TWISTER II

High-End Rack Modulator / Exciter

- User Manual -

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Revision sheet

Document Number	Revision	Date	Product covered	Version	Comments
MPD-1711201	A	Apr 2018	XTTR-TW20-3102/3 XTTR-TW20-4102/3 XTTR-TW20-5102/3	S100	Document creation
MPD-1711201	B	Apr 2018	XTTR-TW20-3102/3 XTTR-TW20-4102/3 XTTR-TW20-5102/3	S102	ASI out generator
MPD-1711201	C	Jan 2019	XTTR-TW20-3102/3 XTTR-TW20-4102/3 XTTR-TW20-5102/3	S104	ASI out generator with PID selection

Warning

Content warning
This document contains preliminary information about some of the TeamCast 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

TWISTER II High-End Rack Modulator / Exciter

About this manual

- **Intended audience**

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

- **Product described**

The following products are described in this user manual:

XTTR-TW20-3102/3 (0dBm max./ VHF I, VHF III, UHF)
XTTR-TW20-4102/3 (+14dBm max./ VHF I, VHF III, UHF)
XTTR-TW20-4102/3 (+20dBm max./ VHF I, VHF III, UHF)

- **Commercial references and available options**

Product ref.	Description
XTTR-TW20-3102	DVB-T/T2 rack modulator (0dBm) with VHF I & III and UHF output, DAP and onboard GPS
XTTR-TW20-4102	DVB-T/T2 rack exciter (+14dBm) with VHF I & III and UHF output, DAP and onboard GPS
XTTR-TW20-5102	DVB-T/T2 rack exciter (+20dBm) with VHF I & III and UHF output, DAP and onboard GPS
XTTR-TW0-xx03	Idem with onboard GPS/GLONASS
XTTO-TW20-EGAP	GAP (Enhanced DAP) software license
XTTO-TW20-AGC0	AGC (Automatic Gain Control) software license
XTTO-TW20-SNMP	SNMP client software license
XTTO-TW20-SNMP	TSoIP software license
XTTO-TW20-T2LI	T2-Lite software license
XTTO-TW20-REDU	Redundancy/N+1 software license
XTTO-TW20-ISDB	ISDB-T/T_B software license
XTTO-TW20-DTMB	DTMB software license
XTTS-FOR0-TW20	One day training course

Document structure :

- **Chapter 1 – System Overview**
  This chapter gives an overview of the product.
- **Chapter 2 – Features Summary**
  This chapter describes the features of the product.
- **Chapter 3 – TWISTER II rack**
  This chapter describes the mechanics, characteristics and performances.
- **Chapter 4 – TWISTER II Installation**
  This chapter explains how to install the rack.
- **Chapter 5 – TWISTER II Operation**
  This chapter explains how to basically operate the rack.
- **Chapter 6 – 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.

- **Associated publications**

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

[T1]	DVB-T standards	EN 300 744 v1.5.1, ETSI TS101 191 v1.4.1
	www.dvb.org	
[T2]	DVB-H	EN 302 304 v1.1.1, ETSI TR 102401 v1.1.1
	www.dvb.org	
[T3]	MIP Packet	TS 101 191 V1.4.1 (2004-06)
	DVB mega-frame for Single Frequency Network (SFN) synchronization	
	www.dvb.org	

Table 1: Relevant standards for DVB-T/H

[T4]	DVB-T2 standard	ETSI EN 302 755 V1.3.1 (2012-04)
	DVB-T2 Framing structure, Channel Coding and Modulation	
	www.dvb.org	
[T5]	DVB-T2 Guidelines	ETSI TS 102 831 v1.2.1 (2012-08)
	DVB Implementation Guidelines for a second generation digital terrestrial television broadcasting system (DVB-T2)	
	www.dvb.org	
[T6]	T2-MI Interface	ETSI EN 102 773 V1.3.1 (2012-01)
	Modulateur Interface (T2-MI) for DVB-T2	
	www.dvb.org	

Table 2: Relevant standards for DVB-T2

[I1]	IP	RFC-791
	www.ietf.org	
[I2]	UDP	RFC-768
	www.ietf.org	
[I3]	RTP & MPEG/RTR	RFC-1889 / RFC-2250
	www.ietf.org	
[I4]	IP Multicast	RFC-2365
	www.ietf.org	
[I5]	Ethernet	IEEE-802.3
	http://www.ieee802.org/3/	
[I6]	Multicast protocol IGMP	RFC-2236 / RFC-3376
	www.ietf.org	
[I7]	FEC over IP	RFC-2733
	www.ietf.org	
[I8]	ProMPEG Cope#3	SMPTE-2022 (2010-03)
	http://www.smpte.org/	
[I9]	TS over IP	ETSI 102 034 V1.3.1 (2007-10)
	Transport of MPEG-2 TS Based DVB Services over IP Based Networks http://www.dvb.org/	
[I10]	Network Time Protocol	RFC 1305 (Version 3) RFC 5905 (Version 4 – 2010-06) RFC 2030 (SNTP) – Version 4
	www.ietf.org	

Table 2: Relevant standards for IP

[D1]	DVB ASI	EN50083-9, ETSI TR101 891 v1.1.1
	www.dvb.org	
[D2]	MPEG-2 TS Standard	ISO/IEC 13818-1
	http://www.iso.org	

Table 3: Other standards

1 System Overview

1.1 General overview

TWISTER II comes as a new model taking part of the TWISTER product range. This second generation of Terrestrial DTV exciter has been especially designed to support an increase number of IP interfaces and therefore is a future proof solution for any Broadcasters for being prepared to the TS to IP future transition.

As its predecessor, TWISTER II supports a wide range of standards including DVB-T, DVB-T2, ISDB-T/T_B and DTMB. It features Digital Adaptive Pre-correction (DAP) circuits and all required mechanisms to feed transmitter sites with flexible and highly secured input streams formats. This ready-to-use high-end 1RU rack offers best-in-class performances for transmitter manufacturers willing to launch products with a high-performance and secured solution.

In order to bring the highest performances, TWISTER II rack integrates up-to-date FPGA technology as well as sophisticated digital signal processing algorithms, especially for the modulation and the output filtering processes.
In this way, with TWISTER II rack, Broadcasters are able to take full advantage of digital broadcast technology.

The clock system has been carefully designed to reach a very low phase noise clock and it achieves the flexibility required to operate with different synchronization schemes. TWISTER II rack includes a high-stability OCXO oscillator and an on-board GPS receiver. It generates a fully modulated analogue signal and includes all necessary clock & synchronization features for high quality synchronization, especially for SFN network.

Fully controlled via a friendly WEB GUI and via SNMP, TWISTER II also features some very unique functionalities dedicated to control the transmitter such as a Power Measurement Unit (measuring in real-time the forward and reflected power levels), the TX power ON/OFF control system and the Automatic Gain Control (AGC) mechanism. TWISTER II Digital Adaptive Pre-correction circuits, powered by TeamCast GAP® - Green Adaptive Processing - algorithm, permits transmitters operation very close to their saturation limit, with unequalled RF signal performances and allowing significant gain in transmitter Power Efficiency. This creates significant savings in the operating expenses (OPEX).

A total of seven Ethernet control and data ports are available and brings the opportunity to upgrade a classical transmitter configuration into a fully IP-controlled solution!

1.2 Block diagram

The generic block diagrams is described below.

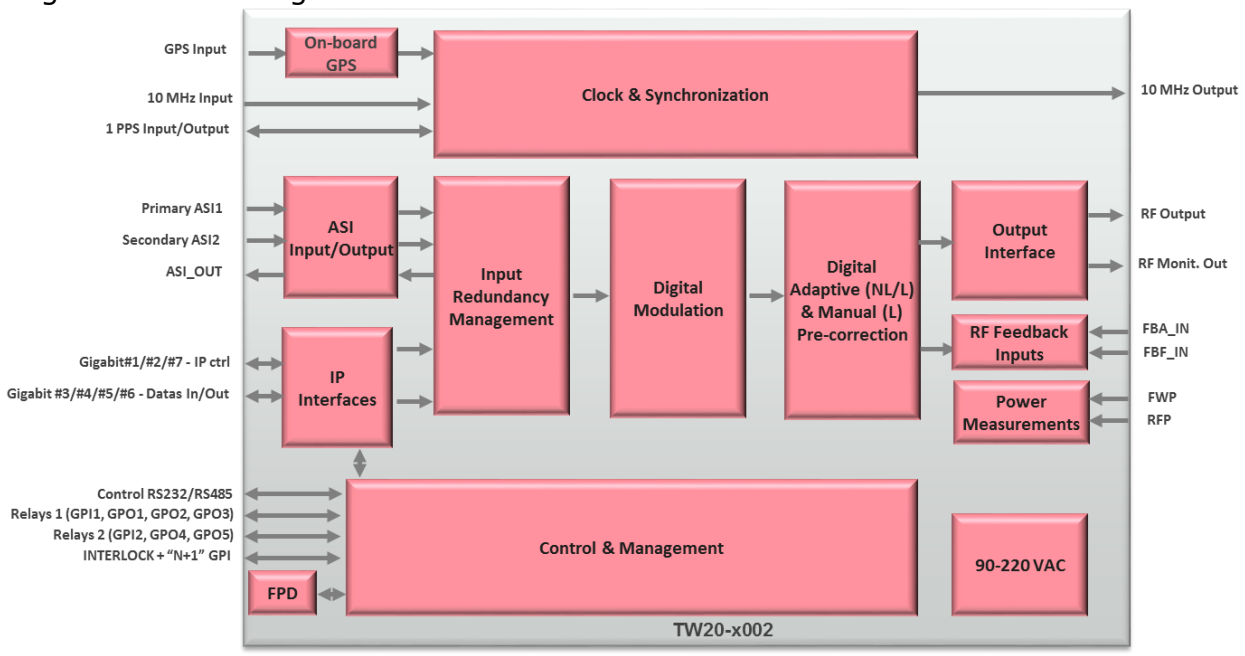

Figure 1: Functional block diagram

TWISTER II features two ASI input streams that can be processed in parallel for stream redundancy (Primary/Secondary).
Four IP streaming (Gigabit) input/output ports are reserved for TSoIP inputs.

The clock and synchronization process has been carefully designed to reach the best performances for any of the standards supported. 1PPS and 10MHz external reference signals are available to reach higher frequency accuracy. An on-board GPS receiver is also available and may be used for this purpose.

Regarding the control and management, an embedded webserver provides a user-friendly graphical user interface that that can be accessed by any web browser. Three IP control ports are available.

Two connectors are provided for the feedback inputs from the amplifier (FBA_IN) and from the filter (FBF_IN). These inputs are used for the Digital Adaptive Pre-correction (DAP).

A serial port is also available for a complete transmitter control and monitoring integration within the modulator's Web GUI. Using simple commands (based on the TeamCast serial protocol), the Transmitter manufacturer will be able to "design" its own Web GUI in the modulator interface.

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2 Features Summary

2.1 Features Overview

- Input Stream Management
  - 2x ASI Inputs (188 or 204 byte format with RS decoding) – TS/ASI or T2-MI/TS/ASI (ETSI EN 102 773, *[T6]*)
  - 2x IP streaming (Gigabit) inputs with FEC decoding (SMPTE-2022, *[I7]*) – TS/IP or T2-MI/TS/IP – Only one processed IP stream – (Optional software license xTT**O**-TW20-TSIP)
  - 1x ASI Output (188 byte) – Stream output type: TS or T2-MI/TS or NULL packet generator (20Mbps)
  - Redundancy management :
  - ➢ TS *CleverSwitch*: stream switching between Main and Secondary input (seamless in SFN) – See *TS CleverSwitch control*
  - ➢ IP *CleverSwitch*: stream switching between Gigabit inputs – See *IP CleverSwitch control*
  - Control management from T2-MI packets (DVB-T2)
  - Time alignment for SFN operating (DVB-T & DVB-T2)
  - Bit rate adaptation & PCR re-stamping (DVB-T2 MFN System A & DVB-T)
  - Null packet deletion (DVB-T2 MFN System A & DVB-T)
  - Both normal-mode and High-Efficiency Mode (HEM) supported (DVB-T2)
- DVB-T2 framing and channel encoding
  - Mono or Multi PLP
  - SISO or MISO
- Dual DVB-T/T2 modulation core
- T2-Base & T2-Lite profiles, including simultaneous (mixed) transmission (optional software license xTT**O**-TW20-T2LI)
- Digital Adaptive Non-Linear Pre-correction circuits
  - Flexible operating modes: STATIC (EDIT), SINGLE, or CONTINUOUS
  - RF feedback signals sampled in real-time after Power Amplifier
- Digital Linear Pre-correction circuits
  - Manual mode
  - Adaptive mode : STATIC (EDIT) or SINGLE
  - RF feedback signals sampled in real-time after RF filter

- PAPR reduction system and protection clipping
- RF output
    - Frequency band: UHF and VHF band I & III
    - Low phase noise figure (Compliant with DVB-T phase noise mask)
    - Main output (0/+14/+20dBm) and monitoring output (-30dB)
    - Manual mute and programmable mute conditions: LORS, SFN_Not_Ready (DVB-T/T2) ; MND, MOME & MIP missing (DVB-T)
    - Mute on stream input Loss with RF Maintain function
- Clock and synchronization signal management
    - Optimized for SFN operating
    - External reference sources: 1PPS, 10MHz inputs and TOD (DVB-T2)
    - Onboard GPS
    - 10 MHz reference output
    - LORS Management
- Measurement/Monitoring
    - MER (with GAP option) and shoulder level monitoring
    - 2 dedicated inputs for Forward and Reflected Powers measurement
- AGC feature (optional software license XTT**O**-TW20-AGC)
    - able to automatically adjust the TWISTER output power to ensure a stable system output power
    - feedback input using direct adapted RF signal from amplifier output (-10dBm) or VDC signal from external power sensor
- Control and Management
    - Control and monitoring via web based GUI
    - LCD front panel for main features control and monitoring
    - 4 front panel status leds
    - Alarm relays
    - Configuration selection from GPI (Control Port) for N+1 redundancy purpose
    - 2x fast INTERLOCK inputs (mute ≤ 1ms) for N+1 redundancy purpose
- Transmitter Environment Interface
    - Full control/monitoring using seamless Web GUI
    - Based on Teamcast serial protocol and integrated serial port

  - On transmitter request

- ISDB-T/T_B modulation (see specific user manual)
  - bTS input on ASI inputs
  - multi-layer modulation
  - 1seg modulation compliant

- DTMB modulation (see specific user manual)
  - Multi-carrier or single-carrier modes
  - SIP control.

- Other
  - 110-240 VAC
  - 1RU rack form factor

Features availability depends on software release version.
(Please refer to the product release note)

2.2 Input Stream Interfaces

2.2.1 ASI Inputs

The unit offers 2 ASI inputs compliant with *[D1]* & *[D2]*. They can be used either in single mode, redundant mode or hierarchical mode in DVB-T/H. 188 or 204 byte packets without RS coding and 204 byte packets with RS coding are supported. If 204 byte packets including RS coding are provided, then the RS error checking and correction are performed. For hierarchical modes, this error correction is performed on both MPEG-TS flows (HP & LP) in parallel.
Both ASI "Packet mode" and "Burst mode" are supported.

Input Equalizer
Each input has an equalizer that can be turned ON or OFF. This equalizer works well to equalize cable length attenuation but does not perform as well if the input cable is mismatched.

ASI Output
ASI output can be configured to forward what comes on the different input. Thanks to the "ASI generator" feature, ASI output can generate a 20Mbps packets stream that can be used to feed any equipment that needs a signal on an ASI input. This is particularly the case when TWISTER is used to upgrade a DVB-T transmitter that will be used in DVB-T2 mode: TWISTER can be fed with T2MI IP stream and the ASI output will feed the original exciter to avoid any alarm.

This stream will be composed of packets whose PID can be selected by the user and whose paylod is set to 0.

2.2.2 IP Inputs

It is possible to feed the rack with a TS stream through one of the 10/100/1000Base-T ports which are electrical interfaces (Gigabit Ethernet). Both physical ports can be used for either controlling the rack or for IP streaming. A primary IP stream plus a secondary IP stream can be configured with a dedicated receiving IP address that can be either multicast or unicast. The one that results out of the *IP CleverSwitch*, named *Active IP*, is then processed and becomes one of the eligible stream sources for the *TS* CleverSwitch for which is defined a primary and a secondary stream, according to the user settings.

Mode	ASI1	ASI2	Active IP	Switching
Redundant (DVB-T/T2)	Primary	Secondary	Not used	Yes
Single Input	Stream Input	Not used	Not used	No
Hierarchical (DVB-T)	HP	LP	Not used	No

Table 4: Example of input stream management (default settings)

The IP input process is responsible for the different mechanisms that run at the layers above IP. In particular, it implements FEC decoding with error recovering (compliant with SMPTE 2022 *[I7]*, *[I8]*) and performs the MPEG-TS stream(s) extraction. It does support "UDP only" stream but we recommend the TS stream to be encapsulated in RTP+UDP
or UDP only. The "UDP only" mode is supported for point-to-point connection: the source equipment must be directly connected to the module (the UDP stream cannot come through a jittered network).

In UDP mode, for best performances, there should be 7 MPEG-TS packets per IP packet.

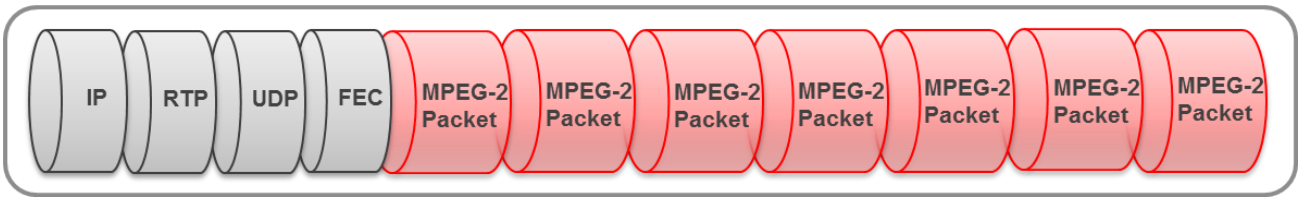


Figure 2: MPEG-TS packet over IP encapsulation

The modulator supports both IGMPv2 and IGMPv3 modes.
Remark: The default gateway address used is the one set on the Gigabit1/Ctrl port.

2.3 Input Stream Management

The Stream Management consists in routing the incoming data from ASI or Ethernet interfaces towards the modulation core. This part can manage all types of interfaces and it also provides the TS or T2-MI output stream for the ASI output interface. The Stream Management process might operate additional basic functions such as data monitoring, data extraction, bit-rate adaptation and routing.

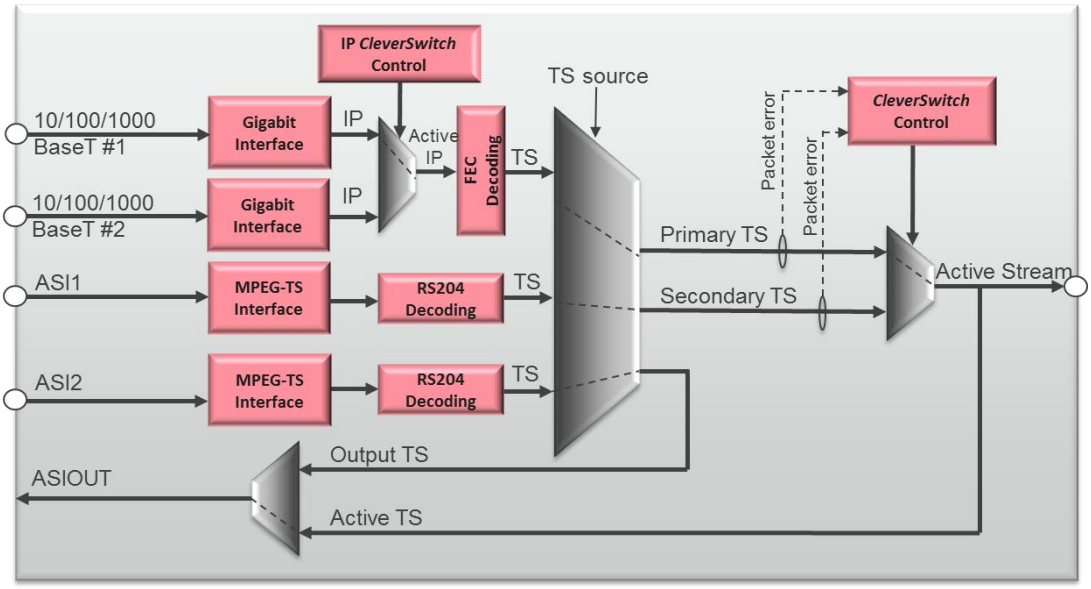


Figure 3: Stream Management diagram

In DVB-T non-hierarchical and DVB-T2 modes, the active stream can be either primary or secondary. The switch from primary to secondary is controlled either manually or by *CleverSwitch,* a redundant input switching mechanism designed by TeamCast (See next chapter *TS* CleverSwitch *control* & *IP CleverSwitch control*).

Bit-rate adaptation: when operating in DVB-T MFN or in DVB-T2 system A, the TS management unit can perform bit-rate adaptation if needed. When this mode of operation is activated, the unit discards or inserts null packets in order to accurately adapt the TS input bit-rate to the bit-rate defined by the selected mode.
PCR re-stamping is then executed accordingly.

At last, an ASI output has been designed for copying either one of the input streams (ASI1, ASI2 or the TS from the active IP input) or the Active_Stream which is:
- in case of DVB-T or DVB-T2 system A: the exact stream forwarded and proceeded by the modulator (after bit-rate adaptation and PCR re-stamping),

in case of system B: a copy of the T2-MI input which is currently selected to be broadcasted over the RF channel. Note: the switching from an input to another is never seamless on ASIOUT since it is done before the streams synchronization.

2.3.1 TS *CleverSwitch* control

CleverSwitch is a flexible input redundancy management mechanism designed by TeamCast. It is enabled by default and can be manually disabled or enabled.

