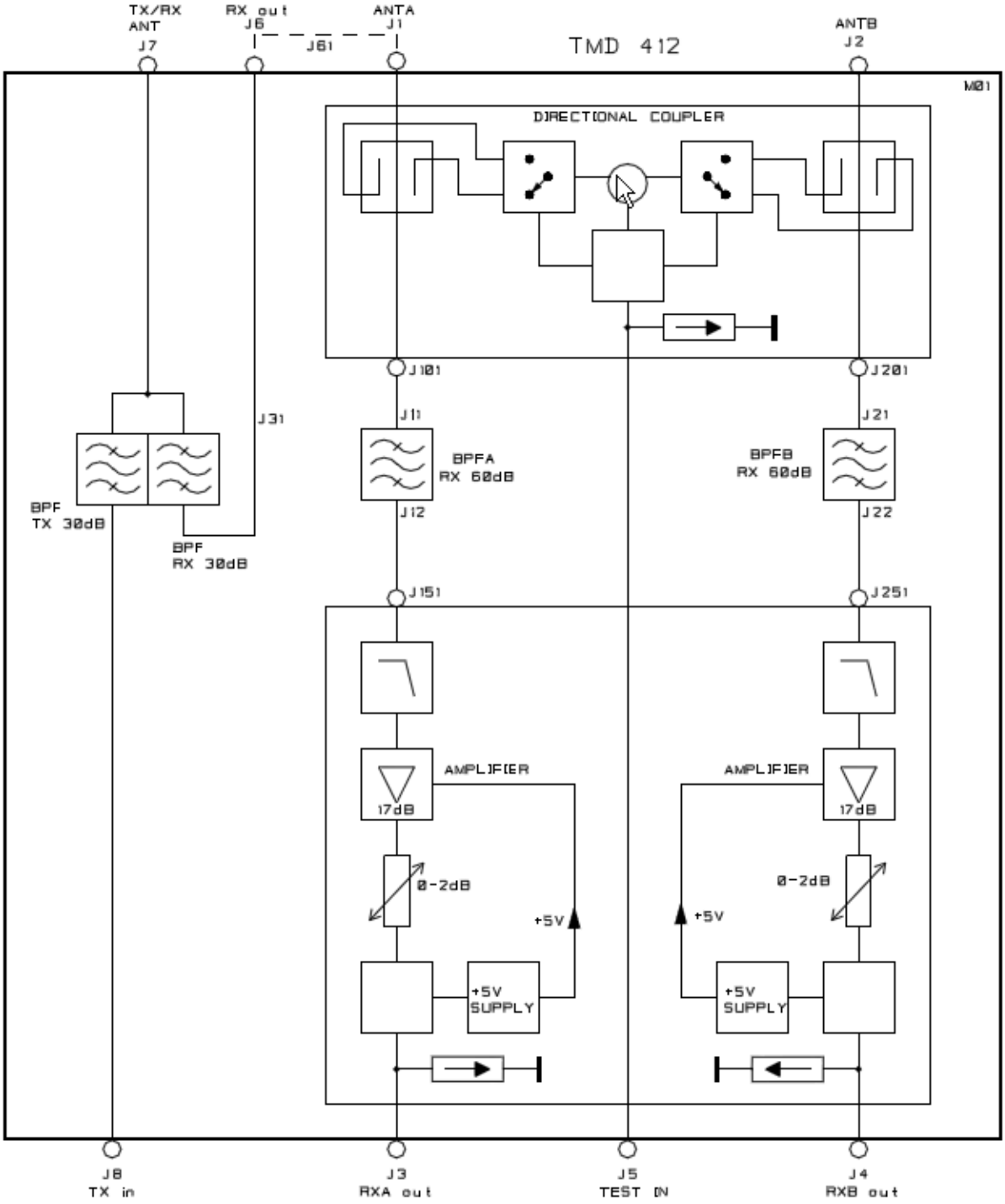
4.1.2 Typical antenna configuration

The drawing below shows a typical antenna arrangement for a base station. If the duplexer is used it combines the RX-A and TX feeder to e single antenna. The feeder system from the BS to the top of the mast is the same for both cases.



4.1.2.1 TMA412/TMD412

A block diagram of the TMD412 is shown below. The TMA412 is identical except for the omitted Duplexer.



4.1.2.2 RX antenna

The BS uses two receiver antennas for its dual RX diversity implementation. The TMA is provided with a dual tower-mounted amplifier with input filters, amplifiers and test circuits for measurements. The BS includes all the required circuitry to supply the two amplifiers with DC power and to control the test circuit through the feeders.

The two RX antennas should be mounted as widely spaced as possible to optimize the gain of the diversity reception. In addition they should be mounted to have a coupling with the TX

antenna of >30dB to ensure proper operation. The TX separation is normally achieved without much effort.

Three identical low-cost feeders are required for the RX antenna system. As the main RX filters are located in the TMA, cables with good screening are needed to avoid radiation into the cables. Cables should either be double shielded or with solid screen. For most applications ¼ inch corrugated cables is the optimum choice. Cables of type RG58/U and RG213/U should not be used.

The TMA has a nominal gain of 15 dB and the system is designed to have a nominal total gain from TMA input to BS RX connector input of +6dB. With some margins this allows a maximum feeder loss of 8dB. Attenuators are provided in the BS to adjust the total gain. Note that use of lower-loss cables will not improve system performance, just increase the cost.

The following table indicates the maximum allowed length of different possible cable types:

Cable with 8dB loss	450MHz	850MHz
RG223/U	28m	19m
RG214/U	50m	35m
1/4 inch (RFS CF14-50)	85m	60m
3/8 inch (RFS LC38F-50)	105m	75m
1/2 inch (RFS LCF12-50)	170m	120m
5/8 inch (RFS LCF58-50)	220m	155m

If very thick cables are used, jumper feeders in both ends may be needed.
Cables and connectors between antenna and TMA412/TMD412 shall be resistance to water ingress and migration.

4.1.2.3 TX antenna

The BS uses a TX antenna for all the installed TETRA carrier units, which may optionally also be used for receiving. All components used in the TX antenna system need to be high quality components with low inter-modulation to avoid distortion product to jam the receiver inputs. The requirements include the TX antenna itself and also the feeders and connectors.

The TX antenna feeder should be provided with connectors of type 7/16. Other connector types should be avoided, including connectors of type N. For 2-carrier only base stations without Duplexer N-type connectors can be used at antenna and BS.

The feeder cables shall have as low as possible insertion loss and have a solid screen. Cables with woven shields of thin wires should never be used.

The TX cable loss can be compensated, by increasing the TX output power to balance the system requirements. For a low-power Base Station this can be an acceptable solution but for a high-power BS this can give an unacceptable increase in the mains power consumption or may not be possible at all.

As guideline, the TX antenna feeder loss for a high-power BS should not exceed 2dB. This can be achieved when not exceeding the following cable lengths:

Cable 2dB loss	450MHz	850MHz
1/4 inch (RFS CF14-50)	21m	15m
3/8 inch (RFS LC38F-50)	27m	19m
1/2 inch (RFS LCF12-50)	42m	30m
5/8 inch (RFS LCF58-50)	55m	39m
1 1/4 inch (RFS LCF114-50)	93m	65m
1 5/8 inch (RFS LCF158-50)	128m	88m

For normal installations 5/8 inch cables or thicker is recommended. When thick cables are used it is normal needed to have jumper cables in both ends to avoid stress to the connectors on the antenna and BS.
Cables and connectors between antenna and TMD412/BS41x shall be resistance to water ingress and migration.

4.1.3 GPS antenna

Each Base Station Controller includes a GPS receiver, which requires an antenna. The GPS antenna connector delivers +5V for an antenna with built-in amplifier. The GPS antenna should preferably be mounted on top of the building with good all round vision the whole horizon. It should NOT be mounted in top of a high mast and should be kept at the greatest possible distance from any transmit antenna.

The GPS signal is received on 1575.42 MHz with a bandwidth of a little more than 2 MHz Special care with separation from the TX antenna is important especially, if any transmitter is located in the range 393.5-394.2 MHz (4th harmonic). The current used GPS receiver module in the BSC411 is a Motorola M12 and in BSC412 it is an iTrax.

Several manufactures have appropriate antennas, which match the receiver. An example is shown below.

The GPS antenna shall include an amplifier with a gain of about 25dB. As a guideline the cable loss should not exceed 14 dB, which gives the following maximum cable lengths:

Cable type	14dB
RG223/U	23m
RG214/U	46m
¼ inch (RFS CF14-50)	70m

Cables and connectors between antenna and BS41x shall be resistance to water ingress and migration.

4.1.4 TX inter-modulation considerations

One of the most critical aspects about antenna systems for a multi-carrier base station is to control the inter-modulation generated between the different transmitters in the BS.

Inter-modulation happens in many different places on different levels. One major place is the TX output amplifier itself. When a signal from another TX reaches a TX output amplifier, all typical transmitters will generate 3rd order IM products with a level typically 15dB below the interfering signal. The BS41x Base Station is provided with double circulators in the TX output to make sure, that IM3 products close in frequency will be at least 70dB below the carrier.

At greater differences in frequency the inter-modulation products are further reduced by the selectivity of the TX cavity combiner and the TX output filter. In the RX frequency band of the BS spurious and 5th-order IM products measured at the TX antenna connector are verified to be less that –106dBm. With the expected RX-TX antenna separation of 30 dB, any generated product in the receiver input will be less than –136dBm, well below the RX sensitivity level. This verification has been done with up to 16 simultaneous transmitters of 50W each.

For carrier output of 20W (+43dBm) the –106dBm gives a rejection of –149dB. To reach this level, extreme care is needed to avoid inter-modulation at any point.

Some connector manufacturers have recently started to specify 2-tone 3rd-order IM for their high quality connectors. These specifications typically is about –150dB. IM with more than 2 carriers are not specified. It is recommended only to use DIN 7/16mm connectors in the TX antenna feeder section. N-connectors are an order of magnitude worse and should never be used for more than 2 carriers.

Feeders shall be with solid screen and inner conductors to avoid any possibility for un-linearity due to undefined connections between individual cores in the cable. High quality RG214/U cable has been demonstrated to produce noise when bent mechanically in the lab, simulating a windy condition on a mast.

The larger antenna vendors have in the last years established test set-ups to verify IM properties of their cellular antennas for 900 and 1800MHz. For 400MHz this is almost non-existent. It is recommended that if a tested antenna cannot be purchased, then ask the vendor to confirm that all construction principles are identical to those used in verified antennas in the 900 or 1800 MHz range.

