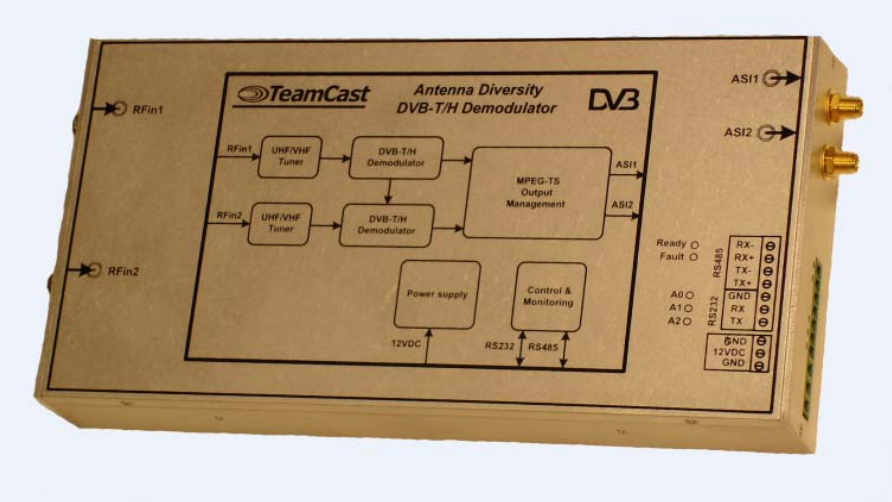
DVB-T/H Diversity Demodulator
- RXH 1000 User Manual -



Document Reference: MPD-0701031A

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Revision sheet

User manual RXH 1000

MPD-0701031A – January 2007

Document Number	Revision	Date	Product covered	Version	Comments
MPD-0701031	A	Jan. 07	~TCM-RXH0-1020 ~TCM-RXH1-1020	From H100-S100	First release

Warning

- **Content warning**
  This document contains preliminary information about some of the ModulCast family products. TeamCast keeps the right to make changes at any time without prior notice in order to improve, to design and to supply the best possible product.

- **Copy warning**
  This document includes some confidential information. Its usage is limited to the owners of the product that it is relevant for. It cannot be copied, modified, or translated in another language without prior written authorisation from TeamCast.

About this manual

- **Intended audience**
  This user manual has been written to help people who have to use, to integrate, to install the product. Some chapters require some prerequisite knowledge in electronics and especially in broadcast technologies and standards.

- **Product described**
  The 5 following products are described in this user manual:
  - ~TCM-RXH0-1020 – DVB-T/H antenna diversity receiver, ASI outputs,
  - ~TCM-RXH1-1020 – DVB-T/H antenna diversity receiver, SPI output,

- **Document structure**
  The document is organized in 5 chapters:
  - **Chapter 1 – Introduction to the ModulCast family product.**
    This chapter gives an overview of the ModulCast family product to which the RXH-1000 receiver belongs to.
  - **Chapter 2 – Description.**
    This chapter describes the products and gives its performances.
  - **Chapter 3 – Installation.**
    This chapter explains how to install the RXH-1000 receiver.
  - **Chapter 4 – Operation.**
    This chapter explains how to operate, control and monitor the RXH-1000 receiver.
  - **Chapter 5 – Maintenance and checking.**
    This chapter gives recommendation on how to maintain the product and how to perform a first level maintenance in case of problems. It also describes how to get and download software updates of the product.

- **Associated publications**
  The reader of this document could improve the understanding of the product and its environment by reading the following documents :

[D1]	DVB-T standards	EN 300 744 v1.5.1, ETSI TS101 191 v1.4.1
	www.dvb.org	
[D2]	DVB-H	EN 302 304 v1.1.1, ETSI TR 102401 v1.1.1
	www.dvb.org	
[D3]	DVB ASI	EN50083-9, ETSI TR101 891 v1.1.1
	www.dvb.org	
[D4]	Measurement	ETSI TR 101 290 v1.2.1
	www.dvb.org	
[D5]	MPEG-2 TS Standard	ISO/IEC 13818-1
	http://www.iso.org	
[D6]	Nordig Specification	Specification V1.02 – Test specif. V1.0
	http://www.nordig.org/	

1. Introduction to ModulCast Product family

ModulCast product family from TeamCast includes a range of modules especially designed for easy integration in broadcast equipment.
They provide very high-performance core technologies to the broadcast actors.

ModulCast family currently includes modulators, professional receivers, up-converters, MIP inserter and synthesizers. The table 1 gives the current list of ModulCast modules.

Modules from ModulCast family have many common features:

- They are all packaged in the same shielded metal box,
- They all use a single power supply at 12 volts,
- They all offer a standard RS232 and RS485 interface for control and monitoring,
- They use same type of connectors,
- Thanks to a very low thermal resistor package, they could be easily mounted in a closed equipment,
- High quality professional components selection provides for all modules a high reliability and no need for preventive maintenance.

The ModulCast modules have been designed to address all of the key requirements of the broadcast equipment manufacturers. For special applications or special packaging, they could be easily customized to fit precisely special requirements.

2. Description

2.1 General overview of the RXH 1000 receiver

RXH-1000 is a low cost DVB-T/H professional receiver, addressing the OEM market, especially designed to operate in difficult reception environments. RXH-1000 takes benefit of the spatial antennas diversity provided by its two demodulators coupled with two independent antennas, to provide reliable reception even in the worst RF situations experience in transmission sites, Electronic News Gathering vehicles (ENG), or mobile applications.

The receiver includes 2 sets of RF tuner and DVB-T/H demodulator that could be used in different way according to the selected mode of operation. It supports all DVB-T and DVB-H modes including hierarchical and could operate in VHF and UHF band for channel of 5 MHz, 6 MHz, 7 MHz or 8 MHz.
The MPEG transport stream is presented as a serial ASI interface or parallel SPI according to the type of receiver.

In order to be compliant with the DVB-H standard, it includes:

- The 4K mode,
- An In-depth deinterleaver,
- The DVB-H signalization (Time slicing and MPE-FEC) in TPS field.

- The Receiver will of course accept DVB-H signals using time slicing but without any power reduction management.
- It does not perform MPE-FEC decoding and the outputs are the MPEG-TS packets over DVB-ASI layer.

The RXH-1000 receiver is offered as 2 different models:

- The ~TCM-RXH0-1020 provides the full functionalities of the antenna diversity receiver, and provides the MPEG transport stream on 2 ASI outputs.
- The ~TCM-RXH1-1020 provides most of the functionalities of the previous model but with a single SPI output,

Depending on the model of the module, the DVB-T/H receiver could be used:

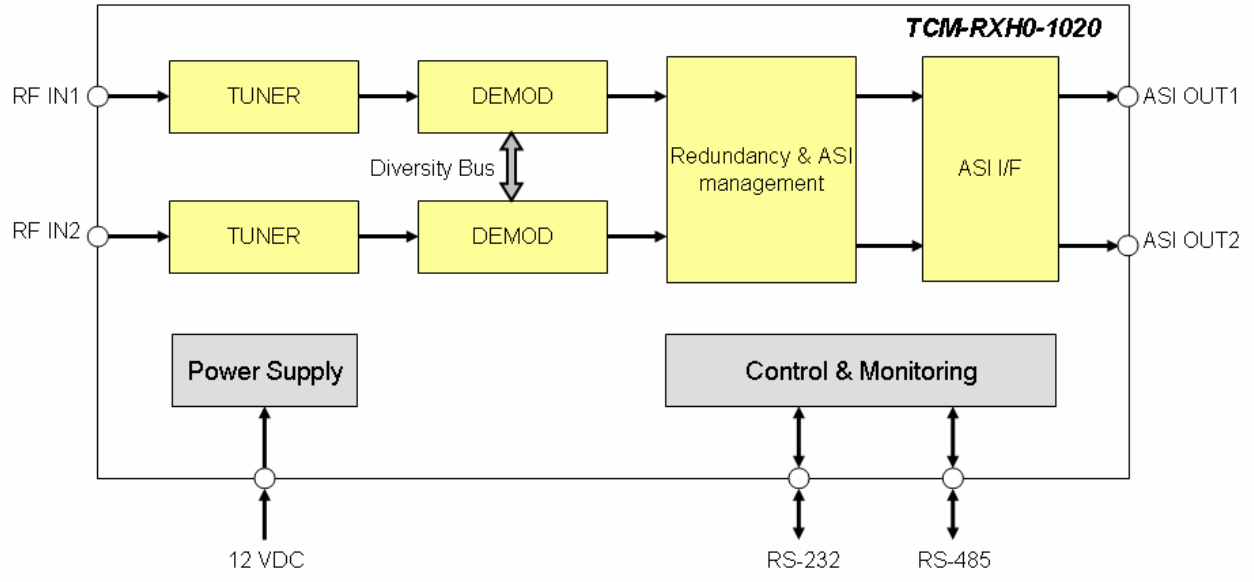
- As a single or dual receiver,
- As a diversity receiver with two different antennas connected to the two RF inputs (output could be either ASI or SPI),
- As a hierarchical receiver that demodulates the two MPEG-TS streams, LP and HP, and providing them simultaneously on the two ASI outputs,
- As redundant receivers.

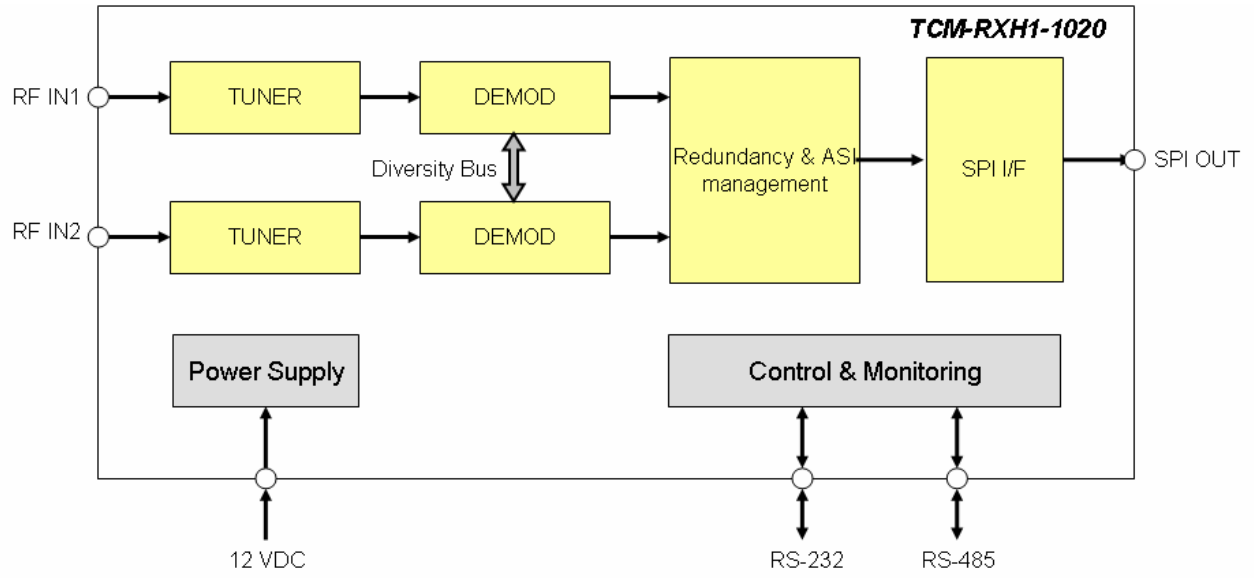
The module is based on the demodulator chip DIB7000MCX from DibCom company, that has been especially designed for mobile, portable and fixed applications. This chip includes special features for difficult environment, that improve significantly the reception:

- High performance digital input filter,
- Digital automatic frequency correction allowing ±350 KHz offset recovery.

Technical information about the benefit of using antenna diversity receiver could be found on the TeamCast web site (http://www.teamcast.com).

2.2 Block diagram of the receiver





2.3 Features of the RXH-1000 receiver

- **RF Inputs**
  The 2 RF inputs accept DVB-T/H signals in UHF band IV and V (channel 21 to 69) and VHF band III (channel 5 to 12).
  Channel bandwidth could be 5 MHz, 6 MHz, 7 MHz or 8 MHz.
  Offset of ± 166.667 KHz as well as offset of ± 125 KHz are supported.

- **DVB-T/H demodulation**
  The RXH receiver performs the demodulation according to ETS 300 744 standard and its DVB-H extension.
  It supports all DVB-T modes including hierarchical modes.
  Automatic mode detection is performed by the receiver thanks to the TPS information.
  When receiving a hierarchical signal, the RXH-1020 can demodulate both flows HP and LP simultaneously, if the same RF signal is supplied to the 2 RF inputs.

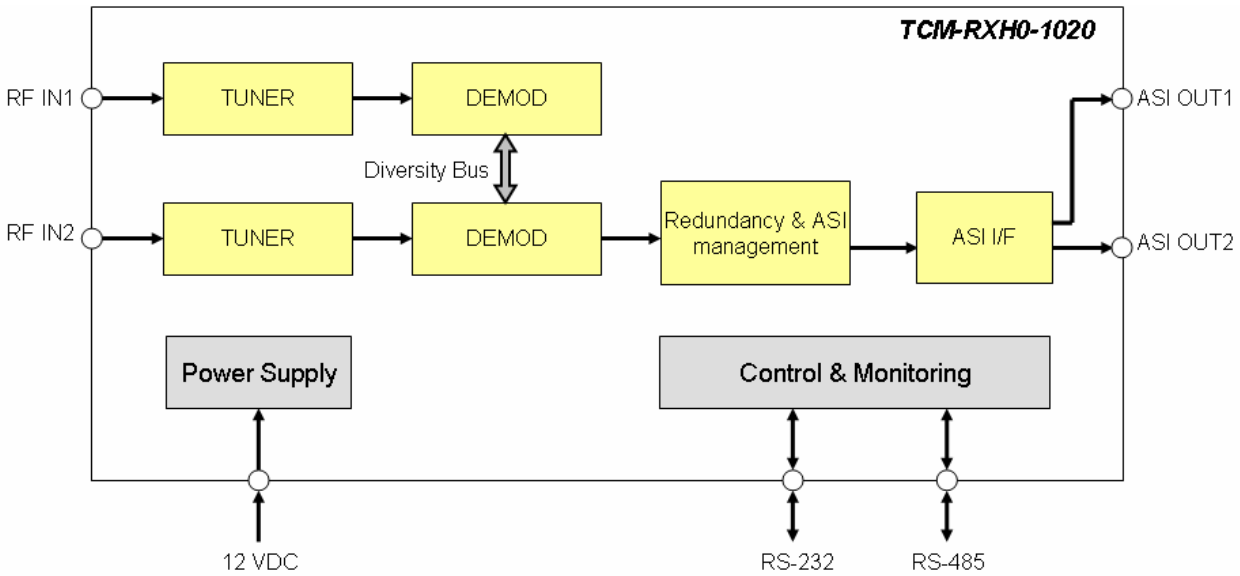
- **Operation mode**
  Depending on the type of receiver modules, different modes of operation are available.

