Technical Description

Evolution Series METRO

Multi Service Radio Link System, 6 - 38 GHz

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Document history

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1. INTRODUCTION

The Nera Evolution Series microwave radio dramatically changes the operations for wireless transmission network owners. With a common platform architecture, which is fully software configurable; transmission capacity, system configurations and transmission protocols can be changed to adapt to future needs. Evolution Series dramatically reduces the cost of ownership. With significantly reduced number of parts and high MTBF Evolution Series ensures maximum uptime and low maintenance.

The Evolution Series microwave radio is designed to transmit data rates from about 6 Mb/s to 600Mb/s, in the frequency bands from 5 GHz to 38 GHz. The configuration of capacity and modulation is software configurable, giving an optimal balance between system gain and spectral efficiency.

Network operators can easily future proof the network as the microwave radio can easily adapt to the evolution of the transmission network. Growing traffic and the convergence of network technologies causes changing requirements, such as capacity upgrades, change of transmission systems between PDH, SDH/SONET and pure Ethernet; all this is simply implemented by software configuration change and change of interface modules. The available interfaces range from E1, T1, E3, DS3 STM-1/OC-3, STM-4/OC12 to 10/100BASE-TX and Gigabit Ethernet.

The Evolution Series product can be configured to work in three different modes. Payload capacity is also configurable and is selected by SW licences. Changes and upgrades can be done by the user without HW changes to the basic platform.

The **METRO** variant

- 155 Mb/s, 311Mb/s and 622 Mb/s transmission capacity
- Configurations up to 3+1/4+0
- CCDP configuration with XPIC
- 28, 40 and 56 MHz BW
- Options for embedded ADM mux / X-connect
- TDM traffic : 63xE1, 3xE3/DS3, 64xT1
- Advanced Ethernet : 4xFE and 1xGbE with QoS, nxVC12(VT1.5), VC-3(STS-1) or VC-4(STS-3-3c) mapping
- Traffic Node with 4 radio directions, SNCP with Ring, Chain, Star or Mesh topology

The **IP** variant

- 1xFE, 4xFE or 1xGbE
- Scalable 100, 150, 300 & 600 Mb/s transmission capacity
- 28, 40 and 56 MHz BW
- CCDP configuration with XPIC

The **XPAND** variant (ETSI)

- Scalable 8, 16, 32, 40, 80, 100, 160 Mb/s transmission capacity
- 7, 14 and 28 MHz BW
- Scalable TDM/Ethernet mix (step of 2Mb/s)
- 4, 8, 16, 20, 40, 50, 75 E1 capacity
- Ethernet 1xFE, scalable with 2 Mbit/s granularity
- Ring protection for E1s, based on SNCP

The **XPAND** variant (ANSI)

- Scalable 6, 12, 24, 48, 100 Mb/s transmission capacity
- 5, 10, 20 and 30 MHz BW
- Scalable TDM/Ethernet mix (step of 1,5Mb/s)
- 4, 8, 16, 32, 64 T1 capacity
- Ethernet 1xFE, 1.5 Mbit/s granularity
- Ring protection for T1s, based on SNCP

The Evolution Series is an integrated part of Nera's wide product portfolio, from the leading microwave specialist. The product portfolio covers products for all type of professional wireless carrier systems. Nera's microwave experience dates back more than 50 years, with a leading position in this field. The Evolution Series radio is integrated in Nera's new EM/NMS system, NetMaster.

This document contains specifications for **Evolution Series METRO**.

1.1. Features

The Evolution Series microwave radio utilises the latest advanced technology, a high degree of RF circuit integration, using Microwave Integrated Monolithic Circuits (MIMC), combined with advanced direct RF modulation, enabling a broadband, revolutionary compact design for a high power microwave module. The patented technology enables a revolutionary low power consumption and high reliability due to fewer parts in the radio module.

The modem contains multidimensional coded modulation, combined with a powerful block code. The resulting two-stage error correction improves system margin over traditional single FEC systems such as QAM, TCM or MLCM. The modem is extremely flexible, enabling an optimum configuration for all capacities and channel plans.

The ODU Unit consists of a XVCR and a Diplexer Unit. The ODU is frequency and capacity agile. The tuning range is very wide and most frequency bands can be covered by four variants for the whole band. The frequency setting is easy and is performed locally or remotely by the LCT function.

The ODU can for most frequency bands be mounted directly on the antenna, both in unprotected and protected configurations. The ODU can also be mounted on the antenna pole, using a short flexible waveguide to the antenna.

The InterFace Unit (IFU) is an extremely modular system, catering for the various system configurations and traffic interfaces by plug-in modules. The IFU can easily be expanded from a single channel system up to a traffic node handling up to 8 ODUs. The IFU contains the user interfaces, baseband processing and multiplexing, management and radio interface.

The demodulator contains an integrated digital interference canceller, which can be used to provide the XPIC function, enabling two carriers to be transmitted over the same frequency, using dual polarised antennas.

The optional embedded ADM/DXC function provides multiplexing for user traffic into the STM-1/OC-3 signal. In traffic node systems, the digital cross connect (DXC) routes the user traffic between the various link directions without the need for cabling or external multiplexers. Chain, ring, star and mesh topologies are supported, with individual choice of unprotected or protected (SNCP) traffic circuits. The multiplexer supports a mix of traffic types, such as E1, T1, E3, DS3 and Ethernet.

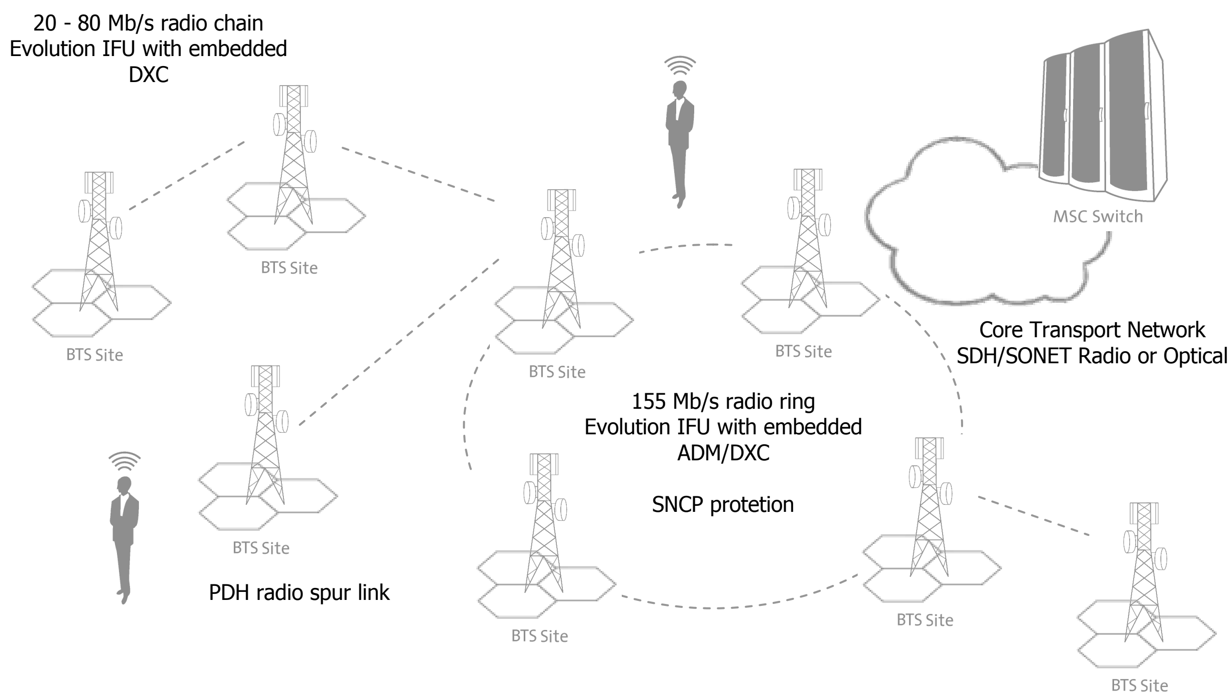
The equipment configuration, licences and the operating software version can be stored on the memory key available for plug-in at the front of the equipment or downloaded to a computer. When a new Supervisory Unit is inserted, the equipment configuration can then easily be restored to the radio equipment.

1.2. Network Applications

The Evolution Series microwave radio is ideally suited for a wide range of applications. Due to the flexibility in configurations, the choice of traffic interfaces and the capacity scalability, it can easily adapt to the specific requirements of a given network application. The flexibility and ease- of upgrade, future proof the investment, as the equipment can grow with the increasing traffic demand as well as easily adapt to other transmission technologies.

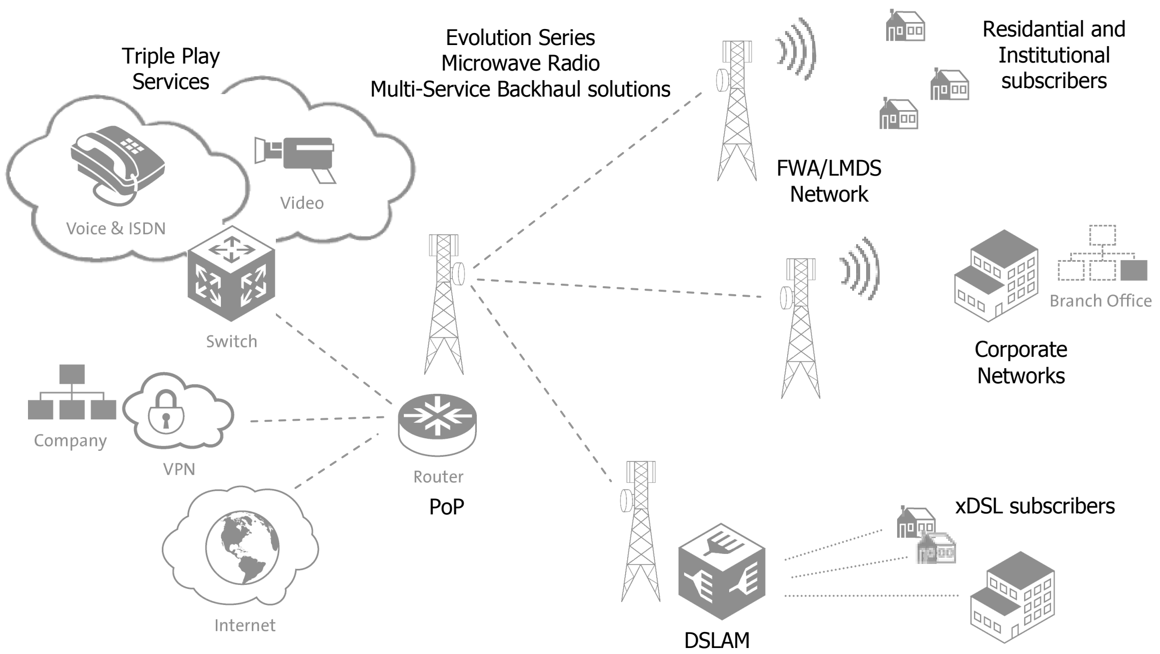
Mobile (BTS) Backhaul

- The Evolution Series microwave radio is ideal for demanding and critical application such as backhaul of BTS traffic. Where loss of traffic directly results in loss of revenue, reliability and maximum uptime are critical parameters for the network operator. The Evolution Series reliable and flexible architecture as well as high system gain, ensures increased availability of the offered services, and a secured revenue stream. The optional embedded ADM multiplexer and cross-connect enables routing of traffic without the need for external cabling. Further, the traffic circuits can be individually protected via ring or mesh topologies, and various traffic types can be mixed, sharing the transmission capacity of the radio. The radio can be configured for a wide range of capacities, ensuring an optimal utilization of the available spectrum as well as capabilities for upgrading when traffic demand increases or new services are introduced.
- With the introduction of new mobile technologies (3G), as an overlay network or a Greenfield installation, the aggregate capacity demand typically raise above 16xE/T1. High density PDH and/or SDH radios are needed, and a common platform system, represent large savings in the network operation, compared to more traditional network designs.