One very critical thing to remember about inter-modulation is, that it is very difficult to predict accurately. For antenna constructions two factors heavily degrade the performance. Over years connectors etc. starts to corrode, degrading IM. Additionally, IM properties can also degrade under windy conditions. Therefore a short verification of a new antenna set-up after installation does not guarantee performance in the longer term.

Inter-modulation can be calculated with the formulas:

3^{rd}: f = 2xf1 – f2
5^{th}: f = 3xf1 – 2xf2
7^{th}: f = 4xf1 – 3xf2

RX frequencies should never be selected to be on frequencies, where 3^{rd}-order IM is present for high-power Base Stations. However, 3^{rd} order IM is only possible with special Base Stations with a TX frequency separation larger than the guard-band between RX and TX bands.

For high power Base Stations running with Duplex Filter, 5^{th} order should always be avoided, and 7^{th}-order should preferably be avoided as well.

The BS41x is provided with an RSSI indication accurate down the RX noise floor. This can be easily used to check for disturbance from the transmitters.

First, display the RSSI for all carriers with the OM command:

B/21/1

Note the actual RSSI and the try to key all the transmitters simultaneously with the command:

B/10+

Check the RSSI again. The difference in RSSI indicates directly the reduction in sensitivity due to disturbance from the Transmitters.

4.2 TX COMBINER FOR BS41X

4.2.1 Introduction

The BS41x Tetra Radio Base Stations are provided with a TX combiner system to combine all the installed transmitters to a single antenna.

The combiner system has the following requirements:

- Combine the transmitters to a single feeder with lowest possible insertion loss.
- Give isolation between the TX input ports to avoid the signal from one transmitter to reach the other transmitters and generate inter-modulation. The isolation requirement is normally minimum 55dB in order to reach a suppression of the inter-modulation signals of 70dB relative to the individual carriers.
- Filter the TX antenna output to reduce any unwanted signal in the receiver band of the Base Station to be less than –106dBm in order to avoid interference in the receiver with an TX/RX antenna separation of >=30dB.
- Make wide-band filtering of the TX output signal to avoid interference to other radio equipment installed in the same mast.

Two different methods exist in order to combine several transmitters to a single antenna:

- Cavity Combiner (combining with filters)
- Hybrid Combiner (combining with 3-dB couplers)

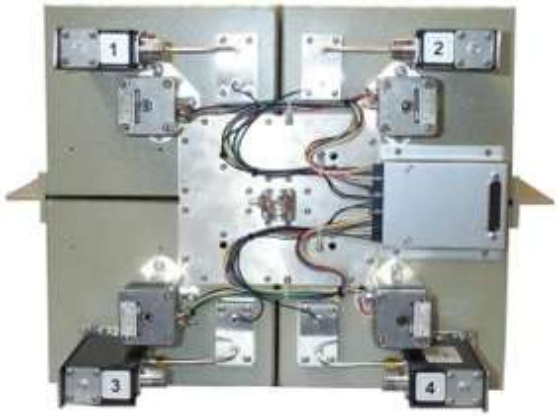
The cavity combiner has the advantage that it can combine a high number of transmitters selectively with almost constant insertion loss independent of the number of transmitters used. The disadvantage of the Cavity Combiner is that it requires minimum frequency spacing between each individual transmitter of minimum 175 kHz for the 400MHz band and 250 kHz for the 800MHz band.

The Hybrid Combiner has the advantage that is can combine transmitters with no frequency spacing restrictions and without any adjustment. For a 2-way Hybrid Combiner the insertion loss is almost equal to a Cavity Combiner. However to combine more transmitters the insertion loss increases rapidly. The theoretical insertion loss for a 2-way hybrid is 3dB, for a 4-way hybrid 6dB and for an 8-way hybrid 9dB.

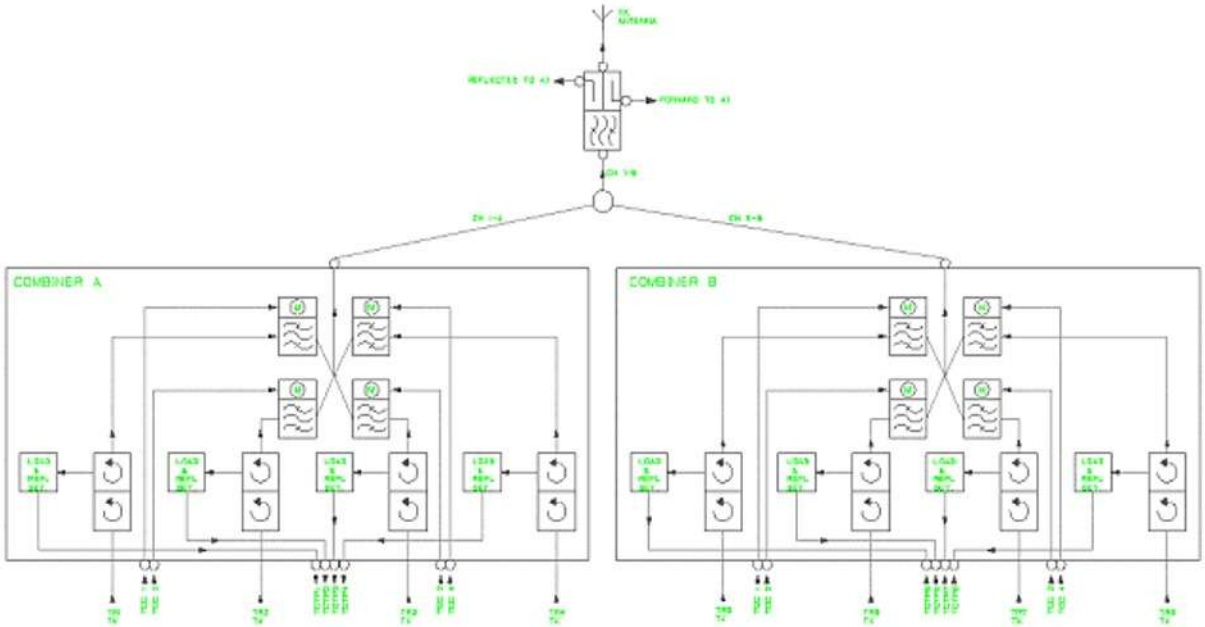
The BS412 2-carrier BS is provided with a hybrid combiner whereas the BS411 and BS414 as standard are provided with cavity combiners. The BS414 can however also be delivered with a 4-way hybrid combiner.

4.2.2 Cavity combiner system

The Cavity combiner system consists of the TC411 TX Combiner 4-way module and the TF411 TX Filter. Kits with junction and connection cables connects the units together.



The schematics of the cavity combining system are shown below:



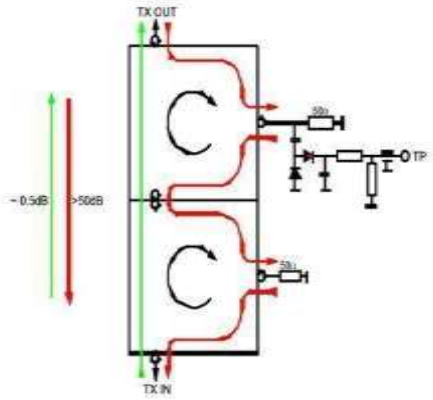
4.2.2.1 Circulator

The TX output signals come from the TR41x to the TC411 in cables attached to the Cassettes. In the TC411 it first passes a dual circulator, which gives a reverse isolation of at least 50dB.

A circulator is a very special device with different insertion loss in the two directions. It is a passive but non-linear device, which do not follow Ohm's law.

A circulator is a 3-port device, which behaves as a turn-around with the rule, that when you enter a port you follow the direction of the arrow around and leave the first-coming outlet again.

The function of a dual circulator is shown on the drawing below:



The TX signal enters the port on the lower circulator and follows the green line. It enters the first circulator, follows the arrow and leaves it again in the first-coming port. The same happens in the second circulator. The TX signal passes the circulator with an insertion loss of around 0.5dB.

Any signal entering the upper port in the reverse direction will follow the red line. This could be the transmitter signal reflected at the cavity filter or at the antenna, or a signal from another transmitter.

Most of the reverse signal will be dissipated in the big high-power resistor connected to the first port. A diode detector connected to the resistor makes it possible to monitor the size of the reverse signal.

Some of the signal will be reflected at the high-power resistor and follow the red line to the low-power resistor on the next circulator, where most of the remaining signal will be dissipated. However a small fraction will be reflected and end up at the TX input port. The total rejection in the reverse direction will normally be higher than 50dB.

The size of the reverse signal can be monitored either by a voltmeter attached directly to the Test Point or via the O&M interface and the TR41x or the TCC411. The test point is used for adjustment of manually tuned combiners. The TR41x will also monitor the level on the TP and generate an alarm if the reverse signal becomes too high.

Note, that when the Base Station runs without antenna or with the cavity filter tuned to a wrong frequency, all the reflected power ends up in the high power resistor, which is designed to dissipate the total transmitted power continuously. The PA of the TR41x will always look into a perfect load as long as the cable is correctly connected between the TR41x and the circulator.

4.2.2.2 Cavity Filter

From the Circulator the TX signal enters the Cavity filter to combine the TX signals selectively. For the 400MHz range the cavity is a ¼ lambda TEM resonator with an unloaded Q of about 10.000. For the 800MHz range the cavity is a ¾ lambda TEM resonator with an unloaded Q of about 13.000.

The cavity is fully temperature compensated, and is tuned to the center frequency of the transmitter either automatically with a stepper motor or optionally manually by hand.

The TC411 module contains 4 cavity filters, which are internally combined together with a 4-way ¼-lambda junction, which transforms the short circuit of the cavity at out-of-band frequencies to open circuit at the junction point.

4.2.2.3 Junction cables

The TC411 combiner module can either be connected directly to the TF411 filter or expanded with junction cables to 8 channels (optionally up to 16 channels). The junction cables are ½-lambda (or multiply thereof) long in order to keep the high impedance for all out-band frequencies in all junction points.

The junction cables are manufactured with extremely high precision and measured individually for electrical length. Never try to create these cables on your own.

4.2.2.4 Filter connection cable

The combiner output from the junction point is connected to the TF411 TX output filter with a cable with a specific electrical length. The electrical length is important for out-band frequencies due to the serial connection of two filters.