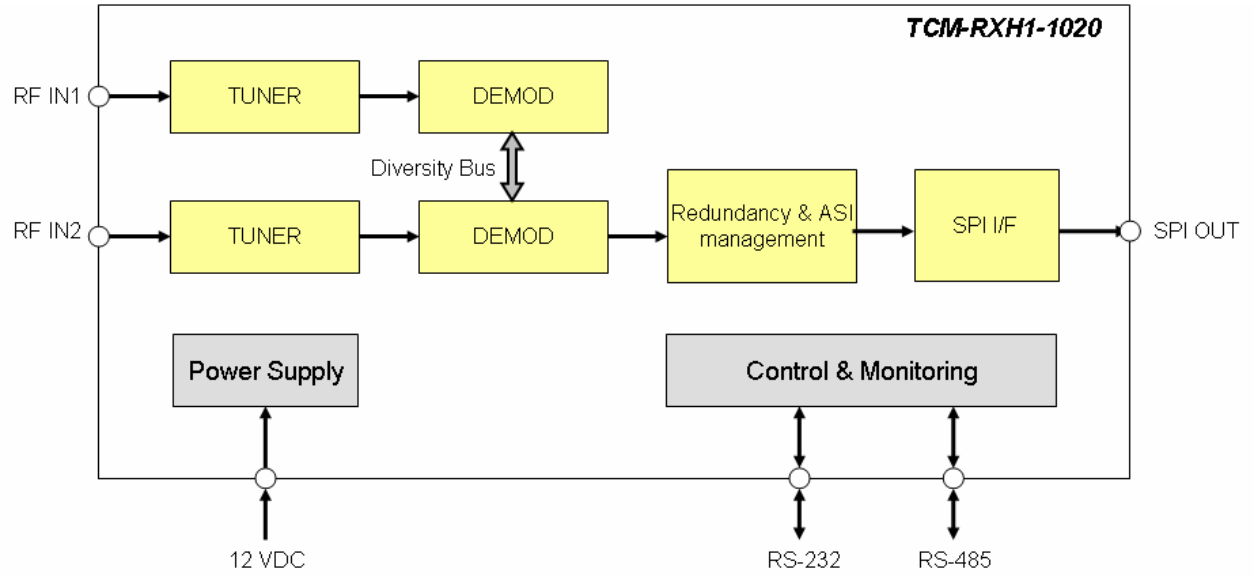
Mode of operation	~TCM-RXH0-1020	~TCM-RXH1-1020
Normal	NO	NO
Dual inputs mode	YES	NO
Redundant mode	YES	YES
Hierarchical mode[1]	YES	NO
Diversity mode	YES	YES

  - In the dual inputs mode, the two demodulator channels are independent and can be programmed differently. Each of them has its own ASI output. This mode can be used for redundant input with external switching (switching is performed externally by operator). Normal mode is similar but reserved to the versions that have no possibility to demodulate 2 flows.

[1] Hierachical mode is very similar than the Dual inputs mode.

- In the redundant mode, the two demodulators channels are also independent and can also be programmed differently. But in this mode, an internal switching is performed. This switching can be manual or automatic. The automatic switching event can be a loss of synchronization or uncorrected packet detection (depending on the configuration). The same output stream is available on both ASI outputs or on SPI output.
- In the hierarchical mode, the two demodulators channels should have the same configuration except the stream priority. But for more flexible use, they can also be independently configured. In this mode, the behavior is exactly the same as in dual mode. Each demodulator gets its signal from the relevant RF input.
- In the diversity mode, the two demodulators channels have the same configuration. The “diversity processing” is performed by the demodulator chips themselves. The same output stream is available on both ASI outputs or on SPI output.





- **ASI / SPI output**
  ASI and SPI outputs are fully compliant with EN 50083-9.
  The ASI / SPI interface generates 188 or 204 bytes packets.
  ASI interface operates in data burst format ("continuous mode").
  The correspondence between the RF inputs and the ASI / SPI outputs depends on the mode of operation. It is defined in the table hereafter.

Management of outputs	~TCM-RXH0-1020	~TCM-RXH1-1020 (1 SPI output)
Normal		
Dual inputs mode	ASI 1 <-> RF In 1 ASI 2 <-> RF In 2	
Redundant mode	ASI 1 = ASI 2 = (RF In 1 or RF In 2)	RF In 1 or RF In 2
Hierarchical mode[2]	ASI 1<-> HP(RF In 1) ASI 2<-> LP(RF In 2)	
Diversity mode	ASI 1 = ASI 2 = (RF In 1 + RF In 2)	SPI = (RF In 1 + RF In 2)

- **Control of the module**
  The module could be externally controlled through a RS232 control port or a RS485 control port.
  Both interfaces are set with:
    - 19200 to 115200 bauds (57600 bauds as default value)

[2] Hierarchical mode works like Dual inputs mode.

- 8 data bits,
- 1 STOP bit,
- No parity bit.

There is no need to select one or the other port. The receiver monitors both control ports. Nevertheless only one control port (RS232 or RS485) should be used at a time.

The control port could be used by an external CPU:

- To set the mode of operation of the module and the associated parameters. All these parameters are stored in an EEPROM memory, so that there is no need to initialize the module each time it is powered on, but only when a change of parameter is required.
- To monitor some information from the receiver and especially BER, MER, Input RF signal strength, MPEG-TS lock, …
- To download new software versions.

The protocol and the list of command are fully described in the “chapter 4 – Operation”.

2.4 Performances and technical characteristics

RXH0-1020 - Characteristics	Typical Value	Comment
RF characteristics		
UHF Frequency band	474 to 860 MHz	These are centre frequencies
VHF Frequency band	174 to 234 MHz	
Frequency step	166,6 KHz	
Channel Bandwidth	5, 6, 7 and 8 MHz	
Sensibility range - Min value for QPSK, ½, 8K - Min value for 64 QAM, 2/3, 8K	- 20 to – 95 dBm - 95 dBm - 75 dBm	Min value depends on the mode. Min. value given for QEF criteria (BER=10^{-4})
Positive and negative offset	0 or ± 166 KHz	
Adjacent digital channel rejection	Between 20 dB and 30 dB	
Monitoring performances		
MER in normal operation Values at RF input -40dBm: - For 64 QAM, 2/3, 8k - For 16 QAM, 7/8, 8k	0 to 28 dB 28dB 27 dB	Resolution of 1 dB
C/N in normal operation	0 to 28 dB	Resolution of 1 dB
BER accuracy	10 -8	Bit Error Rate – the value is computed before RS decoder and after Viterbi
PER	Packet Error Rate expressed in error packets per second	Uncorrected packet after RS
Constellation		Return the input DVB-T/H constellation parameter
Impulse Response	512 points	Time of the FFT window: [-Tu/6 ; Tu/6] where Tu is the symbol duration
Input Signal Strength Accuracy - ≥ -50dBm - < -50dBm	 +/- 3dB +/- 1dB	
Demodulation		
According to ETS 300 744	All modes	

Diversity	Level 2	2 combined demodulators
Automatic frequency compensation	± 350 KHz	Performed in digital
Transit delay		variable
Outputs		
MPEG-TS	188 or 204 bytes	
2 x ASI	Continuous mode	
Control		
RS 232 & RS485	- 57 600 Bauds - 8 data bits - 1 STOP bit - No parity bit	The serial speed can be set from 19200 Bauds to 115200 Bauds
RS485 only	Full or half duplex	
Environment		
Power Voltage Power consumption	12 V ± 0,2 Volts 12 W	
Operating temperature	0 °C to 50 °C	
Altitude	3 000 m	
Dimensions	240 x 110 x 35 mm	Including connectors
Weight	1,1 Kg	
Storage recommendations		
Storage Temperature	-10 °C to +70 °C	
Storage relative humidity	10 to 80 % at 50 °C	

RXH1-1020 - Characteristics	Typical Value	Comment
RF characteristics		
UHF Frequency band	474 to 860 MHz	These are centre frequencies
VHF Frequency band	174 to 234 MHz	
Frequency step	166,6 KHz	
Channel Bandwidth	5, 6, 7 and 8 MHz	
Sensibility range - Min value for QPSK, ½, 8K - Min value for 64 QAM, 2/3, 8K	- 20 to – 95 dBm - 95 dBm - 75 dBm	Min value depends on the mode. Min. value given for QEF criteria (BER=10^{-4})
Positive and negative offset	0 or ± 166 KHz	
Adjacent digital channel rejection	Between 20 dB and 30 dB	
Monitoring performances		
MER in normal operation Values at RF input -40dBm: - For 64 QAM, 2/3, 8k - For 16 QAM, 7/8, 8k	0 to 28 dB 28dB 27 dB	Resolution of 1 dB
C/N in normal operation	0 to 28 dB	Resolution of 1 dB
BER accuracy	10 -8	Bit Error Rate – the value is computed before RS decoder and after Viterbi
PER	Packet Error Rate expressed in error packets per second	Uncorrected packet after RS
Constellation		Return the input DVB-T/H constellation parameter
Impulse Response	Computed on 512 points	Time of the FFT window: [-Tu/6 ; Tu/6] where Tu is the symbol duration
Input Signal Strength Accuracy - ≥ -50dBm - < -50dBm	 +/- 3dB +/- 1dB	
Demodulation		
According to ETS 300 744	All modes	
Diversity	Level 2	2 combined demodulators

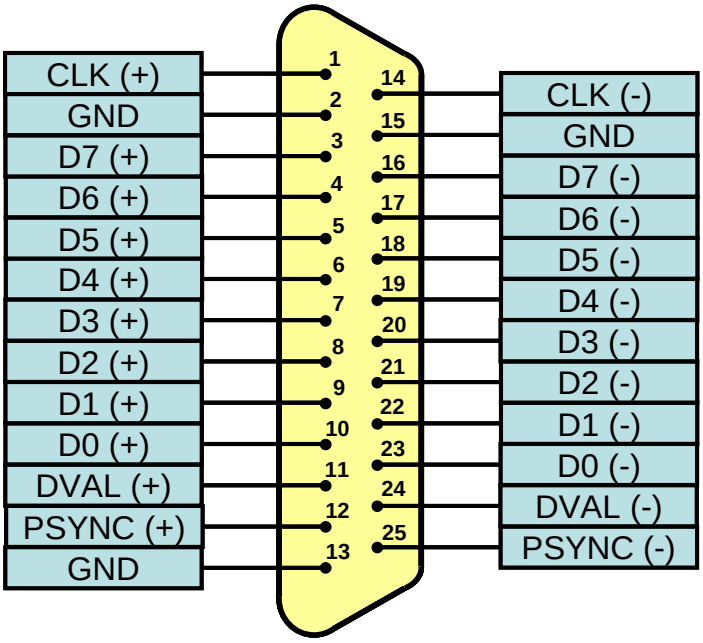
Automatic frequency compensation	± 350 KHz	Performed in digital
Transit delay		variable
Outputs		
MPEG-TS	188 or 204 bytes	
1 x ASI	LVDS level	See EN 50083-9
Control		
RS 232 & RS485	- 57 600 Bauds - 8 data bits - 1 STOP bit - No parity bit	The serial speed can be set from 19200 Bauds to 115200 Bauds
RS485 only	Full or half duplex	
Environment		
Power Voltage Power consumption	12 V ± 0,2 Volts 12 W	
Operating temperature	0 °C to 50 °C	
Altitude	3 000 m	
Dimensions	240 x 110 x 35 mm	Including connectors
Weight	1,1 Kg	
Storage recommendations		
Storage Temperature	-10 °C to +70 °C	
Storage relative humidity	10 to 80 % at 50 °C	

2.5 Input / Output interfaces

- RF Inputs for UHF / VHF inputs
  - Connector: F female coaxial,
  - Impedance: 75 ohms,
  - VSWR = 3 dB (typical),
  - Input level: - 20 dBm to – 95 dBm (depends on DVB-T mode)

- ASI Outputs
  - Connector: SMA female coaxial,
  - Impedance 75 ohms,
  - Compliant with ASI specs (EN 50083-9)

- SPI Output
  - Connector: DB25 female,
  - Level: LVDS,
  - Compliant with SPI specs (EN 50083-9),



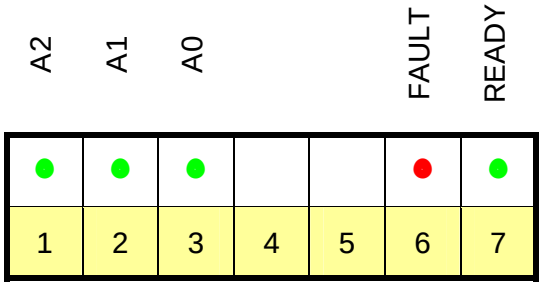
- RS232 / RS485 port

A seven points MINICONNEC (header + screw plug) connector (3.81mm step) is used for the control interface:

1	2	3	4	5	6	7
RS232 Tx	RS232 Rx	GND	RS485 Tx+	RS485 Tx-	RS485 Rx+	RS485 Rx-

2.6 Signalization

A simple signalization is performed using 5 CMS LEDs and optical guides. They are located on the right side of the module above the 7-points connector:



FAULT LED is red, others are green
These LEDs are fully described in chapter 4 – Operation.

2.7 Power requirements

- 12 volts ± 200 mV,
- Ripple lower than 1 mVpp (recommended value for optimized performance),
- Power consumption for RXHx-1020 < 12 W (1,0 Amps),

A three points MINICONNEC (header + screw plug) connector (5.08mm step) is used for the power supply:

1	2	3
GND	+12V	GND

2.8 Safety requirements

The RXH-1000 module complies with the European Directives for Electromagnetic Low Voltage Directive (75/23/CEE).