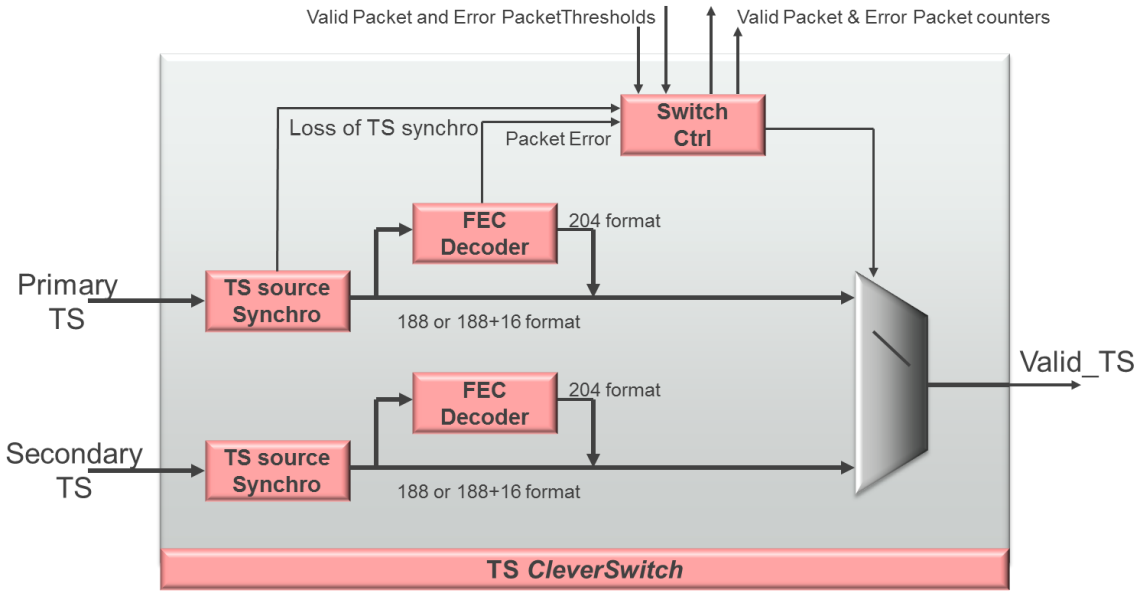
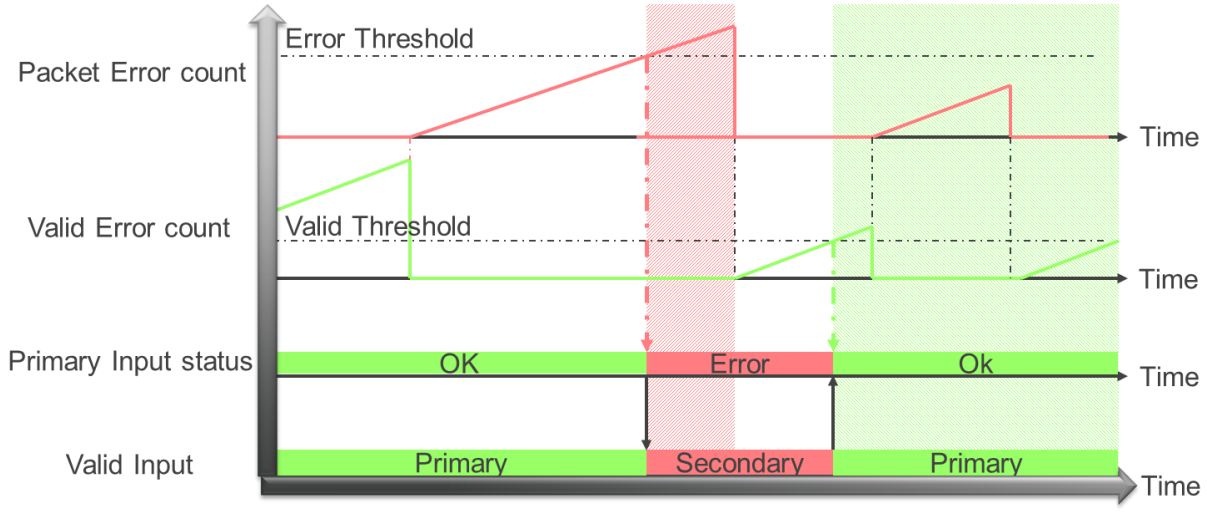


Figure 4: TS *CleverSwitch* block diagram

CleverSwitch is based on a programmable consecutive error threshold. Once it is reached, the stream selection switches automatically from an input to the other. When the number of valid packets threshold is reached, the stream input switches back to the primary. In 188 byte format, the switch criteria only considers the number of consecutive valid and error packets (0x47 sync detection), whereas in 204 byte mode, it also uses the RS errors. The switch decision is implemented only on the primary input. The switch-back is manual or automatic in case of secondary signal failure.



2.3.2 TS Manual Switching

In addition to CleverSwitch mechanism the user will be able to enable the manual switching checking the "Force manual selection" box. It will be then possible to force Primary or Secondary input use clicking on the appropriate button.

In that case no automatic switching will be possible until the function is re-enabled.

Figure 5: TS manual switching

2.3.3 IP *CleverSwitch* control

The IP *CleverSwitch* is derived from TS *CleverSwitch*. It manages a first level of redundancy management between the two IP input streams (primary IP stream and secondary IP stream). It shall be enabled (by default) or disabled.

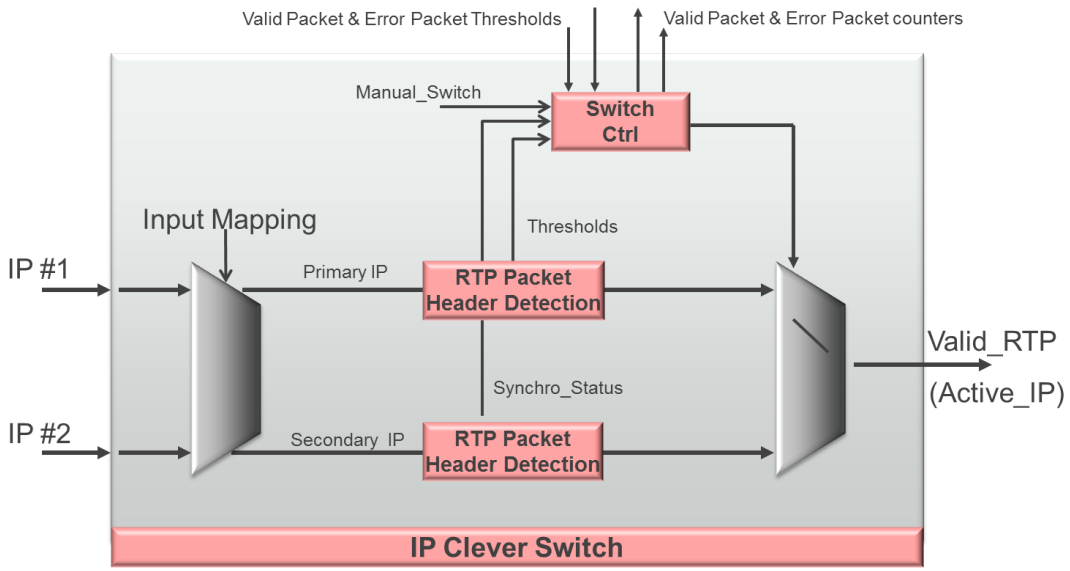
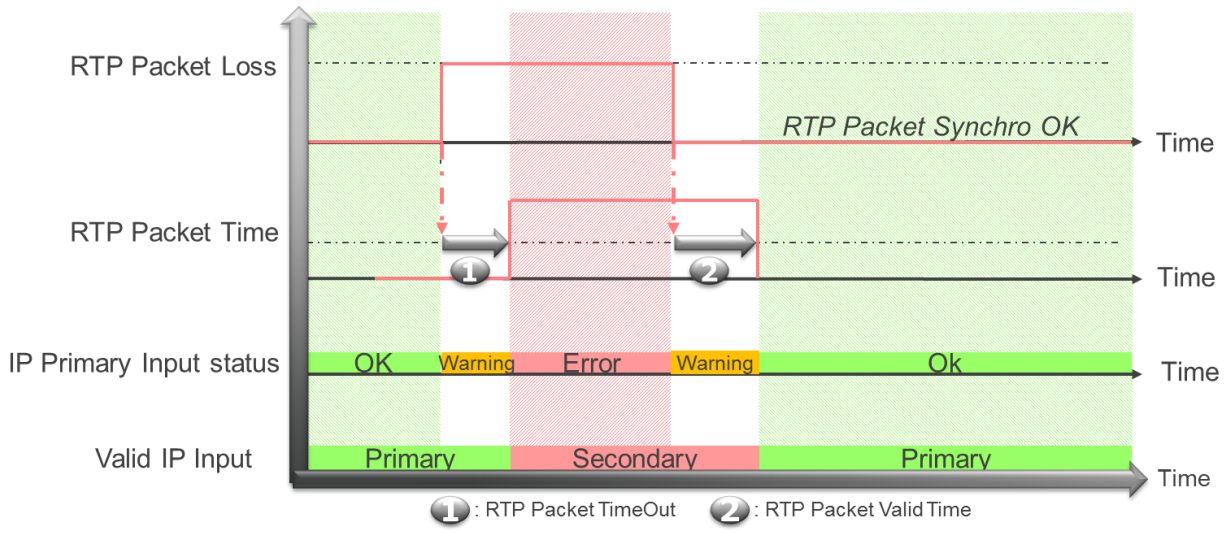


Figure 6: IP *CleverSwitch* Blockdiagram

The switch criteria uses RTP Packet Error Count and RTP Valid Packet Count. The switch decision is implemented only on the primary IP input (user-selectable from IP#1 or IP#2). The automatic switch back feature is always enabled and cannot be disabled.



2.3.4 Seamless Switching

The switching (and switching back) performed by the *TS* CleverSwitch between the primary and the secondary stream is seamless in SFN mode for both DVB-T and DVB-T2 standards, whereas the *IP CleverSwitch* is not seamless, besides any product evolution.

This means that seamless switching is only possible:

- when the primary and secondary streams are:
  - either all from ASI inputs
  - or one from ASI input and the other one from IP input
- and when operating SFN, which allows to automatically compensate for the delay between the inputs thanks to the MIP or T2 Time Stamp information.

2.3.5 Maximum delay between Primary and Secondary inputs

In case a seamless switching is expected (under the conditions that are described in the previous paragraph), the user must care about the maximum delay allowed between the primary and the secondary stream.
In DVB-T2 with absolute Time Stamp (see *DVB-T2 System B mode*), the stream is memorized in order to match the exact transmission time, thus it allows a delay greater than one second (which is not possible in DVB-T, or in DVB-T2 with relative Time Stamp).

For input streams of 50Mbps, up to 5s of delay is allowed between the primary and the secondary streams. If the input bit-rates are lower, then the maximum allowed delay will be larger (for instance 25Mbps gives 10s).

Additional latency for IP streams

In case one of the TS streams is received over IP, a user-configurable *Receiver Latency* (ranging from 1 to 1000ms, default value is 100ms) is added in order to compensate for the distribution network jitter. This additional latency shall be included in the maximum delay described previously. That means that if the primary or the secondary stream selected is *Active IP*, the maximum delay between the primary and the secondary stream is decreased by the *Receiver Latency*.

Input bit-rates	Primary	Secondary	Max-TS-Delay	Receiver Latency	Max Total Delay
50Mbps	Active IP	AS1 or ASI2	5s	100ms	4.9s
25Mbps	AS1 or ASI2	Active IP	10s	400ms	9.6s

Table 5: Examples of Maximum authorized delay between input streams

2.4 Modulation Core

The modulator is fed by the active TS stream coming out of the *CleverSwitch*. Then it delivers IQ samples towards the Digital Pre-corrector.

It can support DVB-T/H and DVB-T2 standards which are both embedded in the same firmware. The user just selects the desired standard using a simple command.

2.4.1 DVB-T/H modulation core

The DVB-T implementation offers all DVB-T modes and TS treatment such as PID management (PID filtering, re-mapping and insertion). Here below are the possible parameters that can be set:

- Modulator configuration:
  - Bandwidth 5, 6, 7 or 8 MHz
  - DVB-T mode : 2K, 4K, 8K
  - Inner Interleaver : Native or In-depth
  - Guard Interval : 1/32, 1/16, 1/8 or 1/4
  - Constellation : QPSK, 16QAM or 64QAM
  - Hierarchical modulation : No, Alpha1, Alpha2 or Alpha4
  - Code Rate HP & LP: 1/2, 2/3, 3/4, 5/6 or 7/8
- Synchronization:
  - SFN/MFN
  - MFN parameters: MIP in MFN, bitrate adaptation, NIT table update
  - MFN delay by step of 100ns
  - NIT frequency by step of 1Hz
  - SFN parameters: Time offset and Extended Time offset by step of 100ns
  - TPS signalling: CELL ID validation, CELL ID value, DVBH signaling, HP/LP Time Slicing, HP/LP MPE FEC
  - MIP control : No, Mandatory, Mandatory + Optional (TX power and Frequency offset are monitored but not applied)
  - Resynchronization on SFN Error

2.4.2 DVB-T2 modulation core

Two transmission modes are available to perform a DVB-T2 transmission: System A and System B. These two modes are detailed below.
Moreover TWISTER rack is providing a unique way to experiment T2-Lite broadcasting in a "mixed" mode allowing to broadcast DVB-T2 and T2-Lite in the same time.

2.4.2.1 DVB-T2 System A mode

A DVB-T2 system in mode A transports one TS input stream (or an input stream of different type) into a mono-PLP transmission.

In this case, the T2 configuration is locally determined within the DVB-T2 modulator.

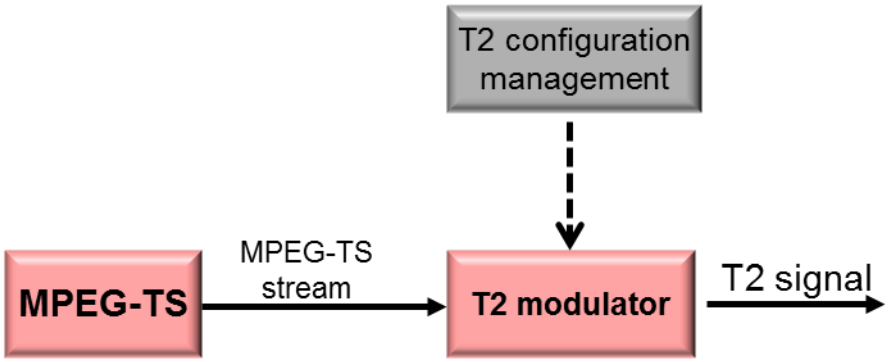


Figure 7: DVB-T2 System A Transmission mode

This system type allows to perform **only MFN transmission** and **no time reference is needed**. In that case, the TS management unit can perform bit-rate adaptation:

- discarding or inserting null packets in order to accurately adapt the TS input bit-rate to the bit-rate defined by the selected DVB-T2 mode,
- executing PCR re-stamping accordingly.

2.4.2.2 DVB-T2 System B mode

In DVB-T2, **SFN Transmission** implies system B mode operation. For this purpose, a **T2-gateway is mandatory** as well as high stability clock reference.

A DVB-T2 system B mode includes a T2-gateway that associates one or more input streams to one or more PLPs. The gateway then transmits the different PLPs as well as the DVB-T2 configuration parameters to the modulator that constructs the signal to be transmitted.

In that case the modulator is the gateway's "slave" regarding the DVB-T2 transmission configuration.

The interface between the gateway and the modulator is based on a specific format, named T2-MI that also transports the modulation parameters.

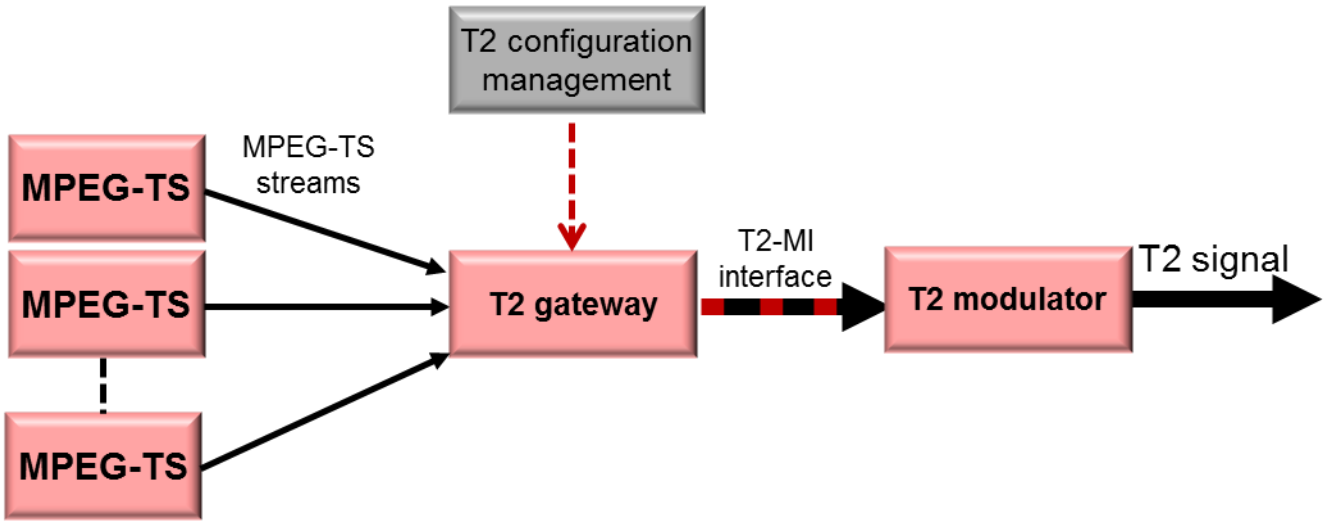


Figure 8: DVB-T2 System B Transmission mode

In such a system B mode, both MFN and SFN transmissions are available. However, even if MFN transmission is considered, **synchronization must be ensured** between the gateway and the modulator because no rate adaptation can be inserted in-between.

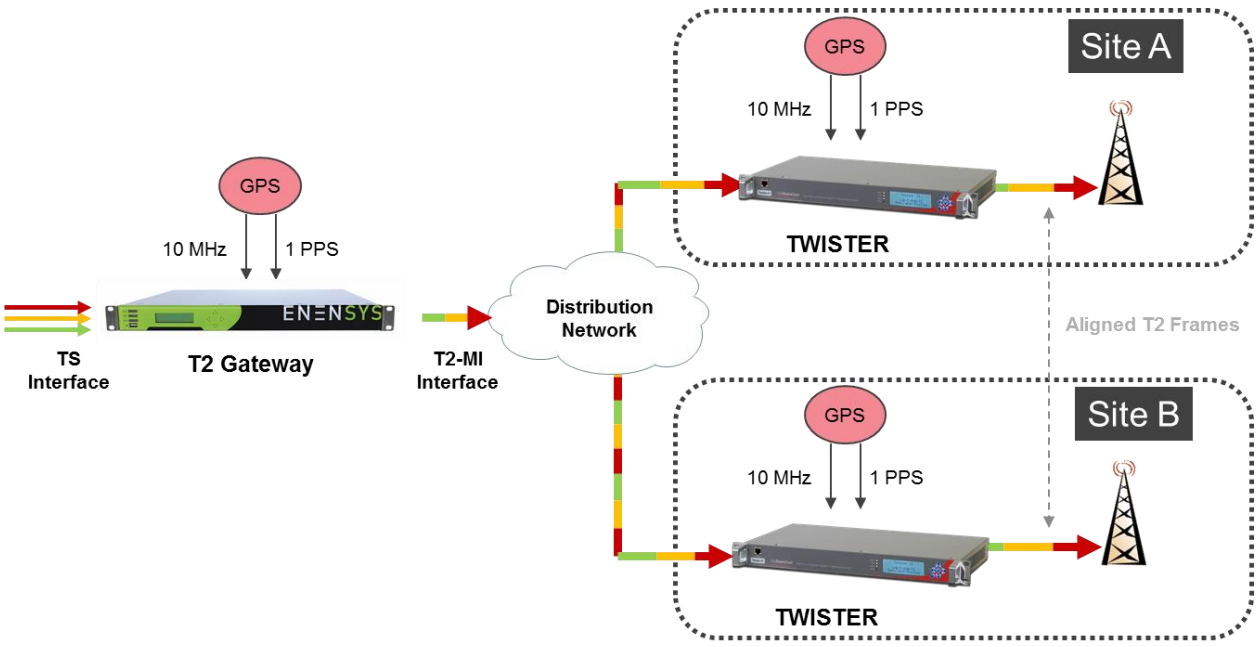


Figure 9: DVB-T2 SFN architecture (System B operation)

In addition to a common frequency reference (10 MHz), the various equipment require the same time reference:

- Relative time reference: the 1PPS signal allows a relative TimeStamp which is sufficient for most of the applications; in that case the "absolute time reference" (seconds_since_2000 field) of the TimeStamp is set to zero.
- Absolute time reference: the Time of Day (TOD from a GPS) or NTP may be required in addition to the relative time reference in order to allow an absolute TimeStamp. This is mandatory in the cases where the maximum delay between the various equipment is greater than the second.

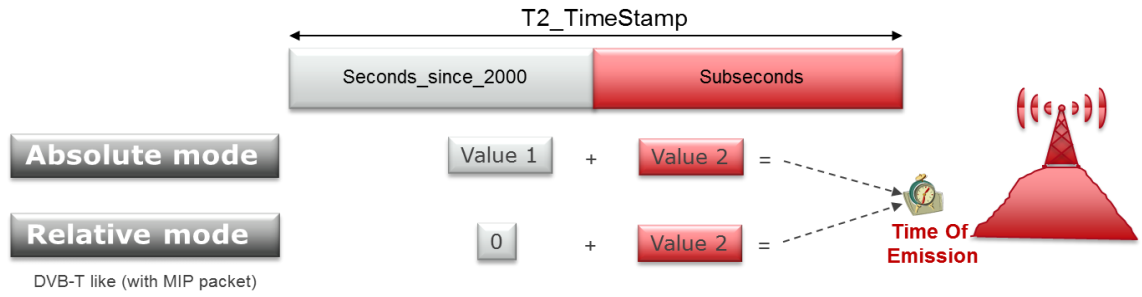


Figure 10: Absolute / relative time reference for synchronization

The gateway usually synchronizes its absolute time reference through the NTP data (Network Time Protocol) through IP link, whereas the modulator can use either:

- TOD input (needs GPS connection through RS232 port) with 1 PPS signal,
- TOD from on-board GPS (only on G4C0-xxx2/xxx3 products) with 1 PPS signal,
- NTP through IP network with 1 PPS signal (possible in a future SW release).