4.2.2.5 TX output filter

The TF411 high-power TX output filter gives an additional rejection of the TX noise of 25dB in the RX frequency band, which together with the cavity filters gives a total RX band rejection of 60dB minimum.

The output connector of the filter is a DIN 7/16mm connector with good inter-modulation properties.

The filter output also contains two directional couplers with BNC connectors with an accurately adjusted coupling of -40dB and a directivity of minimum 25dB.

4.2.2.6 Power measurement

The outputs of the two directional couplers are connected with BNC cables to the rear of AI411, which contains two precision RMS detectors to convert the actual power into DC current.

The current outputs are forwarded to the BSC412 Base Station Controller, which can display the actual output and reflected power at the TX antenna connector.

The following OM commands can be used to check the output

F15/F (output and freq for each running TR412)
F13 (summarized output after combiner)

The AI411 is provided with two adjustments on the front plate, to allow accurate calibration of the displayed power.

4.2.2.7 TCC411 TX Combiner Controller

The TC411 Cavity Combiner is equipped with the TCC411 TX Combiner Controller, which controls the position of the stepper motors based on channel information received from the TR41x Transceiver.

At power-up the Micro-Controller tunes the cavity to the upper mechanical end stop to know its exact position.

When receiving a channel command from the TR41x the MC calculates the required motor position and automatically tunes the cavity to the required position. The required motor position is calculated from a calibration table inside the MC, created when the TC411 is factory adjusted.

The channel command to the TCC411 is automatically generated in the TR41x when a channel change is done.

If the TR41x is powered off or removed, the TCC411 will automatically after about 30 seconds in brackets return the cavity to the upper end stop to avoid it to interference with other cavities.

The TCC411 is provided with an O&M interface and can be accessed from the BSC411.

The center frequency of the cavity can be fine adjusted with the 13 command in the TCC411. This is normally not needed but could be done if e.g. the BS is placed at a high altitude, where the air pressure is lower, which will increase the cavity frequency.

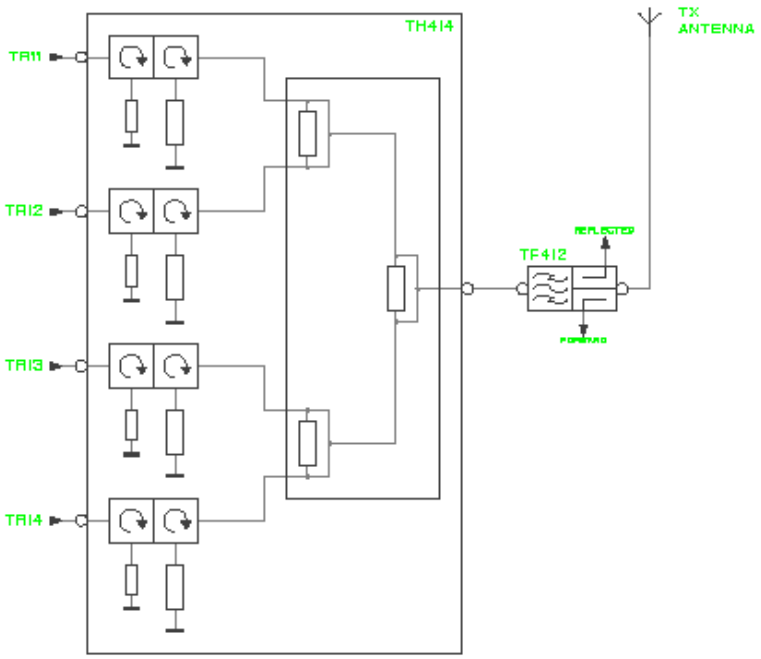
4.2.3 BS414 4-way Hybrid Combiner system

The BS414 can optionally be fitted with a 4-way Hybrid Combiner module instead of the Cavity Combiner. To compensate for the missing filtering in the cavity the TF411 is replaced with the TF412 60dB TX Filter.

TH414

TF412

The TH414 consists of four dual circulators followed of a 3-dB Wilkinson combining tree giving a theoretical insertion loss of 6dB.



4.3 RX MULTI COUPLER FOR BS41X

4.3.1 Introduction

The purpose of the RX multi-coupler system is to distribute signals from the RX antennas to the RX inputs of the TR41x Transceiver.

The Base Station is provided with two completely independent RX signal paths to connect the two RX antennas.

The use of two RX antennas in a diversity scheme gives a considerably improvement in sensitivity of the Base Station. The improvement is described in the Diversity Application Note.

In addition the use of two RX antennas with completely separate signal paths gives redundancy to the BS RX. If a fault occur in one leg of any of the components (antenna, feeder, amplifier etc.), the BS will still be able to operate with the other antenna, only loosing the sensitivity of the diversity gain.

The system includes as standard a Tower Mounted Amplifier to eliminate the sensitivity degradation normally caused of the RX feeder loss. The TMA can compensate for up to 8dB feeder loss with no change in RX sensitivity, allowing the use of thin feeders with a considerably saving in feeder expenses. See the Antenna application note for antenna and feeder configurations.

The Base Station is provided with an RF Test Loop feature, which allows a transmitter to generate a test signal for test of the complete RX section, including measurement of RX sensitivity at the TMA input and measurement of RX antenna return loss.

Dependent of the type of Base Station used, up to 16 TR41x can be connected to a single Radio Cell, and up to 4 Radio Cells can be configured in a BSC411 Base Station Controller.

4.3.2 RX signal path description

The RX signal normally comes from the RX antenna to the TMA input with a short jumper cable. The TMA is provided with an N-female connector.

Inside the TMA the signal first passes a dual directional coupler used to insert test signals in forward and reverse directions. This feature is described in the RFTL section.
The signal then passes a big low-loss pre-selection filter. The input of the filter is DC grounded to ensure that no DC voltage can be build-up on the antenna feeder. The filter has the following specifications:

Parameter	400MHz	800MHz
Pass-band width	5MHz	14MHz
Guard-band width	5MHz	25MHz
Out-band rejection	60dB min.	60dB min.

The high 60dB out-band rejection ensures proper duplex operation of the Base Station. With the required RX-TX antenna isolation of 30dB a total rejection of the TX signal of 90dB is

obtained before reaching the first amplifier. The filter also ensures good rejection of signals from other transmitters in the same mast.

The filter is followed of an LNA with a GaAs PHEMT transistor with simultaneous very low noise figure and high IM intercept point.

The amplifier output goes to the N-female output connector, where the DC-feed from the BS to supply the amplifier is extracted. An over-voltage arrestor is provided on the connector to protect the amplifier during lightning.

The RX signal is then going from the TMA to the RX input connector on top of the BS through the RX feeder, and further internally in the BS to the RM input of rear side of the AI411 Antenna Interface Unit.

The AI411 input is also provided with an over-voltage arrestor. After passing the DC insertion circuit, the RX signal passes a directional coupler, which can be used to provide a test input signal through the TNC connector on the AI411 front plate.

Afterwards follows the attenuator used to balance the RX feeder loss, adjustable through the hole in the front plate marked “Gain”.

The signal is amplified in a low-noise high dynamic range transistor to compensate for the following splitters. The AI411 is provided with two outputs coming from a 2-way Wilkinson splitter.

The two outputs can either feed up to eight TR41x through external splitters with 13dB insertion loss (used in 4- and 8-carrier BS versions) or feed two TR41x directly (used in the 2-carrier BS version).

A jumper internally in the AI411 changes the output level with 13 dB to compensate for the splitter. The actual setting of this jumper is marked outside the AI411 besides the type plate.

4.3.3 Supply and alarm circuits

Each RX path is provided with independent voltage regulators to feed the TMA and RM amplifiers.

The TMA DC feed is provided with circuitry to detect low-current alarm (no TMA connection) and low-voltage (TMA connection short-circuit).

Similarly the RM amplifier is provided with circuitry to detect low-current and high-current alarms.

The alarms are connected to the BSC and send to the TR41x’s assigned to the particular Radio Cell. If faults exist in one leg only, a warning alarm is generated. If alarms exist in both legs, a blocking alarm is generated.

4.3.4 RF Test Loop path description

The Base Station is provided with an RF Test Loop feature allowing extensive test of the whole Base Station both locally and remotely without any additional equipment.

Each TR41x is provided with an RFTL output (BNC connector) on the front plate. The output can be activated with either a high level output (-40dB relative to the TX output connector), low level output (-50dBr) or turned off (<-80dBr).

The output signals are either combined in RFTL combiner modules and brought to the AI411 RFTL inputs (4- and 8-carrier versions) or brought directly to the AI411 inputs (2-carrier versions).

In the AI411 the two inputs are combined, followed of and attenuator/jumper to compensate for the loss of the external combiner. This setting always follows the similar settings in the RM.

Afterwards follows a variable attenuator adjustable through the AI411 front hole marked IN. This attenuator is used to compensate for output power selection of the TR41x.

The signal now enters a double balanced mixer, where the frequency is converted from the TX band to the RX band. A Crystal oscillator running on the RX/TX duplex frequency offset provides the injection signal.

The mixer is followed of a HPF and a buffer amplifier before it reaches the variable output attenuator, accessible from the front of the AI411 through the hole marked OUT. This attenuator is used to compensate for actual cable loss of the TEST feeder going to the TMA.

A combining circuit at the output connector allows the insertion of an external test signal from the BNC connector on the AI411 front plate marked TEST IN.

At the output connector a DC control signal insertion circuit is provided to the TMA, together with an over-voltage arrestor.

From the TNC output connector on the rear of the AI411 the test signal is connected internally in the BS to the N-female TEST connector on the BS top, from where it goes to the TMA in the top of the mast with a feeder similar to the RX feeders.

The TEST input in the TMA is also provided with an over-voltage arrestor and a DC separation circuit.

In the TMA the test signal is divided in two, one for the A-path and one for the B-path. The test signal is then inserted in either the forward direction of the two paths to the BS (-50dBr) or optionally in the reverse direction against the antennas (-40dBr).

The direction is controlled of the DC signal in the TEST feeder and reverse direction can be activated of each of the TR41x, when RX antenna return loss measurement is performed.

4.4 TR412 TRANSCEIVER DESCRIPTION

4.4.1 Introduction

The TR412 Transceiver is a complete Tetra Carrier Unit containing a dual diversity receiver, a highly linear transmitter and all the necessary computer power to handle the lower protocols and control functions. The TR412 is an upgraded plug-in replacement for the TR411.