The module complies with the EN60950 standard applied for information technology equipment.

2.9 EMC requirements

The RXH-1000 module complies with the European Directives for Electromagnetic Compatibility (EMC 89/336/EEC).

The module complies with the EN55022-B class and the EN55024 standards.

EMC characteristics can be guaranteed only:

- If installation of the module is performed according to recommendations of chapter 3,
- If appropriate shielded cables are used to connect the module inside the equipment.

3. Installation

3.1 Unpacking the RXH 1000 Receiver

The usual packing of the RXH receiver is a double pack, a storage box and a transport box:

- Each module is first packed in an individual cardboard box named the storage box which weight and dimensions are:
  - Weight: 1.2 Kg,
  - Dimensions: 270 x 145 x 80 mm
  - This first pack is suitable for storage only. It is not robust enough for transport,
- Generally the modules are then packed per quantity of 1, 2 or 10 in a transport box.
  - The 10 units package has the following weight and dimensions:
    - Weight: 13.0 Kg,
    - Dimensions: 395 x 375 x 515 mm,
  - The double unit package has the following weight and dimensions:
    - Weight: 3,0 Kg,
    - Dimensions: 355 x 335 x 145 mm,
  - The single unit package has the following weight and dimensions:
    - Weight: 1,6 Kg,
    - Dimensions: 335 x 210 x 145 mm,

Please check the transport box against any transport damage at the reception. If there is damage please contact the carrier immediately.

Unpack carefully the storage box from the transport box and then the module from the storage box.
Check the module against transport damage.

Please check that the packing content matches the following list:

- RXH-1000 module,
- a 3 pins female MINICONNEC (screw plug) connector (5.08mm step), usually plugged on the power connector,
- a 7 pins female MINICONNEC (screw plug) connector (3.81mm step), usually plugged on the control connector,

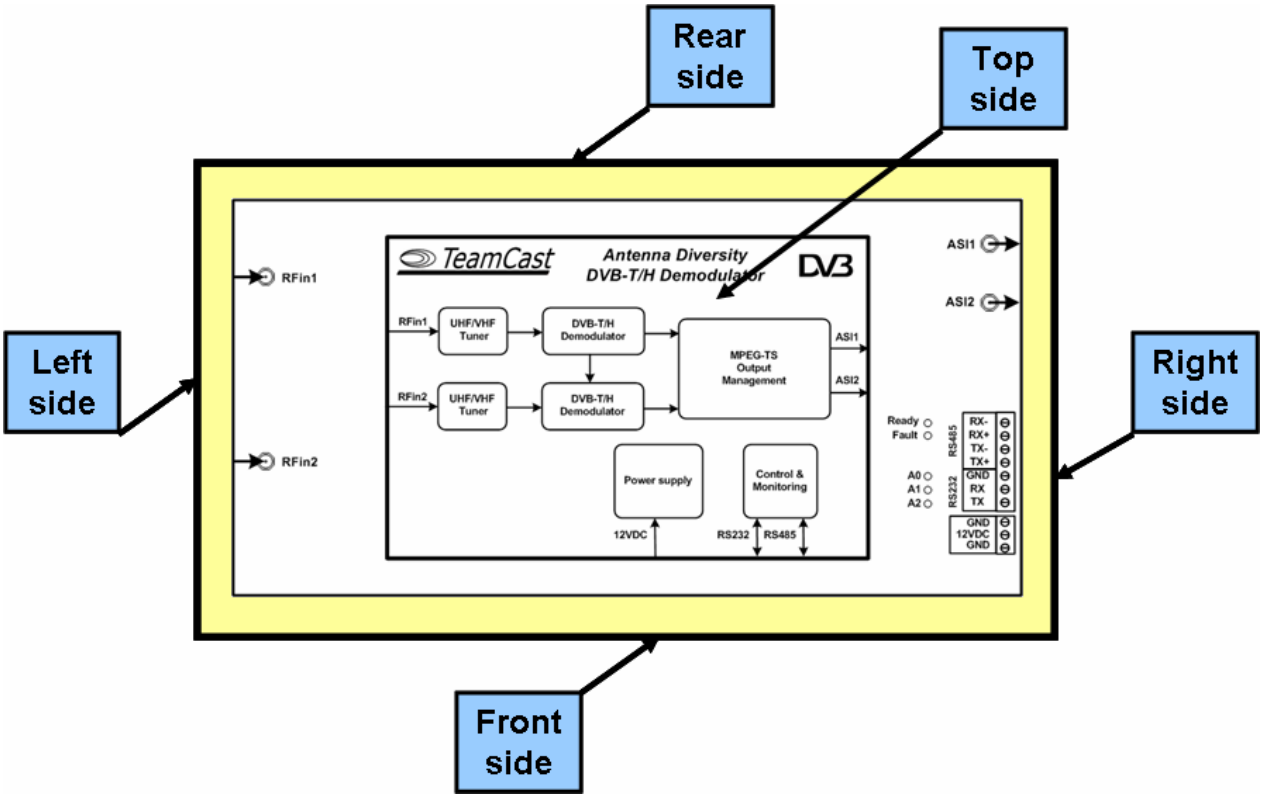
Except if ordered separately, the documentation is not included in the pack.
It is downloadable from the web site (www.teamcast.com) as a pdf file.

3.2 Mechanical mounting

- Mechanical description

The module is made of an electronic board mounted in an aluminium box.

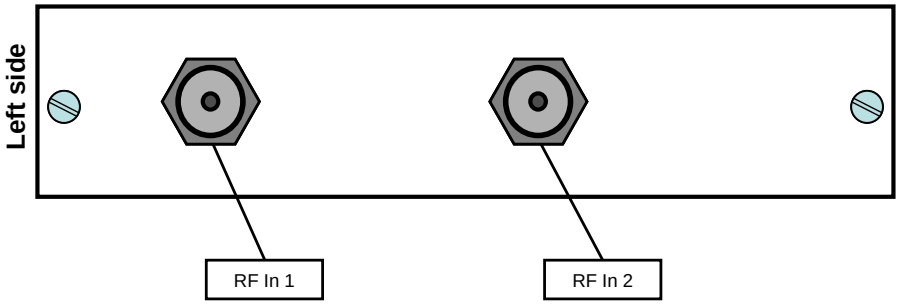
The block diagram of the module is printed on its top side. This helps the user to locate the connectors of the module.



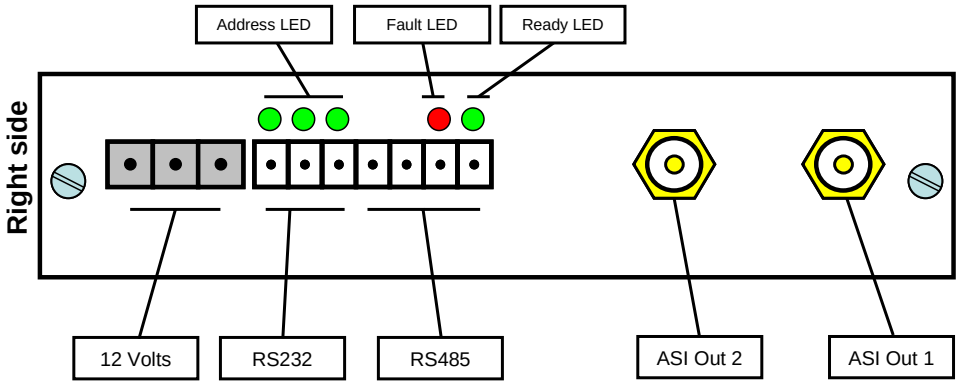
The dimensions of the box excluding connectors are: 220 x 110 x 35 mm.
The dimensions including connectors are: 240 x 110 x 35 mm.
The weight of the module is: 1,000 Kg.

- Connectors localisation

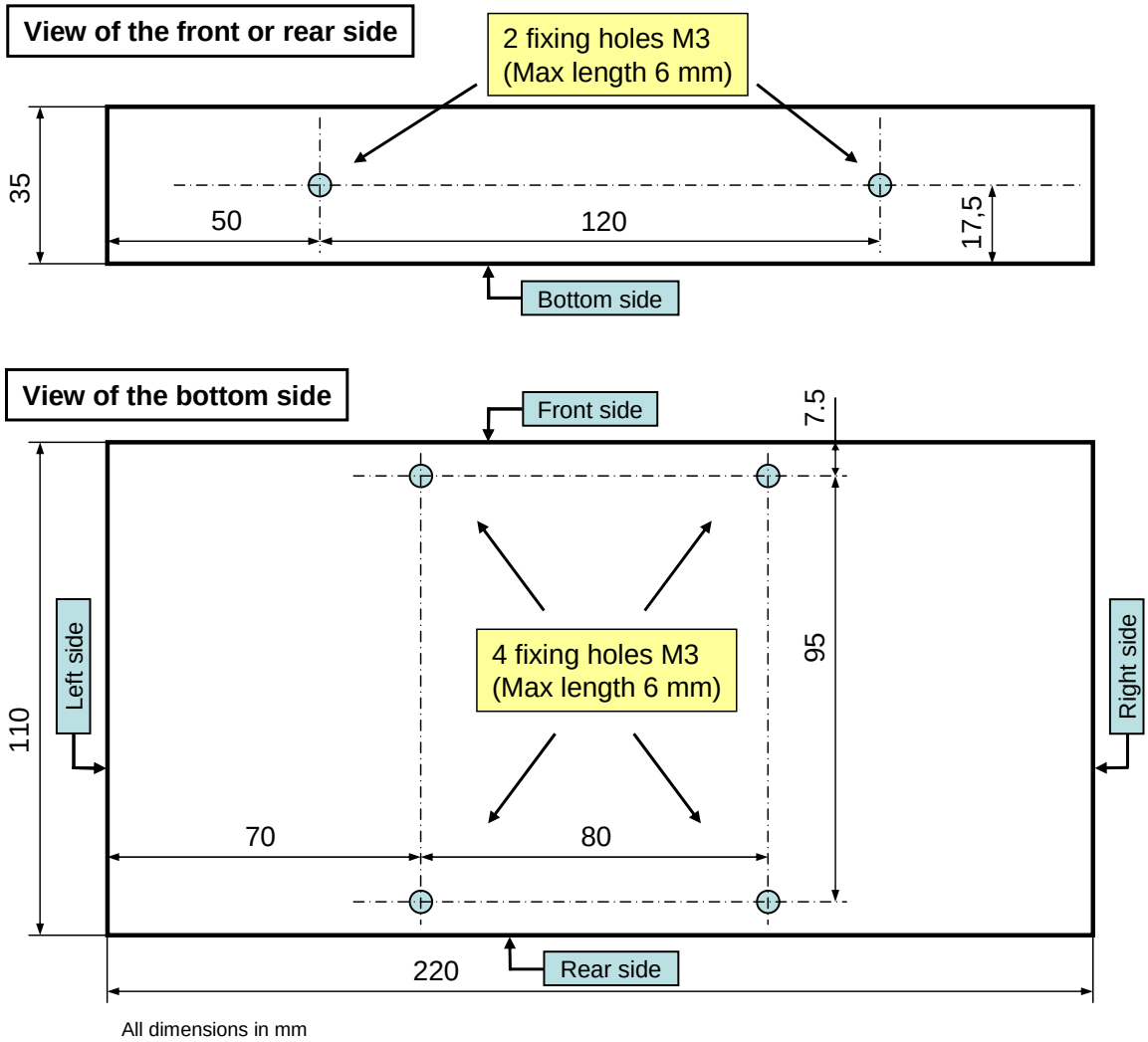
RF inputs connectors are located on the left side.



All other connectors are located on the right side.



The module could be screwed in a chassis on the bottom side or on the front side or on the rear side using the tapped holes.
The drawings below show the position of the fixing holes.



The length of the screws used to fix the module, should be limited to **6 mm maximum** inside the module.
Use of longer screws could damage severely the electronic board inside.

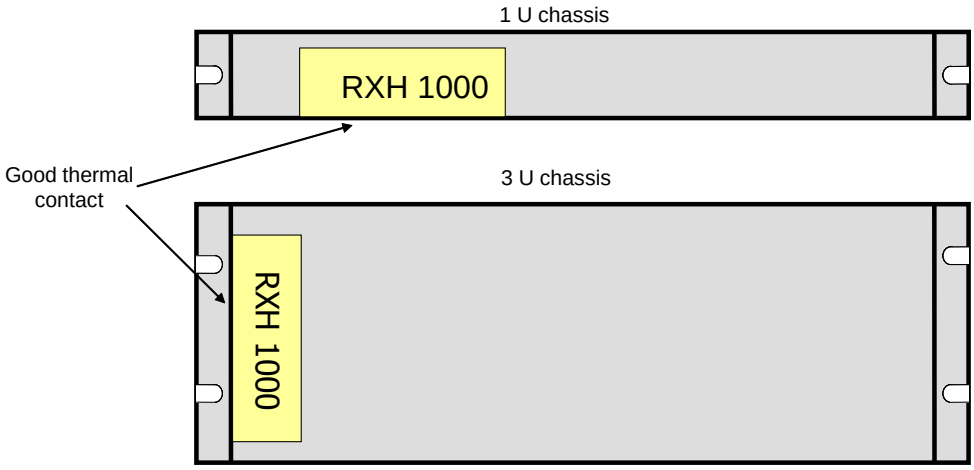
3.3 Thermal considerations

The RXH-1000 receiver is packaged in an aluminium box.
The thermal resistor of the package has been optimized in order to limit the increase of temperature inside the module. It is lower than 1°C/W.

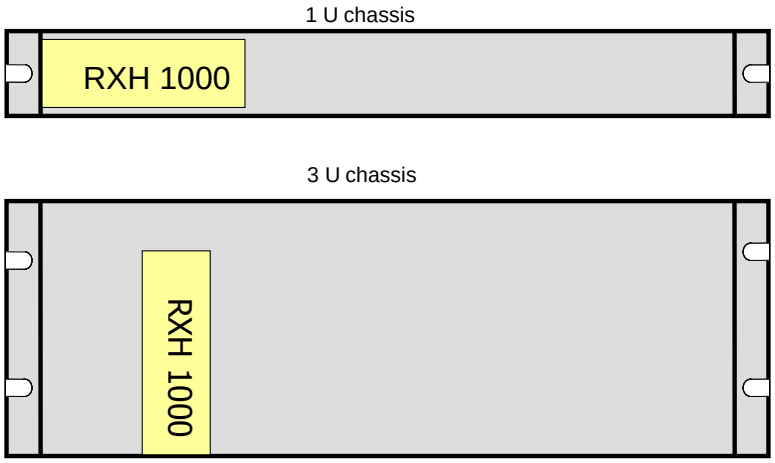
While mounting the module in a chassis, care should be taken to maintain an efficient thermal conduction between the module and the chassis.