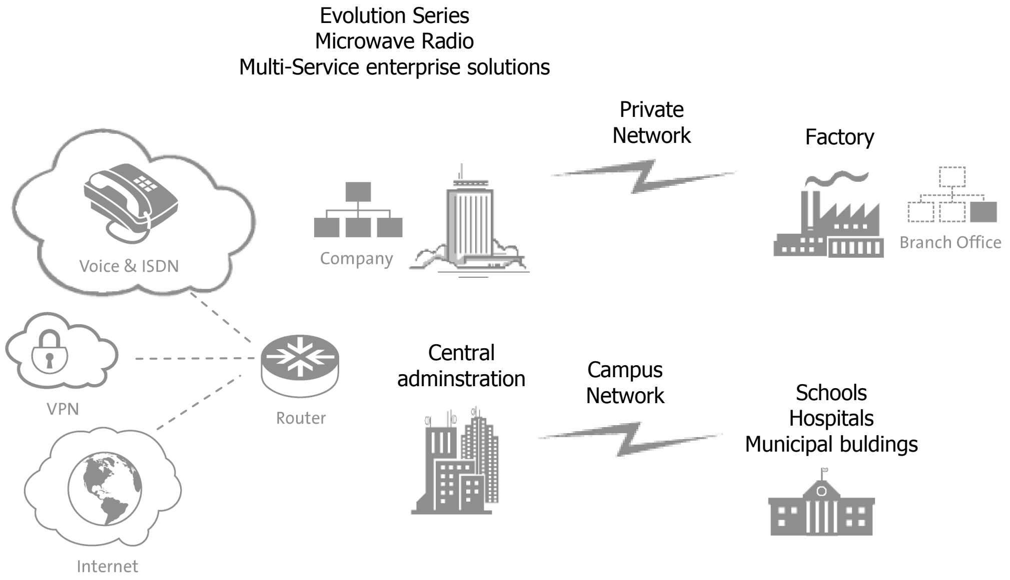
LMDS/FWA Backhaul

- *LMDS/FWA backhaul.* The Evolution Series radio is well suited for backhaul of traffic from Point-to-MultiPoint radio access systems like WiMax. With a selectable capacity, ranging from about 20 Mb/s to 600Mb/s, the Evolution Series radio can easily be deployed in small network as well as in larger constellations and networks with several sites linked together. The choice of pure Ethernet/Gigabit Ethernet, 155Mb/s SDH/SONET, or a combination of TDM (E1/T1/E3/DS3) with Ethernet/Gigabit Ethernet, makes the Evolution Series suitable for any FWA network installation.
- *DSLAM backhaul.* The introduction of xDSL services can in some cases uncover a new challenge. The local transmission network may only be dimensioned for the POTS traffic and is not suited for high speed data. Upgrading the local network to fibre might not be feasible due to time and/or cost of such upgrade. The Evolution Series microwave radio offers an easy and flexible solution to this challenge. The Evolution Series microwave radio can offer backhaul of the DSLAM to the optical backbone network, whether the network interfaces are PDH, ATM/SDH/SONET or Ethernet/Gigabit Ethernet. With the Evolution Series radio, the various traffic types are catered for merely by change of interface modules.



Private Networks Operators

- *Corporate/Campus Networks.* The Evolution Series radio is a good alternative to more common unlicensed microwave solutions. With higher capacity, choice of pure Ethernet/Gigabit Ethernet, 155Mb/s SDH/SONET, or a combination of TDM (E1/T1/E3/DS3) with Ethernet/Gigabit Ethernet, makes the Evolution Series suitable for most private networks, whether they are carrying legacy services or data only. Flexibility and simplicity, combined with a predictable reliability, proves for many network owners to be an unbeatable combination.



2. SYSTEM DESCRIPTION

The Evolution Series microwave radio system comprises an indoor part (IFU), and an outdoor part (ODU) and an antenna. The IFU and ODU is interconnected with coaxial cable which carries transmit and receive user traffic, management communication between the IFU and ODU, and the power supply to the ODU.

2.1. Interface Unit (IFU) description

The Evolution Series IFU is a 1RU high modular unit, containing 9 plug-in slots for various modules. The modular architecture with plug-in slots enables a high degree of flexibility, ease of upgrading/changing configurations and easy maintenance.

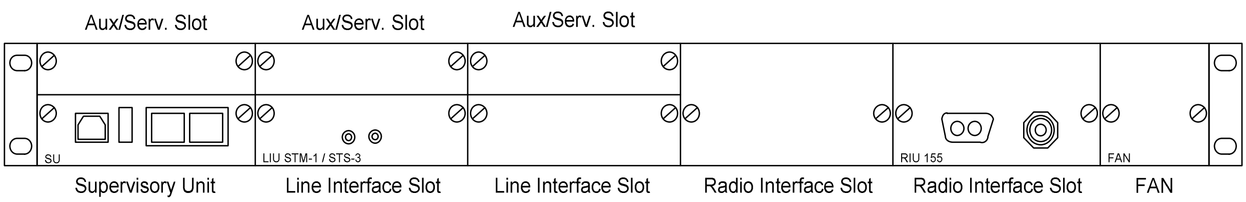


Figure 2-1 IFU, 1+0 system

The basic IFU frame is common in all configurations and up to four basic IFU frames can be stacked together by a rear mounted IFU connection panel.

- The lower left position contains the Supervisory Unit. The Supervisory Unit is handling the configuration of all system units as well as reporting system status to the EM/NMS system.
- The rightmost position houses the FAN Unit, handling the ventilation and temperature management of the IFU frame.
- The Line Interface slots houses the various user traffic interfaces and optional DXC Unit. The PDH and Ethernet traffic interfaces are full height and covers the upper Aux/Serv. position as well.
- The two Radio Interface slots houses the RIU Unit(s) or Power Supply Unit. The RIU provides connection to the ODU and includes power supply to the unit and the ODU.
- The upper Aux/Serv. slots houses any Auxiliary or Service Channel units, such as Alarm and Control Unit, Wayside Unit, 64 kb Data Channels Unit and EOW Unit.

All units can be replaced in the field. Non traffic carrying units can be replaced without interrupting the service. See paragraph 2.3 for further description of the various plug-in units.

2.2. OutDoor Unit (ODU) description

The ODU hardware is capacity and modulation independent. It consists of a XCVR and a Diplexer. The XCVR is tuneable over the whole frequency band, both high and low part. The diplexer determines the sub-band coverage. The ODU is normally mounted directly to the antenna for all configurations. In HSB and 1+1/2+0 configurations an RF-Coupler is used when connecting the ODU to the antenna interface.

An optional pole mount kit is also available.

Figure 2-2 ODU, 1+0 System

2.3. IFU Unit Descriptions

2.3.1. Supervisory Unit

The Supervisory Unit is handling the configuration of all the system units as well as reporting system status to the EM/NMS system. It has two 10/100 BASE-TX Ethernet ports and two USB ports; one host port and one device port.

The Ethernet ports are connected to an internal switch and can both be used for connection to the EM/NMS system and/or for connecting terminals together in an Ethernet LAN. One of the Ethernet ports (LAN2) can be used for wayside traffic. The Ethernet traffic is then mapped in the wayside traffic capacity.

The USB host port serve as the LCT port. The USB ports can also be used to connect IFUs together, and the host port can be used as interface for storage devices for SW backup and download.

2.3.2. Radio Interface Unit – RIU

The RIU contains the interface for connecting the IFU to one ODU with a single coaxial cable. It also contains the connector for power supply to IFU and ODU.

2.3.3. Line Interface Unit – LIU

The LIU contains the interface for connecting the user traffic to the IFU. The LIU is available for a wide range of traffic types, ranging from E1, T1, STM-1/OC-3 to STM-4/OC-12 and Ethernet traffic interface unit.

2.3.4. Digital X-Connect Unit

The optional DXC Unit handles the SDH/SONET x-connect and SNCP function as well as the SETS function. The multiplex structure is selectable between SDH and SONET. The SETS function handles node synchronisation and selection of synchronisation sources.

2.3.5. Wayside Unit

The Wayside Unit supports two wayside channels, selectable to either E1 or T1 traffic. One RF-channel can carry one wayside channel.

2.3.6. Alarm and Control Unit

The unit provides interfaces for collection of external alarms or analogue values, and relays for external alarm and control outputs.

- Eight alarm inputs
- Four relay outputs
- Seven analogue inputs

2.3.7. 64 kb/s Serial Channel Unit

The unit contains four 64kbit/s channel interfaces. Two with co-directional interface, one with contra-directional interface and one V.11 interface (without byte timing). The channels are used for user traffic and can be routed towards line or radio.

2.3.8. EOW Unit (Service channel)

The EOW Unit provides a party line service channel for voice communication to other terminals in the network. It provides the following functions:

- Selective call with two digit telephone number.
- Collective call by pressing *-button.
- Built-in bridge for east/west connections.
- 4-wire analogue interfaces for connection to other service channel equipment.
  - One 4-wire Interface with level adjustment
  - Two Other Equipment (OE1 and OE2) interfaces
  - The two OE interfaces can be configured for Daisy-chain operation
- The pinning configuration is adapted to standard Ethernet CAT-5 cable; this enables use of standard cables.

The IFU can be equipped with two service telephone plug-in units unit. A standard telephone handset connects to the unit.

2.3.9. Fan Unit

The Fan Unit handles temperature management of the IFU and consists of three fans. An alarm is generated if one of the fans should fail. The Fan Unit is field replaceable without interrupting the service.

2.3.10. Power Supply Unit

This unit is used if the IFU is not equipped with RIU or for duplicated power supply in a 1+0 configuration.

3. SYSTEM CONFIGURATIONS

Evolution Series METRO is available in the following configurations:

- 1+0 (Unprotected)
- 1+1 Hot Standby
- 1+1 Hot Standby – Dual Baseband
- 1+1 Hot Standby – Dual antenna/Space Diversity
- 1+1 Frequency Diversity
- 1+1 Frequency Diversity – Space Diversity
- 1+1 Frequency Diversity – Dual Polarised
- 2+0 Dual frequency – Single Polarisation (DF-SP)
- 2+0 Single frequency – Dual Polarisation (SF-DP/CCDP)

3.1. 1+0 system

The 1+0 configuration consists of an IFU basic frame, a Line Interface Unit, a Radio Interface Unit, a single coaxial cable to the ODU and an ODU mounted directly on the antenna or near the antenna. When the ODU is not mounted directly on the antenna, a short flexible waveguide is used to connect the ODU to the antenna port.

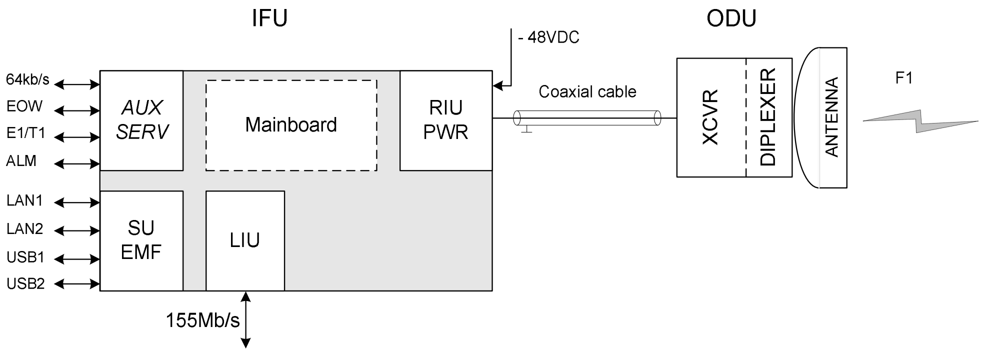


Figure 3-1 System Block Diagram 1+0 Terminal

Legend

ALM	External alarm input/output
AUX	Auxiliary functions
EMF	Embedded Management Functions
EOW	Engineering Order Wire
LAN	Local Area Network port (10/100BASE-TX Ethernet)
LIU	Line Interface Unit
RIU	Radio Interface Unit
PWR	Power Supply
SERV	Service functions
SU	Supervisory Unit
USB	Universal Serial Bus
XCVR	Transmitter/Receiver

3.2. 1+1 HSB / 1+1 FD system

The 1+1 HSB or 1+1 Frequency Diversity configuration, consist of an IFU basic frame, a Line Interface Unit, two Radio Interface Units, two coaxial cables to the ODUs and two ODUs mounted on an RF-Coupler Unit. The RF-Coupler can be asymmetrical or symmetrical, and the RF-Coupler/ODU assembly can be mounted directly on the antenna or near the antenna. When the RF-Coupler is not directly mounted, a short flexible waveguide is used to connect the RF-Coupler to the antenna port.