The TR412 is able to run different modulation and protocol types depending on the actual software running on the DSP and controller. The standard TETRA version also support analogue PM modulation for testing purposes, to allow complete testing of a site with analogue test equipment.

4.4.2 Receiver

The receiver contains two completely independent signal paths for dual diversity reception as standard.

Each RX signal comes from the Receiver Multi-coupler system into the TR412 via the TNC connector on the front plate, and is amplified with about 17dB in the RF amplifier, followed of a 3-pole BPF.

The signal now enters 1st mixer, where it is converted down to 1st IF of 45MHz. 1st mixer is a high-level double balanced mixer running with an injection level of +17dBm to obtain a high dynamic range.

The 1st mixer is followed of a 4-pole 45MHz crystal filter, an IF amplifier with about 30dB gain and a second 2-pole crystal filter. The crystal filters are of linear phase type to avoid distortion of the digital modulation.

From the output of the second crystal filter the signal enters 2nd mixer, where it is converted down to 2nd IF of 144kHz. The signal is then amplified and balanced with op-amps before it goes from the RX Front End Board to the Main Board, where it is converted to digital.

The ADC samples the 2nd IF signal of 144kHz directly with a sampling frequency of 576kHz and a resolution of 16bit. The digital signal is going to the DSP on a serial interface.

In the DSP the signal is first down-converted to base-band and is then passing the channel definition filter, which determines the actual bandwidth of the receiver. In TETRA mode the filter is the root-raised cosine filter.
Afterwards frame synchronization, diversity combination and demodulation takes place.

The Local Oscillators for the RX is generated on the RX FS board, locked to a 12.8MHz reference coming from the Main Board.

1st LO is a Voltage Controlled Oscillator running either 45MHz below or above the actual receiver frequency. The VCO is phase locked to the 12.8MHz reference with a fractional-N

PLL circuit, controlled through a serial interface from the Micro-Controller. The VCO signal is amplified to about +23dBm and brought to the RX Front End via the attached cable. Here it is first filtered in a 3-pole ceramic filter before it is split into two +17dBm injection signals for the two 1st mixers.

2nd LO is a Voltage Controlled X-tal Oscillator running on 44.856MHz and this is also phase-locked to the 12.8MHz reference. The signal is amplifier to about +13dBm and brought in another cable to the RX Front End, where it is split into two +7dBm injection signals for the two 2nd mixers.

4.4.3 Transmitter

The transmitter of the TR412 is build around a Cartesian loop to meet the demanding TETRA linearity requirements. The TX signal is generated directly on the transmit frequency to optimize spurious and wide-band noise performance. The transmitter is able to deliver 60Wpep at the output connector of the TR412, equal to 25W TETRA.

The carrier frequency is generated of a Voltage Controlled Oscillator on the actual TX frequency. The VCO is phase locked to the 12.8MHz reference coming from the Main Board with a fractional-N PLL controlled through a serial interface from the MC. The VCO is running independent of whether the TX is keyed.

The output signal from the VCO is amplified to about +23dBm and split into two signals, a +11dBm signal for the I/Q modulator in the forward leg and a +21dBm signal for the I/Q de-modulator in the feedback leg.

The I/Q modulation signals are generated directly of the DSP and send on a serial interface to the dual 16-bit DAC with associated low pass filters. The I/Q signals acts as reference signals for the Cartesian feed-back loop.

After the comparator comes a variable phase circuitry to adjust for the Cartesian loop phase and the loop filter before the modulation is applied to the I/Q modulator. A linear amplifier increases the output level from the Exciter to +14dBm pep.

The Power Amplifier consists of one LDMOS driver and one output transistor, delivering 60W pep output power with good linearity. An attenuator in the input is used to fine adjust the total gain of the Power Amplifier. Both transistors are running in class AB for an optimum compromise between linearity and efficiency and are supplied with +26V DC.

After the PA four directional couplers are provided. A forward and a reverse coupler are used for the Power Meter to allow the display of forward and reflected power. One directional coupler is used to sample the output signal for the RFTL switch, and the last directional coupler is used to take a sample of the output signal for the Cartesian loop feedback.

The feedback signal is brought back to the Exciter in a thin cable. After passing an attenuator to adjust the level it enters the I/Q demodulator, where the signal is converted back to base-band. After the base-band feedback amplifier the signal is compared with the I/Q modulation reference signal from the two DAC.

Running with a DSB signal with 60W pep the forward leg IM3 of about 30dBc. The linearity is improved with the loop gain of about 40dB to reach the Adjacent Channel Power specification for TETRA of 60dB with good margin.

Hardware and software support is provided for open-loop operation with different modulation types to allow easy adjustment and test of the transmitter.

A dual RMS power detector is provided on the main board to permit the read-out of forward and reflected power from the controller as well as for alarm monitoring.

At the TX output the RF Test Loop switch unit is provided with a BNC connector on the front plate. This allows the controller to activate a test output from the TX with an accurately calibrated level of –40dBr and –50dBr relative to the TX output. In off state the maximum level of –80dBr.

4.4.4 Reference oscillators

The TR412 is normally running fully frequency and time synchronized with the BSC. The synchronization is done with the 2.048MHz, the 8kHz and the 1sec. hardware signals and the 1 sec. HDLC message, all coming from the BSC.

The TR412 contains a 12.8MHz VCXO, which is phase locked to the 2.048MHz input signal. This acts as reference for the RX and TX frequencies.

The TR412 also contains a 36.864MHz VCXO, which is phase locked to the 8kHz input signal. This acts as clock reference for the controller, the DSP and for the ADC and DAC and thereby the TETRA symbol-generation.

The TX and RX TETRA framing is normally time synchronized to the 1-second hardware input signal together with the information provided in the HDLC message. This ensures that all TETRA counters are running synchronized on the whole BS. If GPS synchronization is present on the BSC, it will also run synchronized with surrounding Base Stations.

4.4.5 DSP

The TR412 is provided with a single high performance DSP handling modulation and de-modulation task directly in software. This gives a high degree of freedom to adapt to any changes necessary. When running in TETRA mode the DSP also handles the LMAC and UMAC protocol parts.

The DSP is connected directly via its serial interface to the PCM highway on the back-plane. Four timeslots are reserved for each TR position. All circuit-mode communication is going this way to the PCM switch in the BSC.

The MC is connected to the DSP through its host port and controls its functionality, including software installation and booting. All packed-type communication also passes the host port of the DSP and goes to the BSC via the MC and the HDLC bus.

4.4.6 Micro Controller

The MC is handling the over-all administration of the TR412.

The MC is provided with 1024kByte segmented FLASH memory, containing all the code for the MC as well as for the DSP. One segment contains the boot program, which is used during start-up and software download from the BSC. A 50-pin connector inside the TR412 allows the insertion of an external boot card, which is needed to update the internal boot section. Two segments of the FLASH memory are used to save the factory and system configuration of the TR412.

One of the MC's internal HDLC controllers is used to communicate with the BSC via the HDLC bus and carries all message type communication with the BSC, including TETRA messages, packed-type voice and date, O&M and house-keeping.

Its UART is connected to the UART bus giving an alternative way of O&M communication.

The MC is provided with a watchdog, which will make a restart of the TR at improper operation of the software.

4.5 RX DIVERSITY FOR BS41X

The BS41x TETRA Base Stations are provided with a dual RX diversity scheme allowing the connection of two RX antennas simultaneously to improve the RX sensitivity.

The Base Station can run with only one antenna connected. Connecting a second antenna can however give a considerably improvement of the total BS sensitivity, especially under fading conditions. It is therefore highly recommended to make use of the dual diversity receiver feature.

The BS41x runs with a typical TX output power of about 10 W Tetra at the rack connector. Compared with the typical output power of 1W of a handheld mobile station, a difference of about 10dB in the link budget exists between down-link and up-link, if the same RX sensitivity is present.

Considerably effort has been made in the BS41x to improve RX sensitivity to compensate for the low output power of the handheld subscriber units.

The use of an RX Tower Mounted Amplifier removes the influence of the RX feeders, effectively improving the link balance with the loss of the TX feeder, which could be 2 dB for a typical system.

The use of a dual RX antenna diversity system (space diversity) can improve the sensitivity of BS receiver by up to 7 dB and thereby almost compensate for the remaining difference in the link budget.

This application note describes the implemented diversity scheme of the BS41x and gives typical measured sensitivities and diversity improvements under various conditions.

4.5.1 Diversity implementation

The dual diversity system is implemented with two completely independent receive sections from the RX antenna via the TMA, feeder and RX multi-coupler into the carrier unit. In the carrier unit two independent RX sections exists with first and second IF and two Analog-to-Digital converters connected directly to the DSP.

The DSP thereby receives two completely independent RX signals. First it tries to recover the timing synchronization independently of the two signals and to make a signal quality evaluation.

If the two signals are not very different in quality, they will be added and the combined signal will be used to improve the sensitivity.

If the two signals are very different in quality the best signal will be selected and the other signal will not be used. This is done when the addition of the bad signal to the good one reduces the sensitivity.

The improvement of sensitivity is considerably under fading conditions. If the two received signals are close to being uncorrelated, the probability, that a low input signal level is present on both inputs simultaneously becomes low, effectively removing the fading.

The sensitivity will however also be improved under static conditions, when the two signals are fully correlated. Here close to a 3dB improvement in sensitivity is achieved. This is the same result as if the two antennas were combined directly, however without the problem in obtaining the correct phase of the combination.

The gain of combining under static conditions can also be seen from the result of the combining process. If two equal signals are added, the two input signals are added, effectively giving the double input voltage equal to an increase in input signal of 6dB. The noise is also added. However the two noise signals are fully uncorrelated, and adding the power of the two signals only gives an increase in noise of 3dB. The difference between the 6dB and the 3dB gives the resulting improvement of sensitivity under static conditions of 3dB.