That's why it is recommended to mount the module on its bottom side.
Nevertheless mounting the module on its front or rear side is possible, but with special cautions for the cooling of the module. In some situation especially when the chassis is closed, forced air flow could be required to maintain a reasonable temperature inside the chassis.

- Recommended mounting:



- Less recommended mounting:



3.4 Connections of the module

The wiring of the module depends on the chassis and environment in which it is integrated in.

The RF connection is the more critical one, and the cable used, the length of the cable as well as the quality of the connector has to be chosen to avoid any degradation of the RF input signal.

The power supply connection should use wires with a gauge compatible with the consumption of the module (0.5 mm² minimum).

Wiring of the control interface is not critical for connection inside a rack.

The connection of the RS485 requires twisted pair cable.

Special cares should be taken in the wiring of the module to comply with EMC constraints.

3.5 Getting started

Once the RXH 1000 receiver is powered, it starts immediately within less than a second.
If a valid DVB-T signal is received on one of the 2 RF inputs, then the receiver will immediately demodulate the signal and present it on the ASI or SPI outputs, if the parameters have been set correctly.

Parameters are stored in an EEPROM memory of the module, so that there is no need to restore the parameter after a switch off / switch on.
If the receiver always operates on the same channel, in the same conditions, then the use of the control interface is optional.

3.6 Initial configuration

Except otherwise specified at the order, the RXH 1000 module are delivered with a basic configuration as described hereafter.

Any change in this basic configuration requires the use of the control interface as explained in chapter 4 – Operation.

- Default configuration (at the delivery) –

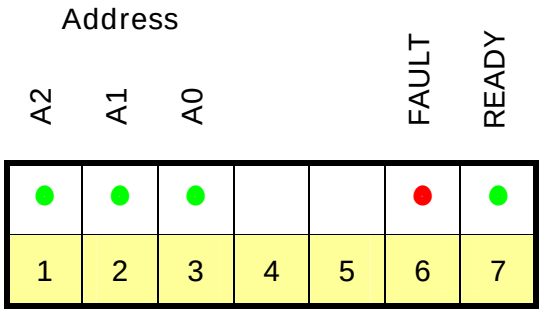
Parameter	**RXH0-1020 (2 ASI outputs)**	**RXH1-1020 (1 SPI output)**
Address of the module	0x11	0x11
Mode	'Diversity'	'Diversity'
Channel bandwidth	8 MHz	8 MHz
Centre frequency RF In 1 Centre frequency RF In 2	666 MHz 666 MHz	666 MHz 666 MHz
Offset frequency	No offset	No offset

Selected flow if the received signal is a hierarchical DVB-T one	HP flow	HP flow
Output format	188 bytes	188 bytes

4. Operation

4.1 Description of the LED

A simple signalization is performed using 5 CMS LEDs. They are located on the right side of the module above the 7-points connector:



- "Address LED": These 3 LEDs display the 3 module address LSB. This address is relevant to the use of the RS485 control interface. It allows the user to control several modules (same or different types), with the same RS485 interface. In such a configuration, the user should set the address of each module at a different value (from 1 to 7).
  At least one of these 3 LEDs is always light on.
  Address LEDs are flashing at the same time during a software download operation.

- "Ready LED": When this LED is ON, a valid signal is usually available on the output (ASI or SPI), meaning that the receiver has been set properly and a valid DVB-T/H signal has been found on one of the 2 RF inputs.
  The "Ready Led" is OFF if there is no DVB-T/H signal on one or the other RF input.
  The "Ready Led" is flashing when there is a RF signal on at least one RF input, and there is no valid signal on the selected MPEG-TS output.
  In Dual Inputs mode or hierarchical mode, the Led is flashing if one of the RF input is missing.
  In Redundant mode with Manual Switching, the "Ready Led" is flashing if there is no DVB-T/H signal on the RF input selected.

- Fault LED: When this LED is ON, this means that the module is not operating properly. (See chapter 5 – Maintenance & checking). It is likely that the signal is not present on the output in such a situation.

4.2 Control interface

4.2.1 Generalities

The control interface could be used to send commands to the module or to get status from the module.

- The commands sent to the module are used to:
  - The setting of the mode of operation of the board:
    - Normal or Dual mode,
    - Hierarchical,
    - Diversity,
    - Redundant.
  - The setting of the channel width, 5, 6, 7 or 8 MHz,
  - The setting of the centre frequency of the UHF or VHF channel used for each RF input,
  - The control of the download of software release.

- The status that the host CPU could read from the module are used to get:
  - The version of the board,
  - The mode of operation that has been setup,
  - The centre frequency of the UHF or VHF Channel used for each RF input,
  - The DVB-T mode parameters (2K/8K, QPSK/16/64QAM, FEC, Guard Interval, hierarchical mode …) of the received signal,
  - The RF input level for UHF / VHF receiver[3]
  - The BER, MER, Packet error rate …
  - Channel profile, constellation
  - Eventually the error status (No RF signal, no demodulation possible, remaining MPEG-TS Packet errors …),

All transfers between the host CPU and the receiver module are initiated and managed by the host CPU.

Usually the module is installed inside equipment.

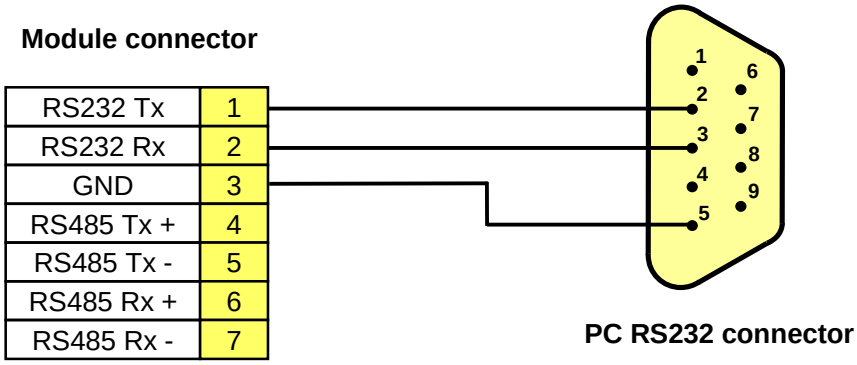
- If this equipment has its own CPU (called host CPU later in this chapter), then a permanent and dynamic control of the module could be done.
- If the equipment has no CPU and no way to managed the module through one of its control interface, then the module has to be configured before its installation in the equipment using a terminal (It could be a PC computer configured in the Hyper terminal mode).

[3] RF Input level measurement is not implemented on the 70 MHz receiver (~TCM-RXT2-1020)

4.2.2 The 2 control ports

The 2 control ports are always active.
There is no need to select one or the other, and the 2 ports could be electrically connected simultaneously.
Nevertheless only one has to be used at a time on the protocol point of view.

- RS232 port
  - The RS 232 port uses the 2 usual RX / Tx lines and a Ground connection,
  - The setting of the port is fixed with the following parameters:
    - No parity bit
    - 57600 bauds (default), can be set from 19200 to 115200 Bauds
    - 8 data bits
    - 1 STOP bit

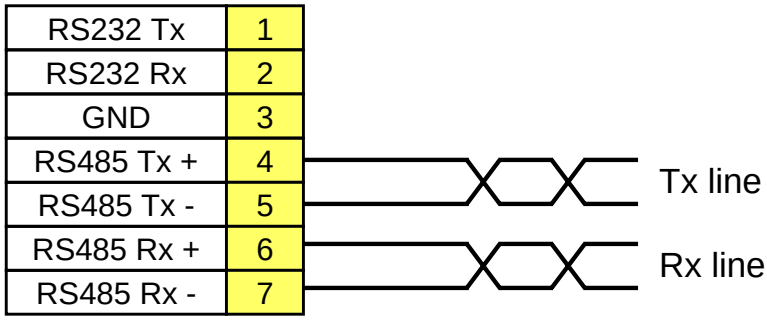


Module to PC RS232 cable

- RS485 port
  - The RS 485 port is a standard full duplex RS485 interface.
  - The setting of the port is the same as the RS232:
    - No parity bit
    - 57600 bauds (default), can be set from 19200 to 115200 Bauds
    - 8 data bits
    - 1 STOP bit

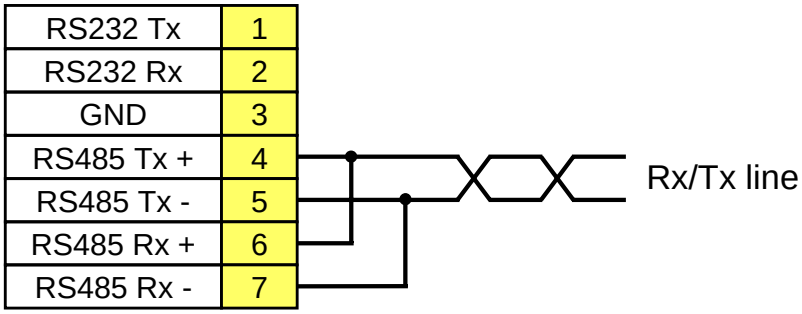
- RX and Tx lines are available as 2 differential signals and a Ground connection.
- The connection should be done using shielded twisted pairs cable.
- The user could use the RS485 :

  - as a full duplex port with separate Tx and Rx lines or,



Full duplex connections

  - as a half duplex port with a single Tx/Rx line. To do so the user should connect Tx+ pin with Rx+ and Tx- with Rx- as shown hereafter:



Half duplex connections

In half duplex mode the host CPU should manage the protocol so that there is no conflict on the communication line.

4.2.3 Addressing the modules

Each module has an internal address which is defined on 8 bits.

This addressing feature allows several modules to be connected on the same control interface (RS485), and to be controlled by the same Host CPU.

The 5 MSB of this address are defined according to the type of the module and the 3 LSB are the number of the module.

Module address (Type-Number)	Address range (byte address in hexa)	Module type
"00000-xxx"	From 0x00 to 0x00	Reserved for broadcast addressing
"00010-xxx"	From 0x11 to 0x17	RXH-1000 = DVB-T/H demodulator
"00100-xxx"	From 0x21 to 0x27	MOD-1000/MOD-2000 = DVB-T/DVB-H modulator SOD-2110/ SOD-2110 = DVB-T/DVB-H Signal Generator
"00110-xxx"	From 0x31 to 0x37	SYN-1000 = Frequency synthesizer
“01010-xxx”	From 0x51 to 0x57	MIP-1000 = MIP Inserter
“01110-xxx”	From 0x71 to 0x77	DAB-1000/DAB-2000 = DAB modulator
“11111-xxx”	From 0xF8 to 0xFF	Forbidden address range

Module type address

The 3 LSB could be defined by the user. These 3 address LSBs are displayed on the 3 green LEDs located on the right side of the module.
These 3 address LSBs are factory set to “001”.

So the default address of a RXH-1000 DVB-T receiver is always “0x11” or “00010 001b”.

Some addresses are reserved for special uses according to the following table.

Address value or range	Address use
"0x00 = 00000 000b"	Reserved for broadcast mode (All module type, all module numbers)
"0x10 = 00010 000b"	Reserved for broadcast mode (RXH 1000 modules, all module numbers)
"0x11 = 00010 001b"	RXH 1000 Module number 1 (default address)
"0x12 = 00010 010b"	RXH 1000 Module number 2
"0x13 = 00010 011b"	RXH 1000 Module number 3
"0x14 = 00010 100b"	RXH 1000 Module number 4
"0x15 = 00010 101b"	RXH 1000 Module number 5
"0x16 = 00010 110b"	RXH 1000 Module number 6
"0x17 = 00010 111b"	RXH 1000 Module number 7
"0xFF = 111111 111b"	Forbidden address

Allowed addresses for a RXH 1000 module

As explained in chapter 4.3 each message sent by the host CPU to the module includes an address field.
The module answers to messages from the host CPU only when its own address matches the address value included in the received message.

A special command described in chapter 4.3 allows the user to set a new address to the module. It is not allowed to set a module with the address "0".

The broadcast address could be used to send the same command to all modules or to all module of the same type. When a module receives such a command, it will execute the command but will not answer to the host CPU.
It could be used for example to Reset all the modules at the same time.
This broadcast addressing mode is limited to the "Control commands" (SET type commands).

4.3 Protocol of the control interface

4.3.1 Message structure

This protocol has been inspired by the famous Hayes commands used for modem.
The module is usually placed under the control of a Host CPU or a terminal.
The module itself is slave to the host CPU meaning that it never takes the initiative of a communication and only answers to request from the host CPU.
The host CPU or the terminal always operates as the master.
The message sent from the host to the module is called the ***Request Message*** and the answer of the module to the host is called the ***Answer Message***.

A message has always the following structure:

<Message> = <AD> <ID> <DATA>

Where:

- <AD> is the module address (1 byte)
- <ID> is a one byte message identifier (1 byte),
- <DATA> is the byte or multi bytes data field of the message. If multi-bytes numeric values are given in the DATA field, most significant byte is sent first.

The number of Data bytes is not indicated in the message itself. It is defined according to the message <ID>.

4.3.2 ASCII encoding

The protocol is ASCII oriented.
For the transmission of a message, each byte is ASCII coded, meaning that two ASCII characters are used to transmit one useful byte. For example the message byte 0xF3 will be transmitted as 0x46 ('F' ASCII code) plus 0x33 ('3' ASCII code).

"Space" characters (ASCII code 0x20) can be inserted before, between and after useful bytes but are ignored by the module and should be ignored too by the host CPU. "Space" characters are not processed in the CRC computation (see 4.3.4).

These space characters facilitate the reading of command files when displayed on a terminal. Especially, the slave answer starts with some "space" characters so that the request and the answer messages can easily be distinguished on a terminal screen.