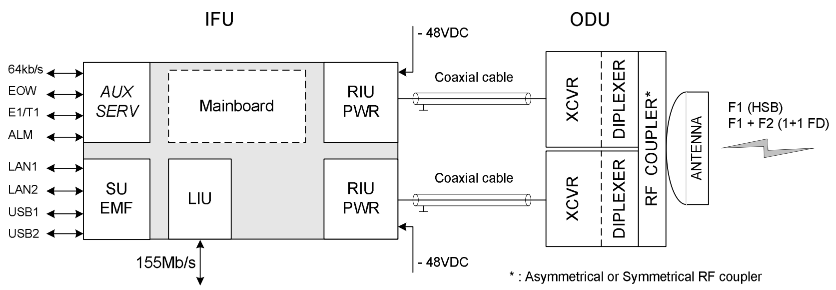


Figure 3-2 System Block Diagram 1+1 HSB/FD Terminal

3.3. 2+0 / 1+1 HSB Dual Baseband system

A 2+0 system or 1+1 HSB Dual Baseband is identical to the 1+1 HSB or 1+1 Frequency Diversity configuration except for the use of two Interface units. The two LIUs provide interface protection in HSB configuration.

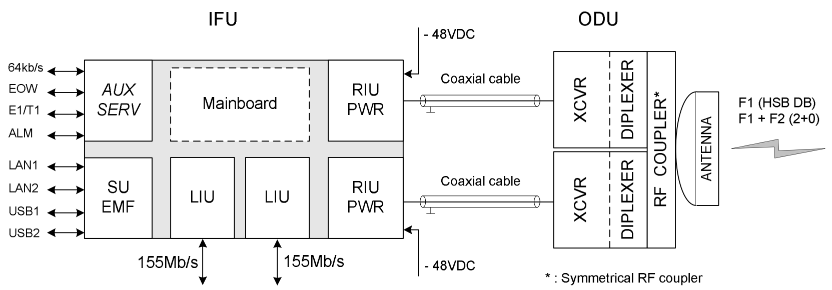


Figure 3-3 System Block Diagram 2+0 Terminal

3.4. Space Diversity/Dual Antenna system

The 1+1 HSB or 1+1 Frequency Diversity configuration can be configured for Space Diversity or Dual Antenna. This configuration uses two antennas, and the two ODUs are mounted one on each antenna without using an RF-Coupler. The use of Space Diversity/Dual Antenna reduces the RF loss and provides path diversity, which can improve system performance (subject to frequency band and path type and length).

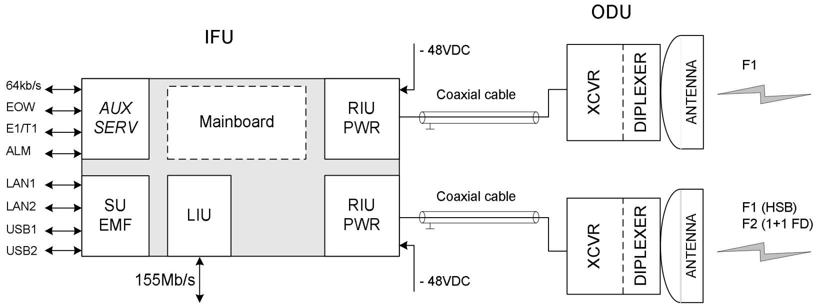


Figure 3-4 System Block Diagram Space Diversity Terminal

3.5. Co-channel Dual Polarised (CCDP) system

In two channel systems the two ODUs can be arranged with dual polarisation (Horizontal and Vertical), utilising a single RF frequency. The RIU contains a XPIC function in this configuration, and the XPIC will handle the interference between the two received signals. See also paragraph 5.3.3 for further description of the XPIC function.

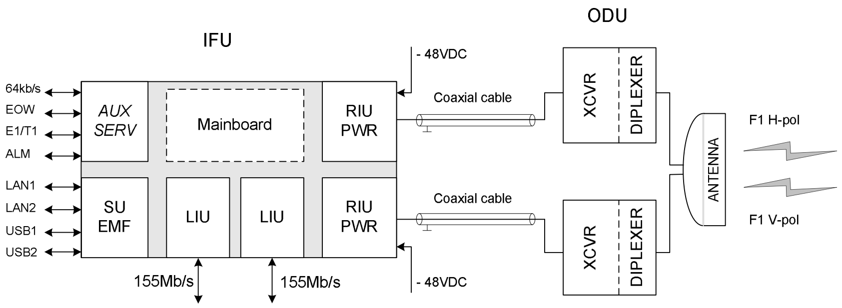


Figure 3-5 System Block Diagram CCDP Terminal

3.6. ADM Ring/Chain system

The equipment can be configured for a wide range of network configurations including terminal and traffic node with two, three or four antenna directions with Add/Drop and digital x-connect of traffic between the directions. The user interfaces (LIUs) can be a mix between E1/T1, E3/DS3, Ethernet and STM-1/OC-3.

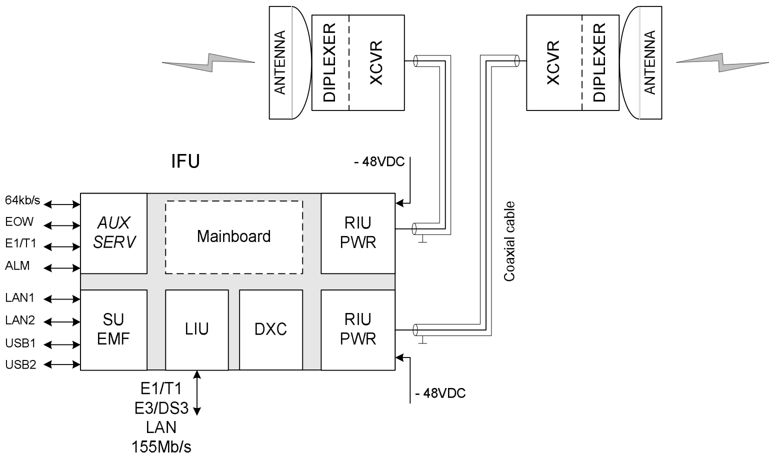


Figure 3-6 System Block Diagram ADM Traffic Node

4. EQUIPMENT CHARACTERISTRICS

4.1. Frequency bands

The **Evolution Series METRO** is available in ITU-R, CEPT, FCC and national frequency bands according to the following tables. Details about ODU tuning range is found in Appendix 1.

Frequency Band	Frequency [GHz]	Channel Plan	Duplex spacing [MHz]	STM-1/OC-3 BW [MHz]
L6 GHz	5.9-6.4	ITU-R F. 383-7 CEPT 14-01E	252.04	29.65
U6 GHz	6.4-7.1	ITU-R F.384-8 CEPT 14-02 E	340	40
U6 GHz	6.4-7.1	ITU-R F.384-8	340	30
7 GHz	7.1-7.4	ITU-R F.385-7 Annex 3	196	28
7 GHz	7.1-7.4	CEPT 02-06 Annex 1	154	28
7 GHz	7.1-7.4	ITU-R F.385-8 Rec. 1-4	161	28
7 GHz	7.1-7.4	ACA Rali FX3	270	30
7 GHz	7.2-7.5	ITU-R F.385-8 Rec. 1-4	161	28
7 GHz	7.4-7.7	ITU-R F.385-8 Annex 3	168	28
7 GHz	7.4-7.7	ITU-R F.385-8 Annex 1,4	154	28
7 GHz	7.4-7.7	ITU-R F.385-8 Annex 1, 1 CEPT 02-06 Annex 1	154	28
7 GHz	7.4-7.7	ITU-R F.385-8 Rec 1-4	161	28
7 GHz	7.4-7.9	ITU-R F.385-8 Annex 4	245	28
7 GHz	7.1-7.7	“Korea”	300	30
8 GHz	7.7-8.3	ITU-R F.386-6 Annex 1	311.32	29.65
8 GHz	7.7-8.3	7.7-8.3 GHz, 40 MHz CS	310	40
8 GHz	7.9-8.4	ITU-R F.386-6 Annex 4	266	28
8 GHz	7.9-8.5	CEPT 02-06	310	28
11 GHz	10.7-11.7	ITU-R F. 387-9 Rec. 1	530	40/30
11 GHz	10.7-11.7	ITU-R F. 387-9 Annex 1 CEPT 12-06 Rec. 1	530	40
11 GHz	10.7-11.7	ITU-R F. 387-9 Annex 2 CEPT 12-06 Rec. 3	490	40
13 GHz	12.7-13.3	ITU-R F. 497-6 CEPT 12 02F	266	28
15 GHz	14.4-15.35	ITU-R F.636-3	490	28
15 GHz	14.5-15.35	ITU-R F.636-3	420	28
15 GHz	14.6-15.2	CFT Mexico	315	28
15 GHz	14.5-15.35	CEPT 12-07E	728	28
15 GHz	14.5-15.35	ACA RALI FX3	644	28
18 GHz	17.7-19.7	ITU-R F.595-8 CEPT 12-03E	1010	55/27.5

Frequency Band	Frequency [GHz]	Channel Plan	Duplex spacing [MHz]	STM-1/OC-3 BW [MHz]
18 GHz	17.7-19.7	ITU-R F.595-8 Norma No 15/96	1560	55/27.5
18 GHz	17.7-19.7	China	1092.5	27.5
18 GHz	17.7-19.7	China	1120	55
23 GHz	21.2-23.6	ITU-R F.637-3 Annex 3 CEPT 13-02E	1008	56/28
23 GHz	22.0-23.6	RA 352	1008	56
23 GHz	21.2-23.6	ITU-R F.637-3 Annex 4	1200	50
23 GHz	21.2-23.6	ITU-R F.637-3 Annex 1	1232	56/28
26 GHz	24.25-26.5	ITU-R F.748-4 Annex 1 CEPT 13-02E	1008	56/28
32 GHz	31.8-33.4	ITU-R F.1520-2 CEPT (01)02	812	56/28
38 GHz	37.0-39.5	ITU-R F.749-2 Annex 1 CEPT 12-01E	1260	56/28
38 GHz	38.6-40.0	ITU-R F.749-2 Annex 3, 1	700	50

Table 4-1 Frequency bands ETSI

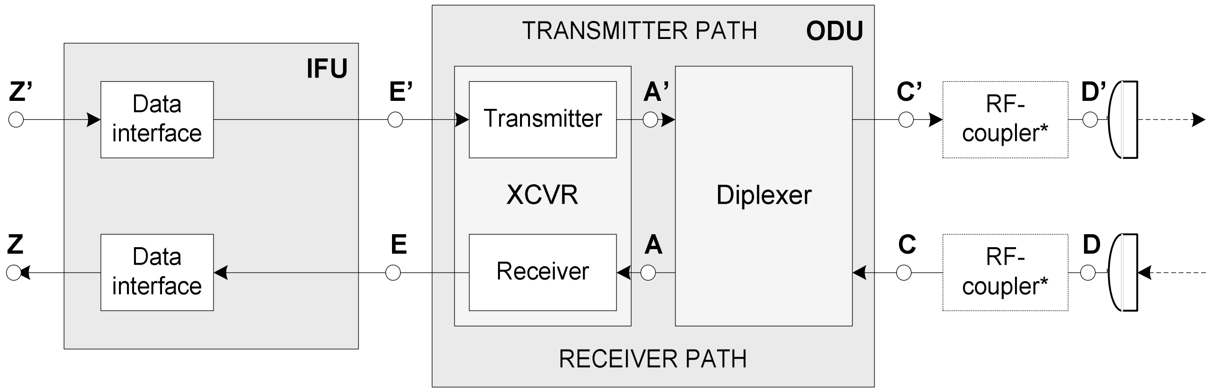
Freq. Band	Frequency [GHz]	Channel Plan	Duplex spacing [MHz]	STM-1/OC-3 BW [MHz]
L6 GHz	5.9 - 6.4	CFR47 101.147 Table (i-8) SRSP –305.9	252.04	29.65
U6 GHz	6.4 - 7.1	SRSP –306.4*	100/340	30
7 GHz	7.1 - 7.4	SRSP –307.1	175	30
7 GHz	7.4 - 7.7	SRSP –307.1	150	30
8 GHz	7.7 - 8.3	SRSP –307.7	300	30
11 GHz	10.7 - 11.7	CFR47 101.147 Table o-6, o-7 SRSP –310.7	490	30/40
18 GHz	18.7-19.7	CFR47 101.147 Table r-6, r-7	1560	40/55
23 GHz	21.2-23.6	CFR47 101.147 Table s-5,6,7	1200	30/40/50
38 GHz	38.6-40.0	CFR47 101.147 Table v-1	700	50

Table 4-2 Frequency bands ANSI

4.2. General Equipment Specifications

4.2.1. Equipment Reference Points

A principle block diagram for a digital radio relay system, including the main blocks, is shown in Figure 1-1. The block diagram includes marked interface points, which serve as reference points for several technical parameters used in this document.