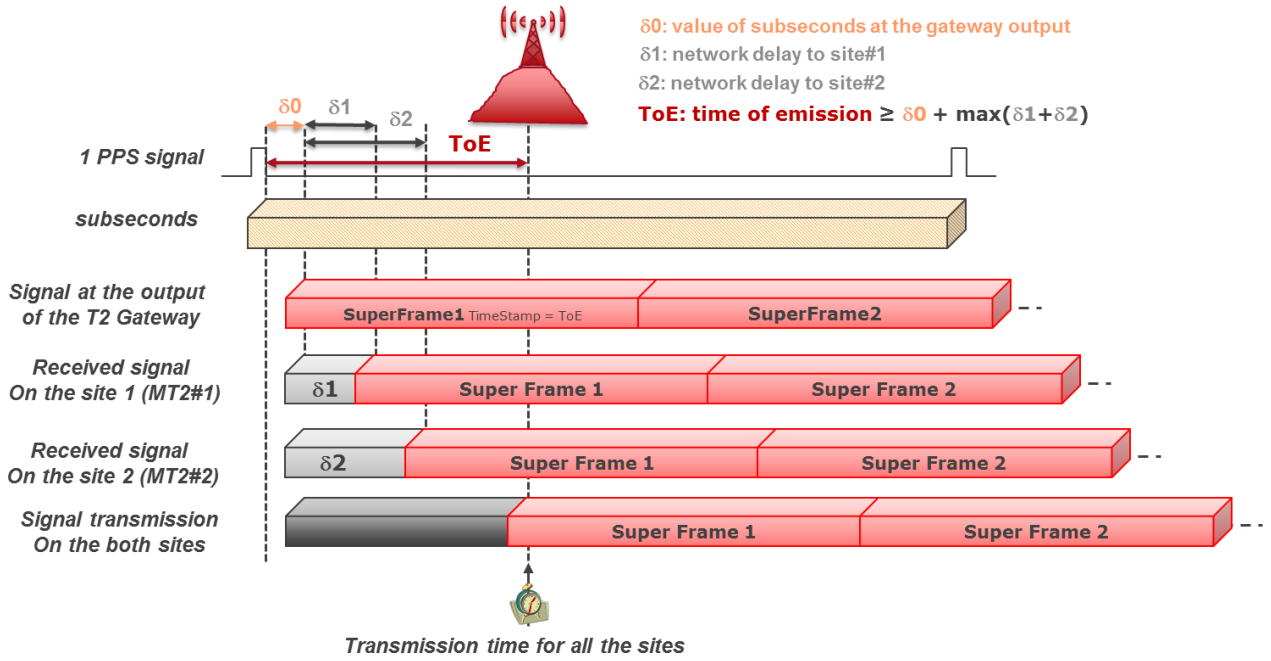


Figure 11: DVB-T2 synchronization for System B operation

2.4.2.3 DVB-T2 supported modes

The DVB-T2 modulation core supports the main following features:

- Mono or Multi PLP
- SISO or MISO
- Constant Bit Rate and modulation
- System A mode (Standard MPEG-TS)
- System B mode where the modulation will be transparently configured by the T2 gateway: the modulator retrieves and monitors all the DVB-T2 modes configuration (global and PLP parameters) from the T2-MI stream. Some addressing functions (including individual addressing) can be either controlled via T2-MI from the gateway or can be set locally from the modulator:
  - ✓ The MISO group, Cell ID, TX Time offset can be set remotely or locally,
  - ✓ The Bandwidth, Power and Frequency offset parameters are only monitored by the modulator and they must be set locally (for amplifier's safety).
- T2-Base and T2-Lite profiles, including simultaneous (mixed) T2-Base & T2-Lite transmission (optional software license).

Transmissions modes								
SISO (Single Output)				MISO (Multiple Output)				
Bandwidths								
1.7 MHz	5 MHz		6 MHz	7 MHz	8 MHz		10 MHz	
Rotated constellation								
29°		16.8°		8.6°		Antan (1/16°)		
Mapping								
QPSK		16-QAM		64-QAM		256-QAM		
FFT								
1K	2K	4K	8K	e8K	16K	e16K	32K	e32K
Guard Interval								
1/128	1/32	1/16	19/256	1/8	19/128	1/4		
FEC (BICM)								
1/2	3/5	2/3	3/4	4/5	5/6	1/3	2/5	
Number of PLPs								
2	4	8	16	32	64	128	255	
Input Format								
TS (System A)				T2-MI (System B)				

Feature availability: Supported | T2-Lite Profile | Possible Evolution | Not supported

Figure 12: DVB-T2 Supported modes

Some parameters combinations are not relevant and thus, forbidden. Please refer to product release note for exhaustive list of supported features according to the product software version.

2.4.2.4 T2-Lite Operation

As with any TeamCast DVB-T2 modulator, TWISTER features as a software option the Mixed T2-Base/T2-Lite transmission capability.

DVB-T2 Lite, as standardized in DVB-T2 1.3.1 Appendix I, has been defined to fulfill reduced bandwidth applications requirements, being based on a subset of DVB-T2 (now called DVB-T2 Base) and adding enhanced reception efficiency.

As a unique implementation today available on the market, TWISTER allows simultaneous (so called "mixed") transmission of DVB-T2 Lite with DVB-T2 Base on the same RF channel, which greatly facilitates the launch of mobiles services, using existing infrastructures.
This mechanism is based on Future Extension Frames (FEF). The FEF mechanism allows DVB-T2 and DVB-T2-Lite signals to be transmitted in one RF channel, but with each using different modes and levels of robustness (in particular in terms of number of carriers). Both profiles can also be transmitted separately.

Figure 13: T2-base only frames

Figure 14: T2-Base frames with empty FEF

Figure 15: T2-Base + T2-Lite frames (using FEF)

Restriction of use:

For DVB-T2/T2-Lite "mixed" mode, incoming streams must come :

- From ASI inputs: one stream on ASI1, the other one on ASI2. The Primary input will be ASI1, the Secondary input will be ASI2.
- From ASI and IP inputs: one stream from ASI, the other one from the active IP input. The Primary input will be ASI1, the Secondary input will be Active IP.
- From IP inputs: both streams are coming from the active IP input. The Primary input will be Active IP, the Secondary input will be Active IP. In that specific case, both DVB-T2 and T2-Lite T2MI streams shall come from the same IP address (Unicast or Multicast)

Then Primary and Secondary PID will be selected depending on the gateways settings.

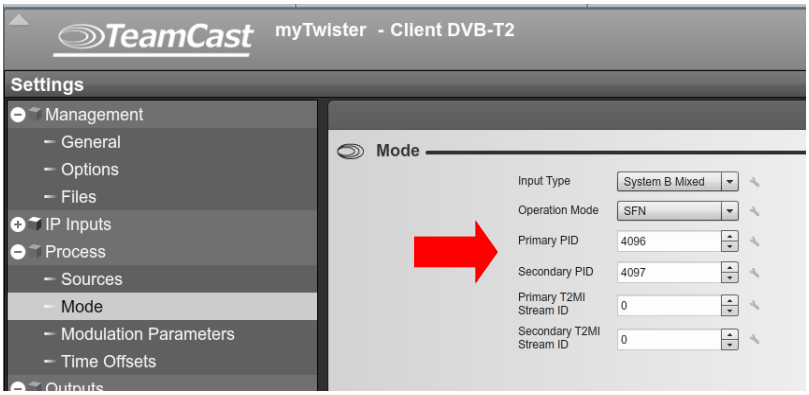


Figure 16: PID selection example

2.5 Test modes operation

2.5.1 PRBS sequence

A PRBS sequence can be locally generated and inserted at the input of the modulator instead of a useful MPEG-TS or IP packets. The PRBS polynomial coefficients is fixed.

2.5.2 Sinus tone generation

Two sinus tone modes are available: sinus and +6dB Boosted sinus. In these modes, the output OFDM signal is replaced by a simple sinus wave at the RF frequency. The boosted mode allows phase noise measurement without requirement of an external amplifier.

Boosted sinus might damage the power amplifier

2.5.3 Null symbol insertion

A Null symbol is inserted at the beginning of each mega frame or T2 frame. This is useful to perform temporal synchronization measurement using a simple oscilloscope, for example to check the SFN synchronization or to measure the transfer delay of a transmitter.

2.5.4 Central Carrier Cancelled

When this test is activated, 251 carriers located in the middle of the spectrum are cancelled. This creates a hole in the spectrum that could possibly be used for in band signal to noise evaluation.

2.6 Processing Time

The Total processing delay is the sum of the TS core processing delay and the Modulation core processing delay.

2.6.1 DVB-T Mode

TS core processing time:
It is directly linked to the configurable *Time Offset* (ranging from -3.2768 to +3.2767 ms) plus the *Ext. Time Offset* (ranging from -999 999 to +999 999ms) defined by the user.

Modulation core processing time:
It depends on the FFT size, as depicted in the table below.

FFT Size	Processing Time (in ms)
2K	1.341
2K in Depth	2.034
4K	2.125
4K in Depth	2.587
8K	3.693

Table 6: Modulation core processing time

Attention should be paid on the fact that these delays are the time required to process the stream. But in case of SFN, the stream will be dynamically buffered so that the actual transmission time corresponds exactly to the time specified in the MIP.

2.6.2 DVB-T2 Mode

TS core processing time:
In DVB-T2, the TS core processing time is also linked to user-configurable delays:
- *Time Offset*: ranging from -3.2768 to +3.2767 ms), valid in SFN only
- *Ext. Time Offset*: ranging from 0 to 1s, valid in SFN only

Modulation core processing time:

In system A, due to possible Time Interleaving, the modulation core has the same processing time than in System B MFN: it is about 250/300ms.

In system B, the received stream is a T2-MI stream consisting of BBF frames that contains *Time Stamp* packets and signalling packets that are received after the data to be modulated. Thus, in DVB-T2, the entire frame needs to be stored in memory before modulation.

In system B MFN, the frame is then stored and modulated 10ms after the whole frame has been received, which means about 250/300ms according to the frame duration and settings.

In system B SFN, the frame is dynamically stored so that the actual transmission time corresponds exactly to the time specified in the T2-MI *Time Stamp* (see details in *DVB-T2 System B mode*).
- For firmware version lower than S110: the input buffer is always read 400ms before the Transmission Time. This means that the input stream must be present at least 400ms before Transmission Time.
- Since firmware version S110: the processing time has been optimized and is now related to the T2 frame duration. The processing time value is now equal to the T2 frame duration plus 100ms.

Important remark:
- When performing SFN between firmware version lower than S110 and firmware version higher than S110, the modulators could be processing the frame in a different

second. The 2 figures below show, firstly, the case where the SFN works properly and the case where the SFN would not work properly.

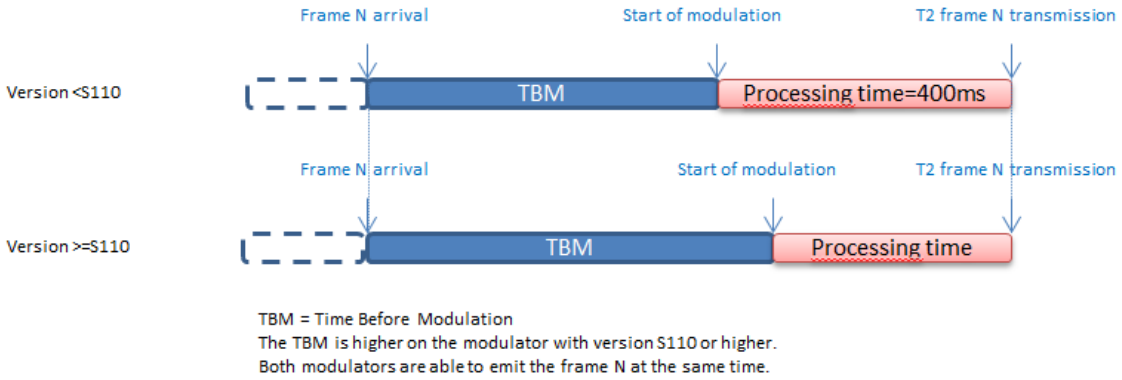


Figure 17: Working SFN configuration

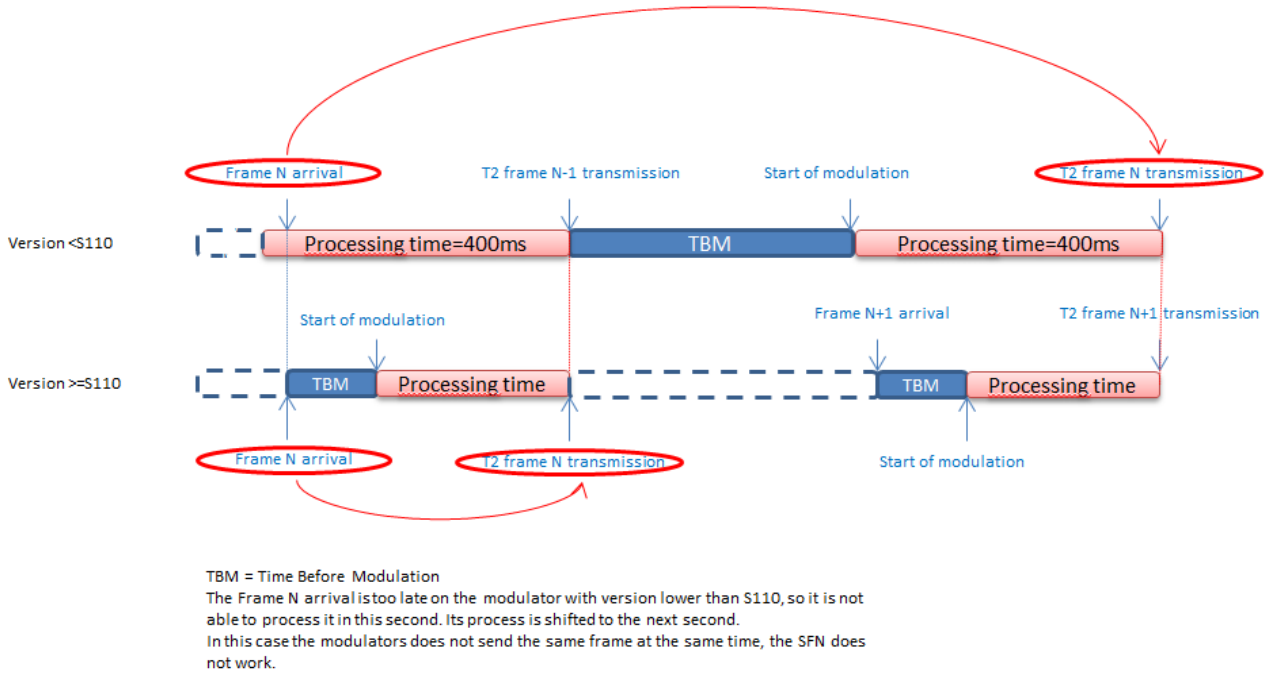


Figure 18: Non-working SFN configuration

The command *SFN Time Margin* gives the time margin (*Delay before Time of Transmission*) between stream reception and time at which the stream must be read.

- In relative synchronization mode, this time always varies from 0s to 1s,
- In absolute synchronization mode, it varies from -10s to +10s (a negative value means that the *Transmission Time* has been missed)

2.7 Digital Precorrection

The digital precorrection feature is available for digital signal waveforms.

It consists in two types of correction:

- Linear pre-correction for compensating the distortion due to the channel filter,
- Non-linear pre-correction in order to cope with the power amplifier distortion.

Digital precorrection can be either:
- adaptive: running automatically thanks to an internal (DAP) algorithm,
- or manual: curves are set via ***TuneCast*** software (using IP connection).

TWISTER II product integrates both Linear and Non-Linear Digital Adaptive Precorrection, as well as Linear manual precorrection.

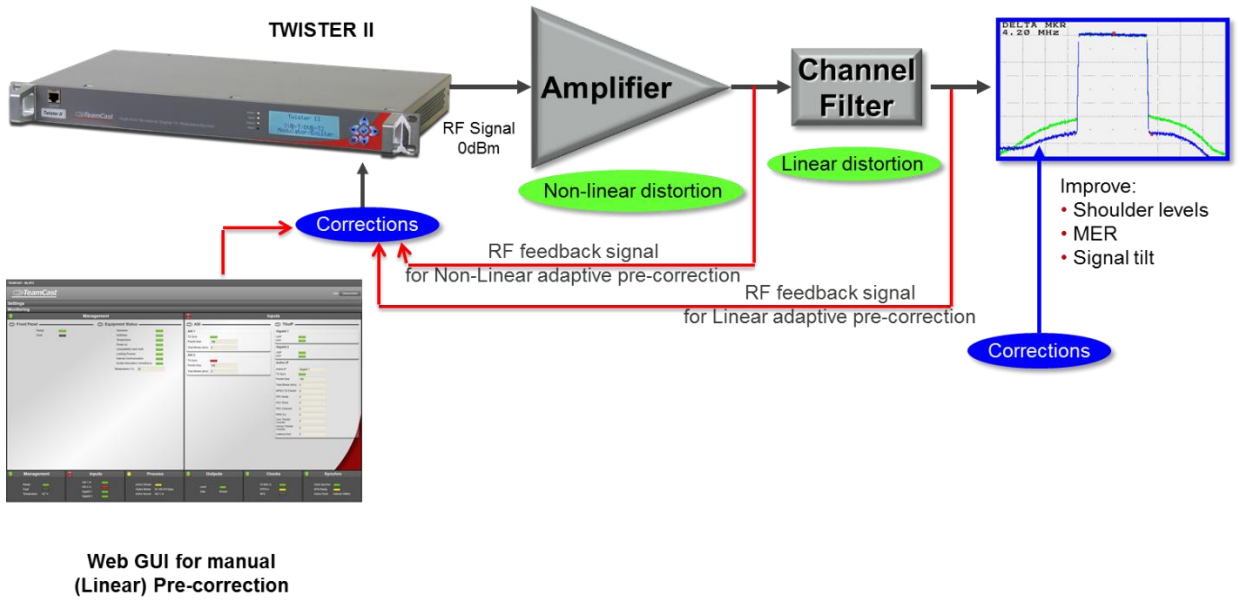


Figure 19: Linear & Non-Linear Precorrection methods

Indeed, the use of adaptive precorrection is generally preferred in order to reach higher performances and efficiency, but also in order to save transmitter production cost. However, when several RF signals are combined together (adjacent channels), the use of Linear DAP is not possible because the feedback signal is then a combined spectrum of several channels. In that case a manual Linear precorrection is needed.

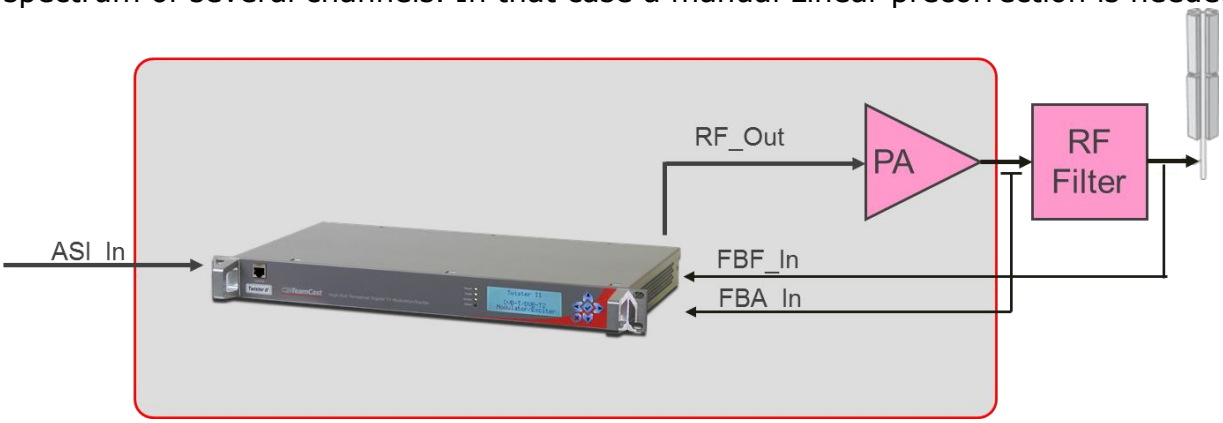


Figure 20: Linear DAP typical use-case

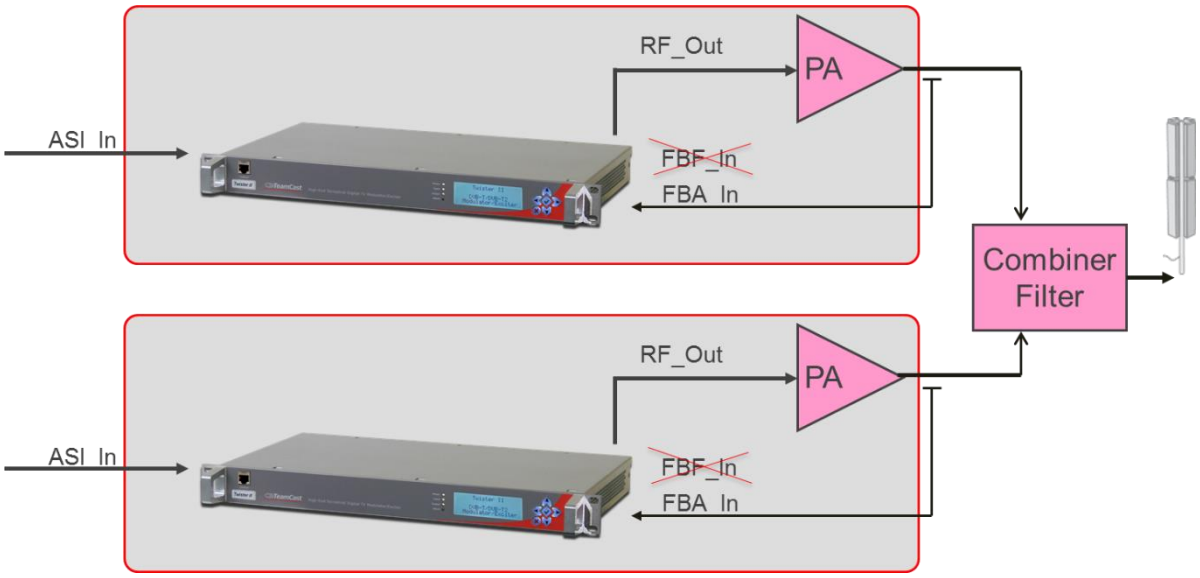


Figure 21: Manual Linear Precorrection use-case – Combined filter

2.7.1 Digital Adaptive Precorrection

The Digital Adaptive Precorrection (DAP) block is illustrated here below.