4.3.3 Message encapsulation

A message is always encapsulated between a prefix and a suffix:

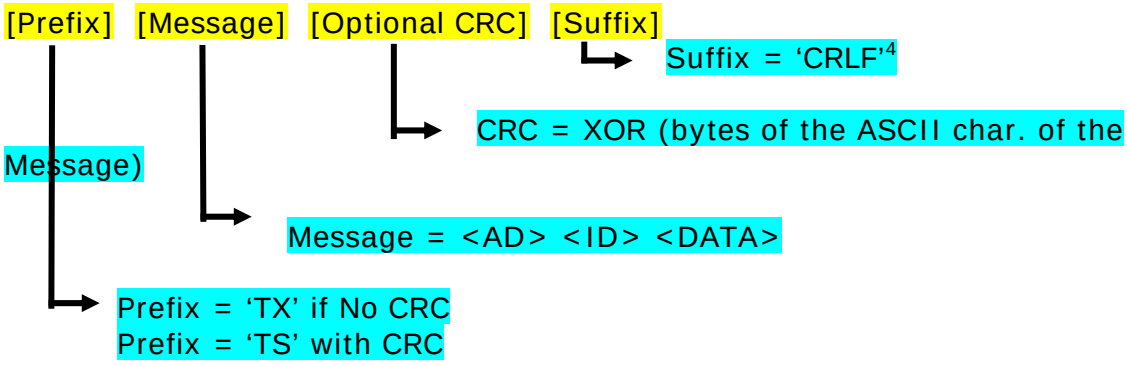
- The prefix could take the value “TX” (ASCII codes 0x54 and 0x58) for normal operation, or “TS” for secured operation (See here under 4.3.4 Optional CRC)
- The suffix includes a Carriage Return character (ASCII code 0x0D) followed by a Line Feed character (ASCII code 0x0A).

4.3.4 Optional CRC

If the Prefix sent is "TS" (ASCII codes 0x54 and 0x53) instead of "TX", this means that a CRC is added to the message. This CRC is computed by XOR between all bytes of the ASCII codes of the useful message [<AD>, <ID> and <DATA> fields] except “space” characters, and inserted at the end of this message before the suffix. It is then transported as two ASCII characters like all other bytes of the message.
In this mode the CRC is inserted by the sender of a message and checked by the receiver.
If a CRC check is wrong on the module, it will answer to the host CPU with an error message (see hereafter “error message” in 4.4.1 and 4.4.3).
If a CRC check is wrong on the Host CPU, the host CPU should resend the message to the module.
If multiple CRC errors happened then the link between host CPU and the module should be verified.

4.3.5 Global Message Structure

Here is given the global structure of the messages.



[4] ‘CR LF’ are the 2 ASCII characters Carriage Return (0x0D) for CR and Line Feed (0xOA) for LF.

4.3.6 Example

- **The Reset Command**[5]

Reset command identifier is: **Id = 0 = 0x00**
In this example the host CPU sends a reset command to the RXH receiver which address is the default address.

- If CRC checking is required, the following string of characters (ASCII codes) is sent by the host CPU to the module:
  Character string: **TS 11 00 00 CRLF**[6]
  ASCII code: **0x54 0x53 0x31 0x31 0x30 0x30 0x30 0x30 0x0D 0x0A**
  ("Space" characters 0x20 could be inserted between any characters)

- If no CRC checking is required, the following string of characters (ASCII codes) is sent by the host CPU to the module:
  Character string: **TX 11 00 CRLF**
- ASCII code: **0x54 0x58 0x31 0x31 0x30 0x30 0x0D 0x0A**
  (Blank characters 0x20 could be inserted between any characters)

- **The Attention Command**

The "Attention Command" is similar to the one of the Hayes commands for a modem.
This command is one of the "Manual commands" that are used by the user to check that the module is OK. It is generally not used by the host CPU.

It is an easy way for the user to check that the module is alive.

If a user wants to check that a RXH 1000 receiver with its default address is alive, it should send the following *Request Message*:

Character string: **TX CRLF**

ASCII code: **0x54 0x58 0x0D 0x0A**

It will get back the following *Answer Message* from the module:

[5] Please note that a Reset Command is performed only by sending a *Request Message*. There is not *Answer Message* from the module.
[6] This is the line of characters that has to be typed on the PC in the hyper terminal mode.
The CRC is computed on ASCII characters so = XOR [31, 31, 30, 30] = 0x00

Character string: **'TEAMCAST, YOUR TEAM FOR BROADCAST'**

4.4 Description of the different Messages

4.4.1 Different types of messages

A communication is always initiated by the host CPU by a message called the *Request Message*. The module answers this request with an *Answer Message.*

4 types of Commands can be handled by a module:

- Manual commands from a terminal for checking purpose,
- Control commands from a host CPU or a terminal for configuration purpose,
- Monitoring commands from a host CPU or a terminal for state monitoring purpose,
- Download software command for software upgrade of the module from a host CPU.

An error message is a special *Answer Message* sent by the module if:

- An unknown message identifier <ID> is received in a *Request Message,*
- An invalid command is received,
- The CRC check performed by the module in the "TS" mode, failed,
- The number of received bytes in the Data Field is not the one expected according to the message identifier <ID>
- A parameter of the <DATA> section has not a valid value

For most Control Commands, the *Request Message and Answer message* have the following format:

- <Request Message> = <AD> <ID> <DATA>
- <Answer Message> = <AD> <ID>

Nevertheless it may happen that a control message needs an *Answer Message* with a DATA field from the module

For most Monitoring Commands, the *Request and Answer messages* has the following format:

- <Request Message> = <AD> <ID>
- <Answer Message> = <AD> <ID> <DATA>

Nevertheless it may happen that a Monitoring message may include a DATA field in the *Request Message* to the module.

Identifier values are organized as follow:

- id. From 0 (0x00) to 31 (0x1F): ..... for common[7] Control commands
- id. From 32 (0x20) to 111 (0x6F): ..... for special Control commands
- id. From 128 (0x80) to 159 (0x9F): for common Monitoring commands

[7] "Common" means commands that are common to all types of modules while "Special" means commands that apply only to the Receiver RXT 1000 module

- id. From 160 (0xA0) to 239 (0xEF): for special Monitoring commands
- id. From 240 (0xF0) to 255 (0xFF): ..... for miscellaneous command

4.4.2 List of Commands

RXHR-10x0 Command set		Request Message			Answer Message		
		Identifier <Id>		Data field size (in bytes)	Identifier <Id>		Data field size (in bytes)
		Decimal	Hexa		Decimal	Hexa	
Control Commands							
Common	Reset	0	0x00	0			
	Set Address	1	0x01	1	1	0x01	0
	Set EEPROM Data	2	0x02	8	2	0x02	0
Special	Set Serial Speed	8	0x08	1	8	0x08	0
	Set Mode	32	0x20	4	32	0x20	0
	Set RF Input 1	33	0x21	7	33	0x21	0
	Set RF Input 2	34	0x22	7	34	0x22	0
	Set Output Format	37	0x25	1	37	0x25	0
Monitoring Commands							
Common	Get Address	129	0x81	0	129	0x81	1
	Get EEPROM Data	130	0x82	0	130	0x82	8
	Get Type & Version	131	0x83	0	131	0x83	8
	Get Serial Number	132	0x84	0	132	0x84	2
	Get General Status	133	0x85	0	133	0x85	2
Special	Get Serial Speed	136	0x88	0	136	0x88	1
	Get Mode	160	0xA0	0	160	0xA0	4
	Get RF Input 1	161	0xA1	0	161	0xA1	7
	Get RF Input 2	162	0xA2	0	162	0xA2	7
	Get Selected Input	163	0xA3	0	163	0xA3	1
	Get Input 1 status	164	0xA4	0	164	0xA4	17
	Get Input 2 status	165	0xA5	0	165	0xA5	17
	Get Input 1 TPS	166	0xA6	0	166	0xA6	7
	Get Input 2 TPS	167	0xA7	0	167	0xA7	7
	Get Signal_to_Noise In1	168	0xA8	0	168	0xA8	1
	Get Signal_to_Noise In2	169	0xA9	0	169	0xA9	1
	Get Channel Profile In1	170	0xAA	1	170	0xAA	0 or 65
	Get Channel Profile In2	171	0xAB	1	171	0xAB	0 or 65
	Get_RF_Level_Input1	172	0xAC	0	172	0xAC	2
	Get_RF_Level_Input2	173	0xAD	0	173	0xAD	2

	Get Output Format	174	0xAE	0	174	0xAE	1
	Get Constellation In1	175	0xAF	0	175	0xAF	64
	Get Constellation In2	176	0xB0	0	176	0xB0	64
	Get DVB-H TPS field In1	177	0xB1	0	177	0xB1	5
	Get DVB-H TPS field In2	178	0xB2	0	178	0xB2	5

4.4.3 Description of each Command

Command Label:	***Reset***		
Command Type:	*Control Command*	Identifier =	**0** **0x00**
Command description: *This command performs a total software reset of the module.*			
Data Field Description:	Request message	Data Field size:	0 bytes
Restriction of use			
	After a Reset command the module needs about 0.5 second before becoming operational again. The module does not answer to a reset command.		

Command Label:	***Set Address***		
Command Type:	*Control Command*	Identifier =	**1** **0x01**
Command description: *This command is used to set the address of the module.*			
Data Field Description:	Request message	Data Field size:	1 bytes
Byte 1:	Value of the address of the module within the range of 1 to 7 The 3 LSB only are used (b0 to b2 are used) Default value of this Address is '0x01'		
Restriction of use			
	The address value "0" is not allowed.		

Command Label:	***Set EEPROM Data***		
Command Type:	*Control Command*	Identifier =	**2**	**0x02**
Command description: *This command is used to store user data in the EEPROM memory of the module.*			
Data Field Description:	Request message	Data Field size:	8 bytes
Byte 1 to 8:	The use of these 8 bytes is free and no control on the values is performed by the module. Default value of these bytes is '0xFF'.		
Restriction of use			
	None		

Command Label:	***Set Serial Speed***		
Command Type:	*Control Command*	Identifier =	**8**	**0x08**
Command description: *This command is used to set the speed of the serial port*			
Data Field Description:	Request message	Data Field size:	1 byte
Byte 1	Value 0x00 : Baud rate = 19200 bps Value 0x01 : Baud rate = 38400 bps Value 0x02 : Baud rate = 57600 bps (default) Value 0x03 : Baud rate = 115200 bps		
Restriction of use			
	Warning: **A reset of the device is needed for the serial speed changing to be taken in account.** **Any change of the baud rate implies a loss of the serial connection. The COM port of the PC communication shall be updated as well.**		

Command Label:		***Set Mode***	
Command Type:	*Control Command*	Identifier =	**32** **0x20**
Command description: *This command is used to set the mode of operation of the module*			
Data Field Description:	Request message	Data Field size:	4 bytes
Byte 1:	Value = 0x00 Value = 0x01 Value = 0x02 Value = 0x03	Mode = Dual inputs mode (1) Mode = Redundant mode Mode = Hierarchical mode (1) Mode = Diversity mode	
Byte 2:	 Value = 0x00 Value = 0x01 Value = 0x02	This byte is relevant to redundant mode only. Manual Switching Automatic switch on Synchro loss Automatic switch on DRS (Remaining error packet after Reed Solomon)	
Byte 3:	Value = 0x00 Value = 0x01	Select RF Input 1 Select RF Input 2	
Byte 4: (2)	Value = 0x00 Bit 0 set to 1 Bit 1 set to 1 Bit 2 set to 1	Nominal condition (Default value) Optimized for mobile operation, Rfu Diversity mode – optimized reception (MER, sensibility),	
Restriction of use			
	(1) These 2 modes are managed in the same way, meaning that both channels have to be setup even in hierarchical mode. (2) Byte 4 is reserved for optimization in special applications. Special algorithms are activated in the demodulator chip so that the performance could be optimized in some specific configurations. Bit 0 is used to get a faster channel estimation algorithm, Bit 2 forces a frequency offset between the 2 tuners in diversity mode. This improves the MER and sensibility.		

Command Label:		***Set RF Input 1 parameters***		
Command Type:	*Control Command*	Identifier =	**33**	**0x21**
Command description: *This command is used to set the parameters of the RF input 1.*				
Data Field Description:	Request message		Data Field size:	7 bytes
Byte 1:	Value = 0x00 Value = 0x01 Value = 0x02 Value = 0x03	Channel Bandwidth = 7 MHz Channel Bandwidth = 8 MHz Channel Bandwidth = 6 MHz Channel Bandwidth = 5 MHz		
Byte 2 to 5:	Value of the center frequency of the selected RF channel Byte 2 is the MSB and byte 5 the LSB. The Frequency is expressed in hertz. For example 666 000 000 Hz should be coded as 0x27B25A80, byte 2 = 0x27, byte 3 = 0xB2, byte 4 = 0x5A, byte 5 = 0x80.			
Byte 6:	Value = 0x00 Value = 0x01 Value = 0x02	No offset frequency Negative offset frequency (- 167 KHz) Positive offset frequency (+ 167 KHz)		
Byte 7:	Value = 0x00 Value = 0x01	Select LP stream (1) Select HP stream (1)		
Restriction of use				
	(1) Only useful when Hierarchical DVB-T mode is detected			

Command Label:		***Set RF Input 2 parameters***		
Command Type:	*Control Command*	Identifier =	**34**	**0x22**
Command description: *This command is used to set the parameters of the RF input 2.* *It works exactly the same way as the previous command for Input 1.*				
Data Field Description:	Request message		Data Field size:	7 bytes
Byte 1 to 7:	Same description as the command for RF Input 1			
Restriction of use				
	Same restriction and comments as for the "Input 1" command.			