* The RF-Coupler is used in HSB and 1+1/2+0 single polarised configurations

Figure 4-1 Principle block diagram for a radio system

4.2.2. ETSI Equipment Class

The equipment is compliant to the relevant specifications in EN 302 217 for the following classes.

Frequency band	BW	Modulation	Class
6-38 GHz	~30MHz	128 state	5A (ACAP) 5B (ACCP/CCDP)
U6, 11, 18 GHz	40 MHz	64 state	5B
18-38 GHz	56 MHz	32 state	4

Table 4-3 ETSI Equipment Class

4.2.3. Modes of operation

The system can be operated in Adjacent Channel Alternate Polarization (ACAP) mode, Adjacent Channel Co-Polarization (ACCP) mode, and Co-Channel Dual Polarized (CCDP) mode.

4.2.4. Electromagnetic Compatibility Conditions (EMC)

ETSI: The equipment conforms to the EMC standard as specified in EN 301 489 part 1 and 4.
FCC: The equipment conforms to FCC Part 15 subpart B class A.

4.2.5. Safety conditions

The equipment conforms to EN 60215, EN 60950 and UL/CSA 60950. The optical interfaces conform to EN 60825-1 and EN 60825-2.

4.2.6. RoHS and WEEE compliance

The equipment is compliant to EU Directive 2002/95/EC (RoHS) and EU Directive 2002/96/EC (WEEE)

4.2.7. Equipment Type Approval

The equipment is type approved and labelled according to EU Directive 1999/5/EC.
The CE marking is located on both IFU and ODU.

4.2.8. Environmental conditions

The equipment conforms to the environmental classes defined in ETS-300-019:

- **Transportation:** ETSI-EN-300-019-1-2, class 2.3, public transportation. (temperature range: -40 °C to +70 °C).
- **Storage:** ETSI-EN-300-019-1-1, class 1.2, weather protected, not temperature-controlled storage locations. (temperature range: -40 °C to +70 °C).
- **Use:**
  - Indoor mounted units: Temperature range: -5 °C to +50 °C. According to ETSI-EN-300-019-1-3, class 3.2, partly temperature-controlled locations. For temperatures between +45°C and +50°C the relative humidity must be between 5% and 40%.
  - Outdoor mounted units: Standard temperature range: -33 °C to +50 °C. According to ETSI-EN-300-019-1-4, class 4.1, non weather protected locations.

For temperatures below 0°C the equipment must be switched on for at least 10 minutes in order to operate according to the specifications.

4.3. Mechanical Characteristics

4.3.1. Installation

The equipment is very easy and quick to install. It is designed for stationary use in split mount installations. IFU and ODU are interconnected with coaxial cable. One cable for each ODU is used. (i.e. Two cables needed for HSB, 1+1 FD and 2+0 systems).
The IFU can be installed as a stand-alone unit, or it can be mounted in a standard 19" rack.(Ref. IEC 297-2 and IEC 297-3) or in an ETSI standard cabinet (Ref. ETSI EN 300 119).
The ODU[1] may be mounted directly to the antenna for antenna sizes up to and including 1.8 m. Alternatively the ODU can be supplied with a mount for a vertical column (Ø=60-115).

4.3.2. Dimensions

IFU[2]	1+0/1+1/HSB:		444 mm (W) x 225 mm (D) x 44 mm (H), 17.5" x 8.9" x 1.73"
ODU	1+0	6 - 11 GHz:	227 mm (W) x 140 mm (D) x 240 mm (H), 8.9" x 5.5" x 9.4"
ODU	1+0	13 - 38 GHz:	206 mm (W) x 132 mm (D) x 210 mm (H), 8.1" x 5.2" x 8.4"
RF Coupler		6 - 11 GHz[3]:	232 mm (W) x 102 mm (D) x 415 mm (H), 9.1" x 4.0" x 16.3"
		13 - 38 GHz:	220 mm (W) x 106 mm (D) x 374 mm (H), 8.7" x 4.2" x 14.7"

4.3.3. Weights

IFU:	2.5 kg / 5.5 lbs
ODU 6 - 11 GHz:	8.0 kg / 17.7 lbs
ODU 13 - 38 GHz:	6.5 kg / 14.3 lbs
RF Coupler:	5 kg / 11 lbs

[1] The ODUs in 6 GHz are pole mounted
[2] The width and depth of the unit are exclusive flanges (mounting brackets) and table studs for free-standing mounting. Special brackets for mounting into different cabinets are available
[3] The 6 GHz RF-coupler has a shorter antenna insert

4.4. Power supply and consumption

The equipment operates from a battery supply between -40.5 volt and -57 volt, nominally -48 volt DC according to EN 300 132-2. The primary DC-power is supplied to the indoor unit through a filtering function that includes input filter to attenuate the common mode noise.
The power to the outdoor unit is supplied from the indoor unit via the IFU-ODU coaxial cable.

Terminal without interface	**L6-11 GHz**		**13-38 GHz**	
	Average	Maximum	Average	Maximum
1+0 Terminal	65 W	71 W	52 W	58 W
HSB/1+1/2+0 Terminal	117 W	128 W	91 W	102 W

Table 4-4 Power consumption terminal

Unit	
ODU L6-11 GHz	48 W
ODU 13-38 GHz	35 W
Basic IFU, incl. SU and fans	13.5 W
Radio Interface Unit	9.3 W
Line Interface Unit, electrical, S-1.1 optical	2.3 W
Line Interface unit, L-1.1, L-1.2 optical	4 W
Auxiliary Units, 64 kb, Wayside and Alarm Unit	2 W
Service channel Unit	2.5 W
3xE3/DS3 Interface Unit	3 W
25xE1and 16xT1 Interface Unit	4 W
Gigabit Ethernet Unit	10 W
DXC Unit	5.5 W

Table 4-5 Maximum power consumption units

4.5. System Reliability

4.5.1. Mean Time Between Failures (MTBF)

The MTBF figures are predicted and calculated according to methods in MIL-HDBK-217E including adjustment for experienced field data.
MTBF for 1+0 Terminal with electrical 155 Mb/s interface: 30 Years

Unit name:	**MTBF, 25 °C ambient temp: [Hours]**
Transceiver Unit (ODU)	400 000
Basic IFU incl. one RIU	1 000 000
RIU	3 200 000
Supervisory Unit	3 200 000
Interface units	1 600 000-5 000 000
DXC	5 000 000

5. RADIO CHARACTERISTICS

5.1. Transmitter Characteristics

5.1.1. Nominal Output Power 155 Mbit/s

Typical values measured with modulation (PRBS-data). Ref. Point C'.
The tolerance is ± 1.5 dB for 6-11 GHz and ± 2 dB for 13-38 GHz
For RF-Coupler loss see chapter 5.5.2

Frequency band: [GHz]	L6	U6	7	8	11	13/15	18	23	26	32	38
~28 MHz channel [dB]	+25	+25	+24	+24	+23	+18	+17	+17	+16.5	+16	+15.5
40 MHz channel [dB]	-	+25	-	-	+23	-	+17	-	-	-	-
~56 MHz channel [dB]	-	-	-	-	-	-	+18	+18	+17.5	+17	+16.5

Table 5-1 Nominal output power, 155 Mbit/s

5.1.2. Automatic/Manual Power Control (ATPC/MTPC)

ATPC is an optional feature, which is aimed to drive the TX power amplifier output level from a proper minimum, which is calculated to facilitate the radio network planning and is used in the case of normal propagation, up to a maximum value, which is given in Chapter 5.1.1. When ATPC is disabled (i.e. MTPC mode), the output power can be set by the user.

ATPC-figures:
Transmitter power output regulation speed > 50 dB/s
ATPC-range 20 dB

Nominal input level is adjustable by the user.
Adjustment range: -30 dBm to -60 dBm

In Hot Standby configuration it is recommended to use simultaneous switching of Tx and Rx side within a terminal, when ATPC is enabled.

MTPC figures:
MTPC range: 15 dB[1]
Step size: 0.1 dB
Accuracy: See output power tolerance in Chapter 5.1.1

5.1.3. TX oscillator frequency tolerance

Frequency tolerance: ≤ ± 10 ppm
This limit includes both short-term factors (environmental effects) and long-term ageing effects.

[1] For compliance to optional ETSI mask requirement of -60 dBc in 3-8 GHz the MTPC range is 10 dB.

5.2. Receiver Characteristics

5.2.1. Receiver Threshold 155 Mb/s

Typical values measured with modulation (PRBS-data). Ref. Point C'.
Guaranteed values are 1.5 dB higher. For RF-Coupler loss see chapter 5.5.2

Frequency band: [GHz]	18	23	26	32	38
BER ≤ 10-6 [dBm]	-74	-74	-73.5	-72.5	-72
BER ≤ 10-8 [dBm]	-73	-73	-72.5	-71.5	-71
BER ≤ 10-10 [dBm]	-72.5	-72.5	-71.5	-70.5	-70

Table 5-2 Receiver threshold, 155 Mb/s in ~56 MHz channel

Frequency band: [GHz]	U6	11	18
BER ≤ 10-6 [dBm]	-73.5	-73	-71.5
BER ≤ 10-8 [dBm]	-72.5	-72	-70.5
BER ≤ 10-10 [dBm]	-71.5	-71	-69.5

Table 5-3 Receiver threshold, 155 Mb/s in 40 MHz channel

Frequency band: [GHz]	L6	U6	7	8	11	13/15	18	23	26	32	38
BER ≤ 10-6 [dBm]	-71	-71	-71	-71	70.5	-70	-69	-69	-68.5	-67	-66.5
BER ≤ 10-8 [dBm]	-69.5	-69.5	-69.5	-69.5	-69	-68.5	-67.5	-67.5	-67	-65.5	-65
BER ≤ 10-10 [dBm]	-68	-68	-68	-68	-67.5	-67	-66	-66	-65.5	-64.5	-63.5

Table 5-4 Receiver threshold, 155 Mb/s in ~28 MHz channel

The listed values are for ACAP configuration, if filtering for ACCP is required a setting for this is available. The threshold will be 1 dB higher for BER ≤ 10-6 and 1.5 dB higher for BER ≤ 10-8 and BER ≤ 10-10.

5.2.2. Maximum input level

Maximum input signal levels in point C (measured with PRBS of 2^{23}-1).
These limits apply without interference:

Frequency band: [GHz]	6-18	23-38
BER ≤ 10^{-6} [dBm]	-17	-20
BER ≤ 10^{-8} [dBm]	-19	-22
BER ≤ 10^{-10} [dBm]	-21	-24

Table 5-5 Maximum input signal level

5.2.3. RX oscillator frequency tolerance

Frequency tolerance: ≤ ±10 ppm
This limit includes both short-term factors (environmental effects) and long-term ageing effects.

5.2.4. Noise Figure

Ref. Point C. Guaranteed Values.

Frequency band: [GHz]	**6-8**	**11**	**13/15**	**18/23**	**26**	**28**	**31/32**	**38**
Noise figure F [dB]	≤ 3.9	≤ 4.4	≤ 4.8	≤ 5.8	≤ 6.3	≤ 7.3	≤ 7.4	≤ 7.9

5.3. Interference sensitivity

5.3.1. Co-channel interference sensitivity

The limits of the co-channel interference sensitivity are shown in Table 5-6, referred to point C. The table shows maximum C/I values for 1 dB and 3 dB increase of the 10^{-6} BER threshold.

System		**C/I at BER = 10-6 @ RSL Degradation**	
Capacity	Channel BW	**1 dB**	**3 dB**
155 Mb/s	~30 MHz ACCP	32.5 dB	28.5 dB
155 Mb/s	~30 MHz ACAP	31.5 dB	27.5 dB
155 Mb/s	40 MHz	28 dB	24 dB
155 Mb/s	~56 MHz	24.5 dB	20.5 dB

Table 5-6 Co-Channel Interference Sensitivity

5.3.2. Adjacent channel interference sensitivity

The limits of the adjacent channel interference sensitivity are as given in Table 5-7, referred to point C. The tables show maximum C/I values for 1 dB and 3 dB increase of the 10^{-6} BER threshold.