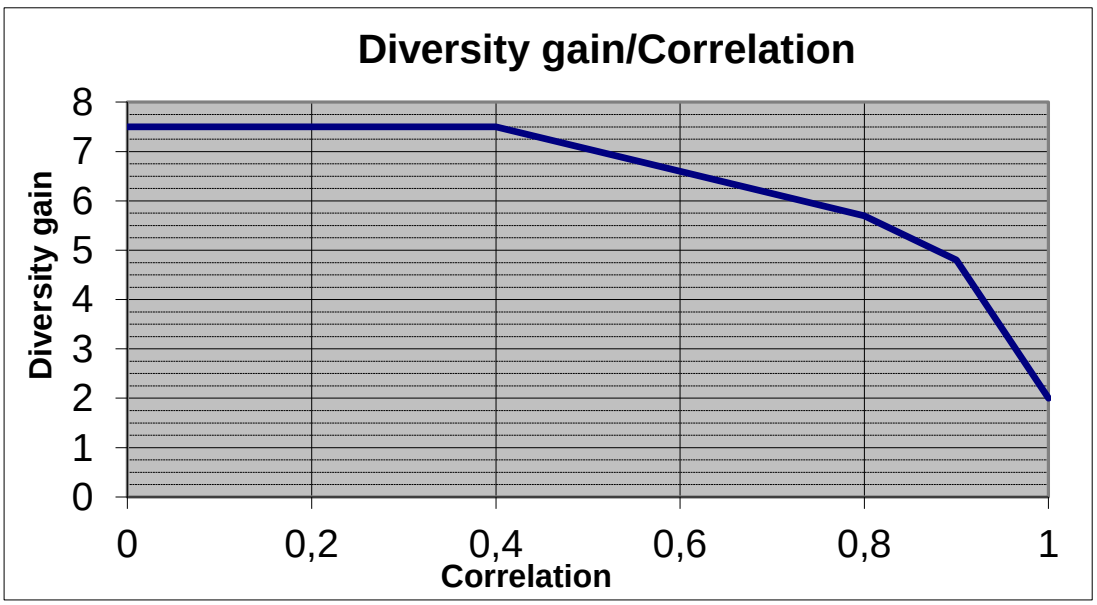
The same improvement of 3 dB is achieved if two signals with fully correlated fading are present. When the two received signals become uncorrelated, the sensitivity improvement will increase.

In the following sections graphs are shown with typical measured RX sensitivity improvements under various conditions.

4.5.2 Diversity gain versus correlation factor

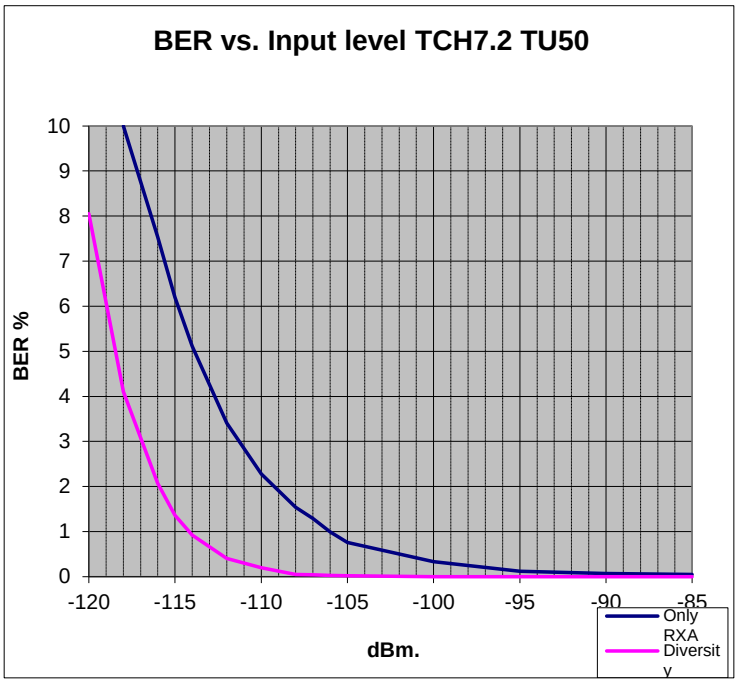
This curve shows the diversity gain (RX sensitivity improvement) for an SCH/F channel (signaling channel) with TU50 fading profile and an MER (Message Error Rate) of 4.7%.

For two fully correlated signals the gain is almost 3dB as described. When the correlation factor approaches zero, the diversity gain is about 7.5 dB.



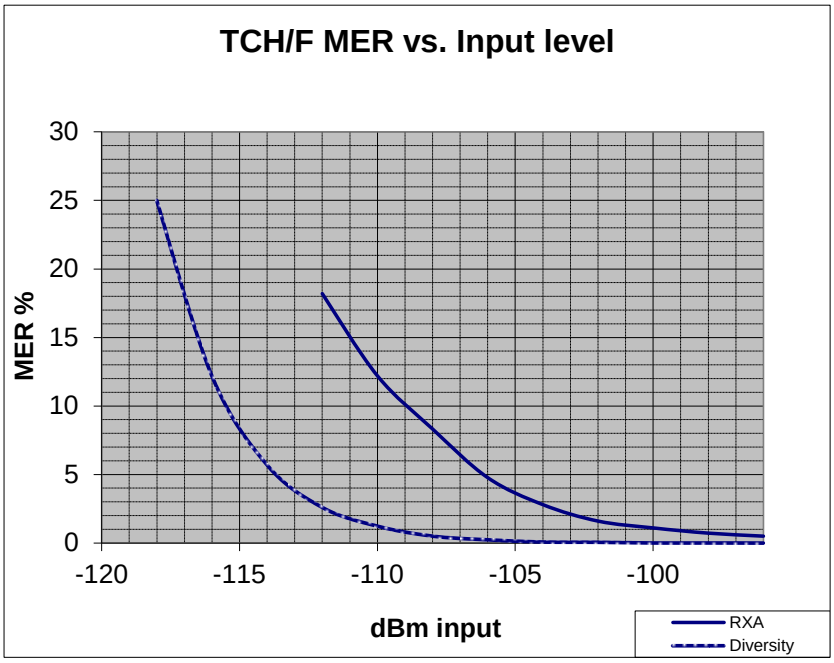
4.5.3 BER versus input signal TCH7.2

These curves show the measured BER (Bit Error Rate) for a standard TCH7.2 traffic channel with the TU50 fading profile. The correlation factor between the two signals is 0.2.



4.5.4 MER versus input signal SCH/F

These curves show the measured MER (Message Error Rate) for a standard SCH/F (Signaling Channel Full) with the TU50 fading profile. The correlation factor between the two signals is 0.2.


TCH/F MER vs. Input level
30
25
20
15
10
5
0
MER %
-120
-115
-110
-105
-100
dBm input
RXA
Diversity

4.6 POWER SUPPLY FOR BS41X

4.6.1 Introduction

The BS41x Base Stations are provided with a flexible Power Supply scheme allowing it to run in a variety of different configurations. It can run from either mains AC directly, run from a DC battery source or a combination hereof with battery charging.

The different BS versions have space for from 2 to 4 PS411 Power Supply units running in parallel with full power share on all sections. Redundant n+1 operation is provided as all Base Stations can run with full specification with one PS411 out of operation.

All the variants can be connected with an external –48V lead-acid battery and has all the needed circuitry to charge the battery

The PS411 Power Supply contains 4 major parts:

- AC Rectifier providing –48V DC
- DC/DC converter providing +26VDC (for the TX PA)
- DC/DC converter providing +14V DC (for all other BS parts)
- Microprocessor (for charging control, monitoring and alarm generation)

The following number of PS411 is needed depending on the number of carriers installed in the Base Station:

Carriers	No redundancy	N+1 redundancy
1 carrier	1 x PS411	2 x PS411
2 carriers	1 x PS411	2 x PS411
3 carriers	2 x PS411	3 x PS411
4 carriers	2 x PS411	3 x PS411
5 carriers	2 x PS411	3 x PS411
6 carriers	3 x PS411	4 x PS411
7 carriers	3 x PS411	4 x PS411
8 carriers	3 x PS411	4 x PS411

4.6.2 Rectifier

The Rectifier section converts the mains AC input to –48VDC, which can charge the battery and feed the two DC/DC converters. The connection of the battery is optional.

The Rectifier accepts a wide voltage input range, supporting the 3 different standards used worldwide, namely 100V, 115V and 230V. It also accepts both 47Hz and 63Hz. No jumper or setting changes are needed to switch between the variants. However a change of the size of the fuse mounted from the front of the PS411 is needed when changing from 230V to 100/115V. The values are marked on the front plate.

The –48V DC output is fed to a common –48V power rail on the back plane of the cassette. A power sharing circuit ensures close to equal load on all inserted PS411.

The actual produced output voltage depends of the configuration. When battery charging is active, the delivered output voltage will vary around 54V, controlled of the micro-controller. The accurate value is determined of the charging voltage setting, consisting of a fixed voltage part and an associated temperature compensation setting.

When charging is not selected or the external temperature sensor is not working, the rectifier will deliver 48.0V fixed.

Two different connections are provided on the back plane:

- –48V Battery connection
- –48V DC external load

The –48V battery connection is provided with a current sensor to measure the actual battery charge/discharge current.

The –48V DC external load connection allows the Base Station to drive external units, e.g. Ethernet switches, E1 modems etc.

4.6.3 +14V and +26V DC/DC converters

The PS411 Power Supply contains two independent DC/DC converters providing +14V and +26V respectively from the –48V DC input.

The outputs are fed to two power rails on the back plane. Independent power-share circuits on each converter ensures about equal load on all inserted PS411.

The input to the two converters comes from the external –48V rail. An internal feed is also provided allowing the converters to run even if the external –48V rail is short-circuiting to ground.

The DC/DC converters are able to run on –48V as provided of the rectifier or an external battery.

The input of the DC/DC converters are provided with an under-voltage detector to turn off the load on the battery when nearly discharged to prevent deeply discharge of the battery, which could affect its lifetime. The turn-on voltage is about 45V DC and the turn-off voltage about 40V DC. The 5V hysteresis is provided to prevent oscillations between on and off.

4.6.4 Micro-controller

The PS411 is provided with a micro-controller to allow close monitoring of the actual operating condition of the Power Supply. In addition the micro-controller also controls the battery charging voltage.

The PS411 is connected to HDLC-bus in the Base States as well as the serial UART interface. O&M communication is possible on both interfaces.

The PS411 is provided with internal resident settings to hold the charging configurations etc. When used in a BS41x these settings will normally be overwritten of the common configuration received from the active BSC at power-up. The yellow power led on front of the PS411 will flash until the configuration from the BSC is received.