Command Label:	***Set Output Format***		
Command Type: *Control Command*		Identifier = **37**	**0x25**
Command description: *This command is used to set the output format.*			
Data Field Description: Request message		Data Field size: 1 byte	
Byte 1:	Value = 0x00 Value = 0x01	Output Format at 204 bytes Output Format at 188 bytes	
Restriction of use			
	None		

Command Label:	***Get Address***		
Command Type: *Monitoring Command*		Identifier = **129**	**0x81**
Command description: *This command is used to get the address of the module* *As an exception to the general protocol, the <AD> value for this command could be 0x00, whatever the address of the module is.* *Note: This command is the only "Get" type command that is allowed to be used with address field <AD> = 00.*			
Data Field Description: Answer message		Data Field size: 1 byte	
Byte 1:	*Value of the address of the module within the range of 0x81 to 0x87.* *If not previously set, the default value of this Address is '0x81'*		
Restriction of use			

Command Label:	***Get EEPROM Data***		
Command Type: *Monitoring Command*		Identifier = **130**	**0x82**
Command description: *This command is used to get back the data from the EEPROM memory of the module, which has been previously stored with the "Set EEPROM" command.*			
Data Field Description: Answer message		Data Field size: 8 bytes	
Byte 1 to 8:	Free use of the 8 bytes. Default value of these bytes is '0xFF'.		
Restriction of use			
	None		

Command Label:	***Get Type & Version***		
Command Type: *Monitoring Command*		Identifier = **131**	**0x83**
Command description: *This command is used to read the type and the version of the module* *The type of module is coded as a numerical value in this command while the command "Get Type" described after, returns the ASCII string of characters.*			
Data Field Description: Answer message		Data Field size: 8 bytes	
Byte 1 & 2:	Hardware Version, BCD coded on 2 bytes in the range of 0x0100 to 0x0999 (see chapter 5.x – Version management)		
Byte 3 & 4:	Software Version, BCD coded on 2 bytes in the range of 0x0100 to 0x0999 (see chapter 5.x – Version management)		
Byte 5 to 8:	4 bytes Numerical BCD value that gives the type of module according to the following list: 0x080F 1020 = "~TCM-RXHR-1020"		
Restriction of use : None			

Command Label:	***Get Serial Number***	
Command Type: *Monitoring Command*	Identifier = **132**	**0x84**
Command description: *This command is used to get the serial number of the module.*		
Data Field Description: Answer message	Data Field size: 2 bytes	
Byte 1:	*Value of the serial number from 1 to 9999 (0x0001 to 0x9999 - BCD coded)*	
Restriction of use : None		

Command Label:	***Get General Status***	
Command Type: *Monitoring Command*	Identifier = **133**	**0x85**
Command description: *This command read the "General Status" of the module.*		
Data Field Description: Answer message	Data Field size: 2 bytes	
Byte 1:	Value = 0 Value = 1 Value = 2 Value = 3	The module is OK A hardware problem/warning has been detected A software problem/warning has been detected A hardware and a software problems/warnings have been detected
Byte 2:	Bit 0 Bit 1 Bit 2 Bit 3 Bit 4	Detailed warning reporting (Active if bit xx = 1) - A power-on reset occurred - Temperature Alarm - Non compatibility Hardware / Software - Failure in loading process - Failure in internal communication
Restriction of use : None		

Command Label:	***Get Serial Speed***		
Command Type:	*Monitoring Command*	Identifier =	**136**	**0x88**
Command description: *This command is used to get the speed of the serial port*			
Data Field Description:	Answer message	Data Field size:	1 byte
Byte 1	Value 0x00 : Baud rate = 19200 bps Value 0x01 : Baud rate = 38400 bps Value 0x02 : Baud rate = 57600 bps Value 0x03 : Baud rate = 115200 bps		
Restriction of use			

Command Label:		***Get Mode***	
Command Type:	*Monitoring Command*	Identifier =	**160** **0xA0**
Command description: *This command (1) is used to get the mode of operation of the module*			
Data Field Description:	Answer message	Data Field size:	4 bytes
Byte 1:	Value = 0x00 Value = 0x01 Value = 0x02 Value = 0x03	Mode = Dual inputs mode (2) Mode = Redundant mode Mode = Hierarchical mode (2) Mode = Diversity mode	
Byte 2:	 Value = 0x00 Value = 0x01 Value = 0x02	This byte is relevant to redundant mode only. Manual Switching Automatic switch on Synchro loss Automatic switch on DRS (Remaining error packet after Reed Solomon)	
Byte 3:	Value = 0x00 Value = 0x01	RF Input 1 is selected RF Input 2 is selected	
Byte 4: (3)	Value = 0x00 Bit 0 set to 1 Bit 1 Bit 2 set to 1	Nominal condition (Default value) Optimized for mobile operation, Rfu Diversity mode – optimized reception (MER, sensibility),	
Restriction of use			
	Same restriction and comments as for the *"Set Mode"* command		

Command Label:			**Get RF Input 1 parameters**
Command Type:	*Monitoring Command*	Identifier =	**161** **0xA1**
Command description: *This command is used to get back the parameters of the RF input 1.*			
Data Field Description:	Answer message	Data Field size:	7 bytes
Byte 1:	Value = 0x00 Value = 0x01 Value = 0x02 Value = 0x03	Channel Bandwidth = 7 MHz Channel Bandwidth = 8 MHz Channel Bandwidth = 6 MHz Channel Bandwidth = 5 MHz	
Byte 2 to 5:	Value of the channel center frequency Byte 2 is the MSB and byte 5 the LSB. The Frequency is expressed in hertz. For example 666 000 000 Hz should be coded as 0x27B25A80, byte 2 = 0x27, byte 3 = 0xB2, byte 4 = 0x5A, byte 5 = 0x80.		
Byte 6:	Value = 0x00 Value = 0x01 Value = 0x02	No offset frequency Negative offset frequency Positive offset frequency	
Byte 7:	Value = 0x00 Value = 0x01	LP stream selected HP stream selected	
Restriction of use			

Command Label:		***Get RF Input 2 parameters***		
Command Type:	*Monitoring Command*	Identifier =	**162**	**0xA2**
Command description: *This command is used to get the parameters of the RF input 2.* *It works exactly the same way as the previous command for Input 1.*				
Data Field Description:	Answer message		Data Field size:	7 bytes
Byte 1 to 7:	Same description as the command for RF Input 1			
Restriction of use				
	Same restriction and comments as for the *"Input 1"* command			

Command Label:		***Get Selected Input***		
Command Type:	*Monitoring command*	Identifier =	**163**	**0xA3**
Command description: *This command is used to know which RF input is active in redundant mode.*				
Data Field Description:	Answer message		Data Field size:	1 byte
Byte 1:	Value = 0 Value = 1	RF Input 1 is selected RF Input 2 is selected		
Restriction of use				
	To be used only in redundant mode			

Command Label:		***Get Input 1 Status (1/2)***	
Command Type:	*Monitoring Command*	Identifier = **164**	**0xA4**

Command description:

This command is used to get back status of the RF input 1 from the relevant demodulator chip.

Data Field Description - byte 1 to 7:		Data Field size: 17 bytes
Byte 1:	Bit 0 = AGC locked Bit 1 = Carrier locked Bit 2 = TPS locked Bit 3 = Viterbi locked (2) Bit 4 = MPEG Synchro locked (2) Bit 5 = MPEG Data locked (2) Bit 6 = Uncorrected MPEG Packet (2)	
Byte 2:	Signed value	RF Input level in dBm (From -20dBm to -92dBm with accuracy around ±1dBm for level under -50dBm). For example 0xC8 means Input level = -56dBm
Byte 3:	Value = 0 Value = 1 Value = 2	DVB-T/H mode – 2K DVB-T/H mode – 8K DVB-T/H mode – 4K
Byte 4:	Value = 0 Value = 1 Value = 2 Value = 3	DVB-T/H mode – Guard interval = 1/32 DVB-T/H mode – Guard interval = 1/16 DVB-T/H mode – Guard interval = 1/8 DVB-T/H mode – Guard interval = 1/4
Byte 5:	Value = 0 Value = 1 Value = 2	DVB-T/H mode – Constellation = QPSK DVB-T/H mode – Constellation = 16 QAM DVB-T/H mode – Constellation = 64 QAM
Byte 6:	Value = 0 Value = 1 Value = 2 Value = 3	DVB-T/H mode – Non Hierarchique DVB-T/H mode – Hierarchique with α = 1 DVB-T/H mode – Hierarchique with α = 2 DVB-T/H mode – Hierarchique with α = 4
Byte 7:	Value = 0 Value = 1 Value = 2 Value = 3 Value = 4	DVB-T/H mode – Code rate = 1/2 DVB-T/H mode – Code rate = 2/3 DVB-T/H mode – Code rate = 3/4 DVB-T/H mode – Code rate = 5/6 DVB-T/H mode – Code rate = 7/8

Command Label:			***Get Input 1 Status (2/2)***	
Command Type:	*Monitoring Command*	Identifier =	**164**	**0xA4**
Command description: *This command is used to get back status of the RF input 1 from the relevant demodulator chip.*				
Data Field Description - byte 8 to 17:			Data Field size:	17 bytes
Byte 8 - (1)	Value = 0 Value = 1 Value = 2 Value = 3 Value = 4	DVB-T/H mode – LP code rate = 1/2 DVB-T/H mode – LP code rate = 2/3 DVB-T/H mode – LP code rate = 3/4 DVB-T/H mode – LP code rate = 5/6 DVB-T/H mode – LP code rate = 7/8		
Byte 9:	Value = 0 Value = 1	Native inner interleaver IN-depth inner interleaver		
Byte 10 to 11:	Cell Id as defined in ETS 300744.			
Byte 12:	MER – Modulation Error Ratio expressed in dB (For example 0x1B means MER = 27 dB) Range: Min = 0dB Max = [23dB to 28dB] depending on RF input level and modulation parameters			
Byte 13 to 15 (3):	BER – Bit Error Rate expressed in 10^{-8} (For example value 0x012345 means a BER = 7.45 x 10^{-4})			
Byte 16 & 17 (3):	PER – Packet Error Rate expressed in error packets per second. (For example value 0x0123 means 291 error packets per second).			
Restriction of use				
	(1) Significant only when hierarchical DVB-T mode is detected. (2) In diversity mode, the 4 MSB bits of byte 1 are significant only on the second demodulator through the command *"Get Input 2 status"*. (3) No significant in diversity mode			

Command Label:	***Get Input 2 Status***		
Command Type:	*Monitoring Command*	Identifier = **165**	**0xA5**
Command description: *This command is used to get the parameters of the RF input 2.* *It works exactly the same way as the previous command for Input 1.*			
Data Field Description:	Answer message	Data Field size:	17 bytes
Byte 1 to 16:	Same description as the previous command for RF Input 1		
Restriction of use	Command not available on ~TCM-RXHR-1010		
	Same restriction as for "Get Input 1 Status"		

Command Label:	***Get Input 1 TPS***		
Command Type:	*Monitoring Command*	Identifier = **166**	**0xA6**
Command description: *This command is used to get back the parameters of the RF input 1.*			
Data Field Description:	Answer message	Data Field size:	7 bytes
TPS bits are referred according to ETS 300744 standard			
Byte 1:	TPS bits b16 to b23		
Byte 2:	TPS bits b24 to b31		
Byte 3:	TPS bits b32 to b39		
Byte 4:	TPS bits b40 to b47 - Odd frames		
Byte 5:	TPS bits b48 to b55 - Odd frames		
Byte 6:	TPS bits b40 to b47 - Even frames		
Byte 7:	TPS bits b48 to b55 - Even frames		
Restriction of use			
	None		

Command Label:	***Get Input 2 TPS***		
Command Type: *Monitoring Command*		Identifier = **167**	**0xA7**
Command description: *This command is used to get back the parameters of the RF input 2.*			
Data Field Description: Answer message		Data Field size: 7 bytes	
TPS bits are referred according to ETS 300744 standard			
Byte 1:	TPS bits b16 to b23		
Byte 2:	TPS bits b24 to b31		
Byte 3:	TPS bits b32 to b39		
Byte 4:	TPS bits b40 to b47 - Odd frames		
Byte 5:	TPS bits b48 to b55 - Odd frames		
Byte 6:	TPS bits b40 to b47 - Even frames		
Byte 7:	TPS bits b48 to b55 - Even frames		
Restriction of use			
	Command not available on ~TCM-RXHR-1010		

Command Label:	***Get Signal_to_Noise Input 1***		
Command Type: *Monitoring Command*		Identifier = **168**	**0xA8**
Command description: *This command is used to get the measurement of the Signal to Noise ratio of the RF input 1.* *The value measured by the demodulator chip is in fact the ratio C/(N+I) in dB. (1)*			
Data Field Description: Answer message		Data Field size: 1 byte	
Byte 1:	Value of the C/(N+I) in dB. (For example value 0x1E means a C/(N+I) = 30 dB).		
Restriction of use			
	(1) This measurement is disturbed by the presence of narrow band interferers, especially if a residual LO is present on the central frequency (direct I/Q modulation). Range : [0dB to 28dB] Resolution of 1dB		

Command Label:		***Get Signal_to_Noise Input 2***	
Command Type:	*Monitoring Command*	Identifier =	**169** **0xA9**
Command description: *This command is used to get the measurement of the Signal to Noise ratio of the RF input 2.* *The value measured by the demodulator chip is in fact the ratio C/(N+I) in dB.*			
Data Field Description:	Answer message	Data Field size:	1 byte
Byte 1:	Value of the C/(N+I) in dB. (For example value 0x1E means a C/(N+I) = 30 dB).		
Restriction of use			
	(1) This measurement is disturbed by the presence of narrow band interferers, especially if a residual LO is present on the central frequency (direct I/Q modulation). Range : [0dB to 28dB] Resolution of 1dB		

Command Label:		***Get Channel Profile Input 1***	
Command Type:	*Monitoring Command*	Identifier =	**170** **0xAA**

Command description:

This command is used to get the measurement of the Channel Profile of the RF input 1.

Because of the important number of bytes to be transmitted to the host processor for the channel profile monitoring (2 x 128 x 16-bits word), this command is performed through 9 sub commands using the same ID (1).

Computation of the channel profile from the monitored information is given in annex.

Data Field Description:	Request message	Data Field size:	1 byte
Byte 1:	Value = 0x00	Request for monitoring	
	Value = 0x01	Request for point 0 to 15	
	Value = 0x02	Request for point 16 to 31	
	Value = 0x03	Request for point 32 to 47	
	Value = 0x04	Request for point 48 to 63	
	Value = 0x05	Request for point 64 to 79	
	Value = 0x06	Request for point 80 to 95	
	Value = 0x07	Request for point 96 to 111	
	Value = 0x08	Request for point 112 to 127	

Data Field Description:	Answer message	Data Field size:	65 bytes (2)
Byte 1:	Packet number (1 to 8)		
Byte (4*n+1) to (4*n+2) (1≤n≤16)	Real part of point n (16-bits signed integer)		
Byte (4*n+3) to (4*n+4) (1≤n≤16)	Imaginary part of point n (16-bits signed integer)		

Restriction of use

(1) In a first step, the host processor requests for a monitoring (Byte 1 = 0x00) and the module answers immediately using a standard answer form. Then, the host can request packets from 0x01 to 0x08 of 16 points. For each packet, the module answers with the 64 bytes preceded by the packet number.