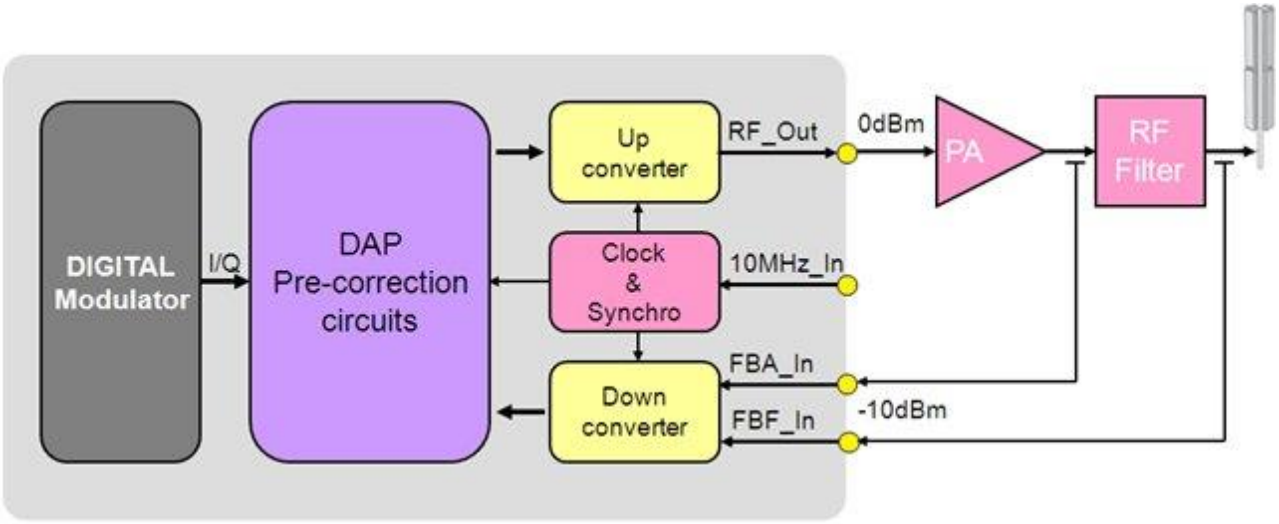


Figure 22: DAP integration block diagram

The DAP function is composed of Non-Linear and Linear Precorrection and a dedicated down-converter. The down-converter receives the signal feedback after the external amplifier (FBA_In) and after the RF filter (FBF_In). Then, a particular algorithm processes the digital IQ samples to reduce the signal distortions at the transmitter output.

To monitor the DAP process several status are available:
- ✓ MER indicative measure
- ✓ PAPR indicative measure
- ✓ Shoulder left and Right measured level
- ✓ DAP elapsed time
- ✓ DAP status: Active, Stopped by user, Stopped by timer, Failed

2.7.1.1 Non-Linear Adaptive Precorrection

TWISTER II performs non-linear precorrection over a 75 MHz bandwidth. The purpose of non-linear precorrection is to correct the distortion from the power amplifier. With the feedback from the output amplifier, an adaptive non-linear precorrection should automatically find the best precorrection and follow the variations of the amplifier characteristics.

Four operating modes are available:

- **STATIC (EDIT) mode**: The DAP is disabled. The user can load a previous DAP configuration to be applied to the modulator.

- **SINGLE DAP**: The DAP process is manually started and is stopped either after a timer value (user configurable) or manually stopped.

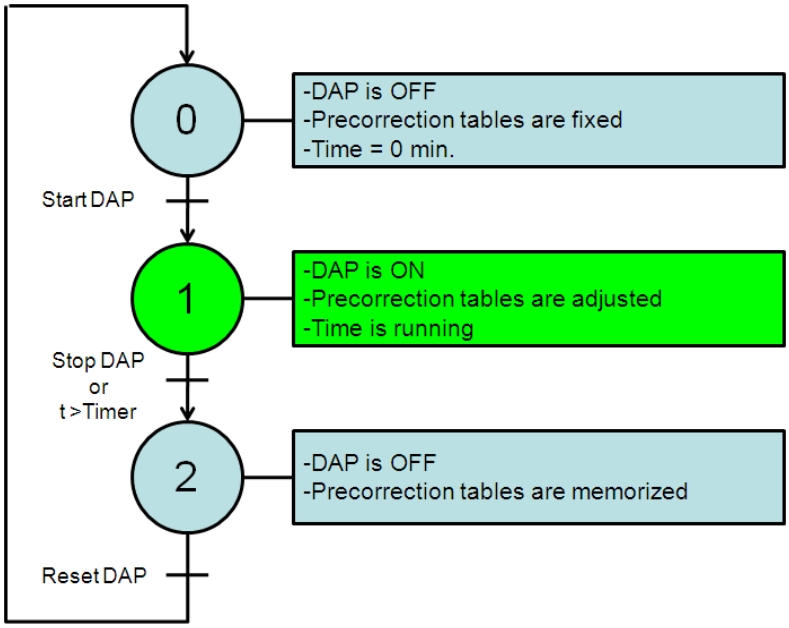


Figure 23: Single DAP mode operation

- **SURVEY DAP**: In this mode, the DAP process is started as the Single DAP mode. Once the timer is reached, then the DAP process can be automatically restarted if a shoulder or MER deviation is detected (user configurable).

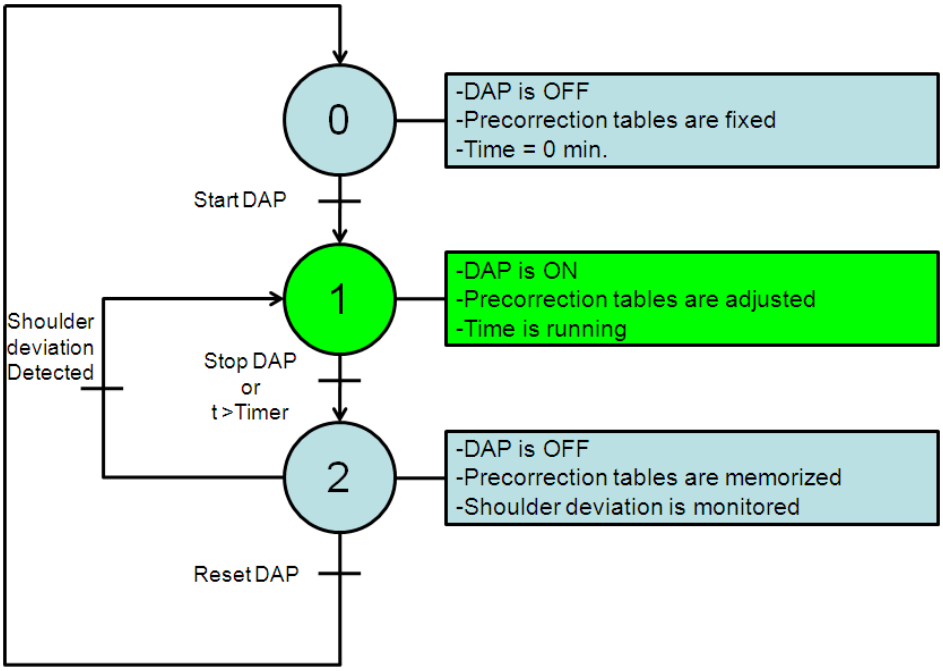


Figure 24: Survey DAP mode operation

- **CONTINUOUS DAP**: The DAP works continuously until the user exit the continuous mode.

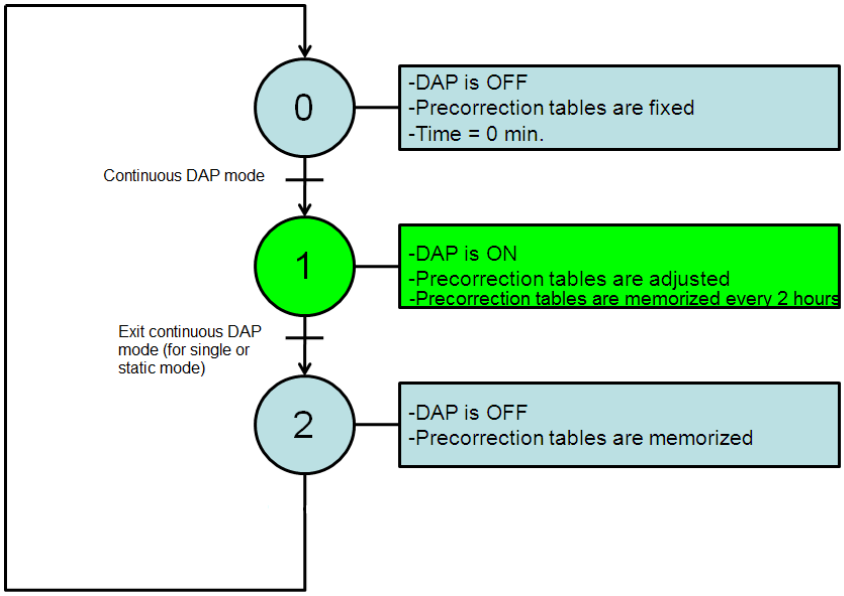


Figure 25: Continuous DAP mode operation

For more information concerning Digital Adaptive Precorrection, please refer to the dedicated Application Note.

2.7.1.2 Linear Adaptive Precorrection

The purpose of Linear precorrection is to correct the distortion in amplitude and in group delay of the output filter. The pre-corrector is based on a complex FIR filter which allows to correct up to 3dB (range -3dB to 3dB) in amplitude and up to 3µs (range 0 to 3µs) in group delay.With the feedback after the output filter, an adaptive linear precorrection should automatically find the correct pre-correction curve in a few minutes.

Two operating modes are possible:

- **STATIC (MANUAL EDIT) mode**: The DAP is disabled. The user can load a previous DAP configuration to be applied to the modulator or can edit manually the pre-correction curves.
- **SINGLE mode:** The user starts the adaptive pre-correction manually. The adaptive precorrection process is stopped if the timeout value has been reached or if the user stops the process manually

For more information concerning Digital Adaptive Precorrection, please refer to the dedicated Application Note.

2.7.2 Manual Digital Pre-correction (Linear precorrection only)

In addition to digital adaptive pre-correction, TWISTER II also performs manual linear pre-correction. Using the "MANUAL EDIT" mode, both amplitude and phase corrections are performed over the full spectrum of the signal.

For this purpose, a table of 32 points can be loaded in the modulator with the *Set Linear Curves* command. The table defines the amplitude and the phase pre-correction that will be applied on the spectrum. For each point, a correction of ±3 dB can be defined for the amplitude and ±500 ns for the phase. The 32 points are equally spaced over the useful spectrum. The module then computes itself the correction to apply to each carrier accordingly.

	8 MHz	7 MHz	6 MHz	5 MHz
Useful bandwidth	7.61 MHz	6.66 MHz	5.71 MHz	4.76 MHz
Frequency spacing between 2 consecutive points	245 KHz	215 KHz	184 KHz	154 KHz

Table 7: Linear pre-correction - frequency spacing

Using the *Set Linear Curves* command, the processing time required by the module (for computing the corresponding coefficients) can be long. It is therefore **recommended to use the busy flag** (available in *Get Linear Status* command) before any further module request, **or even better: the command *Set Linear Coefficients*** can be used instead in order to directly load the coefficients. Please refer to the product Developers' Guide.

2.8 Output Processing

The nominal output level of the main output "RF Out" is 0 dBm for the modulator rack and +14dBm for the exciter rack. An attenuation between 0 and 20 dB per step of 0.1 dB can be set. As well, an offset gain between -1 dB and + 1 dB per step of 0.1 dB can be set. If needed, the output spectrum can be reversed. A copy of the main signal is available on the "RF Monit". This output signal is the same as the main "RF Out" signal but with a lower level (-30dB compare to main RF output).

2.8.1 RF output muting and RF maintain features

The output can be muted either by the user or automatically on some conditions. The un-mute is pre-configured to "progressive" (2 seconds). The mute function is available for any standards.

Mute Mode	Mute cases & conditions in DVB-T2
Manually set	Manual Mute
	Starting Delay (after a boot)
Configurable mute conditions	Warm-up Time (before 10MHz regulation starts)
	Clock Not Synchro
	SFN Not Ready (while PLL is unlocked)
	Loss of Reference TimeOut (LORS) see *LORS Management*
Additional mute conditions for DVB-T mode	Maximum Network Delay (MND)
	MIP sync warning (MOME)
	MIP Missing
Mandatory mute	Stream Input Loss (allowing "RF Maintain" feature) (In DVB-T2 it also includes L1 packet loss, TimeStamp error, T2-MI packet loss)

Table 8: Mute cases and configurable mute conditions

RF Maintain feature:

The "RF Maintain" feature consists in keeping a RF signal presence out of the modulator in order to allow a constant power at the modulator RF output during an input stream error (the function *"RF Maintain on Input Stream Error"* shall then be enabled).

The overall objective is to avoid any RF signal interruption at the output of the modulator for protecting the amplifier.

When the "RF maintain" feature is selected, no specific data are broadcasted during the switching time from an input stream to the other, but just any signal to maintain the original RF signal and RF power level. Thus the broadcasted signal cannot be decoded by any receiver.

2.8.2 Crest Factor Reduction Management

PAPR (Peak to Average Power Ratio) issues are associated with high power peaks present in the signal. By correctly managing PAPR reduction (Crest Factor reduction), the user will be able to avoid high power peaks from the modulator and so increase the output power level from the amplifier. It will then allow a best coverage for a given transmission site. But this PAPR reduction feature will decrease MER performances as well as shoulder levels. It must be used carefully following the following explanations.

The TeamCast PAPR solution uses two clipping modules for the best efficiency. Figure 26 shows the location of the two modules as well as the user parameters.

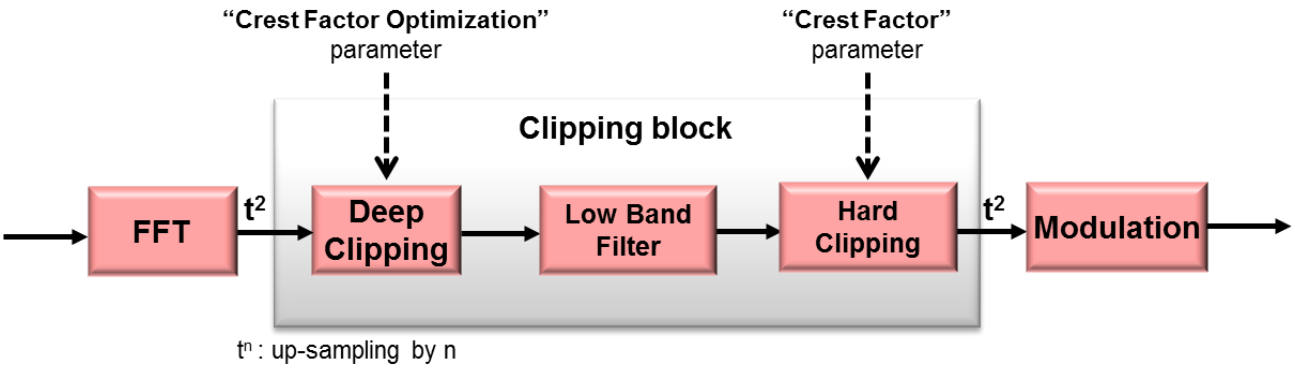
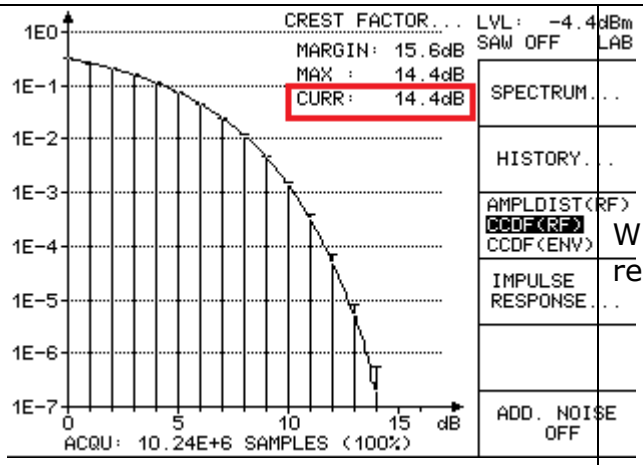
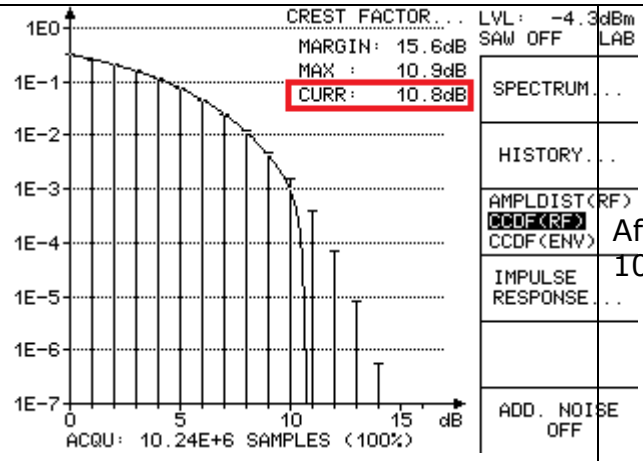


Figure 26: PAPR block diagram

2.8.2.1 Crest Factor Parameter

In order to reduce these peaks and avoid to damage the amplifier, TeamCast modules offer a "crest factor" parameter. It is used to set the clipping level of the signal. The range is from 8dB to 20dB. The default value is 10 dB, meaning that a light crest factor reduction is performed.

The following figures display the Crest Factor parameter impact on a signal:

Crest Factor setting = 20dB (No reduction)		Without any crest factor reduction, the PAPR is 14.4dB
Crest Factor setting = 11dB		After the adjustment, PAPR is 10.8dB

Note: In the screenshots above, the measurements are made using the <RF> value because the crest factor limit is fixed in the modulator using the RF value. But please note that some equipment may however consider the <ENV> (Envelope) value, which is also commonly used and which is about 3db less.

2.8.2.2 Crest Factor Optimization Parameter

In order to allow the best amplifier efficiency a "Crest Factor Optimization" parameter has also been added. It is active when the crest factor reduction is enabled (value ≠ 0).

For a given "Crest Factor", the "Crest Factor Optimization" enhances the signal shoulders. Finding the best value for this parameter allows the user to gain dB on the shoulders of the signal, thus optimizing the amplifier power.

This shoulder optimization involves a limited MER performance reduction. That is why the user must find the best trade-off for the best efficiency.

This parameter can vary in a range from 0 to 255 (no unit). Figure 27 shows the variation of the shoulder level and the MER for different parameter values at a given crest factor. When the Crest Factor Optimization parameter is increased, the shoulder level becomes better (from -33dBm to -50dBm). At the same time, the MER performance decreases (from 28dB to 15dB). As explained earlier, a trade-off between the two is necessary to obtain the best overall optimization.

In addition, due to curve shape we see there is an ideal range for the Crest Factor Optimization parameter between about 70 and 150. In this range the variation of both shoulder level and MER are significant. Out of this range the loss of MER is too severe for no little or no shoulder level gain. For instance, for a Crest Factor Optimization of 120, we observe a gain of 10dB for the shoulder level and a loss of only 3dB for the MER.

TeamCast therefore recommends to set this parameter in this ideal range of 70 to 150.

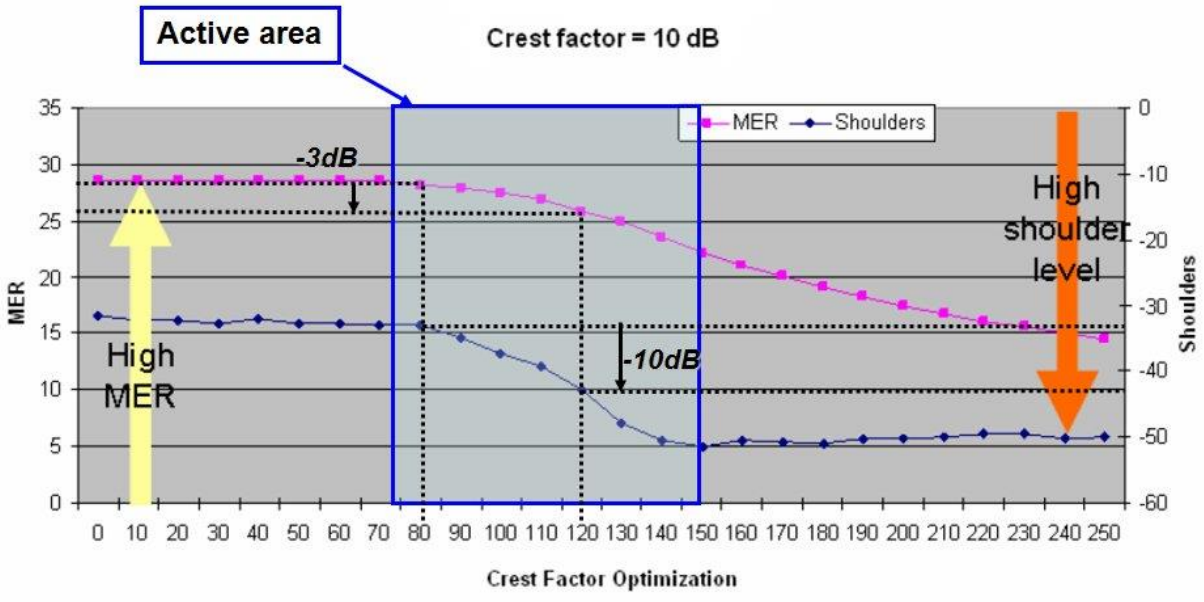


Figure 27: Crest Factor Optimization Impact

2.8.2.3 Protection Clipping Parameter

Since adaptive pre-correction can produce power peaks at the modulator output, a "protection clipping" has been added at the output of the modulator. It will allow the user to protect the amplifier input by clipping the signal out from the modulator.