Part-5: Hardware Units

5.1 HARDWARE UNIT REFERENCES

Description	Doc. No.
Indoor:	
BS 414 Base Station 4-Carrier	D100200-REF
BS 411 Base Station 8-Carrier	D100300-REF
BS 411 Base Station 8-Carrier High Power	D100300 HP-REF
BSC412 Base Station Controller	D104211-REF
TR412 Transceiver	D104011-REF
CAB411 BS Cabinet for BS411	D104811-REF
CAS411 TR Cassette for BS411	D104307-REF
CAS414 Cassette for BS414	D104306-REF
CAS417 PS Cassette	D104352-REF
CON411 Connection Box	D104803-REF
External Battery kit for BS41x	D104260-REF
PS411 Power Supply with rectifier	D104251-REF
RMD411 Dual 8-way div.	D104431-REF
RMD414 Dual 4-way div.	D104441-REF
RTC411 RFTL 8-way combiner	D104451-REF
RTC414 RFTL 4-way combiner	D104461-REF
TC411 4-way TX combiner	D104601-REF
TF411 TX filter 25dB	D104701-REF
TH414 4-way hybrid combiner	D104661-REF
TMD412 Tower mounted duplexer	D104531-REF
AI411 Ant. Interface	D104401-REF
Outdoor:	
BS421 Base Station Outdoor	D105001-REF
SB421 Service Box, 1,4GHz	D105101-REF
CS421 2-way Combiner/Splitter	D105911-REF
External log units:	
External log workstation	D105638-REF
External log server	D105639-REF

5.2 RECOMMENDED HARDWARE

The following hardware represents the items used at DAMM
These items are not mandatory, but the list indicates items which are tested, and thus can be recommended for use

All listed items may be purchased from DAMM

If this recommendation is not used, it is mandatory to procure hardware with similar of better characteristic to ensure a problem free operation of the system

DAMM item No.	Description	Page No.
880014	Sealed coaxial cable got BS to BS and BS to Antenna	5-4
105091	Ethernet Cable (Reel of 150m)	5-6
105092	Ethernet Cable (Reel of 500m)	5-6
105093	Power cable BS/BSC421 (Reel of 150m)	5-10
105094	Power cable BS/BSC421 (Reel of 500m)	5-10
798001	Internal Battery SB421 1 piece (4 total in SB421)	5-11
823001	GPS antenna	5-13

5.2.1 Sealed Coaxial cable 880014

1/2" | Extremeflex™

CommScope WIRELESS

SFX 500 (1/2") Super Flexible Cable Specifications

Cable Type	
Standard PE jacket	SFX 500 PE
Fire Retardant, Riser Rated, CATVR	SFX 500 R
Fire Retardant, Premise Rated, Non-Halogen	SFX 500 NHR

Cable Characteristics

Electrical		
Impedance, Ohms	50 ± 1	
Cutoff Frequency, GHz	12	
Velocity %	87	
Peak Power Rating, kW	15.6	
DC Resistance, Ohms/1000 ft (1000m)		
Inner	0.82	(2.69)
Outer	0.85	(2.79)
DC Breakdown, Volts	2500	
Jacket Spark, Volts RMS	5000	
Capacitance, pFd/ft(m)	24.2	(78.9)
Inductance, µH/ft(m)	0.058	(0.19)
VSWR Specification		
30-2500 MHz	1.10:1	(26.4)
Distance to Fault (DTF)		
30-2500 MHz	1.006	(50.0)
Mechanical		
Jacket	PE or riser rated CMR/CATVR	
Outer Conductor	Aluminum	
Inner Conductor	Copper-Clad Al.	
Inner Conductor Dia., in. (mm)	.140	(3.56)
Dia. Over Outer Conductor, in. (mm)	.396	(10.1)
Dia. Over Outer Jacket, in. (mm)	.450	(11.4)
Minimum Bend Radius, in. (mm)	1.25	(31.75)
Number of Bends, min	20	
Bending Moment, ft-lbs. (Nm)	2	(2.7)
Cable Weight, lbs/ft (kg/m)	0.07	(0.10)
Tensile Strength, lbs. (N)	250	(113)
Flat Plate Crush Strength, lbs./in. (kg/mm)	95	(1.71)

Nominal Attenuation and Average Power

Frequency Mhz	Attenuation dB/100 ft	Attenuation dB/100m	Average Power kW
100	0.955	3.13	2.89
108	1.01	3.31	2.78
150	1.20	3.94	2.34
174	1.31	4.30	2.16
200	1.42	4.66	2.01
300	1.72	5.64	1.62
400	2.00	6.56	1.39
450	2.13	6.99	1.30
500	2.26	7.41	1.23
512	2.29	7.51	1.21
600	2.47	8.10	1.11
700	2.67	8.76	1.02
800	2.83	9.28	0.949
824	2.89	9.48	0.932
894	3.04	9.97	0.890
960	3.12	10.2	0.855
1000	3.20	10.5	0.836
1700	4.25	13.9	0.616
1800	4.40	14.43	0.598
1900	4.51	14.8	0.580
2000	4.70	15.4	0.552
2200	4.86	15.90	0.512
2300	5.04	16.5	0.508
2400	5.16	16.9	0.495
2500	5.28	17.3	0.483
2600	5.42	17.8	0.471
3000	6.07	19.9	0.436
4000	7.00	23.0	0.366
5000	8.00	26.2	0.319
6000	9.00	29.5	0.284
7000	9.91	32.5	0.258
8000	10.7	35.1	0.236
9000	11.5	37.7	0.220
10000	12.3	40.4	0.202
11000	13.0	42.7	0.190
12000	13.7	44.9	0.179

Standard Conditions:
- For Attenuation, VSWR 1.0 ambient temperature 20° (68°F), atmospheric pressure, dry air.
- For Average Power, VSWR 1.0, inner temperature 100° (212°F), ambient temperature 40° (104°F), atmospheric pressure, dry air, no solar loading.
- Specifications subject to change without notice.

Sales: 1.888.Cell Reach (235.5732) • Fax: 828.466.8617 • Tech Hotline: 800.541.1220 • wireless@commscope.com • www.commscope.com

SFX 500 (1/2") Connectors

All CommScope Wireless connectors are premium quality. The two piece construction is designed for quick and consistent termination while maintaining superior performance. Termination craftsmanship issues are reduced to a minimum by using a CommScope Wireless self gauging coring tool.

Brass is used as the connector body base material. Surfaces in the RF transmission path are silver plated. All other surfaces are nickel/tin coated. Insulators are made of polypropylene, polytetraflourethylene (PTFE), polycarbonate and Delrin. All O-rings are made of ethylene propylene rubber (EPDM) to ensure the tightest seal against moisture ingress.


N-Male


N-Female


N-Male- Rt. Angle


7/16 DIN-Male


7/16 DIN-Female


DIN Male- Rt. Angle

Insertion Loss, dB-Formula
Straight .05 √F, GHz Right Angle .1√F, GHz

Intermodulation-3rd Order Product-dBm (dBc)
>112 (155) (Two +43 dBm carriers, IM product between 1870-1910 MHz)

Product No.	Interface	Maximum Length inches	(mm)	Maximum Diameter inches	(mm)
SFX ADM	7/16 DIN-Male	2.01	(51.0)	.804	(20.4)
SFX DF	7/16 DIN-Female	3.00	(76.2)	.882	(22.4)
SFX ANM	N-Male	2.846	(72.3)	.804	(20.4)
SFX NF	N-Female	2.61	(66.3)	.882	(22.4)
SFX NMR	N-Male Right Angle	2.846	(72.3)	.882	(22.4)
SFX DMR	7/16 DIN-Male Right Angle	3.12	(79.2)	.882	(22.4)

Extremeflex Jumper Assemblies
Guaranteed Low VSWR Specifications, Type SFX-500 Super flexible

Frequency Code No.	Frequency MHz	VSWR (RL) 1-25 ft. (.5-7.5m)	26-100 ft. (7.6-30.5m)	101-200 ft. (61.2-152.4m)	Connectors
A	824-960	1.06 (30.7)	1.07 (29.4)	1.08 (28.3)	NF, NM, DF, DM
		1.20 (20.8)	1.20 (20.8)	1.18 (21.7)	NMR, DMR
B	824-960	1.12 (24.9)	1.12 (24.9)	1.13 (24.2)	NF, NM, DF, DM
	1700-1900	1.33 (17.0)	1.33 (17.0)	1.33 (17.0)	NMR, DMR
C	1700-2000	1.09 (27.3)	1.10 (26.4)	1.12 (24.9)	NF, NM, DF, DM
		1.25 (19.1)	1.25 (19.1)	1.23 (19.7)	NMR
		1.30 (17.7)	1.30 (17.7)	1.27 (18.5)	DMR
D	1900-2200	1.10 (26.4)	1.12 (24.9)	1.12 (24.9)	NF, NM, DF, DM
		1.33 (17.0)	1.33 (17.0)	1.33 (17.0)	NMR, DMR

Standard assembly lengths are 3', 6', 10' and 12'. (See pg. 12 for standard jumper lengths)
VSWR values are guaranteed for factory assemblies and are typical for cut lengths.

Sales: 1.888.Cell Reach (235.5732) • Fax: 828.466.8617 • Tech Hotline: 800.541.1220 • wireless@commscope.com • www.commscope.com

5.2.2 Ethernet cable 105091 / 105092

Nexans

SF/UTP Category 6 LSZH + PE 500m reel

Nexans ref.: 39020671
Country ref.: 4923455

- Complies to Cat 6 standards
- Supports Class E applications
- Central cross member maintains geometry and performance
- Tested up to 350MHz

Description

Application

Category 6 cable is the ultimate solution for a future proof network. It is specifically designed to support the exacting requirements for tomorrow's protocols, yet is fully backwards compatible with today's needs. It is the recommended cable for all forthcoming installations.

- 10baseT Ethernet
- 100baseTX Fast Ethernet
- 1000baseTX Gigabit Ethernet
- 155 MBit ATM
- 622 MBit ATM
- 1.2 Gbit ATM
- future class E applications

Verified to exceed the requirements of the ISO/IEC 11801:2002 Category 6 requirements.

Standards
International EN 50173-1;EN 50288;IEC 61156-5;ISO/IEC 11801
National TIA/EIA-568-B.2-1

Performance

Tested to 350 MHz and with guaranteed performance to 250 MHz, Nexans Category 6 cables provide guaranteed headroom and bandwidth over and above the requirements of all international, european and american cable standards, including ISO/IEC 11801:2002, IEC 61156-5, EN 50173, EN 50288, TIA/EIA 568-B.2-1.