(2) There is no data field in the answer message when the

	"Request for monitoring" message is received.

Command Label:		***Get Channel Profile Input 2***		
Command Type:	*Monitoring Command*	Identifier =	**171**	**0xAB**
Command description: *This command is used to get the measurement of the Channel Profile of the RF input 2.* *It works exactly the same way as the previous command for Input 1.*				
Data Field Description:	Answer message		Data Field size:	65 bytes
Bytes :	Same description as the command for RF Input 1			
Restriction of use				

Command Label:		***Get_RF_Level_Input1***		
Command Type:	*Monitoring Command*	Identifier =	**172**	**0xAC**
Command description: *This command is used to get the RF level of input 1 with resolution of 1/10 dBm.*				
Data Field Description:	Answer message		Data Field size:	2 bytes
Byte 1 to 2:	Signed value	RF Input level in 1/10 dBm (From -20dBm to -95dBm with accuracy around ±1dBm for level under -50dBm). For example 0xFDC9 means Input level = -56,7dBm		
Restriction of use				
	None			

Command Label:		***Get_RF_Level_Input2***	
Command Type:	*Monitoring Command*	Identifier = **173**	**0xAD**
Command description: *This command is used to get the RF level of input 2 with resolution of 1/10 dBm.*			
Data Field Description:	Answer message	Data Field size:	2 bytes
Bytes :	Same description as the command for RF Input 1		
Restriction of use			
	Command not available on ~TCM-RXHR-1010		

Command Label:		***Get Output Format***	
Command Type:	*Monitoring Command*	Identifier = **174**	**0xAE**
Command description: *This command is used to get the output format.*			
Data Field Description:	Answer message	Data Field size:	1 byte
Byte 1:	Value = 0x00 Value = 0x01	Output Format at 204 bytes Output Format at 188 bytes	
Restriction of use			
	None		

Command Label:		***Get Constellation Input 1***	
Command Type:	*Monitoring Command*	Identifier = **175**	**0xAF**
Command description: *This command is used to get constellation points of the RF input 1.* *16 constellation points are monitored each time the command is sent.*			
Data Field Description: Answer message		Data Field size: 64 bytes	
Byte (4.n) to (4.n+1) (1≤n≤16)	Real part of point n (16-bits signed integer)		
Byte (4.n+2) to (4.n+3) (1≤n≤16)	Imaginary part of point n (16-bits signed integer)		
Restriction of use			
	Real part and imaginary part of point n are the coordinates of the n^{th} constellation point.		

Command Label:		***Get Constellation Input 2***	
Command Type:	*Monitoring Command*	Identifier = **176**	**0xB0**
Command description: *This command is used to get constellation points of the RF input 2.* *It works exactly the same way as the previous command for Input 1.*			
Data Field Description:	Answer message	Data Field size:	64 bytes
Bytes :	Same description as the command for RF Input 1		
Restriction of use			

Command Label:		***Get DVB-H TPS field Input 1***	
Command Type:	*Monitoring Command*	Identifier = **177**	**0xB1**
Command description: *This command is used to get the TPS information of the RF input 1*			
Data Field Description:	Answer message	Data Field size:	5 bytes
Byte 1:	Value = 0x00 Value = 0x01	DVB-H signaling is not performed DVB-H signaling is performed	
Byte 2:	Value = 0x00 Value = 0x01	Time slicing is not used on HP stream Time slicing is used on HP stream	
Byte 3:	Value = 0x00 Value = 0x01	MPE FEC is not used on HP stream MPE FEC is used on HP stream	
Byte 4:	Value = 0x00 Value = 0x01	Time slicing is not used on LP stream Time slicing is used on LP stream	
Byte 5:	Value = 0x00 Value = 0x01	MPE FEC is not used on LP stream MPE FEC is used on LP stream	
Restriction of use			

Command Label:		***Get DVB-H TPS field Input 2***	
Command Type:	*Monitoring Command*	Identifier = **178**	**0xB2**
Command description: *This command is used to get the TPS information of the RF input 2.* *It works exactly the same way as the previous command for Input 1.*			
Data Field Description:	Answer message	Data Field size:	5 bytes
Bytes :	Same description as the command for RF Input 1		
Restriction of use			

command Label:		***Error Message***		
Message Type:	*Answer Message*		Identifier = **254**	**0xFE**
Command description: *This message is sent by the module when something is wrong.*				
Data Field Description:	Answer message		Data Field size:	2 bytes
Byte 1:	Identifier of the message received from the host.			
Byte 2:	Value = 0 Value = 1 Value = 2 Value = 3 Value = 4	Wrong number of Data bytes Unknown message Id Wrong parameter value Invalid command CRC errors		
Restriction of use				
	None			

Command Label:		***Get Type***		
Message Type:	*Manual command*		Identifier = **255**	**0xFF**
Command description: *This command is used to check the type of module.* *When receiving this command the module will answer the following string of ASCII characters:* "Module type = ~TCM-RXHR-1020" According to the type of modules.				
Data Field Description:	No data field		Data Field size:	0 byte
Restriction of use				
	The received bytes are true ASCII characters that cannot be converted to binary as it has to be done for other commands. This command is not available with CRC control but only with the TX prefix.			

Command Label:	***Attention***		
Message Type:	*Manual command*	Identifier =	-	-
Command description: *This command is activated only by sending TX followed by "CRLF" (1)* *This command is used to check that the module is alive.* *When receiving this command the module will answer the following string of ASCII characters:* "TEAMCAST, YOUR TEAM FOR BROADCAST"			
Data Field Description: No data field		Data Field size:	0 byte
Restriction of use			
	The received bytes are true ASCII characters that cannot be converted to binary as it has to be done for other commands. This command is not available with CRC control but only with the TX prefix. (1) "CR" means "carriage return" ASCII character "LF" means "line feed" ASCII character		

Command Label:	***Dowload Packets***		
Message Type:	*Download command*	Identifier = **253**	**0xFD**
Command description: *This command performs the transfer of new software release. It works on a line basis, and so performs the transfer of a packet of 134 bytes. The total transfer is done by repeating this command for each line of data to be transmitted.* *The host CPU should wait for the answer message before sending the next download command.*			
Data Field Description:		Data Field size:	134 bytes
This data field is the copy of the 134 useful ASCII bytes extracted from the .fir file.			
Restriction of use			
	This command cannot be used without CRC, so TX prefix is not allowed. Once a transfer has started, it should be completed before any other command could be sent.		

Command Label:	***Dowload Packets***		
Message Type:	*Answer message*	Identifier = **253**	**0xFD**
Command description: *This message is the answer from the module to a "download packet" command.*			
Data Field Description:		Data Field size:	6 bytes

The 6 bytes data returned in this field, are generally the received line number + 1, meaning that the module has well received the current packet of data, and that the host CPU could send the next packet of data.

If a CRC error has been detected, then the module will return an Error message, so that the host CPU could repeat the previous line.

When the module has received the last data packet, it returns the code 0xFFFFFF in the 6 bytes data field.

After receiving the first line (first data packet) the module performs a cross checking on the type of modules and the hardware version required. The module returns an error code if this cross checking has failed:

- 0xFFFFFD if the module type is not the one expected,
- 0xFFFFFE if the hardware version of the module is not compatible with the new software version.

5. Maintenance & checking

5.1 Versions management

A module is totally defined by its commercial reference and its module version numbers.
Module versions are managed using 2 separate and independent 3 digits numbers:

- The hardware version,
- The software version.

The version of the product is defined for example as:.....**H095-S100**

This means that the hardware of the module is in version 1.22 and the software is in version 1.15.
These numbers could be read from the module using the command “Get Type & Version” described in chapter 4.4.3.
A reduced version number is written on the serial number sticker, usually stuck on the front face of the module. This version number is the version of the module at the delivery time.
It includes only the first 2 digits of the version numbers: **H09-S10**
Hardware update of the module generally requires the module to be returned to the factory while Software update could be done by the user.

5.2 Software update

Software updates could be done by the user itself.
New software can be downloaded from the Teamcast web site (www.teamcast.com) when available.
A new software version is labelled as: . **~TCM-RXH0-1020-H095-S100.zip**

- ~TCM-RXH0-1020 is the commercial reference of the product to which it applies to,
- H095 gives the minimum hardware version required by this new software version,
- S100 is the new software version.

For each software version available a unique file has to be downloaded from the web site.
The file is a compressed .zip file that possibly contains 3 files:

- The **.pdf** file gives instructions and details about the version of the software, (for example ~TCM-RXH0-1020-H095-S100.pdf)
- The **.fir** file is the file that has to be used if the user chooses to perform the download through a host CPU using the dedicated command. (for example ~TCM-RXH0-1020-H095-S100.fir)
- The **.exe** file is the file that has to be executed if the user chooses to perform the download from a PC ,
  (for example ~TCM-RXH0-1020-H095-S100-setup.exe).

5.2.1 Download through a PC

To perform the download of a new software version through a PC computer, the module should be connected to the RS232 serial port of the PC.
Then the user should type the DOS command as follows:

> ~TCM-RXH0-1010-H122-S115-setup [Comport] [speed] [Module Address]

If the command is typed with no argument then the transfer will occur on Com1 serial port, at 57 600 bauds, to module address "11".
Otherwise the user could specify other value for the parameters

- Comport: A value from "COM1" to "COM9" is accepted to specify one port among Com1 to Com5 (default is Com1),
- Speed: this parameter specifies the speed of the communication port. It could be set from 19 200 bauds to 115 200 bauds. Nevertheless ModulCast modules generally operates at 57 600 bauds (default value is 57 600 bauds),
- Address: This parameter is the address of the module to be downloaded as explained in chapter 4.2.3. This address value has to be entered as a 2 digit hexadecimal value. Default value is "11".

The process is automatic. It checks first that the type of module and the hardware version are compatible with this new software version.
If there is a problem of compatibility then one of the the following messages is displayed on the PC screen and the download process is stopped.

> "THIS SOFTWARE VERSION IS NOT COMPATIBLE WITH THE TYPE OF THIS MODULE"

> "THIS SOFTWARE VERSION IS NOT COMPATIBLE WITH THE HARDWARE VERSION OF THE MODULE"

If this checking is positive then the process continues and the download of the new software is performed.
During the download dots are displayed to show the progress of the download process.
>incremental counter

Once it is completed the following message appears on the screen:

> "DOWNLOAD COMPLETED".

An automatic Reset is automatically done on the module and this one is now operational with the new software version.

This download tools is compatible with Windows 2000 and Windows XP.

5.2.2 Download through a host CPU

If the module is installed in equipment and placed under the control of a host CPU, it is possible to implement in this CPU a piece of software that will manage and perform the download of new software versions in the module.
An example of such software is available on the web site as:

"ModulCast_Download_software_Routine.C"

This chapter describe the **.fir** file and the "Download software" command that have to be used for this purpose.

- **Description of the file xxx.fir:**

The **.fir** file is an ASCII file made of several lines, each of these lines includes 137 ASCII characters.
Each line starts with the character "~" (ASCII code 0x7E), and ends with the 2 characters "CRLF" (Carriage return, Line feed – ASCII code 0x0D and 0x0A).
The first 6 characters after the start character "~" give the number of the line from 0x000000 to 0xFFFFEF. Numbers from 0xFFFFF0 to 0xFFFFFF are reserved for error reporting.
The host CPU should read and process the **.fir** file line per line.

- **Description of the first line of the file xxx.fir:**

The first line is dedicated to the host CPU and should not be transmitted to the module.
All other lines of the **.fir** file should be downloaded in the module after being correctly packed.

The first line is numbered as line "000000". It includes:

- the start character "~" (0x7E)
- the number of the line on 6 characters = "000000"
- the number of lines to be downloaded on 6 characters = "xxxxxx",
- the type of module on which this software release applies to,
- the minimum hardware version that could accept this software release
- the software version,
- the reference date of this software version.
- Stuffing characters ("_" = underscore = 0x5F),
- The 2 line end characters ("CRLF" = 0x0D 0x0A)

Example of a first line:
Line 1: ~000000_ABCDEF_TCM-RXH0-1020_H095_S100_25_12_2004_____CRLF
That means:

- The number of line to be downloaded to the module is "ABCDEF",
- The type of module to which this software version applies to, is "~TCM-RXH0-1020",
- This software version requires a hardware platform in a version not lower than H095,

- This software version is labelled as “S100” and dated “25th December 2004”,

- **Description of the “Download” process:**

After having read the first line of the .fir file, the host CPU could start the download process.

The host CPU reads the second line of the file (a pack of 137 ASCII characters).

It extracts the 134 useful ASCII characters (and forgets the start character “~” and the 2 end characters “CRLF”).

It packs these 134 characters in the command format as defined by the protocol:

“TS” <AD> <Id> <Data field> <CRC> “CRLF”

- “TS” prefix mean that a command with CRC is performed. “TX” prefix is not accepted for download command.
- <AD> is the address of the module as defined in chapter 4.2.3,
- <Id> for the Download command is “253” = 0xFD,
- <Data field> is the 134 ASCII characters extracted from the .fir file,
- <CRC> is a CRC8 computed by the host CPU. The CRC computation starts immediately after the space character (if it exists) following the “S” character and should include <AD> <Id> and <Data field>. The CRC byte is then converted in 2 ASCII characters and inserted after the Data field. Space characters are ignored in the CRC computation.
- CRLF (0x0D 0x0A) characters are then inserted to complete the message.

The host CPU sends the command and wait for the answer message from the module.

- If the packet has been well received, the module sends the answer message with the next line number to be transmitted in the data field,
- If a CRC error has been detected by the module, the module sends an error message (“CRC errors”), so that the host CPU will repeat the packet of data.
- After receiving the last packet of data, the module sends the answer message with the line number = 0xFFFFFF. That is the end of the download process.

After receiving the first packet, the module performs some cross checking about the type of module and the hardware version needed.

If this cross checking failed, the module will return an error code instead of the line number of the next transfer:

- 0xFFFFFD: means that the module type is not compatible with the version of the software that is being downloaded.
- 0xFFFFFE: means that the hardware version of the module is not compatible with the version of the software that is being downloaded.

5.3 Checking

If the module does not work properly, a few checking could be done before calling the technical support at TeamCast.

- **Attention command**

Extract your module from the equipment where it is integrated in and try to send the "Attention" command using a PC in hyper terminal mode, (Please refer to 4.2.6 to get a full description of the attention command).