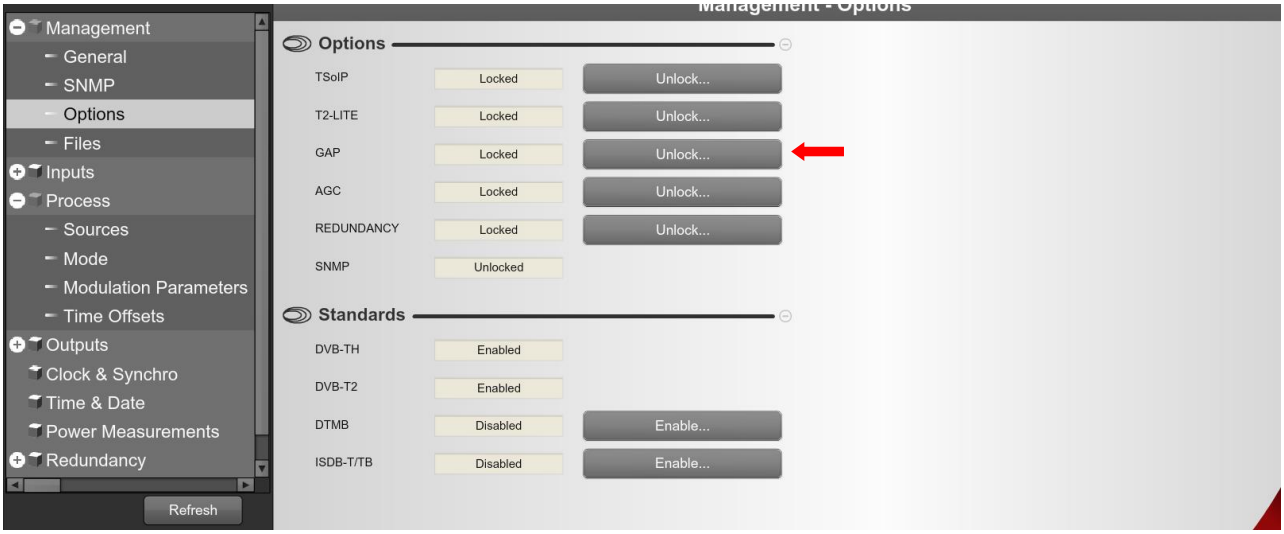
Protection Clipping = 20 means OFF
Recommended value to start = 15dB (default value)

2.8.3 GAP® Operation

GAP® stands for "Green Adaptive Processing", it is an option allowing to run the DAP in very high-end mode in order to reach unequalled RF signal performances and to allow a significant gain in transmitter Power Efficiency.

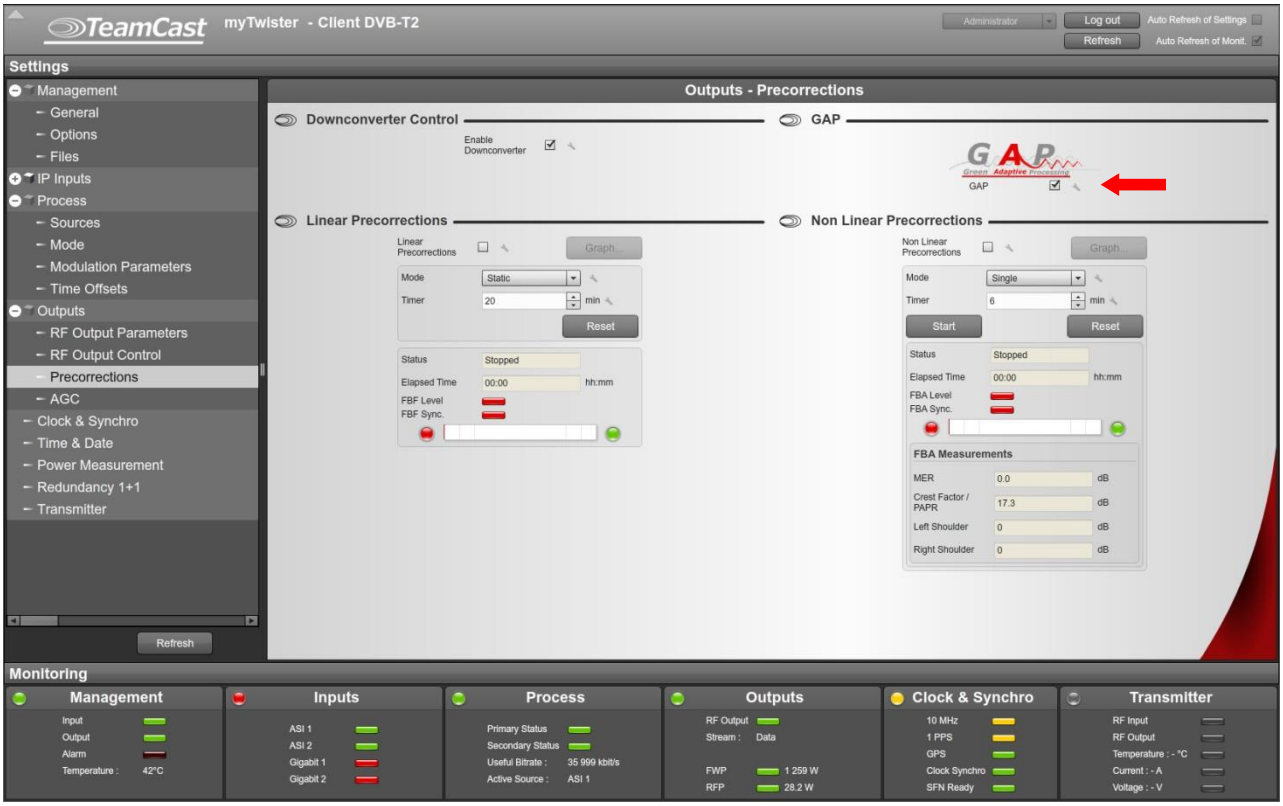
✓ License activation

First, the use of the GAP mode requires to unlock the "GAP" license key. This can be done in the *Settings* Tab, *Management* > *Options*



✓ ***GAP***© mode activation

In the *Settings* Tab, the ***GAP***© mode can be enabled in *Outputs* > *Precorrections* :



Enabling or disabling the ***GAP***© causes a reset of the non-linear curves.
The user is then given the possibility to save the current curves, if needed.

✓ Non-Linear DAP launch

The same protocol as for the basic DAP applies (please refer to the previous chapter).

Please refer to the dedicated application note for a quick understanding and advises about how to set-up and use the pre-corrections.

For more information concerning GAP®, please refer to the dedicated White Paper.

2.9 Clock and Synchronization

The clock and synchronization function is responsible for synthesizing the required clock signals and data rates. A high stability 10 MHz OCXO provides the internal clock reference.

However, if synchronization with other equipment is required, an external 10 MHz clock signal can be chosen as a reference together with external 1PPS. The user shall configure the signal reference edge (rising or falling edge). An internal 1 PPS signal is generated from the external signal in order to maintain synchronized the output signal as long as possible in case of external signal failure.

The modulator clock reference (10MHz) source can be configured as:

- Locked on the external 10 MHz signal reference (by default),
- Derived from the 1PPS source (either on-board GPS or external 1PPS)
- Internal.

The module delivers a 10 MHz clock reference output signal and can also provide 1PPS if the user configures the "1PPS IN/OUT" connector as an output.

2.9.1 GPS and clock management

With TW20-x102, the on-board GPS block gives the possibility to directly receive an incoming GPS or Glonass signal. Please refer to *Appendix C* for GPS installation recommendations and to *Appendix D* for GPS antenna recommendation.

Up to 4 satellite signal levels may be displayed (Note: in case of GPS/Glonass, the 4 strongest levels are chosen amongst the total of 8 signals available). Signal level is normally positive. If it is zero this means that satellite has not been acquired yet. If it is negative then that satellite is not being locked. The absolute value of signal level field is the last known signal level of that satellite.

Note: the GPS configuration parameters (location & time) is kept into memory for faster synchronization after reset or ON/OFF.

The figure below shows the entire TW20-x102 synchronization processing block (the on-board GPS being depicted as "GPS receiver"):

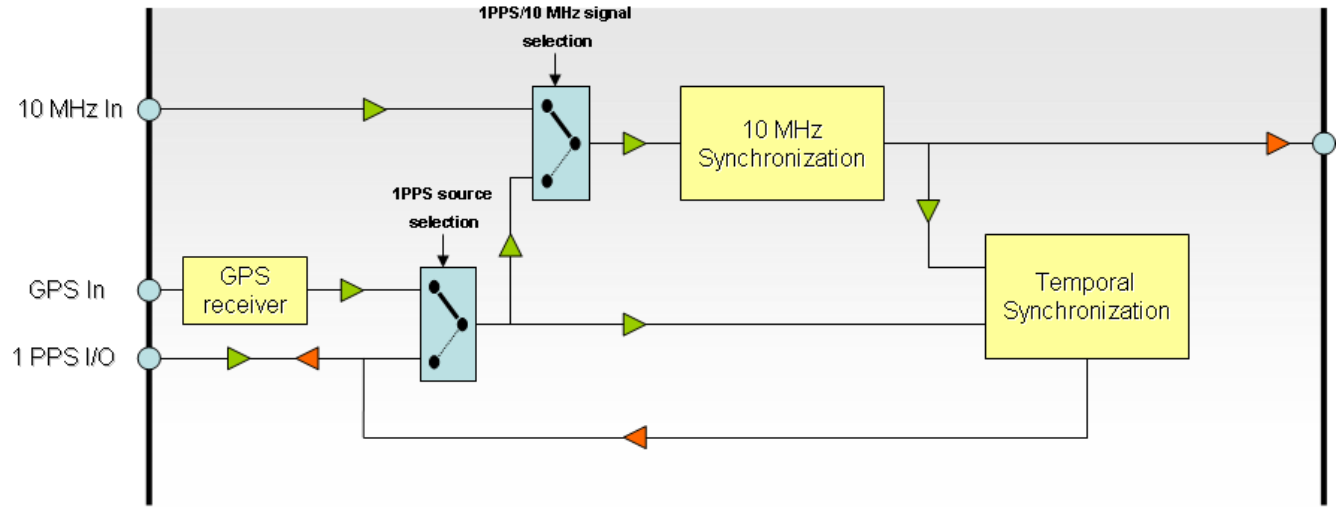


Figure 28: TW20-x102 synchronization processing block

Then, depending on the user's setup, three cases can be considered:

1) Working with external GPS signal reference (using on-board GPS receiver):

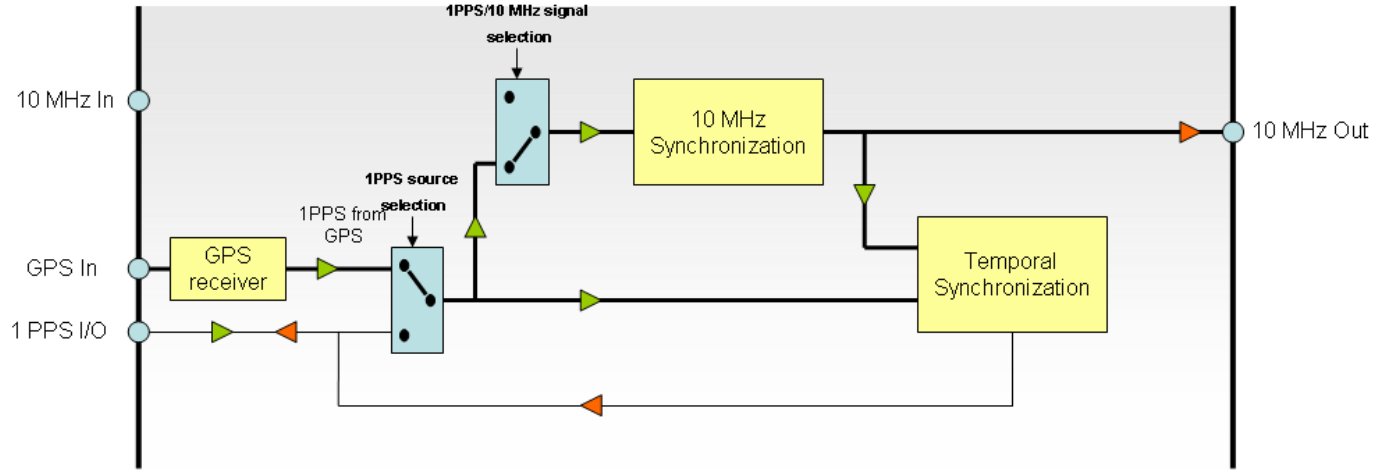


Figure 29: TW20-x102 clock synchronization - GPS signal

In this case, the modulator processes the 1PPS thanks to the on-board GPS receiver. The GPS reference signal is available on GPS In interface. This 1PPS reference signal is used both for temporal synchronization and 10 MHz PLL locking. The 1 PPS I/O can be configured as an output to provide a 1PPS signal to other equipment.

2) Working with external 1PPS reference signal:

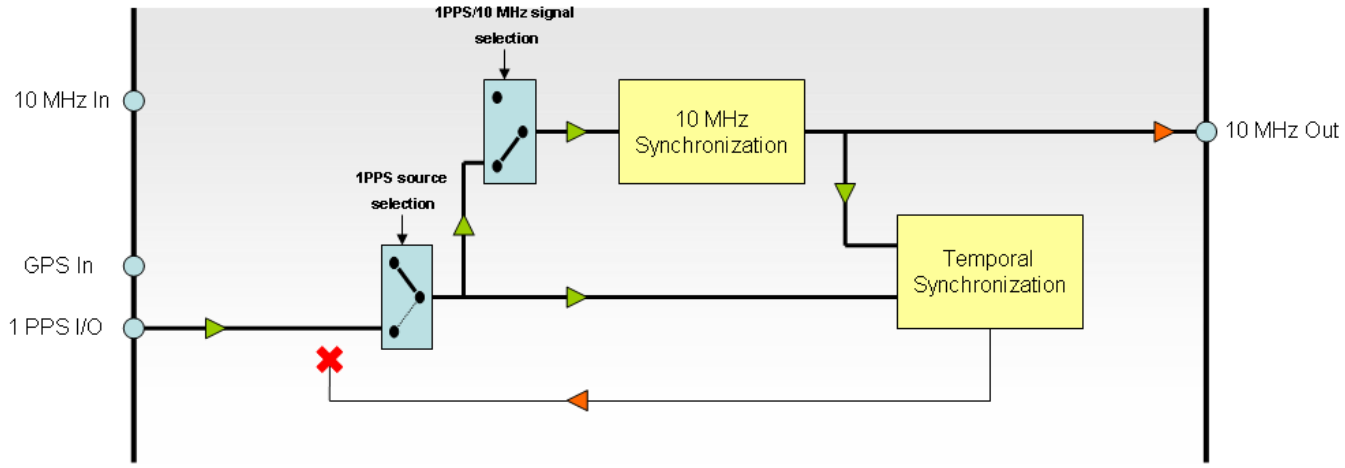


Figure 30: TW20-x102 clock synchronization – external 1PPS signal

In this case, the modulator directly uses the 1PPS from the external source available on the 1PPS I/O interface. This 1PPS reference signal is used for both temporal synchronization and 10 MHz PLL locking.

3) Working with external 10 MHz and external 1PPS reference:

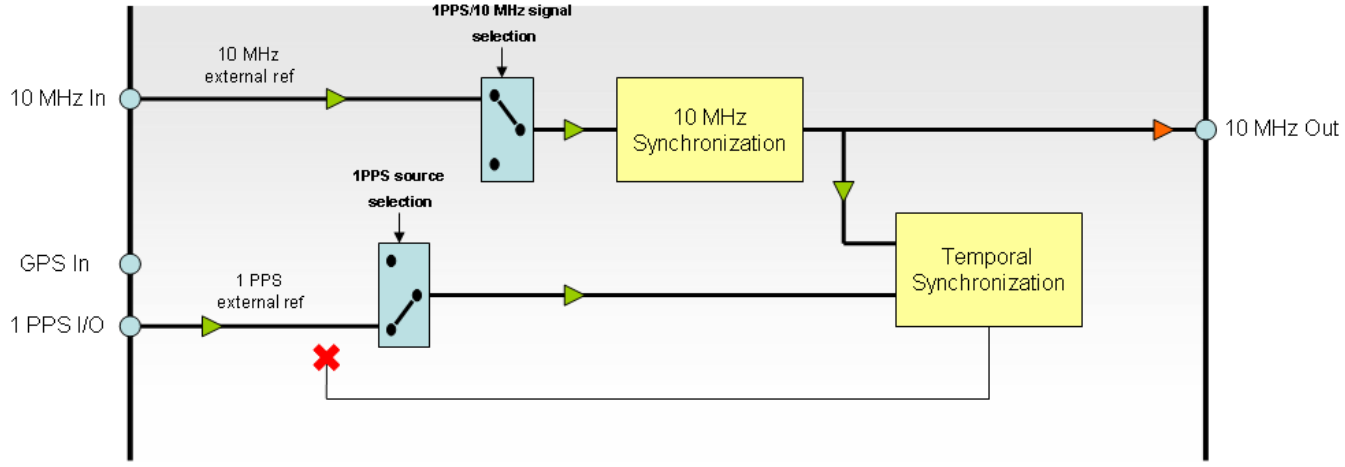


Figure 31: TW20-x102 clock synchronization – external 10 MHz and 1PPS signal

In this case, the modulator uses the external 10 MHz signal as well as the external 1PPS signal available respectively on the 10 MHz In and 1PPS I/O interfaces.

A 10 MHz reference signal is always available on the 10 MHz Out interface.

2.9.2 Warm-up Time

This part aims at describing the WARM-UP function which has been designed for compensating the startup delay of the OCXO (in case, for instance, of power-cut).
Indeed, in order to be stable the internal temperature of the OCXO must be stabilized and equal to 85°C; however this could take up to 5 minutes to obtain a stable 10MHz reference.
During this unstable situation, the OCXO response is not linear and the 10MHz regulation algorithm takes a long time to converge: the Warm-up survey has been defined for optimizing the 10MHz behaviour during that time.

If it is enabled, the WARM-UP function is a new state of the 10MHz regulation, during which it is deactivated until the external reference is stable again. The 10 MHz regulation then starts again after that state is finished.

This WARM-UP time typically takes 3-4 min and is limited to 10 min in any case.

2.9.3 Loss of Reference Signal management (LORS)

Note : LORS is not useful when operating in MFN-Standalone configuration and shall be considered ad reserved for Future Use (RFU).

In SFN, an accurate clock synchronization is very critical for ensuring a good SFN operation. For this purpose, the module implements the following operating modes in case of loss of the synchronization signal reference(s) (LORS).

When losing the clock synchronization, it can be set to automatically mute after a variable delay (Time_Out counter) also set by the user, from 0 (immediate mute) to 1440 min (24 hours), by step of 1 minute.

In the table below, it is assumed that the primary clock is 10MHz and the secondary clock is 1 PPS:

10 MHz	1 PPS	Operating Mode	Status
Detected	Detected	Normal	No alarm
Detected	Loss of Signal	Clock_source= External 10MHz	External 1 PPS warning
Loss of Signal	Detected	Clock_source= External 1PPS	External 10 MHz warning
Loss of Signal	Loss of Signal	Clock_source= Internal (Configurable Mute after LORS TimeOut)	External 1 PPS & 10 MHz critical alarms.
Unlocked PLL	-	Configurable Mute on SFN Not Ready	PLL_ Unlocked status = SFN not ready

Table 9: LORS management table

The PLL_Unlocked status (*Mute on SFN Not Ready*) is used in order to maintain the output signal muted (Please refer to the mute conditions in chapter *RF output muting and RF maintain features*).

In case of SFN application, an optional functionality "PPS auto resync" is available to allow resynchronization of the internal PPS (used as a reference time in SFN) when 10MHz clock control is locked. This optional functionality allows having the best accuracy on time reference PPS used for SFN systems.

The external references have to follow the recommendations specified in the interfaces description § *Interfaces characteristics*. The switching is seamless from external reference signal to the 10 MHz internal clock.

Note: In case both Mute conditions "*Mute on LORS*" and "*Mute on Clock Not Synchro*" (or "*Mute on SFN Not Ready*") are enabled, the Mute will occur only after the LORS TimeOut has ended, as shown in the chronograms below:

1) Mute behaviour when:
   - ✓ *Mute on LORS* is enabled
   - ✓ *Mute on Clock Not Synchro* is enabled
   - ✓ LORS TimeOut is reached

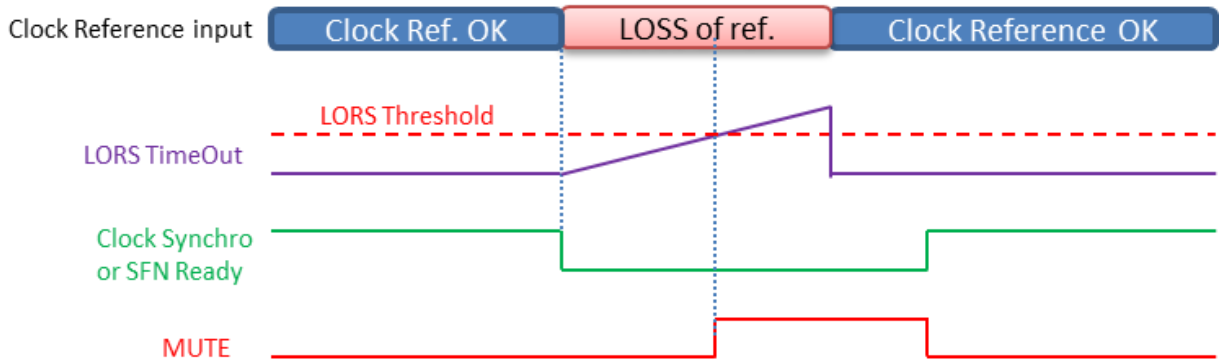


Figure 32: Mute behaviour - LORS TimeOut is reached

2) Mute behaviour when:
   - ✓ *Mute on LORS* is enabled
   - ✓ *Mute on Clock Not Synchro* is enabled
   - ✓ LORS TimOut is not reached

   If the LORS TimeOut is not reached when the clock reference comes back, another timeout starts (fixed to 60 sec), after which the module will mute if the Clock Synchro is still not OK:

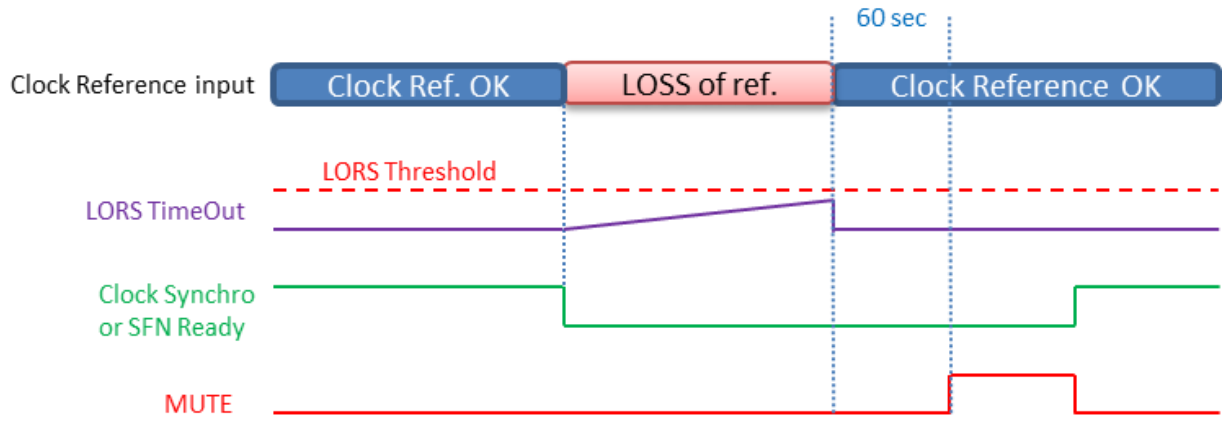


Figure 33: Mute behaviour - LORS TimeOut is not reached

2.10 Power Measurements

TWISTER II provides the capability to measure the forwarded and reflected powers out from the transmitter as described in the following figure.