Installation

The outer PE-sheat of the cable is UV-resistant and the cable is suitable for fixed outdoor installation. It is not suitable for direct burial. It has to be protected in a duct when it is installed in the ground. The cable can be installed indoor if the outer PE-sheat is removed using the rip cord (in this case the cable will be halogen free flame retardant).

Flame retardant	Operating temp. range	Ambient install temp. range (°C)	static bending rad.	operation bending rad.
No	-20 .. 40 °C	-10 .. 50 °C	41.0 mm	81.0 mm

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All drawings, designs, specifications, plans and particulars of weights, size and dimensions contained in the technical or commercial documentation of Nexans is indicative only and shall not be binding on Nexans or be treated as constituting a representation on the part of Nexans.

Nexans

SF/UTP Category 6 LSZH + PE 500m reel

Contact
Sales Telecom and data cables
SE-514 81 Grimsås
Sweden
Phone: +46 325 80 000
telecomcable-pc.se@nexans.com

Flame retardant	Operating temp. range	Ambient install temp, range (° C)	static bending rad.	operation bending rad.
No	-20 .. 40 °C	-10 .. 50 °C	41.0 mm	81.0 mm

All drawings, designs, specifications, plans and particulars of weights, size and dimensions contained in the technical or commercial documentation of Nexans is indicative only and shall not be binding on Nexans or be treated as constituting a representation on the part of Nexans.

Nexans

SF/UTP Category 6 LSZH + PE 500m reel

Nexans ref.: 39020671

Characteristics

Construction characteristics	
Type of cable	S-FTP
Outer sheath	PE
Colour	Black
Inner sheath	Halogen free flame retardant
Dimensional characteristics	
Conductor cross-section (AWG)	24
Diameter over insulation	1.13 mm
Nominal outer diameter (mm)	10.1 mm
Approximate weight (kg/km)	80 kg/km
Electrical characteristics	
Transfer impedance	20
Mutual capacitance (nF/km)	56 nF/km
Max. DC-resistance of the conductor at 20° C	70 Ohm/km
Characteristic impedance	100 Ohm
Transmission characteristics	
Attenuation, max. 250 MHz	32.8 dB/100m
Near End Crosstalk @ 250 MHz	38.3 dB
Attenuation Crosstalk Ratio, 250MHz	5.5 dB/100m
Powersum Near End Crosstalk, 250MHz	36.3 dB
Powersum Equal Level Far End Crosstalk, 250MHz	19 dB
Return loss, 250MHz	17.3 dB
Skew	30 ns/100m
Velocity of propagation	68.0 %
Coupling attenuation at 30 MHz	80 dB
Propagation delay, max. 100 MHz	536 ns/100m
Usage characteristics	
Packaging	Reel
Length (m)	500 m
Category	Cat. 6
Flame retardant	No
Component function	Cable
Operating temperature, range	-20 .. 40 °C
Ambient installation temperature, range (°C)	-10 .. 50 °C
Minimum static operating bending radius	41.0 mm
Laying operation bending radius	81.0 mm

Electrical Performance

Frequency	Attenuation	NEXT pr/pr	ACR	PS NEXT	EL-FEXT pr/pr	PS EL-FEXT	RL
MHz	dB/100 m	dB	dB/100 m	dB	dB/100 m	dB/100 m	dB
1	2.0	74.3	72.3	72.3	70.0	67.0	20
4	3.8	65.3	61.5	63.3	58.0	55.0	23
10	6.0	59.3	53.3	57.3	50.0	47.0	25

All drawings, designs, specifications, plans and particulars of weights, size and dimensions contained in the technical or commercial documentation of Nexans is indicative only and shall not be binding on Nexans or be treated as constituting a representation on the part of Nexans.

Nexans

SF/UTP Category 6 LSZH + PE 500m reel

16	7.6	56.2	48.6	54.3	45.9	42.9	25
20	8.5	54.8	46.3	52.8	44.0	41.0	25
31.25	10.7	51.9	41.2	49.9	40.5	37.5	23.6
62.5	15.4	47.4	32.0	45.4	34.1	31.1	21.5
100	19.8	44.3	24.5	42.3	30.0	27.0	20.1
155	25.2	41.4	16.2	39.5	26.2	23.2	18.8
200	29.0	39.8	10.8	37.8	24.0	21.0	18.0
250	32.8	38.3	5.5	36.3	22.0	19.0	17.3
300	36.4	37.1	1.5	35.2	20.5	17.5	16.8
350	39.8	36.1	-	34.2	19.1	16.1	14.1

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All drawings, designs, specifications, plans and particulars of weights, size and dimensions contained in the technical or commercial documentation of Nexans is indicative only and shall not be binding on Nexans or be treated as constituting a representation on the part of Nexans.

5.2.3 Power cable 105093 / 105094

at.com

REKA CABLES

883013 1(1)

21-07-2004 JJo

DATASHEET

NHH-J

Halogen free, flame retardant, non corrosive, low smoke installation cable

100 V

Construction according to DS 2393, HD 21.5 S3

IEC 60332-1	EN 50265-2-1	Flame retardant
IEC 60754	EN 50267	Halogen free, non corrosive
IEC 61034	EN 50268	Low smoke density

Application

For fixed installation on surface indoors and outdoors, or inlaid in conduits, canals and hollow constructions. Burial in soil is allowed, as long as the relevant national rules of installation are followed.

Max. operating temperature 70 °C
Max. temperature in short circuit 160 °C for max. 5 s
Min. handling temperature -20 °C
Min. bending radius 10 x cable diameter
Max. pulling load when pulling from the conductors A x 50 N/mm² (A=total area of the conductors)

Construction

Conductor:	1,5...2,5 mm² circular stranded copper (IEC 60228 cl 2 RM)
Insulation:	Halogen free polyolefin compound
Identification:	3 core ; green-yellow, blue, black
Outer sheath:	Halogen free polyolefin compound, Colour black

REKA code	Size	Conductor resistance DC +20 °C ohm / km	Insulation thickness average mm	Oversheath thickness nominal mm	Outer diameter maximum mm	Weight approximate kg / km
1702355	3x1,5	12,1	0,7	0,9	8,5	100

NHH-J 100 V 3x

5.2.4 SB421 internal battery 7980001

Independence™

SECTION RE SERIES

SEALED RECHARGEABLE LEAD-ACID BATTERIES

EnerSys
Power/Full Solutions

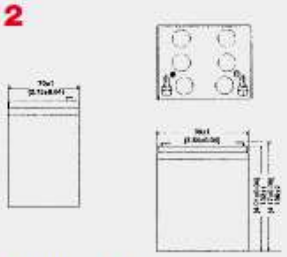
YUASA
RE SERIES
EXTENDED LIFE PRODUCTS

RE5-12FR 12V, 5.0Ah
RE7-12FR 12V, 7.0Ah
RE12-12FR 12V, 12.0Ah

Capacities-Dimensions-Weights

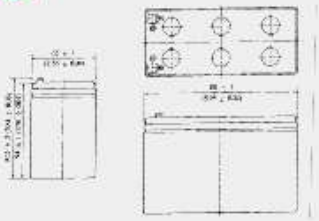
TYPE	NOMINAL CAPACITY				WEIGHT	DIMENSIONS			
	20 HR RATE 1.75 VPC	10 HR RATE 1.75 VPC	5 HR RATE 1.70 VPC	1 HR RATE 1.60 VPC		LENGTH	WIDTH	HEIGHT	OVERALL HEIGHT
RE5-12	0.25A - 5.00 Ah	0.46A - 4.60 Ah	0.85A - 4.30 Ah	3.00A - 3.00 Ah	4.30 lbs (1.95kg)	3.54" (90mm)	2.76" (70mm)	4.02" (102mm)	4.17" (106mm)
RE7-12	0.35A - 7.00 Ah	0.65A - 6.50 Ah	1.19A - 5.95 Ah	4.20A - 4.20 Ah	6.06 lbs (27.5kg)	5.94" (151mm)	2.56" (65mm)	3.70" (94mm)	3.84" (97.5mm)
RE12-12	0.60A - 12.00 Ah	1.15A - 11.50 Ah	2.20A - 11.00 Ah	7.20A - 7.20 Ah	9.15 lbs (4.15kg)	5.95" (151mm)	3.86" (98mm)	3.70" (94mm)	3.84" (98mm)

RE5-12



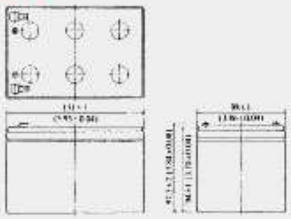
DIMENSIONS: INCHES (MM)

RE7-12



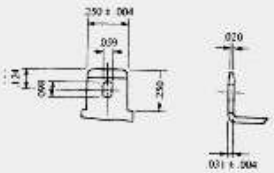
DIMENSIONS: MM (INCHES)

RE12-12



DIMENSIONS: (MM) INCHES

Terminal



INCH	MM
.250	6.35
.124	3.15
.098	2.50
.059	1.50
.031	0.79
.020	0.51

DIMENSIONS: INCHES

RECOGNIZED BY UL, File No. MH 16464

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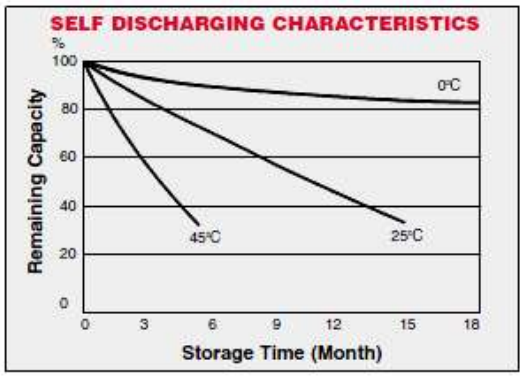

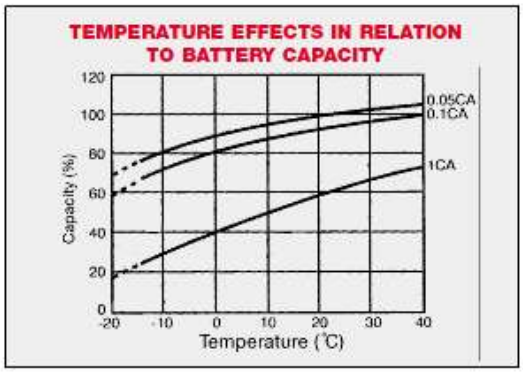

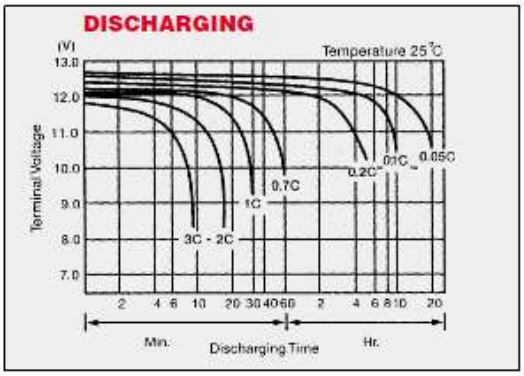

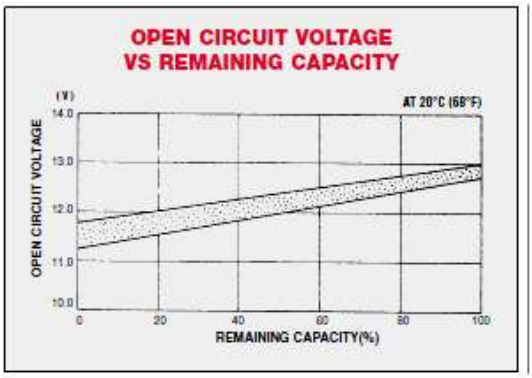

When the battery will be used by the current in excess of 3C, consult with EnerSys Inc. prior to use.