If the module does not answer, try again after a total power on reset of the module.
If you get the right answer '**TEAMCAST, YOUR TEAM FOR BROADCAST'** please check:

- the installation procedure in equipment according to chapter 3,
- the host CPU operation.

If you do not succeed to get your module operational again, please call the Technical support team at TeamCast.

It will help you to locate the problem or give you recommendations to return the module to the factory.

5.4 Return the module to factory

Please never return the module to the factory before having a contact with the TeamCast technical support group.

Refer to the "return to factory procedure" document in appendix B.

6. Appendix A – EC certificate

TeamCast

CERTIFICAT CEM

Déclaration

(EC directive 89/336 article 10)

Nom du fabricant : **TEAMCAST**

Adresse : **Centre Espace Performance**
35769 SAINT GREGOIRE CEDEX

Nom de l'équipement : **Module Récepteur à diversité DVB-T/H de type RXH-1000.**

M. Jean-Luc PAVY, Président Directeur Général,

Déclare avoir acquis la présomption de conformité du matériel ci-dessus référencé, utilisé et installé conformément à la notice, aux exigences essentielles de la Directive 89/336/CEE, par l'application des normes suivantes :

NF EN 55022 classe B
NF EN 55024

Saint-Grégoire, le 23 janvier 2007

TeamCast

CERTIFICAT DE SECURITE BASSE TENSION

Déclaration

(EC directive 73/23)

Nom du fabricant : **TEAMCAST**

Adresse : **Centre Espace Performance**
35769 SAINT GREGOIRE CEDEX

Nom de l'équipement : **Module Récepteur à diversité DVB-T/H de type RXH-1000.**

M. Jean-Luc PAVY, Président Directeur Général,

Déclare avoir acquis la présomption de conformité du matériel ci-dessus référencé, utilisé et installé conformément à la notice, aux exigences essentielles de la Directive 73/23/CEE, par l'application de la norme NF EN 60950 .

Saint-Grégoire, le 23 janvier 2007

7. Appendix B – Return to factory procedure

RETURN TO FACTORY PROCEDURE

IF YOUR TEAMCAST PRODUCT NEEDS TO BE RETURNED FOR REPAIR, PLEASE USE THE FOLLOWING PROCEDURE:

1. Contact TEAMCAST customer support representative to review technical matters. He will decide with you if the product needs to be returned or not, and in this case, he will assist you in the return process.

TEAMCAST CUSTOMER SUPPORT	
Tel. + 33 (0)2 23 25 26 80 Fax. + 33 (0)2 23 25 26 85	Email : ***support@teamcast.com***
TEAMCAST CUSTOMER SUPPORT –NORTH AMERICA AREA	
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2. The TEAMCAST customer support representative provides you the return form document (*After Sales Follow Up*). This document specifies **a RMA (Return Material Authorization) number** allocated only for this return follow-up.

3. Pack the product returned for repair in its original packing, **including the return form document dully filled**.

4. The **RMA number should be clearly indicated** on all returned product, boxes, packages and accompanying paperwork.

5. Send the boxes/packages back to TEAMCAST.

6. Product **out of warranty** :
   Teamcast send you a repairing quote. If you accept this quote, send a purchasing order to Teamcast in return. Then we proceed to the repair. If you don't accept this quote, the product will be returned without any repairing.

7. After repair, TEAMCAST will send you the maintenance report document that describes what has been done to the product.

Note 1: Any return to factory that would not have been authorized (without RMA) will not be processed under the standard guarantee condition.

Note 2: RMA numbers are only valid for thirty (30) days. Older RMA numbers need to be revalidated by a new RMA request procedure.

Note 3: Return cost to TEAMCAST will be prepaid by the customer. TEAMCAST will take care of the cost from factory to the customer site after repair.

8. Appendix C – Computing the channel profile

Once the 128 points have been uploaded, the host processor has to compute them in order to obtain the time domain channel profile.
Considering that the 2 * 128 uploaded integers are placed in the re[128] and im[128] tables, the calculation that has to be applied is given in the following C source code:

```
#include <math.h>
static void fft (double *data_re, double *data_im, unsigned short n)
{
signed long mmax,m,j=0,istep,i;
double wtemp,theta;
double temp_re,temp_im,w_re,w_im,wp_re,wp_im;
j = 0;
for (i = 0; i < n; i++) {// Bit reverse the index (in situ)
if (j > i) {
temp_re = data_re[i];
temp_im = data_im[i];
data_re[i]= data_re[j];
data_im[i]= data_im[j];
data_re[j]= temp_re;
data_im[j]= temp_im;
}
m = n >> 1;
while (m > 0 && j >= m) {
j -= m;
m /= 2;
}
j+=m;
}
mmax=1;
while (mmax < n) { // Routine proper
istep = mmax * 2;
theta = 6.2831853071796 / istep;
wtemp = sin(0.5 * theta);
wp_re = -2.0 * wtemp * wtemp;
wp_im = sin(theta);
w_re = 1.0;
w_im = 0.0;
for (m =0; m < mmax; m++) {
for (i = m; i < n; i += istep) {
j=i+mmax;
temp_re= w_re*data_re[j] - w_im*data_im[j];
temp_im= w_re*data_im[j] + w_im*data_re[j];
data_re[j]= data_re[i] - temp_re;
data_im[j]= data_im[i] - temp_im;
data_re[i]= data_re[i] + temp_re;
data_im[i]= data_im[i] + temp_im;
}
temp_re = w_re + w_re*wp_re - w_im*wp_im;
temp_im = w_im + w_re*wp_im + w_im*wp_re;
```

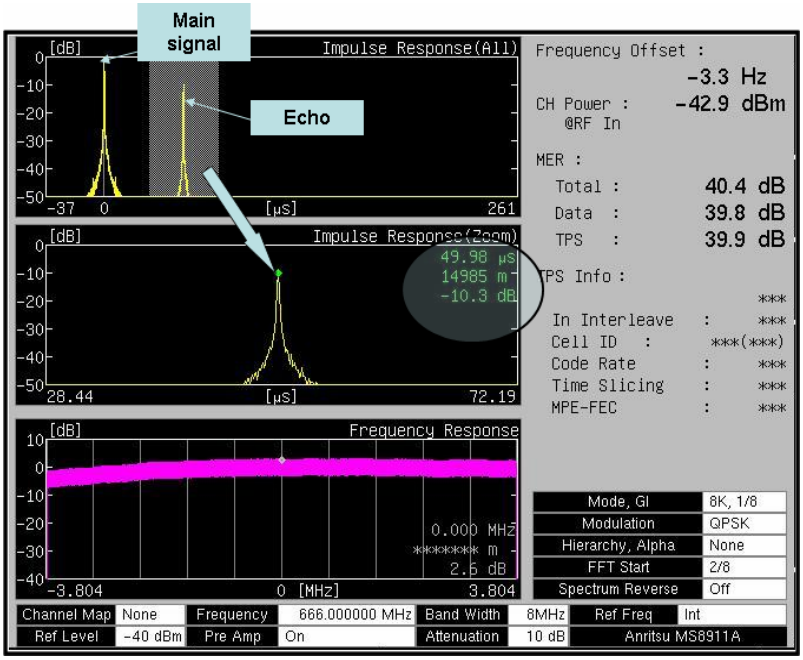
```
w_re = temp_re;
w_im = temp_im;
}
mmax=istep;
}
}
// fft_mode = 2 for 2k, 4 for 4k and 8 for 8k
// bandwidth = 5 for 5 MHz, 6 for 6, 7 for 7 and 8 for 8
void demod_channel_profile_calc(signed short re[128], signed short
im[128],
signed char bandwidth, signed char fft_mode, double *us, double *db)
{
signed long i,j;
double bmwin[128], tmp_re[512] = { 0.0 }, tmp_im[512] = { 0.0 };
double max_us;
for (i = 0; i < 128; i++) {
double p = (i - 127) / (128.0*2.0) * 6.2831853071796;
double tmp = ( 0.40217 - 0.49703 * cos(p) + 0.09892 * cos(p * 2)
- 0.00183 * cos(p * 3));
bmwin[i] = tmp * (569 / (569.0 - i));
}
//--- symetrisation
for (i = 0; i < 128; i++) {
tmp_re[i] = re[i] / 8192.0 * bmwin[i];
tmp_im[i] = im[i] / 8192.0 * bmwin[i];
if (i > 0) {
tmp_re[512-i] = tmp_re[i];
tmp_im[512-i] = -tmp_im[i];
}
}
fft(tmp_re,tmp_im,512);
// search max
max_us = 0;
for (j = 0; j < 512; j ++)
{
if (tmp_re [j] > max_us)
{
max_us = tmp_re [j];
i = j;
}
}
// pic center
j = 256;
do
{
db [j] = 10 * log10(fabs(tmp_re[i]) / 512.0);
// 512 samples = Tu / 3 so 1 sample in µs = Tu / 3 / 512 * 10^6 =
sample_µs
// Tu = FFTsize / Fs And Fs = 8 * Bandwidth_Mhz * 10^6 / 7
// with FFT = 2 for 2k, 4 for 4k and 8 for 8k
// sample_µs = FFT / 2 * 2048 * 7 * 10^6 / (3 * 8 * Bandwidth_Mhz
* 10^6 * 512)
// sample_µs = 7 * FFT / (12 * Bandwidth_Mhz)

            us [j] = (double) ((j - 256) * 7 * fft_mode) / (12 *
bandwidth);
if (--i < 0)
i = 511;
```

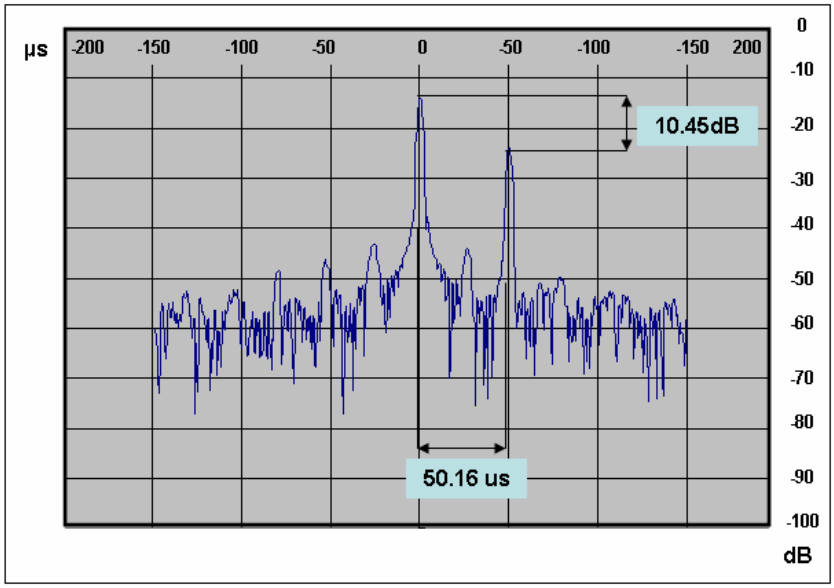
```
if (++j >= 512)
j = 0;
}
while (j != 256);
}
```

The resulting us[512] and **db[512]** tables describe the channel profile in a window of Tu/3.

Following is an example of typical screen that can be computed from the "channel profile" information.

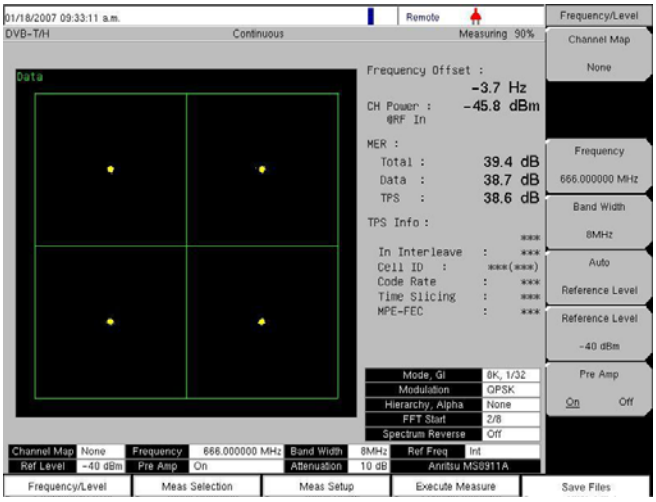


Impulse response measured by ANRITSU MS8911A Digital Broadcast Field Analyser

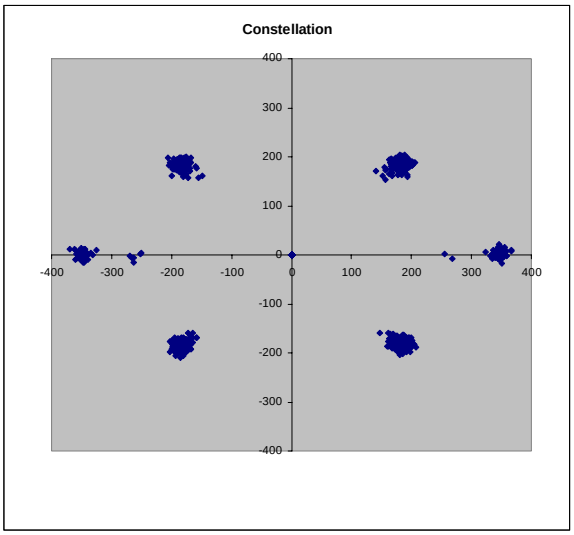


Impulse response derived from RXH-1000 measured samples

9. Appendix D - Constellation diagram



Constellation measured by ANRITSU MS8911A Digital Broadcast Field Analyser



constelation derived from RXH-1000 measured samples

10. Appendix E – Example of host software strategy

The RXH0 module needs a new host software to be controlled. In order to have a single host software able to configure both the RXTR and the RXH0 modules, this new software should implements both sets of commands.

In order to determine the type of receiver it is connected to, the host processor can use the following strategy:

It sends the "Type and version" command (131) with the new module address using "TX 81 83".

If the receiver is the RXTR, because it does not recognize the command ID, it will answer with an error message using "TX 00 40 83 01" (wrong ID). Note that the Error ID (0x40) is not a valid ID of the new protocol. The host processor can then use the old command set.

If the receiver is the RXH0, it will properly answer to the "Type and version" command using "TX 81 83 08 0F 10 x0". The host processor can then use the new command set.