System		**C/I at BER = 10-6 @ RSL Degradation**	
Capacity	Channel BW	**1 dB**	**3 dB**
155 Mb/s	~30 MHz ACCP	-5 dB	-8 dB
155 Mb/s	~30 MHz ACAP	3 dB	-1 dB
155 Mb/s	40 MHz	-4 dB	-8 dB
155 Mb/s	~56 MHz	-5 dB	-9 dB

Table 5-7 Adjacent Channel Interference Sensitivity

5.3.3. XPIC performance

The Cross Polarisation Interference Canceller filter (XPIC) is used in CCDP configurations for systems with ~28 MHz, 40 MHz, or ~56 MHz bandwidth. The XPIC filter has a typical XIF of 20 dB.

5.4. System Performance

5.4.1. System Gain

Typical values: 155 Mb/s @ BER 10^{-6} - ref point C'C.
For RF-Coupler loss see chapter 5.5.2

Frequency band: [GHz]	L6	U6	7	8	11	13/15	18	23	26	32	38
~30 MHz channel [dB]	96	96	95	95	93.5	87.5	86	86	83.5	83	82
40 MHz channel [dB]	-	98.5	-	-	96	-	88.5	-	-	-	-
~56 MHz channel [dB]	-	-	-	-	-	-	92	92	91	89	88.5

Table 5-8 System gain, 155 Mbit/s vs. channel bandwidth

5.4.2. Equipment background BER (Residual BER)

Typical residual BER ≤ 10^{-14}.

5.4.3. System Signature

The equipment includes an Adaptive Time Domain Equaliser (ATDE). The system signature is specified below for 6.3 ns delay. The limits are valid for both minimum and non-minimum phase.

Channel Bandwidth	~56 MHz	40 MHz	~28 MHz	~28 MHz (ACAP)
Max. notch depth, minimum and non-minimum phase [dB]	22	22	22	24
Signature bandwidth [MHz]	39	34	28	28
Signature factor, typical value	TBD	TBD	1.5	1.2
Dispersive Fading Margin (Bellcore), typical value [dB]	TBD	TBD	50	52

Table 5-9 Typical signature values 155 Mb/s

5.5. Diplexer and Antenna Interface

5.5.1. General description

The diplexer determines the ODU sub-band coverage and duplex spacing. Most frequency bands are divided into only two sub-bands. See APPENDIX 1 for details. ODU transmit and receive frequency can be set to any frequency within the given pass-band range.

5.5.2. RF-Coupler

The additional loss for RF-Coupler is given in Table 5-10. The RF-Coupler is used in protected configurations and single polarised 2+0 systems.

	Symmetrical RF-Coupler		**Asymmetrical RF-Coupler**			
			Main		**Protection**	
	Nom	Max	Nom	Max	Nom	Max
Transmission loss [dB]	3.4	3.8	1.5	2	6.5	7

Table 5-10 RF-Coupler loss

5.5.3. Interface to Antenna feeder system

The interface between the ODU and the antenna feeder system is rectangular waveguide. The waveguide flange type can be found in Table 5-11.

Frequency band [GHz]	**L6/U6**	**7/8**	**11**	**13**	**15**	**18/23/26**	**32/38**
Waveguide	R70	R84	R100	R120	R140/ WR62	R220/ WR42	R320
Flange type	PDR70	CBR84	CBR100	CBR120	CBR140	CBR220	CBR320

Table 5-11 ODU waveguide flange type

5.6. IFU-ODU Interface

5.6.1. Cable interface characteristics

The following signals are transmitted via the cable:

- Transmit and Receive data signal.
- Power to the ODU.
- IFU - ODU Communication (IO-Com) for configuration and control of the ODU.

The cable interface has over-voltage, over-current and reverse polarity protection.
The equipment compensates automatically for different cable lengths.

5.6.2. Cable characteristics

The cable must be in accordance with the following requirements:

Cable requirements:

Characteristic impedance:	50 ± 3 Ω
Max. attenuation at 47 MHz:	9 dB
Max. attenuation at 140 MHz:	18 dB
Max. attenuation at 373 MHz:	30 dB
Max. cable length:	300 m
Connector:	TNC, male

Recommended cables and maximum lengths at 40.5 Volt:

Cable **50Ω**	Maximum cable length with minimum supply voltage. (40.5 volt)
Cinta CNT 400 (¼″) (Andrew)	200
Heliax LDF1-50. (¼″) (Andrew)	200
Cellflex LCF 14-50J(¼″) (RFS)	200
Heliax LDF2-50. (3/8″) (Andrew)	300
Cellflex LCF 38-50J (3/8″) (RFS)	300

Table 5-12 Cable lengths, IFU-ODU cable

5.7. Radio Protection Switching (RPS)

5.7.1. Specification of the protection switching system

In order to facilitate switching without introducing bit-errors, a hitless switching system is provided. The Radio Protection Switching function is used in HSB and 1+1 Frequency Diversity configurations. Automatic and manual switching is available. The manual switching can be hitless or forced and is performed from the Element Manager. In Hot Standby configurations the TX- and RX- switching at a terminal normally operates independently, but they may be configured to operate together.

5.7.2. Low Priority Traffic

In a 1+1 Frequency Diversity system it is possible to use the protection channel for low priority traffic.

5.7.3. Switching criteria and switching operation time, Rx

Alarm	Switch time	Configurable
EW (Early Warning)	*	Yes
LBER (Light degradation)	*	Yes
HBER (Significant degradation)	5 ms	Yes
Low RF Input level	5 ms	Yes
Sync loss OOF	5 ms	No
Rx Alarm IFU (LOF, LOC)	5 ms	No

The thresholds for the BER criteria, HBER, LBER and Early Warning (EW), are configurable.
* Depending on alarm detection time.

5.7.4. Switching criteria and switching operation time, Tx

Alarm	Switch time
LIU TX Alarm (input) 1	50 ms
IFU MB TX Alarm (input) 1	50 ms
RIU TX Alarm (input)	50 ms
Radio TX Alarm (ODU)	50 ms

[1] Used only in HSB Dual Baseband

6. BASEBAND CHARACTERISTICS

6.1. Embedded SDH Multiplexer Functionality

The equipment can be equipped with a DXC Unit providing SDH/SONET multiplexer functionality. It can be configured as terminal, ADM with two transmission directions or as X-connect with up to four transmission directions. The node has a non-blocking cross-connect capability at VT1.5, VC-12, VC-3/STS-3 and VC-4 levels with a total cross-connect capacity of 4×VC-4/STS-3. The data traffic can be a mix of TDM and Ethernet.

6.1.1. Line and Tributary Interfaces

The node can be equipped with the following type of interface units.

- 155 Mb/s electrical or optical.
- 12xE1 and 25xE1
- 8xT1 and 16xT1
- 3xE3/DS3
- Ethernet (4x10/100BASE-TX, 1000BASE-T and 1000BASE-X (SFP))

6.1.2. Mapping and multiplexing

The equipment supports both SDH and SONET mapping. For Ethernet traffic, GFP mapping is used. See chapter 6.6.2 for more details.

SDH Mapping and multiplexing of E1 and E3 according to Figure 6-1 is supported.

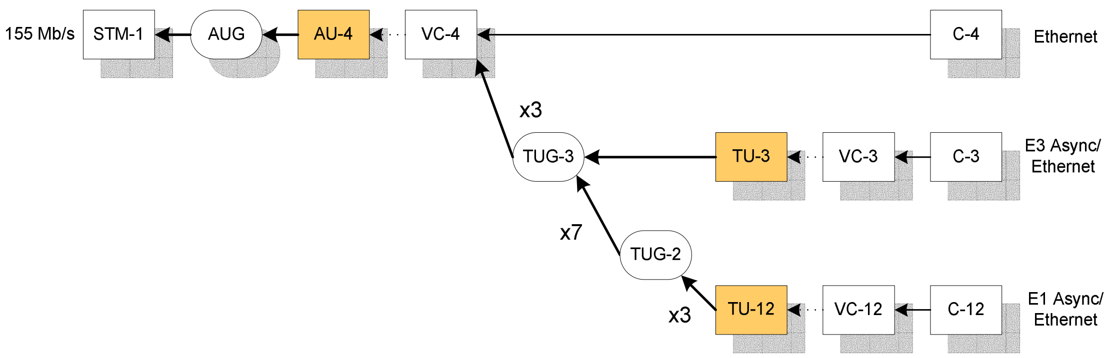


Figure 6-1 SDH Mapping and Multiplexing

SONET Mapping and multiplexing of DS1 and DS3 according to Figure 6-2 is supported.

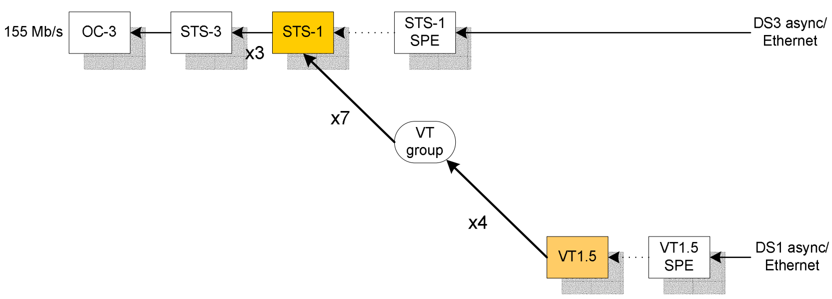


Figure 6-2 SONET Mapping and Multiplexing

6.1.3. Sub Network Connection Protection

In a ring or mesh topology the traffic signals can be protected by SNCP. This is done by transmitting the relevant VC/SPE in both directions in the ring. At the receive direction, the available or better-quality signal is selected.

The following switching criteria are used:

- AU/TU AIS and AU/TU LOP alarms
- Path error performance
- Unequipped Signal and Trace Identifier at VC level
- User Command from the LCT or from EM/NMS.

The protected VC-n/SPEs circuits can be selected from any STM-1/STS-3 signal connected to the DXC.

6.2. Section Termination

The radio channel can be configured with RS- or MS-termination according to ITU-T Rec.G.783. When the radio is configured with DXC or tributary units, the radio will always be configured for MS-termination. When the equipment is not equipped with DXC or tributary units it will be configured with RS-termination and the radio link is a regeneration section.

6.3. Scrambling / descrambling functions

The system contains both a STM-1/STS-3 scrambler/descrambler according to ITU-T Rec. G.707 and a radio specific scrambler/descrambler, which randomises the transmitted digital signal in order to make the RF power spectrum as uniform as possible, irrespective of the transmitted data.

6.4. Section/Transport Overhead (SOH/TOH)

Use of TOH/SOH is according to ITU-T Rec. G.707.
Access to bytes in MSOH at a regenerator is according to ITU-R Rec.750. A description is given in Table 6-1: Shaded bytes can be used for 2Mb/s, 1.5 Mb/s or Ethernet wayside channel. These bytes and the E1, E2, F1, MS#1-3, Z1#1-2, or Z2#2 bytes can be used as 64 kb/s user channels.

RSOH:	A1	A1	A1	A2	A2	A2	J0	N	N
	B1	MS#1	MS#2	E1	X	X	F1	N	N
	D1	MS#3	X	D2	X	X	D3	X	X
MSOH:	H1	H1	H1	H2	H2	H2	H3	H3	H3
	B2	B2	B2	K1	X	X	K2	X	X
	D4	X	X	D5	X	X	D6	X	X
	D7	X	X	D8	X	X	D9	X	X
	D10	X	X	D11	X	X	D12	X	X
	S1	Z1#1	Z1#2	Z2#1	Z2#2	M1	E2	N	N

Table 6-1 Utilisation of SOH bytes

6.4.1. SOH/TOH Frameword and bytes

The first nine bytes in the frame (row 1 in SOH/TOH) are unscrambled according to ITU-T Rec. G.707.

A1:	Frameword (11110110)
A2:	Frameword (00101000)
N:	Bytes reserved for national use. Used for wayside or user channel
J0:	Regenerator Section Trace
B1:	BIP-8 (Bit Interleaved Parity-8) (RST)
B2:	BIP-24 (Bit Interleaved Parity-24) (MST)
MS#1-3:	Media specific bytes. User channel
E1-byte:	User channel
F1-byte:	User channel
H1-H3:	AU-pointers.
K1/K2-byte:	Bytes for APS signalling. MSP function is not implemented
K2 (b6-b8)	MS-Remote Defect Indication
D1-D3 bytes:	Embedded control channel - Regenerator, ECCr
D4-D12 bytes:	Embedded Control Channel - Multiplexer -ECC-M
S1-byte:	Synchronisation Status Message
Z1/Z2-byte:	User channel
M1-byte:	Remote Error Identifier (MS-REI)
E2-byte:	User channel

6.5. Synchronisation

The terminal contains an optional SETS function included in the DXC Unit. In RST mode the SETS function is not required and the incoming 155 Mb/s signal is transmitted without re-timing. Transmit and receive directions are independent from each other and can have different timing sources.