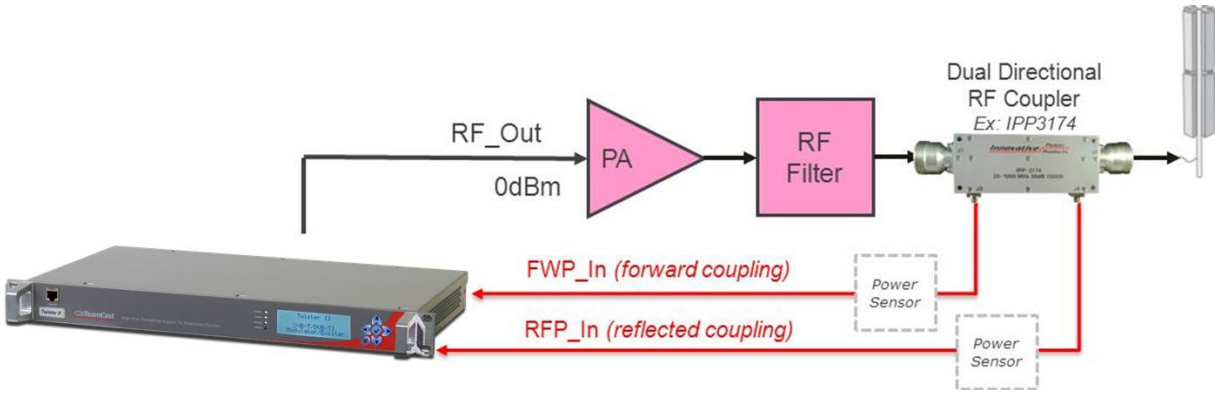


Figure 34: Power measurement

Using a RF coupler, the user will connect the output of the transmitter to both FWP_In and RFP_In dedicated inputs.

Each input is able to receive:

- Either a RF signal from 0 to -20dBm (±0.5dBm accuracy from 0 to -10dBm, ±1dBm accuracy from 0 to -10dBm)
- Or a VDC signal from an external power sensor from 0 to 5VDC

The working mode is configurable using the WEB GUI.
Depending on the selected mode, additional parameters will be needed as coupler gain or external sensor offset/slope to ensure an accurate measurement. Please refer to you external device user manual.

Minimum and maximum warning and alarm thresholds for both forward and reflected power can be set via WEB GUI by the user for error management and monitoring display.

For more information concerning the Power Measurement feature, please refer to the dedicated Application Note.

2.11 Automatic Gain Control (AGC)

TWISTER II provides a built-in output AGC to drive power amplifier stage.
It allows to maintain a very stable system output power that could vary depending on temperature, aging...

This feature uses the previously described FWP-In input. The maximum gain can be configured (depending on the initial TWISTER II output power and the maximum TWISTER II output power) by the user to protect the PA input stage from power peaks.

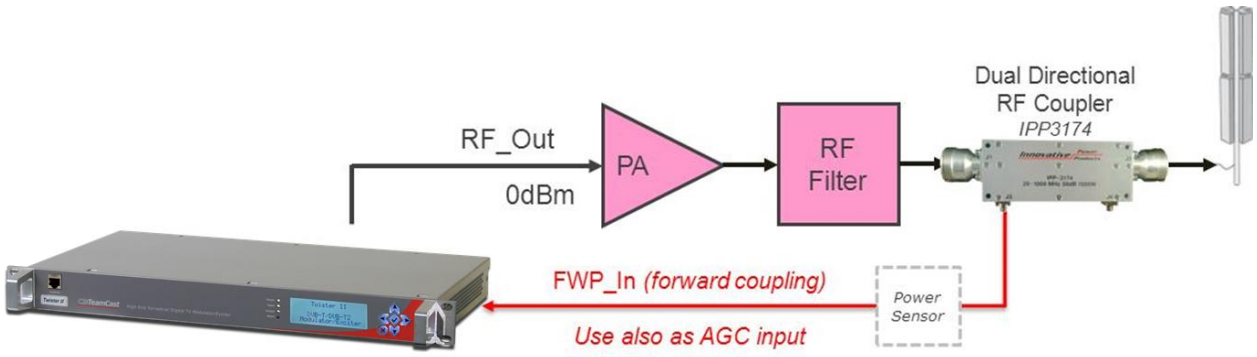


Figure 35: Built-in output AGC

2.12 Redundancy Management

TWISTER II is able to manage "N+1" configuration thanks to its 8 GPI that can be used to select a specific profile (configuration + precorrections curves) among up to 8. It also provides 2 fast INTERLOCK inputs to mute the unit depending on an external event.

For more information concerning the N+1 solution, please refer to the dedicated Application Note.

3 TWISTER II Rack

3.1 TWISTER II mechanics

The TWISTER II unit is a standard 1RU rack. The dimensions are 250 x 483 x 44 mm. The modulator weight is 4.9 kg.

Figure 36: TWISTER II 1RU Rack

3.1.1 Front panel layout

Here below is depicted the rack's front panel:

Figure 37: Front panel overview

The front panel is composed of an IP Control port, a LCD screen display with 6 buttons: 4 navigation buttons (up, down, left and right arrows), 1 "OK" green button and 1 "Cancel/Return" red button.
This front panel display allows the user to monitor and control the main features of the TWISTER II rack. Advanced features needs the Web GUI.
4 status LEDs are also available: Power, Input, Output and Alarm. For detailed description refer to paragraph 3.3.

3.1.2 Rear panel layout

Here below is depicted the rack's rear panel:

Figure 38: Rear panel overview

The rear panel provides all the connectors needed for the use of the rack.
Please refer to next paragraph for detailed description.

3.2 Interfaces characteristics

The product interfaces are the following:

Stream input interfaces		x 2
General	Function: Standard: Name: Connector: Type:	Primary & secondary Inputs DVB-ASI ASI1 & ASI2 BNC Connector– Input impedance 75Ω Input
Performances	Data rate: Mode: Format:	DVB-ASI: 80 Mbps maxi. Burst or Packet mode (DVB-ASI) DVB-ASI: 188/204 bytes

Figure 39 ASI Input interfaces

ASI Stream Output interface		x 1
General	Function: Standard: Name: Connector: Type:	ASI Output DVB-ASI ASI_Out BNC Connector–impedance 75Ω Output
Performances	Data rate: Mode/Format (Out):	ASI: 80 Mbps maxi. Packet mode/188-byte

Figure 40: ASI Output interface

Electrical Gigabit Port (Data & Control)		x 2
General	Function: Standards: Connector Name Connector type Type:	Gigabit Ethernet Port Ethernet, IP Gigabit1/Ctrl & Gigabit2 RJ-45 Input/output
Performances	Data rate: Ethernet: Packet type Protocols: Jitter tolerance Mode: Stream Encapsulation: FEC decoding	1 Gbps max 10/100/1000 Base T IPv4 – IPV6 Ready IEEE802.3, IPv4, IPv6, XML, FTP, SNTP 50 ms Half/full duplex TS/RTP/UDP/IP-T2MI/TS/RTP/UDP/IP SMPTE-2022

Figure 41: Electrical Gigabit Datas interface

Figure 42: Electrical Gigabit Control interface

GPS Antenna input		x1
General	Function: Name: Connector: Type:	GPS antenna input GPS SMA Input
Performances	Antenna type: Antenna voltage	Active 3.3 VDC
	Antenna system gain	10 dB
	Frequency	1575.42 MHz

Figure 43: GPS antenna input

Clock reference input		x 1
General	Function: Name: Connector: Type:	Frequency reference input 10 MHz_IN BNC – 50 Ω Input
Performances	Frequency: Level:	10 MHz From -15 to +15 dBm

Figure 44: Clock reference input

Clock reference Output		x 1
General	Function: Name: Connector: Type:	10 MHz reference output 10 MHz_OUT BNC – 50 Ω Output
Performances	Frequency: Level:	10 MHz 0 dBm ± 3 dB

Figure 45: Clock reference output

1PPS reference input/output		x 1
General	Function: Name: Connector: Type:	Time Reference in/out 1PPS BNC – 50 kΩ Configurable I/O
Performances	Signal : Level:	1 PPS LVTTL / TTL (input) LVTTL (output) ±50ns (input tolerance)

Figure 46: 1PPS reference input/output

RF Output		x 1
General	Function: Standards: Name: Connector: Type:	RF output DVB-T/T2 RF N connector – 50 Ω Output
Performances	Frequency: Bandwidth: Level:	VHF Band I & III, UHF 5, 6, 7 & 8 MHz 0 dBm (TW20-3102) +14 dBm (TW20-4102)

Figure 47: RF output

Monitoring Output		x 1
General	Function: Standards: Name: Connector: Type:	Monitoring output DVB-T / DVB-T2 Monit Out SMA – 50 Ω Output
Performances	Frequency: Level: Other:	See RF Output -30 dB % RF out Monitoring signal from modulator board (before ampli)

Figure 48: Monitoring output

RF Feedback Inputs		x 2
General	Function: Standards: Name: Connector: Type:	RF Feedback inputs / RF Measurements - FBA / FBF SMA – 50 Ω Input
Performances	Frequency: Bandwidth: Level: Max input level Return loss	VHF Band I & III, UHF 75 MHz -5 to -15 dBm +5dBm (before damage) >13dB

Figure 49: Feedback inputs

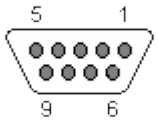
Forward Power Measure Input/AGC		x 1
General	Function: Standards: Name: Connector: Type:	Forward Power Measure - FWP In SMA – 50 Ω / High impedance Input
Performances (RF input)	Frequency: Range: Precision: Max input level Return loss Impedance	VHF Band I & III, UHF 0 to -20dBm Typical 0 to -10dBm 0.5dB typical +5dBm (before damage) >12dB 50 Ω
Performances (VDC input)	Range: Precision: Impedance	0 to 5VDC 0.01VDC typical 80 KΩ

Figure 50: Forward Power Measurement / AGC input

Reflected Power Measure Input		x 1
General	Function: Standards: Name: Connector: Type:	Reflected Power Measure - RFP In SMA – 50 Ω / High impedance Input
Performances (RF input)	Frequency: Range: Precision: Max input level Return loss Impedance:	VHF Band I & III, UHF 0 to -10dBm 0.5dB typical +5dBm (before damage) >12dB 50 Ω
Performances (VDC input)	Range: Precision: Impedance	0 to 5VDC 0.01VDC typical 80 KΩ

Figure 51: Reflected Power Measurement input

TOD		x 1
General	Function: Standards: Name: Connector: Type:	Control / monitoring 1x RS-232 Serial Port 1 Female SubD9 RS-232/RS-485
Performances	Control Baud rate TOD Baud Rate Other:	9600 bps to 115200 bps 9600 bps No parity, 8 bits data, 1 bit stop



PIN	Name	Dir
1	RS232 Tx	Out
2	Rfu	
3	TOD Rx	In
4	RS232 Rx	In
5	GND	
6	RS485 Rx+	In
7	RS485 Rx-	In
8	RS485 Tx+	Out
9	RS485 Tx-	Out
Shield	GND	

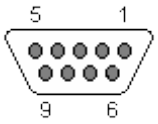
Figure 52: TOD/RS232 Port

The information containing Time Of Day (TOD) is available on Tekelec GPS, whose characteristics are following:

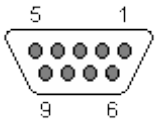
- ASCII, 9600 bps, 8bits, 1 stop bit, no parity
- Protocole <message> <CR> <LF>
- Format day/year hour:minute:seconds e.g. 317/1996_18:16:20

The content of message should be "GPS reference" and not "UTC reference" or "local time".

Alarm		x 2
General	Function:	Alarm relays
	Name:	GPIO1 / GPIO2
	Connector:	SubD9 connectors
	Type:	Dry contacts /GPI / VDC_{in} / VDC_{out}



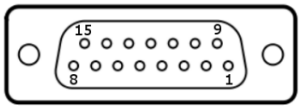
PIN	Name	Dir
1	RELAY1_Normally_Open (Open when active alarm)	
2	12 VDC output through 2.7 Kohms resistor and protection diode	
3	RELAY2_COM	
4	RELAY3_ Normally_Open (Open when active alarm)	
5	GND (cathode of the opto-coupler diode)	
6	RELAY1_COM	
7	RELAY2_ Normally_Open (Open when active alarm)	
8	Anode of the opto-coupler diode through 330 ohms resistor	
9	RELAY3_COM	
Shield	GND	



PIN	Name	Dir
1	RELAY4_Normally_Open (Open when active alarm)	
2	12 VDC output through 2.7 Kohms resistor and protection diode	
3	RELAY5_COM	
4	RFU	
5	GND (cathode of the opto-coupler diode)	
6	RELAY4_COM	
7	RELAY5_ Normally_Open (Open when active alarm)	
8	Anode of the opto-coupler diode through 330 ohms resistor	
9	RFU	
Shield	GND	

Figure 53: Alarms Port

Alarm		x 2
General	Function: Name: Connector: Type:	N+1 management / INTERLOCK CONTROL SubD15 connectors GPI / INTERLOCK / VDC_{in} / VDC_{out}



Male connector

Pin Number	Pin Description
1	GPI 1
2	GPI 2
3	GPI 3
4	GPI 4
5	GPI 5
6	GPI 6
7	GPI 7
8	GPI 8
9	GPI 9
10	V_Interlock 1 (External Voltage for Interlock 1 connected to the anode of the opto-coupler 1 diode through 2.2 kOhms resistor)
11	Interlock 1 (cathode of the opto-coupler 1 diode)
12	V_Interlock 2 (External Voltage for Interlock 2 connected to the anode of the opto-coupler 2 diode through 2.2 kOhms resistor)
13	Interlock 2 (cathode of the opto-coupler 2 diode)
14	3.3 VDC output through 150 Ohms resistor and protection diode
15	GND

Figure 54: CONTROL Port

3.3 Front Panel signalization (LEDs description)

A set of 4 LEDs indicates the module status following the *TeamCast* standard:
- A Power LED indicator
- A Input LED indicator
- A Output LED indicator,
- A Alarm LED indicator.

Depending on the rack function, behaviour may differ.

Here is described a modulator function behaviour.

Name	Description
Power	Green off: power off Green fix: power on
Input	Green off: Primary input is not detected (in manual mode) or primary and secondary input is not detected (in auto mode) Green flashing: Primary input is KO(1) but secondary input is OK (in auto mode) Green fixed: Primary input is ok(1)(4)
Output	Green off: no RF output (module failure) Green fixed: the RF output is available (normal mode) Green flashing: Test signal(2) is generated or RF Maintain mode Yellow fixed: Warning RFP ou FWP Red Fixed : Error RFP or FWP or muted output Red flashing : RFP Critical Error
Alarm	Off: No critical error detected Red fixed : Module failure Red flashing : Primary input failure(3) or primary clock reference(5) loss (10 MHz or PPS in case of ext 10MHz + ext 1PPS primary selection)

Table 10: LED status

(1) If primary input is detected but any condition for "Mute on TS error" is met, the input LED is flashing.
(2) PRBS, Sine, or any special test.
(3) Except in case of PRBS or Sine test mode.
(4) In automatic mode, if primary input is detected, the input LED is fixed whatever the secondary input status.
(5) Alarm due to primary clock reference loss is defined in the following table:

3.4 Power requirements

The rack must be powered by a 110-240VAC 50-60Hz voltage.

The overall modulator (TW20-**3**102) is expected to consume up to 70 W.
The overall exciter (TW20-**4**102) is expected to consume up to 120 W.

Figure 55: Power supply plug

A yellow/green ground cable (0.75mm² min.) must be connected to the small connector located between the power supply plug and the GPS antenna input. This cable must be securely connected to the ground before switching on the equipment

3.5 Performances and technical characteristics

3.5.1 General characteristics

Characteristics	Typical Value	Comment
Environment		
Power voltage Frequency range Power consumption	90 - 264 VAC 50-60 Hz < 70 W <120 W	 TW20-3102 TW20-4102
Dimensions	1U - 19" - P = 25 cm	
Weight	4.9 Kg	
Operating temperature	0 °C to +50 °C	
Storage temperature	-10 °C to +70 °C	
Storage relative humidity	10 to 80 % at 50 °C	
Operating altitude	≤ 2000m	
Cleaning	Air cooling areas	

3.5.2 Control and data Ethernet interfaces

Gigabit interfaces	Typical Value	Comment
Ethernet		
Control Link & Data Link	10/100/1000 Base-T Half / Full duplex Auto nego	
IP characteristics		
Maximum bit rate	100 Mbps	
Number of processed IP streams	1 per physical interface	
Maxi network Jitter tolerance	50 ms	
Ethernet MTU length	Max 1500 bytes	
Data de-encapsulation		
Protocol	TS/RTP/UDP/IP and Pro-MPEG Cope 3 decoding (compliant with SMPTE 2022-1-2007 and SMPTE 2022-2-2007)	
TS packet number per IP packet	1 to 7	User configurable
FEC decoding	SMPTE 2022	
FEC type	SMPTE 2022	
FEC matrix (L,D)/(LxD)	SMPTE 2022	
MPEG-TS packet length	188 bytes	

3.5.3 Serial control interfaces

Control interfaces	Typical Value	Comment
RS232		
Standard	RS232	TX and RX signals only. Limited to the use for "TX control" part (does not fully control the rack)
Electrical level	±12v compatible	
Baud rate	9600 bauds to 115200 bauds	
Others	No parity, 8 bits data, 1 bit stop	
Connector	SuB-D9 specific pinout with RS485 and TOD interfaces	

RS485		
Standard	RS485 Full or Half duplex	TX and RX signals only. Limited to the use for "TX control" part (does not fully control the rack)
Electrical level	RS485 compatible	
Baud rate	9600 bauds to 115200 bauds	
Others	No parity, 8 bits data, 1 bit stop	
Connector	SuB-D9 specific pinout with RS232 and TOD interfaces	

TOD		
Standard	RS232	Limited to RX signal
Electrical level	±12v compatible	
Baud rate	9600 bauds	
Others	No parity, 8 bits data, 1 bit stop	
Connector	SuB-D9 specific pinout with RS232 and RS485 interfaces	

INTERLOCK		
Reaction time	<1ms	
Voltage	From 3.3 to 50 VDC max	

3.5.4 ASI inputs / output and MPEG-TS processing

TS stream	Typical Value	Comment
ASI Inputs		
Format	TS/ASI or T2-MI/TS/ASI	
Packet size	188/204 bytes Packet or Burst mode	DVB-ASI
Maximum total bit rate Maximum useful bit rate	80 Mbps 50 Mbps	DVB-ASI
Max. Input jitter	+/- 100 ms	
Input impedance	75 ohms	
Return loss	> 15 dB up to 270 MHz	
Input processing		
T2-MI delay storage capability Time Offset Extended Time Offset in DVB-T Extended Time Offset in DVB-T2	At least 5s -3.2768 to +3.2767 ms 0 to 1 s -999ms to 999ms	For 50Mbps input rate In SFN mode only In DVB-T SFN mode In DVB-T2 SFN or MFN mode
TS or T2-MI Stream switching TS *CleverSwitch* IP *CleverSwitch*	Automatic or manual Between primary & sec. stream Between prim. & sec. IP stream	With auto or manual switch-back Seamless in SFN DVB-T/T2 Not seamless
TS processing (MFN Only)	NIT update Bit rate adaptation PCR re-stamping	Frequency and mode
T2-MI synchronization	SFN	Absolute or relative sync.
ASI Output		
Format	TS over DVB-ASI	
Packet size	188 byte 188 byte	DVB-ASI SMPTE-310M
Maximum useful bit rate	19.39 Mbps 19.39 Mbps	DVB-ASI SMPTE-310M
Max. Output jitter	Same as incoming jitter	

3.5.5 Digital modulation

Characteristics	Typical Value	Comment
DVB-T/H Modulation		
DVB-T/H modes	Fully compliant	
Channel bandwidth	5 MHz, 6 MHz, 7 MHz or 8 MHz	
DVB-T2 Modulation		
DVB-T2 modes	MISO and SISO All Mapping, FFT, GI and FEC TR-PAPR mode compliant	
Number of supported PLPs	≤8	Constant Bit Rate Static configuration
Channel bandwidth	5 MHz, 6 MHz, 7 MHz or 8 MHz	
Control		
IP	Web based GUI	
TOD input port		
RS-232	- 9600 Bauds - 8 data bits - 1 STOP bit - No parity bit	Limited to Rx

Characteristics	Typical Value	Comment
Miscellaneous		
Automatic mute	Configurable on stream errors Configurable on clock errors	Configurable Timeout (LORS)
RF maintain	Configurable on stream errors	
Spectrum reverse	Configurable	
Test modes	Single sine tone /+6 dB Sinus PRBS	

3.5.6 Clock synchronization

Characteristics	Typical Value	Comment
External references		
External 10 MHz reference input		
Impedance	50 Ohms	
Level	-15 to +15 dBm	
Frequency	10 MHz ± 0.6 ppm	
External 1 pps reference input		
Level	LVTTL level – 5 Kohms	
Min pulse width	1 µs	
10 MHz reference output	0 dBm ± 3 dB	
1 PPS reference output Level Pulse width	 LVTTL ≥ 100 ns	
Characteristics	**Typical Value**	**Comment**
GPS synchronization		
System	GPS	
Frequency	1575.42 MHz	
Max Nb of tracked sat.	12	
Antenna system gain	10 dB	
Sensitivity	<-138 dBm	
PPS accuracy	± 50 ns	
Antenna power supply	3.3 Volts	