TYPE	ENERGY DENSITY (20 HR. RATE)	SPECIFIC ENERGY (20 HR.RATE)	INTERNAL RESISTANCE OF CHARGED BATTERY (approx.) (milliohms)	MAXIMUM DISCHARGE CURRENT (amps)	MAXIMUM SHORT-DURATION DISCHARGE CURRENT (amps)	CHARGING METHODS (at 20°C) VPC	
						CYCLE USE	STANDBY USE
RE5-12	1.54 WH/ cu. inch (94.1 WH/litre)	13.6 WH/lb (30.0 WH/kg)	18	40	120	Max. Current 1.25A 2.40 - 2.50 VPC	Max. Current 1.25A 2.25 - 2.30 VPC
RE7-12	1.49 WH/ cu. inch (91.0 WH/litre)	13.6 WH/lb (30.0 WH/kg)	30	40	120	Max. Current 1.75A 2.40 - 2.50 VPC	Max. Current 1.75A 2.25 - 2.30 VPC
RE12-12	1.70 WH/ cu. inch (104.3 WH/litre)	15.74 WH/lb (34.6 WH/kg)	16	40	180	Max. Current 3.0A 2.40 - 2.50 VPC	Max. Current 3.0A 2.25 - 2.30 VPC

CAUTION
- Avoid short circuit
- Do not charge in a sealed container.

Operating temperature range
Charge ..... 5°F to 122°F (-15°C to 50°C)
Discharge ..... -4°F to 140°F (-20°C to 60°C)
Charge retention (shelf life) at 68°F (20°C)
1 month 97%
3 months 91%
6 months 85%
Life expectancy
Standby use ..... 8 to 10 years
Cycle use (approx.)
100% depth of discharge ..... 180 cycles
50% depth of discharge ..... 425 cycles
30% depth of discharge ..... 1250 cycles
Sealed construction
Can be operated in any position.
Standard terminal ..... Quick Disconnect .250"
Housing material ..... Flame Retardant (UL94-VO)

Represented by:

When ordering new batteries, also remember to properly recycle your old lead batteries. Federal and state regulations require lead-acid batteries be recycled. EnerSys' nationwide service organization can arrange pickup, transportation to and recycling at any one of our company affiliated smelters. Call 1-800-972-7372 for more information.

EnerSys
Powerful Solutions

Sales Offices

Eastern Region:	*201-964-0118 • 1-800-962-1287 FAX 201-964-0720*
Western Region:	*562-949-4266 • 1-800-423-4667 FAX 562-949-5527*
Corporate Office:	*P.O. Box 14145, Reading, PA 19612-4145 FAX 610-372-8613*
Visit us on the web at:	*www.enersysstationary.com*

Please check our website for literature updates

Rev. - 5/01

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5.2.5 GPS antenna 8230001

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SYNERGY SYSTEMS, LLC **TECH NOTE** **#888**

Revised: March 31, 2006

Timing 3000 Antenna

General Description:

The Timing 3000 is a 100% form, fit, function replacement for the original Motorola Timing2000 GPS Antenna.

- Dual Pole Filter 40dB minimum at +/- 50MHz
- Rugged N Style Coaxial Connector
- Mounts with optional Right Angle Bracket or Pipe Adaptor
- Designed for fixed mount Precision Timing and Network Syncronization
- 25 dB Gain Typical

General Characteristics:

Parameter	Value
Operating Frequency:	1575.42 MHz, +/-2 MHz
Input Impedances:	50 Ohm
VSWR:	1.5 (typical)
Bandwidth:	25 MHz (typical) +/- 3dB points
Polarization:	Right Hand Circular
Azimuth Coverage:	360°
Elevation Coverage:	0° to 90°
Gain Characteristics of Antenna Element:	+2.0 dBic minimum at zenith -10 dBic minimum at 0° elevation
Filtering:	40dB minimum @ +/-50 MHz
LNA Gain:	25dB (typical)
Noise Figure:	1.5dB (typical)
Dynamics:	Vibration: SAE J1455

Electrical Characteristics:

Parameter	Value
Power Requirements:	5 +/- 0.25 Vdc
Power Consumption:	26mA @ 5 Vdc (typical)

Physical Characteristics:

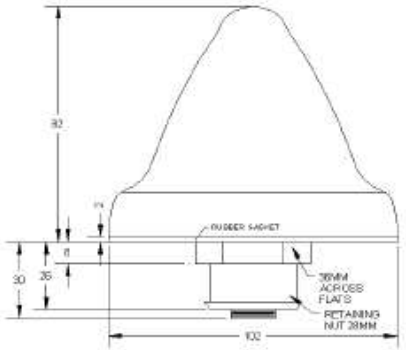
Parameter	Value
Dimensions:	102 diameter x 82 height (mm)
Weight:	312 grams
Mount:	Center mount (M28 nut)
Connector:	N-Connector (jack style)

Environmental Specifications:

Parameter	Value
Operating Temperature Range:	-40° C to +85° C
Storage Temperature Range:	-40° C to +100° C
Humidity:	95% noncondensing
UV Radiation:	JIS D0202 (Sunshine Carbon Arc System)
Salt Spray Test:	Spray 5% NaCl solvent at 35°C
Immersion Test:	1 meter (with connector sealed)
Transient Voltage Test:	+/- 12 kV

Note: All performance measurements are typical and referenced to 25°C unless indicated otherwise.

Dimensional Drawing:



Ordering Information:

Part Number	Configuration
10001724	with N connector

Accessories:

Part Number	Configuration
10001725	Right angle mount bracket
10001511-1	Converts M28x1 to 3/4in NPT & 1-14 Marine
10001511-0	Converts M28x1 to 1.0 in I.D. with setscrew

For configuration assistance, order placement and technical support call:

SYNERGY SYSTEMS, LLC
Time proven products and support

Phone: (858) 566-0666 · Fax (858) 566-0768
Email: oeminfo@synergy-gps.com · www.synergy-gps.com

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Prices and/or specifications subject to change without notice.

5.2.6 MPE declaration

Maximum Permissible Exposure Calculations

DAMM TETRA Base Stations
BS421, BS411, BS412, BS414

Product: Document No.: 128948/5

www.nemko.com

Introduction

The European limits for maximum permissible exposure are defined in document 1995/519/EC, Council Recommandation of 12. July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), Annex II, Table 1, of this document defines the basic restrictions. Annex III, Table 2, defines the reference levels of exposure. Meeting the reference levels ensures the meeting of the basic restrictions.

From table 2, in the frequency range from 10 to 400 MHz, the maximum power density(S) is 2 W/m². From 400 to 2000 MHz, the maximum power density is F/200 W/m², where (f) is the frequency. The DAMM TETRA Base Stations BS421,BS411, BS412 and BS414 transmits in the UHF band in different frequency bands.

Calculation of Safety Distance at MPE limit

$$S = \frac{PG}{4\pi R^2} \quad \text{or} \quad R = \sqrt{\frac{PG}{4\pi S}}$$

S= Power Density
P= (Power input to the antenna)
G= Power gain of the antenna in the direction of interest relative to an isotropic radiator
R= Distance to the centre of radiation of the antenna

BS421 10W 1 carriers Ptot= Carrier + 10log(N) +3 dB (ant.gain) = 20W
BS411 10W 8 carriers Ptot= Carrier + 10log(N) +3 dB (ant.gain) = 160W
BS411H 25W 8 carriers Ptot= Carrier + 10log(N) +3 dB (ant.gain) = 400W
BS412 7,5W 2 carriers Ptot= Carrier + 10log(N) +3 dB (ant.gain) = 30W
BS414 10W 4 carriers Ptot= Carrier + 10log(N) +3 dB (ant.gain) = 80W
BS414H 25W 4 carriers Ptot= Carrier + 10log(N) +3 dB (ant.gain) = 200W

Safety Distance from centre of radiation of the antenna (cm)

Freq. Band (MHz)	Table 2	Maximum power density S (mW/cm²)	BS421 Safety Distance 1 Ch.	BS411 Safety Distance 8 Ch.	BS411H Safety Distance 8 Ch.	BS414 Safety Distance 4 Ch.	BS414H Safety Distance 4 Ch.	BS412 Safety Distance 2 Ch.
336 – 346	2/10	0,2	89,21	252,31	398,94	178,41	282,10	109,26
360 – 370	2/10	0,2	89,21	252,31	398,94	178,41	282,10	109,26
390 – 400	2/10	0,2	89,21	252,31	398,94	178,41	282,10	109,26
420 – 430	(f/200)/10	0,2125	86,54	244,78	387,03	173,09	273,67	105,99
460 – 470	(f/200)/10	0,2325	82,74	234,02	370,01	165,47	261,64	101,33
850 – 870	(f/200)/10	0,43	60,84	172,08	272,08	121,68	192,39	74,51

Council Recommandation 1995/519/EC
Relevant Standard EN50385:2002

Date: 2011-10-06

Roy Uggerud

Roy Uggerud, Certification Manager

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Part-6: List of Figures & Index

DAMM – Stay in touch

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