In MST mode the SETS function is providing the equipment clock. The SETS function can be synchronised to one of the following sources:

- 155 Mbit/s signal from line or radio direction
- 2 MHz clock input
- One selectable 2 or 1.5 Mbit/s tributary input signal
- Internal oscillator (free running)

The user sets the available synchronisation references in priority order. The highest quality source is used to synchronise the equipment clock, but if there are several sources available with equally high quality, the source with higher priority is used. If a timing source is not available (loss of signal) or its timing signal is outside tolerances, the SETS function will select the next available source with the highest quality.

6.5.1. Synchronisation status messaging

Synchronisation status messaging can be used to ensure that the best available timing source will be used. The messaging is also used to prevent timing loops in SDH ring and mesh networks. The status messaging is transferred in the S1 byte in the Section Overhead.
The synchronisation status quality levels are shown in the table below.

Abbr.	ETSI Ref.	Quality
G.811	QL_PRC	Primary Reference Clock (PRC) defined in ITU-T rec. G.811
G.812T	QL_SSU T	Transit node clock defined in ITU-T rec. G.812
G.812L	QL_SSU L	Local node clock defined in ITU-T rec. G.812
SETS	QL_SEC	Synchronous Equipment Timing Source (internal oscillator)
Do Not Use	QL_DNU	Do not use for synchronisation (to prevent timing loops)

Table 6-2 Synchronisation quality levels

In case the synchronisation status message is not contained in the synchronisation input signal, for example in the 2 MHz or in 2/1.5 Mbit/s input signal, the quality level can be defined manually by the operator.

6.5.2. 2.048 MHz synchronisation input/output characteristics

Electrical interface according to ITU-T Rec. G.703:		
Frequency:		2.048 MHz ± 4.6 ppm*
Impedance:		120 Ω balanced.
Return loss (2.048 MHz):		≥ 15 dB
Pulse amplitude (2MHz output):	Maximum	1.9 V
	Minimum	1.0 V
Maximum attenuation of input signal at 1.024 MHz:		6 dB
Connector type:		RJ-45

- Actual output frequency is depending on the synchronisation source accuracy

6.6. Ethernet functionality

6.6.1. General

Ethernet traffic can be transported over the radio link by using the Fast/Gigabit Ethernet Module. The transmission capacity is scalable from one VT1.5/VC-12 to four VC-4 (600 Mb/s).

6.6.2. Ethernet over SDH Mapping

The equipment supports standardised GFP-F mapping with linear extension header according to ITU-T G.7041/Y.1303. Mapping into 1-63xVC-12, 1-3xVC-3 and 1-4xVC-4 is supported.

6.6.3. VCAT and LCAS support

Evolution Series METRO can map Ethernet frames into virtual concatenated VC-x/VTx containers. LCAS (ITU-T G.7042/Y.1305) is implemented for auto detect of bandwidth and handling of the VC-x/VTx containers.

The LCAS protocol implemented covers the following functions:

- Automatically temporary removal of a faulty VCAT member.
- Automatically insertion of a temporary removed VCAT member when the fault is repaired.
- Hitless increase of the VCG capacity by adding a VCG new member.
- Hitless decrease of the VCG capacity by removing a current VCG member.

6.6.4. QoS handling.

The QoS characteristics of the system will naturally be governed by the queuing and buffering strategies of the subsystems. To allow for a wide array of applications for this product these strategies are made user selectable. The following QoS related settings are configurable:

- Per. port priority by mapping into default IEEE 802.1p priorities.
- Mapping from IPv4/v6 priority (TOS, Diff-Serv, Traffic class) to an internal 4 level priority scheme.
- Mapping from IEEE 802.1p/q priority to an internal 4 level priority scheme.
- Per. port ingress rate limiting
- Selectable QoS queuing strategy. Strict or fair (8:4:2:1) strategy.
- Selectable traffic strategy: prevent head of line blocking (full QoS) or maximum throughput (limited QoS). Limited QoS supports ingress rate limiting and per port flow control.
  - If enabled, IEEE 802.1p/Q priority will override IPv4/IPv6 and port priorities.
  - If enabled, IPv4/IPv6 priority will override port priority.
  - Per port flow control and ingress rate limitation can be set independently of other settings.

6.6.4.1. Queuing Strategy

The Ethernet unit uses two different QoS queuing strategies. Strict queuing means that the QoS ordering of packets is the only consideration for the packet scheduler. In this mode no lower priority packets will be forwarded as long as higher priority packets are available for forwarding.

Fair queuing on the other hand tries to distribute forwarding capacity between the different priority levels to prevent high priority data streams from completely blocking lower priority streams. Scheduling is done according to a fair weighting applied to the four priority queues.

6.6.4.2. Buffering strategy

The amount of internal buffering will strongly influence latency of the data streams. Restricting buffering capacity will typically improve overall latency, while increasing packet losses due to traffic bursts. The prevent head of line blocking utilizes the minimum buffering for enhanced QoS performance while maximum throughput uses maximum buffer size.

6.6.5. Link-Loss Failure pass through on the Ethernet port

Evolution Series supports a Link-Loss Failure pass through, LLF. This is useful for routers or switches to detect that the Ethernet connection has failed or there is no pass through connection through the radio link side. The LLF function is based on the principle that the interface on the opposite side will be disconnected when the link on the Ethernet port or the radio link has failed. Hence, a failure situation will be communicated to either ends in the link configuration.

When there is a radio link failure, the LLF function will control the Ethernet link on the opposite side of the radio link by the link status on each side. I.e. if the incoming Ethernet signal on one side is disconnected, the output on the Ethernet port on the opposite side will be turned off.

6.7. Transmission Interfaces - TDM

6.7.1. Interface characteristics 155 Mbit/s electrical

Electrical interface according to ITU-T Rec. G.703:

Bitrate:	155.520 Mbit/s ± 20 ppm
Line code:	CMI
Impedance:	75 Ω unbalanced
Maximum attenuation of input signal at 78 MHz:	12.7 dB
Connector type:	DIN47297, 1.0/2.3mm, dual (IEC 60169-29)

6.7.2. Interface characteristics 155 Mbit/s optical - Intermediate Reach

Optical interface based on **single mode** fibre (G.652 – single mode).
According to ITU-T Rec. G.957; S-1.1 and ANSI: T1.105.06; IR-1
Approximate reach: 15 km

Bitrate:	155.520 Mbit/s ± 20 ppm
Operating wavelength range:	1261 - 1360 nm
Source type:	MLM
Mean launched power: - Maximum:	-8 dBm
- Minimum:	-15 dBm
Minimum receiver sensitivity (BER < 10^{-10}):	-28 dBm
Minimum receiver overload:	-8 dBm
Connector type:	LC Duplex

6.7.3. Interface characteristics 155 Mbit/s optical - Long Reach 1300nm

Optical interface based on **single mode** fibre (G.652 – single mode). Approximate reach: 40 km
According to ITU-T Rec. G.957; L-1.1 and ANSI: T1.105.06-1996; LR-1

Bitrate:	155.520 Mbit/s ± 20 ppm
Operating wavelength range:	1263 - 1360 nm
Source type:	MLM
Mean launched power: - Maximum:	0 dBm
- Minimum:	-5dBm
Minimum receiver sensitivity (BER < 10^{-10}):	- 34 dBm
Minimum receiver overload:	-10 dBm
Connector type:	LC Duplex

6.7.4. Interface characteristics 155 Mbit/s optical - Long Reach 1500nm

Optical interface based on **single mode** fibre (G.652 – single mode). Approximate reach: 80 km
According to ITU-T Rec. G.957; L-1.2 and ANSI: T1.105.06-1996; LR-2

Bitrate:	155.520 Mbit/s ± 20 ppm
Operating wavelength range:	1480 - 1580 nm
Source type:	SLM
Mean launched power: - Maximum:	0 dBm
- Minimum:	-5dBm
Minimum receiver sensitivity (BER < 10^{-10}):	-34 dBm
Minimum receiver overload:	-10 dBm
Connector type:	LC Duplex

6.7.5. Interface characteristics 1.5 Mbit/s

Electrical interface according to ANSI T1.102-1993 and ITU-T Rec. G.703:

Bitrate:	1.544 Mbit/s ± 32 ppm
Line code:	B8ZS
Impedance:	100 Ω balanced.
Line Build Out [feet]:	0-133, 133-266, 266-399, 399-533, & 533-655
Connector type wayside:	RJ-45/RJ48C
Connector type tributaries:	50 pin multiconnector

6.7.6. Interface characteristics 2 Mbit/s

Interface parameters according to ITU-T Rec. G.703:

Bitrate:	2.048 Mbit/s ± 50 ppm
Line code:	HDB3
Impedance:	120 Ω balanced
Maximum attenuation of input signal at 1.024 MHz:	6 dB
Connector type wayside:	RJ-45/RJ48C
Connector type tributaries:	50 pin multiconnector

6.7.7. Interface characteristics 34 Mbit/s

Interface parameters according to ITU-T Rec. G.703:

Bitrate:	34.368 Mbit/s ± 20 ppm
Line code:	HDB3
Impedance:	75 Ω unbalanced
Maximum attenuation of input signal at 17.184 MHz:	12 dB
Connector type:	DIN47297, 1.0/2.3mm, dual (IEC 60169-29)

6.7.8. Interface characteristics 45 Mbit/s

Electrical interface according to ANSI Recommendation T1.102-1993

Bitrate:	44.736 Mbit/s ± 20 ppm
Line code:	B3ZS
Impedance:	75 Ω unbalanced
Power level:	-4.7 to +3.6 dBm for AIS signal
Connector type:	DIN47297, 1.0/2.3mm, dual (IEC 60169-29)

6.8. Transmission Interfaces - Ethernet

6.8.1. Transmission interface characteristics – 10/100 BASE-TX:

Connector type: RJ-45
Electrical interface: IEEE 802.3 Full Duplex
The interfaces are configurable by management software.

- Each port can be configurable Auto-Negotiation, 10BASE-T or 100BASE-TX, half or full duplex.
- Flow control for full duplex connection according to IEEE 802.3x.

6.8.2. Transmission interface characteristics – 1000 BASE-T:

Connector type: RJ-45
Electrical interface: IEEE 802.3 Full Duplex
The interfaces are configurable by management software.

- The port is configurable to Auto-Negotiation, 10BASE-T, 100BASE-TX, or 1000 BASE-T.
- Flow control for full duplex connection according to IEEE 802.3x.

6.8.3. Transmission interface characteristics – 1000 BASE-LX

1.25 Gigabit Ethernet Optical Transceiver (SFP Module) for Single Mode Fibre
Specification: IEEE 802.3z/ab
Operating wavelength range: 1310 nm
Typical reach 10 km
Connector type: LC Duplex

6.8.4. Transmission interface characteristics – 1000 BASE-SX

1.25 Gigabit Ethernet Optical Transceiver (SFP Module) for Multi Mode Fibre
Specification: IEEE 802.3z/ab
Operating wavelength range: 850 nm
Typical reach 500 m
Connector type: LC Duplex

6.9. Wayside traffic and auxiliary interfaces

6.9.1. Wayside channel characteristics

One plug-in unit supports two wayside channels. Each interface is configurable to 1.5 Mb/s or 2 Mb/s.
For interface specification see 6.7.6
The wayside channel is transported in SOH, see chapter 6.4

6.9.2. 64 kbit/s channel characteristics

Four 64kbit/s channel interfaces are available

- Two 64kb/s according to ITU-T G.703, Co-directional timing.
- One 64kb/s according to ITU-T G.703, Contra-directional timing.
- One 64kb/s according to ITU-T V.11, Contra-directional timing without byte timing.

Connector type: RJ-45

The 64 kb/s channels can be transported in available user channels is SOH, see chapter 6.4 or in two user channels in the radio frame.

6.9.3. Service telephone/Orderwire interfaces

The unit has four RJ-45 connectors, one for handset and three for analogue connections.