TWISTER II High-End Rack Modulator / Exciter

Characteristics	Typical Value		Comment
Clocks & Synchronization			
10 MHz lock control type	Digital		
Internal 10 MHz clock			With OCXO
T° Stability (full temperature range)	< ± 5.10^{-9}		0 → 50 °C
Tuning	< ± 0.6 ppm		
Short term stability	< ± 1.10^{-11}		Over 1 s, 10 s
Aging	< ± 5.10^{-10} / day < ± $7.5.10^{-8}$ / year < ± 5.10^{-7} / 15 years		
Synchronization Cases	*Stability*	*Aging*	
External_10MHz_Locked	< ± 3.10^{-10}	-	
External_10MHz_Unlocked	< ± 3.10^{-10}	< ±7.5.10-8 / year < ±5.10-10 / day	Internal
Onboard GPS_Locked	< ± 7.10^{-10}	-	
Onboard GPS_Unlocked	< ± 7.10^{-10}	< ±7.5.10-8 / year < ±5.10-10 / day	Internal
Output phase noise	< -55 dBc/Hz < -85 dBc/Hz < -85 dBc/Hz < -95 dBc/Hz < -113 dBc/Hz < -130 dBc/Hz		@ 10 Hz @ 100 Hz @ 1 kHz @ 10 kHz @ 100 kHz @ 1 MHz

3.5.7 RF and monitoring outputs

Characteristics	Typical Value	Comment
RF Output		
Adjustable Frequency Range Step size Accuracy	VHF I: [54 MHz; 88 MHz] VHF III: [170 MHz; 240 MHz] UHF: [470 MHz; 862 MHz] 1 Hz 0.2 Hz	
Impedance	50 ohms	
Output level Main signal Stability Return loss Attenuation range Attenuation step Monitoring signal (relative to main output)	 0 dBm ± 1 dB +14 dBm ± 1 dB ± 0.1 dB / 10 °C > 13 dB > 12 dB 0 to 20 dB 0.1 dB -30 dB ± 2 dB	 TW20-3102 TW20-4102 TW20-3102 TW20-4102
MER	>40 dB >37 dB (>40dB w/ precor.)	TW20-3102 TW20-4102
Shoulder and Out of band rejection	 >50 dB >40 dB (>40dB w/ precor.)	Measured at 4.2 MHz from the center frequency – 8MHz channel TWS0-3102 TWS0-4102
Spurious	<-50 dBc	Relative to the total power of the signal
PAPR Configuration range Pre-clipping optimization Protection clipping	 8 to 20 dB (0.1 dB step) 0 to 255 8 to 20 dB (0.1 dB step)	

3.5.8 Digital pre-correction

Characteristics	Typical Value	Comment
Feedback inputs		
RF Frequency band	VHF I & III, UHF	
Impedance	50 ohms	
Return loss	> 13 dB	
Nominal input level	-5 to -15 dBm	
Max input level	+5 dBm (before damage)	
Adjacent channel rejection	No adjacent channel support	

Characteristics	Typical Value	Comment
Manual pre-correction		
Linear pre-correction Amplitude Group delay	32 points ± 3 dB (0.1 dB step) ± 500 ns (10 ns step)	On the overall bandwidth
Adaptive pre-correction		
Linear Adaptive pre-correction Amplitude Group delay	 ± 3 dB (0.1 dB step) ± 500 ns (10 ns step)	
Non-Linear Adaptive pre-correction AM/AM AM/PM	 ± 6 dB (0.05 dB step) ± 25° (0.2° step)	

Characteristics	Typical Value	Comment
DAP performances measurement		
RF feedback input levels	Bar graph 0-100 %	
Left and right shoulders	On FBA or FBF input > 45 dB max	Resolution ±1 dB
MER	On FBA or FBF input For relative use only From 20 up to 40 dB Typical	The MER measurement should not be used as an absolute value. It can be used only for variation detection.

3.5.9 Power level measurement inputs and AGC

Characteristics	Typical Value	Comment
Measurement inputs (Forward and Reflected power)		
AC impedance	50 ohms	
DC impedance	~ 80 kohms	
Return loss	> 12 dB	
Nominal input level	-10 to 0 dBm 0 to 5 Vdc	In RF power mode In DC voltage mode
Maximum input level	+5 dBm / 6Vdc	
Accuracy	0,5 dB typical 0,01 Vdc	In RF power mode In DC voltage mode May require significant calibration
Max input level	+5 dBm (before damage)	
Reactivity time	1 s max	
Measurement bandwidth	Full bandwidth	
Measurement calibration		
Configurable coupler gain	0 to +100,0 dB	
Gain step	0,1 dB	
Configurable probe offset	-32768 mV to +32767 mV	
Offset step	1 mV	
Configurable probe slope	-100.00 to +100.00 dB/V -32768 to +32767 mVrms/V 0 to +65535 mW/V	for VDC/dBm type for VDC/Vrms type for VDC/W type
Slope step	0,01 dB/V 1 mVrms/V 1 mW/V	for VDC/dBm type for VDC/Vrms type for VDC/W type
AGC		
Maximum AGC gain	0 to 20,0 dB	
Maximum AGC gain step	0,1 dB	
Nominal Power level	-100,0 to 100,0 dBm	
Nominal Power level step	0,1 dB	

3.5.10 Dry contacts

Characteristics	Typical Value	Comment
Relay characteristics		
Maximum switching voltage	25 VAC / 60 VDC	
Maximum switching current	1 A	
Maximum switching power	62,5 VA / 30 W	
Available contacts	Normally open Normally close	

3.6 Conformity with EC Directive

The CE marking is present on the TWISTER II product.

It shows that:

- TeamCast has checked that this product meets EU safety, health or environmental requirements
- there is an indicator of a product's compliance with EU legislation
- it allows the free movement of products within the European market

By placing the CE marking on our product we are declaring, on our own responsibility, conformity with all of the legal requirements to achieve CE marking.
Therefore, we attached in appendix A the EC Conformity declaration for TWISTER II.

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4 TWISTER II Installation

4.1 Unpack the Unit

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

Unpack carefully the rack from the storage box.
Check the rack against transport damage.

Except if ordered separately, the documentation is not included in the pack.
It is downloadable from TeamCast web site (*www.teamcast.com*) where .pdf files are available including:
- The User Manual (this document) detailing all product functionalities, mechanics, performances and recommendations,
- The Upgrade Procedure for SW updates and licence key management,
- A Release Note (related to the current SW version) that describes product improvements or limitations.

Save the box and foam packaging in case the system needs to be shipped to another location or returned for repair.

4.2 Installation and Recommendations

Install the unit in the appropriate location using four rack mounting screws (not included) as shown in the following figure

Figure 56: Chassis installation

Mechanical mounting into a chassis must take into account any mechanical overload on the rack to avoid dangerous situation

Rack connection to power supply must be taken into account for any electrical overload protection. A specific electrical study must be performed by integrator

The equipment must be connected to power supply with a ground connection. Ground connection of the equipments of the chassis must be checked before use

Installation must be performed by a qualified person and following the CEI60728-11: 2005 directive.

4.2.1 Temperature alarms

The maximum temperature levels are the following:
- A warning will raise when the internal temperature reaches more than 68°C
- An alarm with output muting will occur from internal temperature higher than 71°C

In both cases, the normal situation comes back when the temperature decreases under 67°C.

4.2.2 Cooling methods

Specific care must be taken concerning cooling system. The following figure shows the air flow due to internal fans. When the unit is integrated in a chassis, space must be left on the right and the left side to allow a sufficient air flow.

Figure 57: Rack air flow

4.3 Wiring and Switch on

Once fixed in its location, the rack can be wired depending on the configuration.

When switched on, the rack is fully operational after a few seconds.
Please refer to § *0* for a front panel LED diagnostic.

To simply control and monitor TWISTER II, any web browser software can be used with an IP connection between the rack and the PC. The default IP address is 192.168.0.209 on IP port#1. The control port #1 IP configuration can be retrieved / modified using the font panel menu.

Power supply connector must remain available to easily disconnect the equipment in case of emergency

4.4 Initial Configuration

Except otherwise specified at the order, the module is delivered with the basic configuration as described hereafter.

IP Parameters	Default Settings
Ethernet mode	Auto-sensing
DHCP	Disabled
Gigabit Control 1 (Control) (not changed by *default* command)	MAC address: module unique address Address: 192.168.0.209 Subnet: 255.255.255.0 Gateway: 192.168.0.254 DHCP: OFF
Gigabit Control 2 (SNMP) (not changed by *default* command)	MAC address: module unique address Address: 192.168.1.210 Subnet: 255.255.255.0 Gateway: 192.168.1.254 DHCP: OFF
Gigabit Front Panel Control (not changed by *default* command)	MAC address: module unique address Address: 192.168.2.211 Subnet: 255.255.255.0 Gateway: 192.168.2.254 DHCP: OFF
Gigabit Data 1 (Data Input) (not changed by *default* command)	MAC address: Port#2 unique address Address: 192.168.3.214 Subnet: 255.255.255.0 Gateway: 192.168.3.254
Gigabit Data 3 (ST2L Output) (not changed by *default* command)	MAC address: Port#2 unique address Address: 192.168.5.214 Subnet: 255.255.255.0 Gateway: 192.168.1.254
Gigabit Data 2 (Rfu)	*Rfu*
Gigabit Data 4 (Rfu)	*Rfu*
Gigabit Input Time Out	1 sec.

Table 11: Default IP settings at the delivery

Other Parameters	Default Settings
Standard	DVB-T2
Test mode	Disabled
Serial speed	57600
Serial protocol	Standard
Auto logout time	Off
ASI _IN1 equalizer	Disabled
ASI _IN2 equalizer	Disabled
Primary Source	ASI_IN1
Secondary Source	ASI_IN2
ASI Output	OFF
TS *CleverSwitch* Auto_Switch_Back Packet error threshold Packet valid threshold	Enabled Disabled 5 80000
ASI management unit (Bit rate adaptation)	Enable
Major Channel number update	Disable
Major Channel number	0
Carrier Frequency update	Disable
Carrier Frequency for Carrier Freq. update	666 MHz
Bandwidth	8 MHz
Center Frequency	666 MHz (channel 46)
Output attenuation	20 dB
Crest Factor	10.0 dB
Crest Factor Optimization	0
Protection Clipping	15 dB
Spectrum inversion	No
RF output monitoring	Enabled
Exciter RF failure offset	5.0 dB
Starting delay	5 seconds
AGC	Off
AGC Maximum gain	0 dB
AGC response time	Nominal
Mute Conditions	GPI=0: Disabled GPI=1: Disabled
Mute	Disable
RFP Warning AGC protection	Disabled
RFP Error protection cycle	Disabled

RFP Error protection – Nb retries	3
RFP Error protection – Delay between retries	4
RFP Error protection – Cycle reset time	60
RF maintain	On Input Stream Error: Enabled
Enable down-converter	Enabled
GAP Mode	Off (standard)
Linear Pre-correction circuits Non-Linear Pre-correction circuits	Disabled (Bypassed) Disabled (Bypassed)
Linear DAP mode Non-Linear DAP mode	Static (DAP is disabled) Static (DAP is disabled)
Linear DAP Time_Out Non-Linear DAP Time_Out	20 min 10 min
Primary clock	Internal
Secondary clock	Internal
PPS source	Onboard GPS
PPS Interface	Output
PPS Edge (RFU)	*Rising*
Warm-up time (before 10MHz synchro)	Enabled
GPS Antenna Voltage	3.3 VDC
Absolute reference time	GPS
Time and date setting	Manual
Power measurements (not changed by *default* command)	Active
FWP Input type (not changed by *default* command)	RF input
FWP Coupler attenuation (not changed by *default* command)	0 dB
Nominal Power (not changed by *default* command)	0 dBm
Min FWP Error (not changed by *default* command)	80 %
Min FWP Warning (not changed by *default* command)	90 %
Max FWP Warning (not changed by *default* command)	110 %
Max FWP Error (not changed by *default* command)	120 %
RFP Input type (not changed by *default* command)	RF input
RFP Coupler attenuation (not changed by *default* command)	0 dB
Max RFP Warning (not changed by *default* command)	10 %

Max RFP Error (not changed by *default* command)	20 %
Dualdrive redundancy	Disabled
GPO2 Opening triggers	None
GPO3 Opening triggers	Output error Alarm error
RF switch monitoring	Disabled
Transmitter control	Disabled

5 TWISTER II Operation

5.1 Operation Generalities

5.1.1 Local Operation

The product can be locally controlled using the front panel menu. It is composed of an LCD screen and 6 buttons to navigate into the control/monitoring menu.
Main features are available using the front panel but for a complete access to the unit, please use the web GUI.

5.1.2 Remote Operation

The product can be controlled using any web browser software. It allows the user to control and monitor and maintain the unit.

Here below are the system requirements:

- Personal computer using a Pentium 1GHz or higher microprocessor
- Microsoft Windows Vista/XP or Windows 2000 Service Pack 3 or later
- 1024 x 768 resolution (or higher) video adapter
- Minimum of 128 MB of RAM, 256 MB recommended
- 120 MB free hard disk space
- Microsoft-compatible mouse

Figure 58: TWISTER II IP connexion

Web GUI can be accessed via the web browser using the IP address of the unit. By default, this address is 192.168.0.209. The IP address can be retrieved / modified using the front panel menu.

5.2 Embedded Web GUI Description

5.2.1 Requirements

To connect to TWISTER II web interface, a web browser with Flash Player is mandatory.

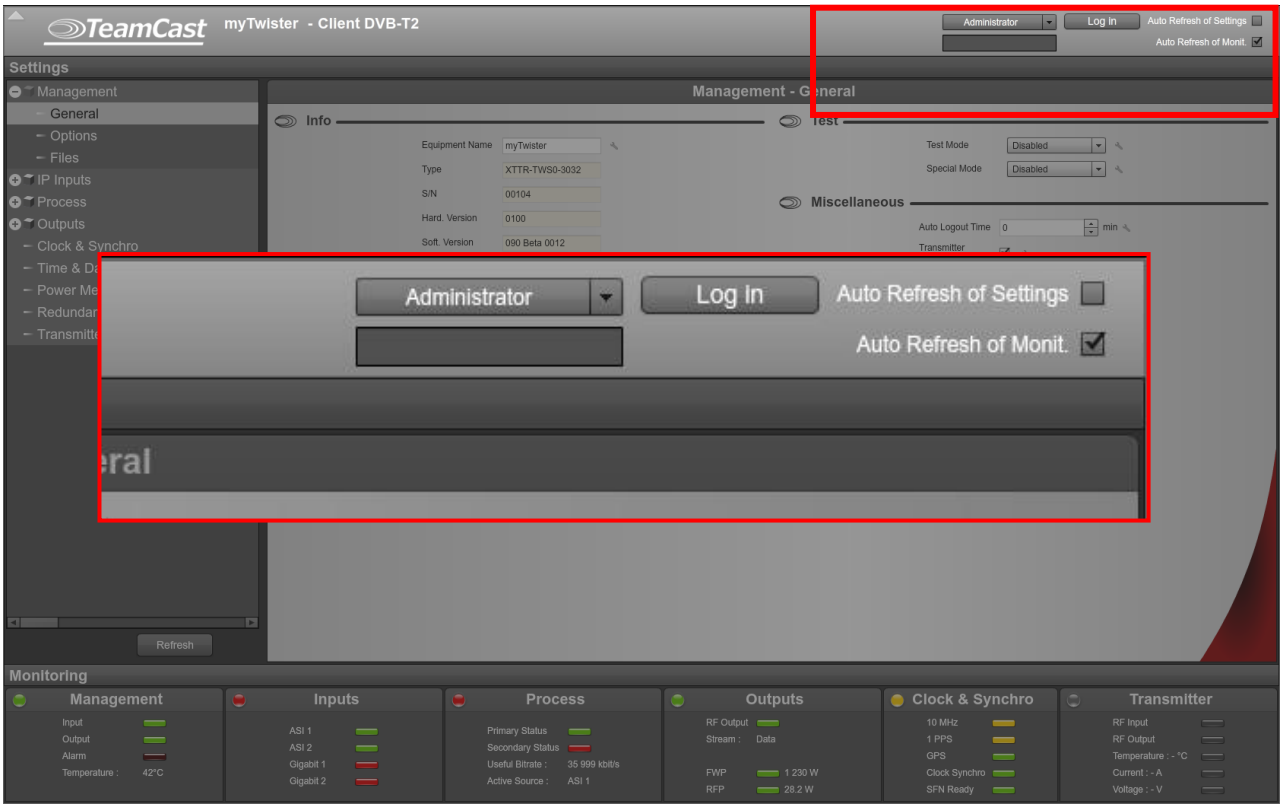
5.2.2 Connection to TWISTER II

Using the web browser, the user will access the modulator by typing « http://myTwisterAddress", where myTwisterAddress is the IP address of the equipment. This address can be retrieved using the front panel display menu: *MANAGEMENT > Control IP Port > Add*

To access any settings of TWISTER II, a login is required. There are 3 logins:

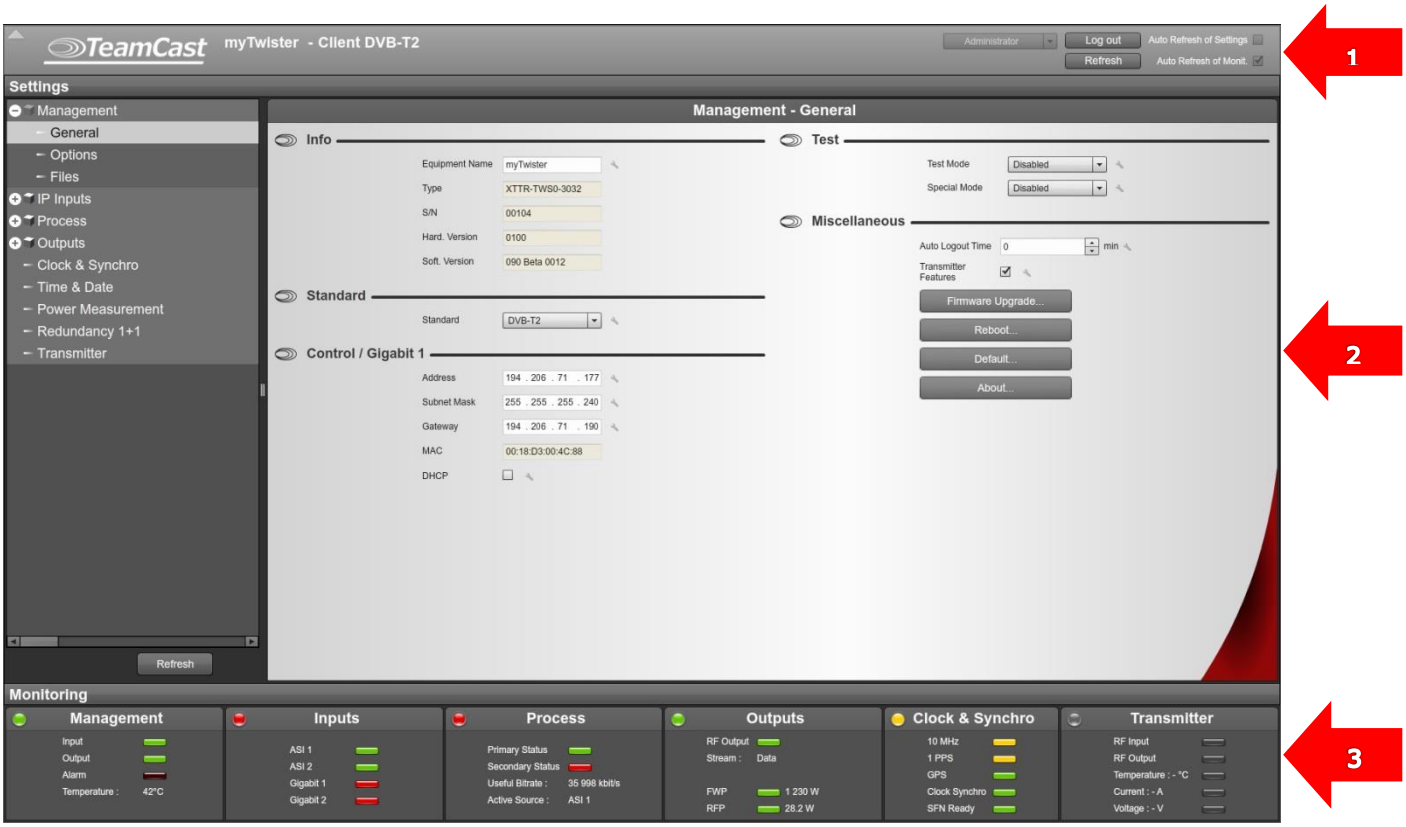
- User (Guest): No change/settings are allowed. Only monitoring is possible
- Maintenance: Minor change are allowed like test mode, input management, precorrections, mute/unmute, clock and synchronization
- Administrator: Complete access to the equipment

To login, the user will choose its level, type the password and click on "Login" button. There is no password for "Guest" account. Both "Administrator" and "Maintenance" accounts have the same password: ***admin***



Depending on the granted access level, each parameter that can be modified by the user will be followed by a small "tool" icon

5.2.3 General Overview



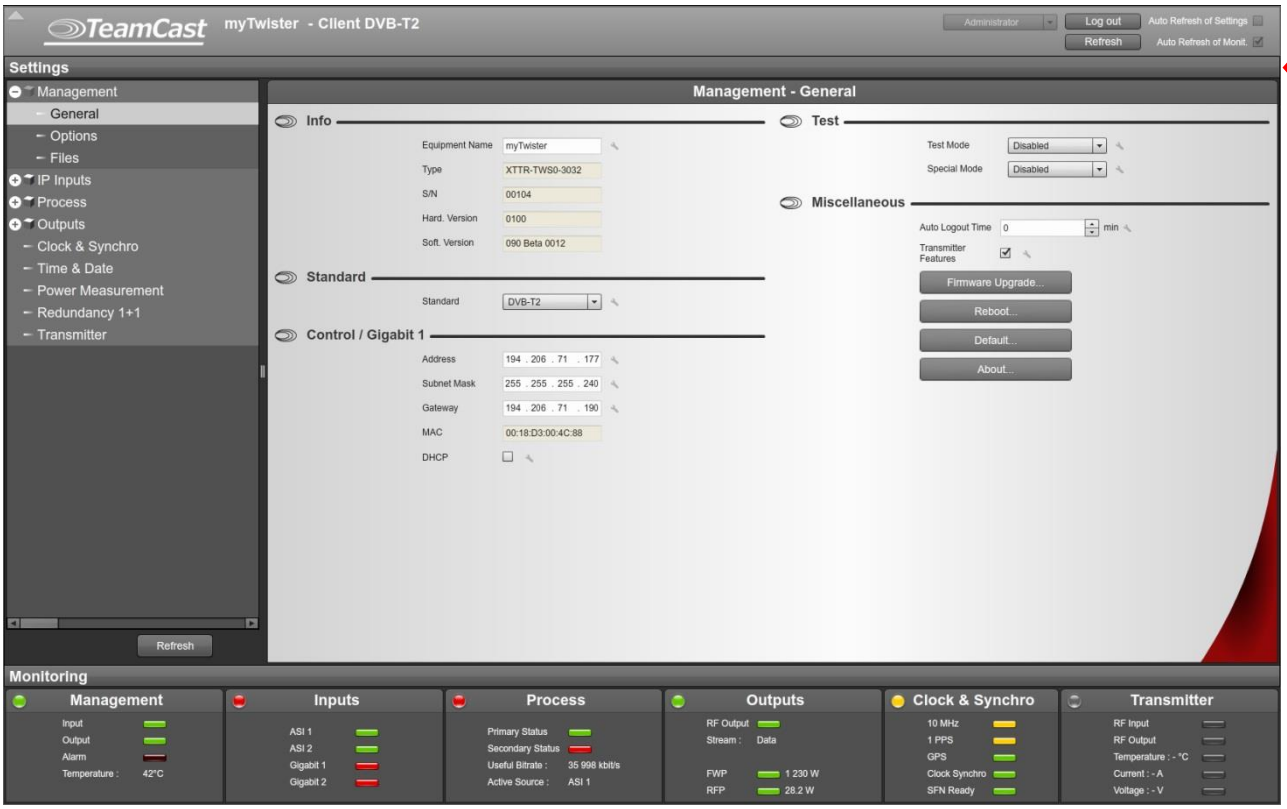
Area 1 is the header of the main window. It presents the login/logout functions as well as the equipment identification

Area 2 is the main window. It presents either the parameters settings or the detailled monitoring.

Area 3 is the "Status Overview" area. It presents an overview of the main status.

5.2.4 « Settings » Tab

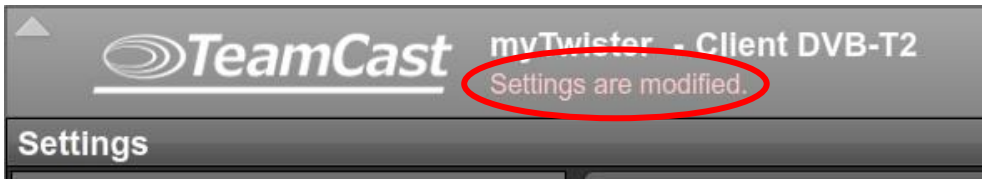
The « Settings » tab can be accessed clicking on « Settings » header.



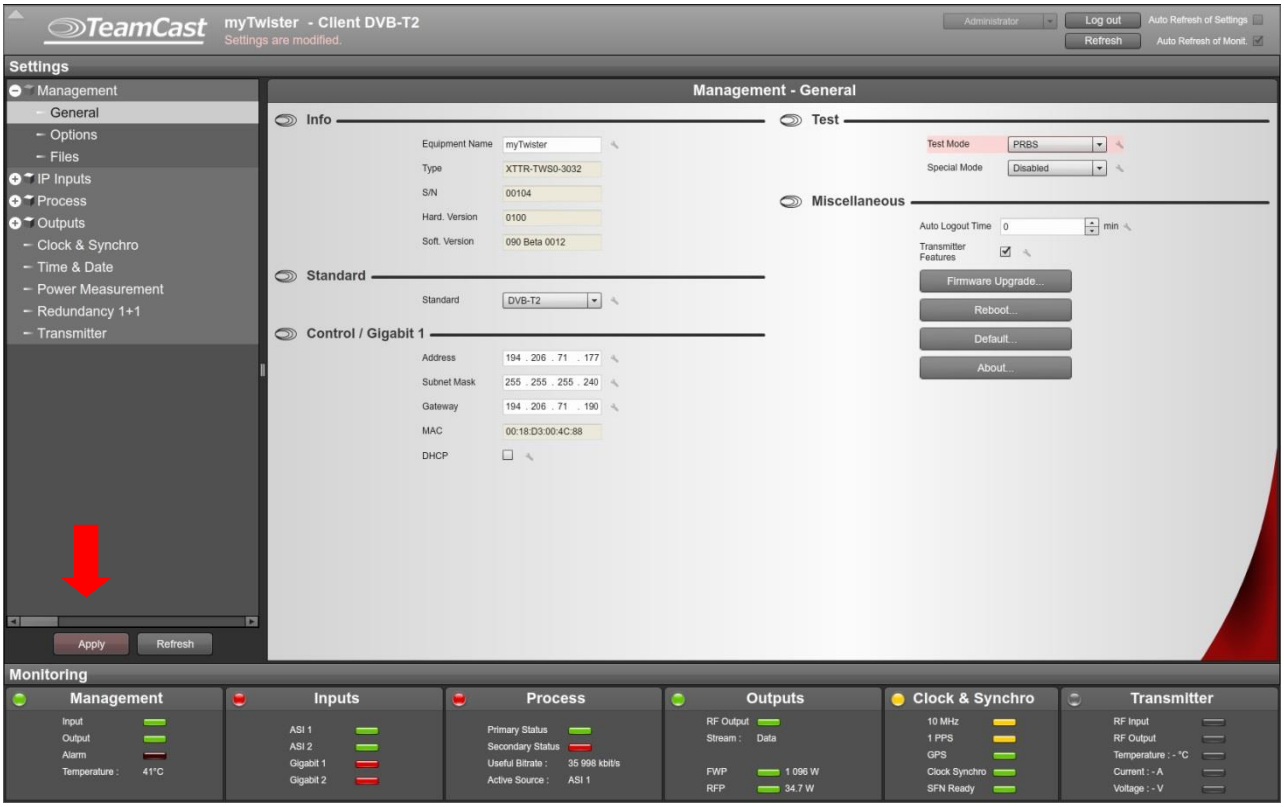
Left part of the screen describes the settings menu.
Right part presents each screen related to one menu item.

When any parameter is changed, it is highlighted.

A message in the main window header allows to verify if the settings have been modified and not applied.



And the « Apply »button appears to confirm the application.



If any change must be discarded, the « Refresh » button can be used to display in the settings screens the current configuration.

5.2.5 « Monitoring » Tab

The « Monitoring » tab can be accessed clicking on « Monitoring » header.

It is divided into 2 independent screens to allow the user to monitor 2 different blocks.

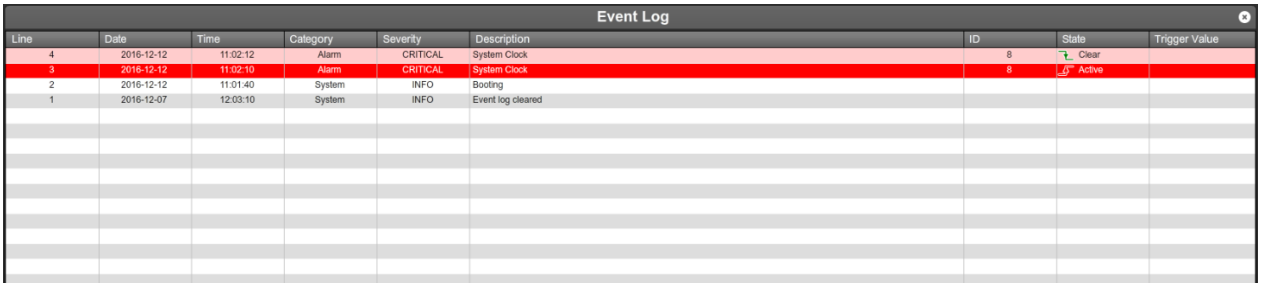
To select a block to monitor, a Drag'n Drop feature can be used from the "Status Overview" area to one of both areas.

5.2.1 Log file

TWISTER II features an onboard Log file to consult the different information, warning or error that occurred on the product.

To access to the Log File window, please press the envelop.

Then the log file window is displayed.



For more information concerning this topic, please refer to the dedicated Application Note.

5.3 Front Panel Menu Description

Main settings can be accessed from the TWISTER II front panel display (FPD)

Menu navigation is done using the keypad at right side of the LCD screen.

6 Maintenance & Checking

6.1 Versions management

A product is totally defined by its commercial reference and its version numbers.
Product 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: **H100-S110**

This means that the hardware of the product is in version 1.00 and the software is in version 1.10.
These numbers can be read from the Web GUI.

6.2 Software updates

Software updates can be made by the user himself.
New software can be downloaded from the TeamCast web site (www.teamcast.com\customer area) as soon as it is available.
If you are not already registered, please contact our Sales Department to get your login and password by sending an email to info@teamcast.com or by calling +33 (0)2 23 25 26 80.

For each software version available, a unique file ("customer pack") has to be downloaded from the web site. It is labelled as **TW20-H100-S100.zip** where:

- TW20 is the commercial reference of the product to which it applies to,
- H100 gives the minimum hardware version required by this new software version,
- S100 is the new software version.

This customer pack contains:

- The firmware for ftp download (IP connection), named as xTTR-TW20-4000-S0100-B0301.tfw
- The Upgrade Procedure (.pdf file) explaining how to make the update,
- The Release Note,
- The User Manual,
- Any additional software if needed

The software upgrade is done using the Web GUI of the product:

- Copy the *.tfw file on your local hard disk.
- Access to the web GUI and go to "Management / General" tab.
- Click on the "Firmware Upgrade" button
- Select the new release file on your local hard disk.

The product will then automatically reboot to take into account the new release.

6.3 Licence key management

New licences may be bought separately and added to the module. For this purpose:

- Access to the web GUI and go to "Management / Options" tab.
- Select the desired option to unlock by clicking on the associated "Unlock" button
- Enter the key code that has been provided by TeamCast following the licence order

The product will then automatically reboot and the new licence is taken into account.

6.4 Dysfunction of the module

6.4.1.1 LED Checking

If the module does not work properly, a few checks could be done before calling the technical support team at TeamCast.
A set of 4 LEDs indicates the modulator status following the *TeamCast* standard: a Power, an Input, an Output and an Alarm LED indicator.

Name	Description
Power	Green off: power off Green fix: power on
Input	Green off: Primary input is not detected (in manual mode) or primary and secondary input is not detected (in auto mode) Green flashing: Primary input is KO(1) but secondary input is OK (in auto mode) Green fixed: Primary input is ok(1)(4)
Output	Green off: no RF output (module failure) Green fixed: the RF output is available (normal mode) Green flashing: Test signal(2) is generated or RF Maintain mode Yellow fixed: Warning RFP ou FWP Red Fixed : Error RFP or FWP or muted output Red flashing : RFP Critical Error
Alarm	Off: No critical error detected Red fixed : Module failure Red flashing : Primary input failure(3) or primary clock reference(5) loss (10 MHz or PPS in case of ext 10MHz + ext 1PPS primary selection)

Table 12: LED status

(1) If primary input is detected but any condition for "Mute on TS error" is met, the input LED is flashing.
(2) PRBS, Sine, or any special test.
(3) Except in case of PRBS or Sine test mode.
(4) In automatic mode, if primary input is detected, the input LED is fixed whatever the secondary input status.
(5) Alarm due to primary clock reference loss is defined in the following table:

6.4.1.2 **Contact the technical support**

Before contacting TeamCast Technical Support Team, please ensure you can provide them with following information:

- Type, hardware and software version and Serial number of the equipment,
- Delivery date of the equipment,
- Symptoms of the breakdown or description of the problem.

TEAMCAST CUSTOMER SUPPORT	
Tel. + 33 (0)2 23 25 26 80	Email : ***support@teamcast.com***

The technical support of TeamCast is present to answer to your questions and to try to understand the problem which you encounter with your module. It will help you to point out the problem or give you recommendations to return the module to the factory.

6.4.1.3 **Return the module to factory**

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

Refer to *Appendix B - Return to Factory Procedure*.

Appendix A

EC Certificate

TWISTER II High-End Rack Modulator / Exciter

TeamCast

DECLARATION OF CONFORMITY

According to EN 17050-1

DCE-1710261-A

CE

FOR-0702031-F

PRODUCT CONCERNED: XTTR-TW20-xxxx

TEAMCAST declares that the "XTTR-TW20-xxxx" product is manufactured and CE marketed since year 2017 in accordance with the essential requirements and the relevant provisions of the following Directives:

- **2006/95/EC (73/23/EC) Low voltage Directive**
- **2004/108/EC (89/336/EEC) EMC Directive**
- **2011/65/UE (RoHS) Restriction of Hazardous Substances Directive**
- **2012/19/EC (2002/62/EC) Waste Electrical and Electronic Equipment (WEEE)**

And also according to the applicable standards indicated below:

Standards	*Titles*
EN 60950-1	*Information technology equipment – Safety – General requirements*
EN 61000-3-2 and 3-3	*Electromagnetic compatibility (EMC)*
EN 55022- class A	*Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement*
EN 55024	*Information technology equipment - Immunity characteristics - Limits and methods of measurement*
FCC part 15 – class A	*Code of Federal Regulations that covers EMC*

October 26th 2017,

Eric DENIAU, General Manager

TeamCast
Centre Espace Performance
F-35769 Saint-Grégoire Cedex – France
Tél. : +33 (0)2 23 25 26 80
web : www.teamcast.com

Appendix B

Return to Factory Procedure

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

CDC-0610271-E

TeamCast

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	
Tel: +1 312 263 0033 Fax: +1 312 263 1133	Email : ***supportUS@teamcast.com***

2. **Product under warranty**

   a) The TEAMCAST Customer Support representative provides you the return form (*After Sales Follow Up*). This document specifies **a RMA (Return Material Authorization) number** allocated only for this return follow-up.

   b) **Pack the product to be returned for repair in its original packing,** including the return form with parts 5 and 6 duly filled.

   c) The **RMA number should be clearly indicated** on all returned products, boxes, packages and accompanying paperwork.

   d) Send the boxes/packages back to TEAMCAST.

   e) After repair, TEAMCAST will send you with the product a maintenance report describing what was done.

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: ***Product out of warranty***

Every repairing for out of warranty products requires a specific commercial deal. TEAMCAST Sales Department will send you a specific quote for this repairing. As soon as this proposal is accepted, the "under warranty" repairing procedure can be activated.

Note 3: RMA numbers are only valid for thirty (30) days. Older RMA numbers need to be revalidated by a new RMA request procedure.

Note 4: Return cost to TEAMCAST will be paid by the customer. TEAMCAST will take care of the cost from factory to the customer site after repair.

Appendix C

GPS Installation Recommendations

While doing GPS installation and setup for product with embedded GPS receiver, it is highly recommended to respect the following conditions:

Considering:

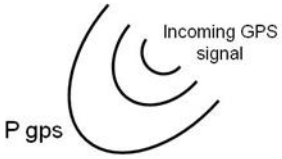
Pgps as the power of the incoming signal (nominal value over the covered area),
Ga as the gain of the dedicated GPS antenna,
Gc as the losses of the several RF components (cable, connectors,…),
Gt as the total Gain of the RF chain.

Gt = **Ga** + **Gc** ;

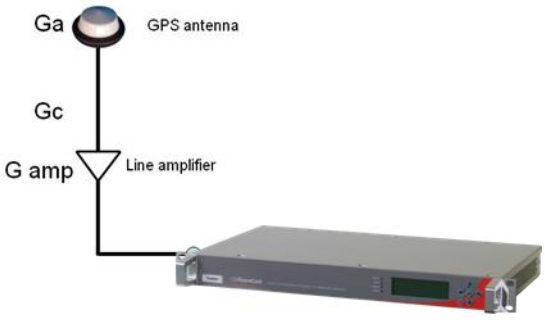
The user shall respect the following condition:

20 dB ≤ Gt ≤ 35 dB

In order to fulfil this condition, and if **Gt** is not sufficient, the user can also add a line Amplifier, as shown in the drawing below:



with **Gt** = **Ga** + **Gc** + **Gamp**

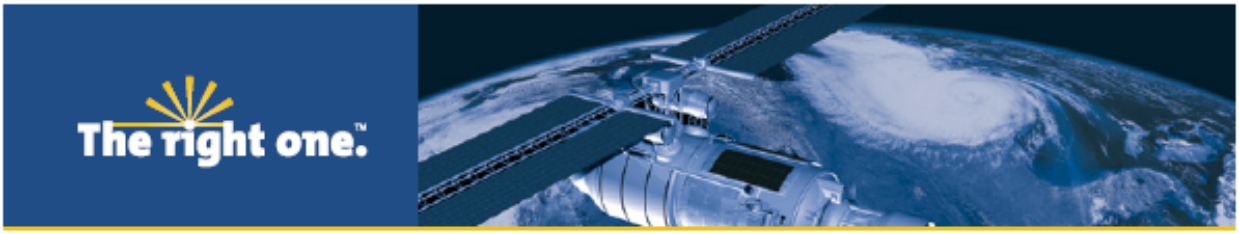


Warning: For the GPS reception to be optimal, it is highly recommended to place the Antenna in a free space (top of the building,…).

Appendix D

Example of GPS Antenna

TWISTER II High-End Rack Modulator / Exciter



BULLET III GPS ANTENNA

KEY FEATURES

- Waterproof and corrosion-resistant housing filtering for harsh RF jamming environments
- Proven extra rugged, reliable
- Available in 3.3v (TNC) or 5v (TNC or F)
- RoHs compliant (Pb free)

JAM-RESISTANT ACTIVE GPS ANTENNA NOW AVAILABLE FOR USE WITH 3.3 V DC AND 5 V DC APPLICATIONS

Whatever the environment—the Trimble® Bullet™ III GPS antenna will perform, year after year. The Bullet III antenna provides a perfect solution for manufacturers who need a fixed-site, rooftop GPS antenna. This antenna is also a high-quality solution for adding GPS RF signals for marine GPS navigation systems.

Put it anywhere

The antenna is housed in weatherproof packaging designed to withstand exposure to shock, excessive vibration, extreme temperatures, rain, snow and sunlight.

The dome is all plastic, and the threaded socket in the base of the antenna is corrosion resistant. The threaded socket accepts either a 1"-14" straight thread (typical marine antenna mount) or a 3/4" pipe thread.

The F-type or TNC antenna connector is located inside the threaded socket, which allows the antenna cable to be routed inside a mounting pole and protects the cable connection for added reliability.

Strong performance

The Bullet III antenna is an active GPS antenna with 35 dB preamp (5 V DC), 30 dB preamp (3.3 V DC). The high-gain preamp allows the Bullet III antenna to be used with up to 75 feet of RG-59 cable. The Bullet III filtering improves immunity to other RF signals for reliable performance in hostile RF jamming environments.

Proven reliability

For over 15 years, Trimble has sold GPS antennas renowned for their survivability in tough environments. The Bullet III antenna is the fourth generation of the proven Bullet antenna family and offers all the reliability and performance benefits that are required for GPS installations.

In unforgiving environments, an antenna failure could be disastrous. Don't risk it. Select a proven GPS antenna—the Trimble Bullet III GPS antenna.

Trimble

TWISTER II High-End Rack Modulator / Exciter

BULLET III GPS ANTENNA

ENVIRONMENTAL SPECIFICATIONS

Operating Temp ..... –40 °C to +85 °C
Storage Temp ..... –40 °C to +100 °C
Vibration ..... 10–200 Hz Log sweep
3 g (Sweep time 30 minutes) 3 axes
Shock ..... 50 g vertical, 30 g all axes
Humidity Mil-STD-810E
Corrosion ..... 5% Salt spray
Waterproof ..... Immersion to 1 meter

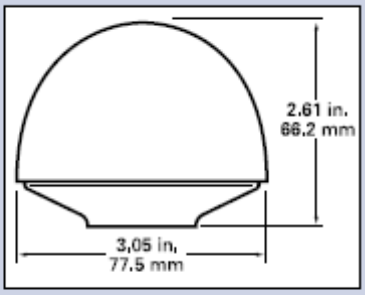
PHYSICAL CHARACTERISTICS - 3.3 V DC AND 5 V DC ANTENNAS

Dimensions ..... 3.05" D x 2.61" H (77.5 mm x 66.2 mm)
Weight ..... 6.0 oz (170 grams)
Enclosure ..... Off-white plastic
Connector ..... F-type & TNC (5 V DC) - TNC (3.3 V DC only)
Mounting ..... 1"-14" thread or 3/4" pipe thread

TECHNICAL/PERFORMANCE SPECIFICATIONS

	3.3v	5v
Prime Power	3.3 V DC (±10%)	+5 V DC (±10%)
Power consumption:	<20 mA	30 mA maximum
Gain	30 dB @ 25 °C	35 dB ± 3 dB
Output impedance	50Ω	50Ω
Frequency	1575.42 MHz ± 1.023 MHz	1575.42 MHz ± 1.023 MHz
Polarization	Right-hand circular polarization (RHCP)	Right-hand circular polarization (RHCP)
VSWR	2.0 maximum	2.0 maximum
Axial ratio	90°: 4.0 dB maximum; 10°: 6 dB maximum	90°: 4.0 dB maximum; 10°: 6 dB maximum
Noise	3.3 dB maximum (25 °C ±5 °C)	3.3 dB maximum (25 °C ±5 °C)
Pass-band width	50 MHz	50 MHz
Out of Band rejection	fc=1575.42 MHz fo ±20 MHz: 7 dB min fo ±30 MHz: 12 dB min fo ±50 MHz: 20 dB min fo ±100 MHz: 30 dB min	fc=1575.42 MHz fo ±20 MHz: 7 dB min fo ±30 MHz: 12 dB min fo ±50 MHz: 20 dB min fo ±100 MHz: 30 dB min
Azimuth coverage	360° (omni-directional)	360° (omni-directional)
Elevation coverage	0° to 90° elevation (hemispherical)	0° to 90° elevation (hemispherical)

MECHANICAL



CONNECTORS

TNC (3.3v only)

F-type (3.3 or 5v)

ORDERING INFORMATION AND ACCESSORIES

Please go to www.trimble.com/timing for the latest documentation & tools, part numbers and ordering information

Trimble has relied on representations made by its suppliers in certifying this product as RoHS compliant.

Specifications subject to change without notice.

Trimble Navigation Limited is not responsible for the operation or failure of operation of GPS satellites or the availability of GPS satellite signals.

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