Telephone connector type: RJ-45 (IEC 60603-7)

The performance of the service telephone complies in general with ITU-T Rec. G.712:

- Code: PCM
- Signalling: DTMF according to ITU-T Rec. Q.23
- Frequency range: 0.3 – 3.4 kHz
- Impedance 600 Ω

The unit has three 4-wire analogue interfaces for connection to other service channel equipment:

OE1 and OE2 Interfaces,

- Not Galvanic Isolated.
- Input/output level -6 dBm

4 Wire Interface.

- Galvanic Isolated
- Input/output level: 4 dBm, 0 dBm -6 dBm (Nominal) and -10 dBm.

The EOW is transported in a 64 kb/s channel, see chapter 6.4 for available user channels in the SOH. The radio frame also has two user channels which can be used.

6.9.4. Alarm and Control Unit

The unit has four RJ45 connectors.
Transient protection: Amplitude: < 100 V
Transient protection: Duration: < 10 ms, non-repetitive

External alarm input interfaces:

Number:	Eight two-pin interfaces. Galvanic isolated.
Interface:	Current loop
State on:	> 3.0 mA
State off:	< 1.0 mA

Relay output interfaces:

Number:	Four two-pin outputs.
Contact Ratings	
Inductive Load:	0.5A at 24V DC 0.1A at 110V DC
Resistive Load:	0.8A at 24V DC 0.1A at 110V DC

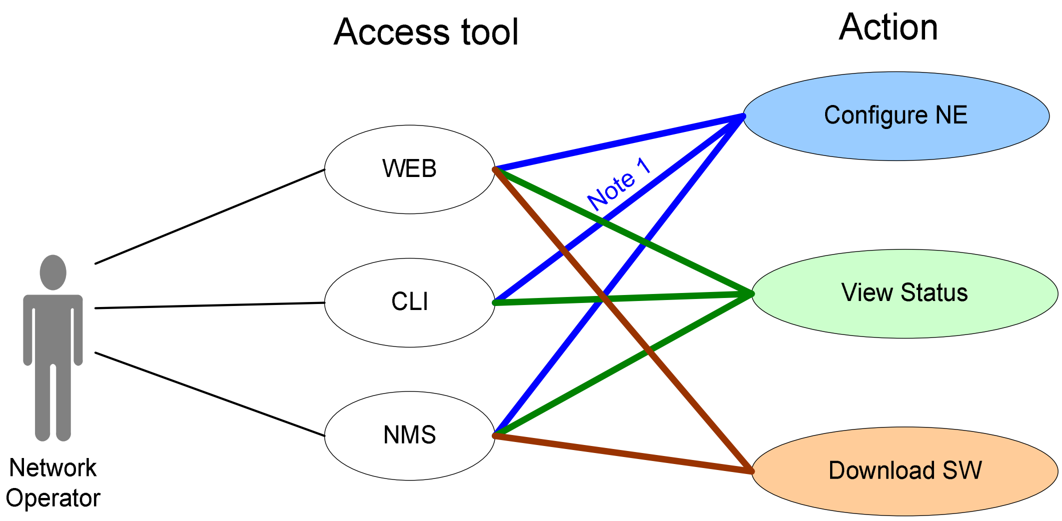
Analogue Input Interfaces:

Number:	Seven single ended inputs, common analogue ground. Not galvanic isolated.
4 inputs:	Voltage Range: 0-20V DC Impedance >100k ohm
2 inputs:	Voltage Range: 18-65V DC Impedance >100k ohm
1 input:	Current Range: 0-50 mA Impedance 50ohm

7. MANAGEMENT SYSTEM CHARACTERISTICS

7.1. General

The powerful integrated supervisory system of Evolution Series provides user-access to the NEs in a most dynamic manner. The management function in the NE can be accessed by the use of a web-browser, Command Line Interface (CLI) or by a SNMP manager such as the NERAs management systems NetMaster EM/NMS.



Note 1: Configuration from CLI is limited.

A NE is controlling all the units connected to a specific node with a common supervisory unit. The NE software performs the following management tasks:

Fault management:	Collecting and logging of alarms and analogue measurements from the management units connected to the Node.
Performance management:	Collecting and logging quality measurements according to standards (G.784)
Configuration management:	Configuration of node (including configuration up/download) and Software download
Security management:	Configuration of user id/password and the users privileges in the NE. Includes logging in NE of user actions.

7.1.1. Event logging

Evolution Series NEs can log events and faults in the local fault log. The log size is 10.000 events. The log can be set to wrap-around or halt when it is full. Alarm logging can be masked based on severity level. The operator can also clear the log.

7.1.2. Monitoring of system performance

Transmission performance data is monitored continuously by the built-in supervision function. The supervision function performs measurements and calculations based on the BIP-codes in the SOH. Traffic bit error rate information from the modem is also available.

7.1.2.1. System performance calculations

Performance data are based on the ITU-T Rec. G.826 system performance parameters. The following system quality calculations are included:

Performance Calculations	Regenerator Section Termination Calculations based on B1 (BIP-8)	Multiplexer Section Termination Calculation based on B2 (BIP-24)
Error Second Ratio (ESR)	Yes	Yes
Severely Error Second Ratio (SESR)	Yes	Yes
Background Block Error Ratio (BBER)	Yes	Yes
Unavailable state (UAS)	Yes	Yes

Table 7-1 Performance Calculations

7.1.2.2. Performance record logging

Evolution Series calculates the performance in G.826 performance parameters based on B1, B2, and M1 parity checksums. The performance records are calculated for STM-1 line interface and for received STM-1 from radio side. 15-min, 24-hour and month records are calculated. The log contains the current and last month, current and last 24-hour and current and the sixteen last 15-min records.
Threshold values can be defined each of the performance records and a performance alarm will be raised if the threshold is exceeded for any of the periods.

In addition cumulative error counters for B1, B2, and M1 parity pulses and for the G.826 performance parameters are available. The operator can read and reset the counters.

7.1.3. Security management

The user must have a username and password defined in the NE in order to log in. Each user name is defined with access privileges. Four levels are defined;

User level	Privileges
Passive Users	Passive users are only able to monitor data. They are not able to change any configuration.
Active Users	Same as Passive. In addition active users are able to reset counters.
Master Users	Master users have access to all commands, except those related to user account administration and Configuration/SW download.
Admin Users	Admin users have access to all commands. The Admin user is the administrator and is responsible for adding, deleting and managing user accounts and privileges. In addition the admin user is responsible for Configuration/SW download.

7.1.3.1. Security event logging

The NE can log events related to security. The log size is 1000 events. When it is full it will wrap-around. The operator can also clear the log.

7.2. ECC (Embedded Communication Channel)

For communication over a link the ECC channel in the SOH/TOH is used. Normally DCC-r (D1 to D3) is used for ECC purpose but any other available SOH byte can be used. When DCC-r is used the transmission capacity is 192 kb/s, if another single SOH byte is used the transmission capacity is 64kb/s.

7.2.1. IP Routing

The Supervisory system contains a routing function that enables routing of TCP/IP and UDP/IP traffic between the various management interfaces such as the Ethernet interface and the ECC channel. The routing protocol used is OSPF/RIP2. This enables both transport of Evolution Series management traffic as well as other telecom equipment IP based management protocols.

7.2.2. Embedded SNMP agent

The embedded SNMP agent supports the following management functions.

- **Basic monitoring of network and interface parameters**
- **Fault Management**
  Supports enumeration of possible alarms, current alarm table and historic alarms (log).
- **Analogue measurements**
  Received signal level.
- **Performance Management**
  Performance data according to G.826 and error pulses B1,B2 and MS-REI.

7.3. Interfaces to the supervision system

7.3.1. General

Four external interfaces are available for the supervision system.

LAN interface	Two 10/100BASE-TX interfaces, IEEE 802.3 Full Duplex. Connector type: RJ-45
USB interface	Two USB ports are available, one host and one device. The host port serves as LCT interface.

7.3.2. LEDs

All IFU units have a LED indicating power on and alarm status.

Colour	**Indication**
Continuous green :	Power on, normal operation
Continuous red	Alarm on unit
Slow blinking red	Unit is receiving configuration
Fast blinking red	Units is not configured or is placed in a wrong IFU slot

Table 7-2 LED status indications

8. REFERENCES

Document code:	Title/Description:
ETSI EN 301 489-4 V1.4.1 (2002-08)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services. For grade B equipment
ETSI EN 300 019-1-1 V2.1.4 (2003-04)	Classification of environmental conditions; Storage. Class 1.2, weather protected
ETSI EN 300 019-1-2 V2.1.4 (2003-04)	Classification of environmental conditions; Transportation. Class 2.3, public transportation
ETSI EN 300 019-1-3 V2.1.2 (2003-04)	Classification of environmental conditions; Stationary use at weather protected locations. Class 3.2, partly temperature controlled locations
ETSI EN 300 019-1-4 V2.1.2 (2003-04)	Classification of environmental conditions; Stationary use at non-weather protected locations
ETSI EN 300 132-2 V2.1.2 (2003-09)	Equipment Engineering (EE); Power supply interface at the input to telecommunication equipment; Part 1: Interface operated by Direct Current (DC)
ETSI EN 302 217-1 V1.1.1 (2004-12)	Overview and system-independent common characteristics
ETSI EN 302 217-2-1 V1.1.1 (2004-12)	System-dependent requirements for digital systems operating in frequency bands where frequency co-ordination is applied
ETSI EN 302 217-2-2 V1.1.1 (2004-12)	Harmonized EN covering essential requirements of Article 3.2 of R&TTE Directive for digital systems operating in frequency bands where frequency co-ordination is applied
CENELEC EN 60950: 2000	Safety of information technology equipment
CENELEC EN 60215: 1989	Safety requirements for radio transmitting equipment
CENELEC EN 60825-1 1994	Safety of laser products, Part 1: Equipment classification, requirements and user's guide
CENELEC EN 60825-2 2000	Safety of laser products, Part 2: Safety of optical fibre communication systems
ITU-R Rec. F.746-7 (2003)	Radio-frequency channel arrangements for fixed service systems
ITU-R Rec. F.1099-3 (1999)	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the 5 GHz (4 400-5 000 MHz) band
ITU-R Rec. F.383-7 (2001)	Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band
ITU-R Rec. F.384-8 (2004-01)	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band
ITU-R Rec. F.385-8 (2005)	Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band
ITU-R Rec. F.386-6 (1999-02)	Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the 8 GHz band
ITU-R Rec. F.387-9 (2002-05)	Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band
ITU-R Rec. F.497-6 (1999)	Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band
ITU-R Rec. F.636-3 (1994)	Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band
ITU-R Rec. F.595-8 (2003-02)	Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz band
ITU-R Rec. F.637-3 (1999)	Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band
ITU-R Rec. F.748-4 (2001)	Radio-frequency channel arrangements for radio-relay systems operating in the 25, 26, and 28 GHz bands
ITU-R F.1520-2 (2003-02)	Radio-frequency arrangements for systems in the fixed service operating in the band 31.8-33.4 GHz
ITU-R Rec. F.749-2 (2001)	Radio-frequency channel arrangements for radio-relay systems operating in the 38 GHz band
ITU-R Rec. F.750-4 (2000-05)	Architectures and functional aspects of radio-relay systems for synchronous digital hierarchy (SDH)-based network
ITU-T Rec. G.703 (11/2001)	Physical/electrical characteristics of hierarchical digital interfaces
ITU-T Rec. G.707 (10/2000)	Network node interface for the synchronous digital hierarchy (SDH)
ITU-T Rec. G.783 (02/2004)	Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks

ITU-T Rec. G.823 (03/2000)	The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy
ITU-T Rec. G.825 (03/2000)	The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH).
ITU-T Rec. G.826 (02/1999)	Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate
ITU-T Rec. G.828 (03/2000)	Error performance parameters and objectives for international, constant bit rate synchronous digital paths
ITU-T Rec. G.921 (11/1988)	Digital Sections based on the 2048 kbit/s hierarchy.
ITU-T Rec. G.957 (06/1999)	Optical interfaces for equipments and systems relating to the synchronous digital hierarchy
ITU-T Rec. G.958 (11/1994)	Digital line systems based on the synchronous digital hierarchy for use on optical fibre cable
ETSI TR 101 036-1 V1.3.1 (2002-08)	Fixed Radio Systems; Point-to-point equipment; Generic wordings for standards on digital radio systems characteristics; Part 1: General aspects and point-to-point equipment parameters
CEPT/ERC Rec. 74-01 E (2002-10)	Spurious Emissions
CEPT/ERC Rec 14-01 E (1996-08)	Radio-frequency channel arrangements for high capacity analogue and digital radio-relay systems operating in the band 5925 MHz – 6425 MHz
CEPT/ERC Rec 14-02 E (1996-08)	Radio-frequency channel arrangements for medium and high capacity digital radio-relay systems operating in the band 6425 MHz – 7125 MHz
CEPT/ECC Rec 02-06 (2002-08)	Preferred channel arrangement for digital fixed service systems operating in the frequency range 7125-8500 MHz
CEPT/ERC Rec. 12-06 E (1996-12)	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.7 – 11.7 GHz
CEPT /ERC/REC 12-02 (1996-08)	Harmonised radio frequency channel arrangements for analogue and digital terrestrial fixed systems operating in the band 12.75 GHz to 13.25 GHz
CEPT/ERC/REC 12-07 E (1996-08)	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the bands 14.5 - 14.62 GHz paired with 15.23 - 15.35 GHz
CEPT/ERC/REC 12-03 (1996-08)	Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 17.7 GHz to 19.7 GHz
CEPT T/R 13-02 (1994-02)	Preferred channel arrangements for fixed services in the range 22.0-29.5 GHz
IEC 297-2	Dimensions of mechanical structures of the 486.6mm (19in) series: Cabinet and pitches of the rack structures".
IEC 297-3	Dimensions of mechanical structures of the 486.6mm (19in) series: Sub-rack and associated plug in units".
IEC 60169-16, Ed. 1.0	Radio-frequency connectors. Part 16: R.F. coaxial connectors with inner diameter of outer conductor 7 mm (0.276 in) with screw coupling - Characteristic impedance 50 ohms (75 ohms)
IEC 60169-29, Ed. 1.0	Radio-frequency connectors - Part 29: Miniature r.f. coaxial connectors with screw-, push-pull and snap-on coupling or slide-in rack and panel applications; Characteristic impedance 50 ohms
IEC 60603-7 (1996)	Connectors for electronic equipment - Part 7-1: Detail specification for 8-way, shielded free and fixed connectors with common mating features, with assessed quality
IEC 60835-2-8 (1993-05)	Methods of measurement for equipment used in digital microwave radio transmission systems - Measurements on terrestrial radio-relay systems - Adaptive equalizer.
IEEE 802.3	Carrier Sense Multiple Access with Collision Detection

ANSI/Industry Canada:

Document code:	Title/Description:
Radio Frequency Channel Plans:	
FCC 47 CFR Part 101	Fixed Microwave Services
SRSP – 305.9	Technical Requirements for Line-of-sight Radio Systems Operating in the Fixed Service in the Band 5915 – 6425 MHz
SRSP – 306.4	Technical Requirements for Line-of-sight Radio Systems Operating in the Fixed Service in the Band – 6425 – 6930 MHz
SRSP – 307.1	Technical Requirements for Fixed Line-of-Sight Radio Systems Operating in the Band 7125-7725 MHz
SRSP – 307.7	Technical Requirements for Fixed Line-of-sight Radio Systems Operating in the Band 7725-8275 MHz
SRSP – 310.7	Technical Requirements for Fixed Line-of-sight Radio Systems Operating in the Band 10.7-11.7 GHz
Electromagnetic Compatibility:	
FCC 47CFR Part 15	Radio Frequency Devices (EMC regulations)
Safety:	
CAN/CSA 22.2 No. 60950-00	Safety – Information processing and business equipment
UL 1950	Safety of Information Technology Equipment
SONET:	
ANSI Rec. T1.105	SONET - Basic Description including Multiplex Structure, Rates and Formats
ANSI Rec. T1.105.06-1996	Telecommunications-Synchronous Optical Network (SONET): Physical Layer Specifications
ANSI Rec. T1.646-1995	Broadband ISDN Physical Layer Specification for User Network Interfaces Including DS1/ATM
ANSI T1.102-1993	Digital Hierarchy – Electrical Interfaces”.

9. TERMINOLOGY

Abbreviation	Description
ACAP	Adjacent Channel Alternate Polarisation
ACCP	Adjacent Channel Co-Polarisation
ADM	Add/Drop/Multiplex
AIS	Alarm Indication Signal
ALM	External alarm input/output
AP	Alternating Polarisation
ATDE	Adaptive Time Domain Equaliser
ATPC	Automatic Transmitter Power Control
AUX	Auxiliary functions
AU	Administrative Unit
BER	Bit Error Rate
BIP	Bit Interleaved Parity
C/I	Carrier to Interference ratio
CS	Channel Spacing
DCC	Data Communications Channel
DF-SP	Dual Frequency – Single Polarisation
ECC	Embedded Control Channel
EM	Element Manger
EMC	Electro Magnetic Compatibility
EMF	Embedded Management Functions
EOW	Engineering Order Wire
EW	Early Warning
GFP	Generic Framing Procedure
HBER	High Bit Error Rate
HSB	HotStandBy
IFU	InterFace Unit
LAN	Local Area Network port (10/100BASE-TX Ethernet)
LBER	Low Bit Error Rate
LIU	Line Interface Unit
LCT	Local Craft Terminal
LOF	Loss Of Frame
LOH	Line OverHead (LOH is a SONET term with same meaning as MSOH in SDH networks)
LOS	Loss Of Signal
MLM	Multi-Longitudinal Mode
MS	Multiplex Section

Abbreviation	Description
MSOH	Multiplex Section Overhead
MSP	Multiplex Section Protection
MST	Multiplex Section Termination
MTBF	Mean Time Between Failure
NMS	Network Management System
OC-3	Optical Carrier – level 3 = 155Mbit/s (OC-1 – level 1 = 51.84 Mbit/s)
ODU	OutDoor Unit
OOF	Out Of Frame
POH	Path OverHead
PRBS	Pseudo Random Bit Sequence
PWR	Power Supply
RIU	Radio Interface Unit
RF	Radio Frequency
RPS	Radio Protection Switching
RS	Regenerator Section
RSOH	Regenerator Section OverHead
RST	Regenerator Section Termination
RX	Receiver
SERV	Service function (plug-in unit)
SDH	Synchronous Digital Hierarchy
SETS	Synchronous Equipment Timing Source
SF-DP	Single Frequency - Dual Polarisation
SNCP	Sub Network Connection Protection
SNMP	Simple Network Management Protocol
SOH/TOH	Section OverHead/Transport OverHead (SOH is used in SDH networks, TOH is used in SONET networks)
SONET	**S**ynchronous **O**ptical **Net**work
SPE	Synchronous Payload Envelope (An STS frame consist of Transport OverHead and the SPE)
STM-1	Synchronous Transport Module, 1 means the lowest defined data rate = 155.520 Mbit/sec
SU	Supervisory Unit
SVCE	SerVice ChannEl, used to define the voice channel circuit board
TU	Tributary Unit
TCP/IP	Transmission Control Protocol/Internet Protocol
TUG	Tributary Unit Group
TX	Transmitter
USB	Universal Serial Bus
VC	Virtual Container
XCVR	Transmitter/Receiver
XIF	XPIC Improvement Factor
XPIC	X-Polar Interference Canceller

APPENDIX 1 – ODU/DIPLEXER SUB-BAND RANGE

The sub-band range in the table is specified with the RF-channel bandwidth as given in the last column. The sub-band range is wider if configured radio bandwidth is narrower.

Freq. band [GHz]	Duplex Spacing	Tx. Freq:	Sub-band 1	Sub-band 2	Sub-band 3	Channel BW
5.9-6.4	252.04	Low: High:	5945 – 6034 6197 - 6287	6063 - 6154 6315 – 6406		~28 MHz
5.9-6.4	252.04	Low: High:	5930 - 6020 6182 - 6272	6049 - 6138 6301 - 6390		~28 MHz
6.4-7.1	340	Low: High:	6450 - 6580 6790 - 6920	6610 - 6740 6950 - 7080		40 MHz
6.4-7.1	100	Low: High:	6595 6695	6625 6725	6655 6755	30 MHz
7.1-7.4	154,161	Low: High:	7128 - 7184 7289 - 7345	7170 - 7226 7331 - 7387	7205 - 7264 7366 - 7425	~28 MHz
7.1-7.4	175	Low: High:	7128 - 7184 7289 - 7345			~28 MHz
7.1-7.4	196	Low: High:	7121 - 7177 7317 - 7373	7177 - 7233 7373 - 7429		~28 MHz
7.4-7.7	150	Low: High:	7428 - 7484 7589 - 7645			~28 MHz
7.4-7.7	154,161, 182	Low: High:	7428 - 7484 7589 - 7645	7470 - 7526 7631 - 7687	7505 - 7564 7666 – 7725	~28 MHz
7.4-7.7	168	Low: High:	7428 - 7484 7589 - 7645	7470 - 7526 7631 - 7687	7513 - 7569 7681 – 7737	~28 MHz
7.2-7.5	161	Low: High:	7266 - 7321 7427 - 7482	7325 - 7380 7486 – 7542		~28 MHz
7.4-7.9	245	Low: High:	7442 - 7526 7687 – 7771	7554 - 7638 7799 – 7883		~28 MHz
7.1-7.7	300	Low: High:	7139 – 7261 7439 – 7561	7289 - 7411 7289 – 7411		~28 MHz
7.7-8.3	310	Low: High:	7732 - 7837 8039 - 8149	7836 - 7956 8147 – 8267		~28 MHz
7.9-8.4	266	Low: High:	7919 - 8013 8185 - 8279	8031 - 8122 8297 – 8388		~28 MHz
7.9-8.5	310	Low: High:	7919 – 8031 8229 - 8341	8059 - 8171 8369 – 8481		~28 MHz
8.2-8.5	119/126	Low: High:	8287.5 - 8305 8411 - 8427	8330 - 8347 8453 – 8469		~28 MHz
8.2-8.5	154	Low: High:	8217 - 8248 8370 - 8400	8273 - 8307 8428 – 8458	8299- 8330 8452 - 8482	~28 MHz
11	490/530	Low: High:	10735 - 10935 11225 - 11465	10975 - 11175 11465 - 11665		40 MHz
11	530	Low: High:	10715 - 10915 11245 - 11445	10955 - 11155 11485 - 11685		40 MHz
11	490	Low: High:	10725 - 10935 11215 - 11425	10965 - 11175 11455 – 11665		30 MHz
13	266	Low: High:	12765 - 12877 13031 - 13143	12849 – 12963 13115 - 13229		28 MHz
15	490	Low: High:	14417 - 14676 14907 - 15166	14669 - 14914 15117 - 15334		28 MHz
15	420	Low: High:	14515 - 14732 14935 - 15152	14669 - 14914 15117 - 15334		28 MHz

15	644/728	Low: High:	14515 - 14683 15159 - 15334			28 MHz
15	315	Low: High:	14641 - 14781 14956 - 15096	14753 - 14893 15068 - 15208		28 MHz
18	1010	Low: High:	17727.5 – 18193.5 18737.5 – 19202.5	18195 – 18662.5 19205 – 19672.5		55 MHz
18	1560	Low: High:	17727.5 – 18112.5 19287.5 – 19672.5			55 MHz
18	1092.5	Low: High:	17727.5 - 18195 18820 - 19287.5	18112.5 - 18580 19205 - 19672.5		27.5 MHz
18	1120	Low: High:	17742 - 18181 18834- 19273	18127 - 18566 19219 – 19658		55 MHz
23	1232	Low: High:	21228 – 21772 22428 - 22988	21791 - 22316 23023 – 23548		56 MHz
23	1200	Low: High:	21225 - 21775 22425 - 22991	21825 - 22375 23025 – 23575		50 MHz
23	1008	Low: High:	22031 - 22562 23039 - 23570			56 MHz
26	1008	Low: High:	24577 - 24976 25585 – 25984	24997 - 25417 26005 - 26425		56 MHz
28	1008	Low: High:	27576.5 - 27975.5 28584.5 - 28983.5	27996.5 - 28416.5 29004.5 - 29424.5		56 MHz
32	812	Low: High:	31843 - 32200 32655 - 33012	32218 - 32543 33030 - 33355		56 MHz
38	1260	Low: High:	37086 - 37590 38346 - 38850	37646 - 38150 38906 - 39410		56 MHz
38	700	Low: High:	38625 - 38800 39325 - 39500	38850 - 39025 39550 - 39725	39075 - 39275 39775 - 39975	50 MHz

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