ProTelevision Technologies A/S
Valhoejs Alle 176
DK-2610 Roedovre
Denmark

PT 3756 Adaptive Precorrector for PT3000 product family

- OptiPower™ edition

Webservice Instruction Manual

Trade Mark of the DVB Digital Video Broadcasting Project

PT3756 Adaptive Precorrector OptiPower™ Total number of pages: 38
Webservice Instruction Manual

Printed in Denmark 20.10.2015
Revision: 1.0
Publication number: 9499 493 17111

Contents

This page is intentionally left blank.

1 Introduction

1.1 General

This document describes the web browser based operation of the ***PT3756 Adaptive precorrector option*** for the PT3000 product family. For an introduction to IP address configuration, log-in procedure and general operation principle for the Webservice[1] control interface for the PT3000 product family, please refer to the separate publication *PT 3000 - Product Family - Product Manual* available from ProTelevision Technologies.

The Webservice control interface allows subject to the log-in status for the user (observer, operator or administrator) monitoring of status as well as configuration of the operational parameters of the PT3756 adaptive precorrector device The user interface (web browser display) applies a user friendly concept where the general navigation between individual sub menus is based on a block oriented representation of the controlled device. The specific control for a certain function is therefore easily accessed by 'dragging' the functional block of interest into the configuration section of the display.

The Webservice interface is equally useful for controlling the PT3000 Product Family product in a configuration with a direct connection (Ethernet patch cable) between the PT3000 Product Family product and the PC as well as in the typical operational environment where multiple products are accessible from the PC over Ethernet..

1.2 Document structure and scope

This instruction manual is divided into three main sections

- Electrical interface for the adaptive precorrector PT3756
- Operation principle for adaptive precorrector PT3756

.

[1] Web browser based control over Ethernet

This page is intentionally left blank.

2 Electrical Interface

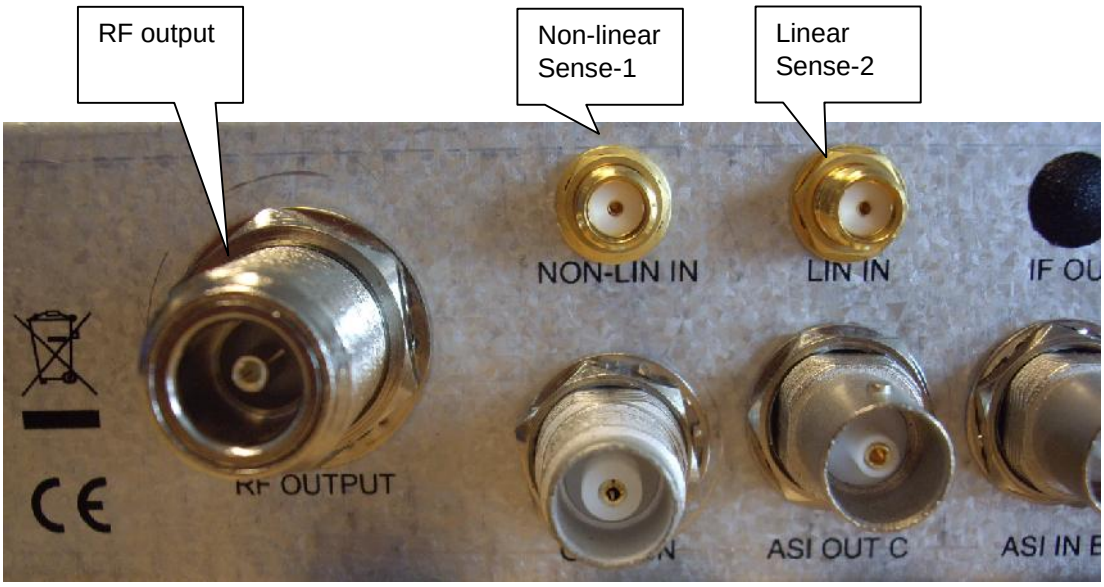
2.1 General information

The adaptive pre-corrector's electrical interface consists of two **SMA** type coaxial connectors:

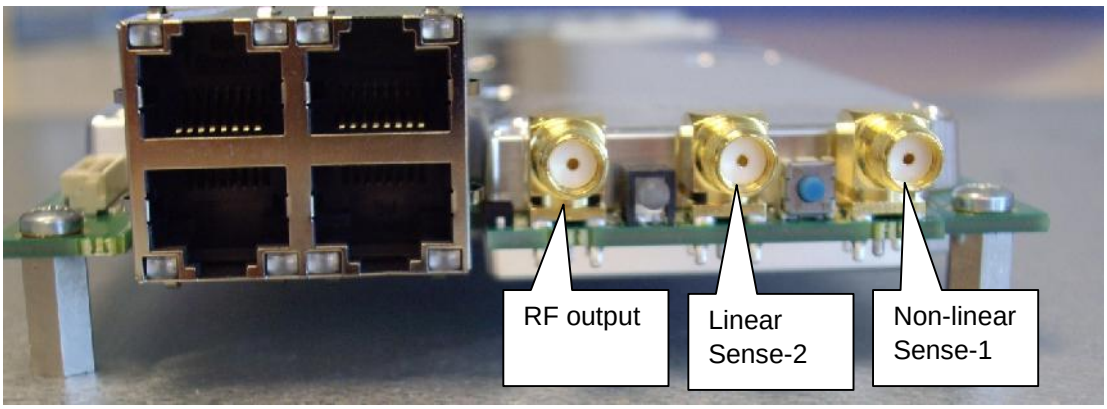
- Sense input 1: Non-linear sense port
- Sense input 2: Linear sense port

The required signal level for both inputs is **0dBm +/-10dB**. The impedance is **50 ohm**.

2.1.1 Location of sense inputs (stand alone 1RU/19" rack mount chassis):

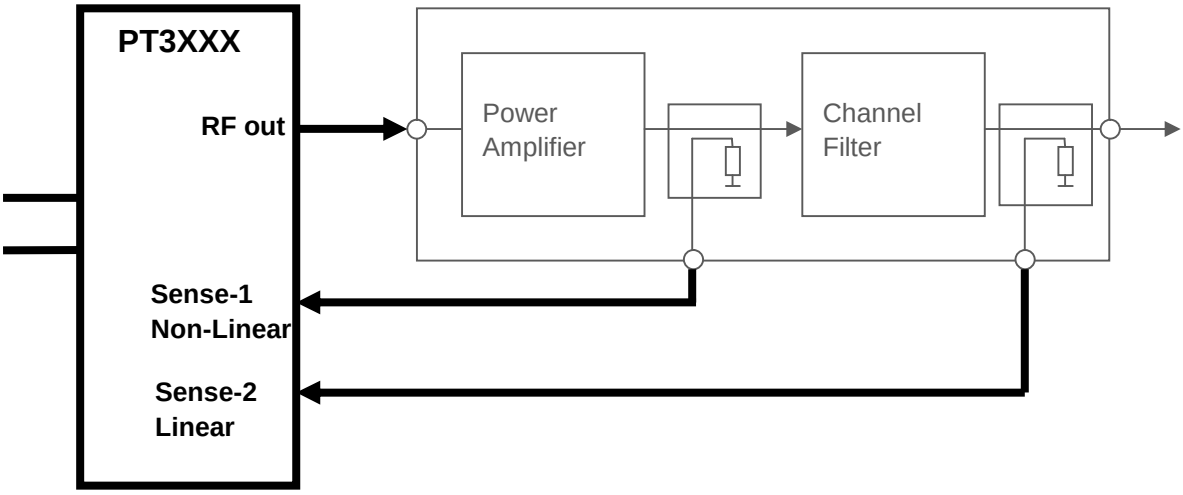


2.1.2 Location of sense inputs (OEM board version):



2.2 Interface to the transmitter

The Non-Linear sense input must be connected to a suitable coupler/tap-off at a point right after the power amplifier before any band limiting filter. The Linear sense input must be connected to a suitable coupler/tap-off point after the channel filter. Notice further that the bandwidth between the RF output of PT3XXX and the input of the power amplifier must be at least 20MHz wide to ensure effective non-linear precorrection of the amplifiers non-linearity.

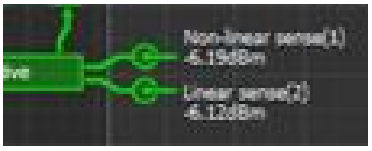


3 Operation of adaptive precorrector PT3756

3.1 Connection and verification of signal levels

The RF output and the sense inputs of the PT3000 product with option PT3756 must be connected as described in chapter 2. The graphical illustration of the two sense inputs in the web service block schematic will appear in green color, if the applied level is within the valid range[2] for the respective input. If the level is marginal relative to the required max/min limits the input will be shown in yellow color. If the level is outside the valid range the input is shown in red color. For optimal result the corrector should only be operated with input levels in the 'green' state. Performance with 'yellow' input state is not guaranteed. The adaptive precorrector is not usable when the level is in the 'red' state. A sense input can be deactivated (disabled) by the user; in this state the input is shown in gray irrespective of the level/status of the applied sense signal (if any).

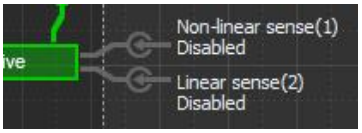
Valid sense input for linear and non-linear precorrector:



Marginal sense input for linear and non-linear precorrector (yellow warning):

Invalid sense input for linear precorrector. Valid sense input for Non-Linear corrector:

Linear and Non-Linear sense inputs are disabled:



[2] Nominal sense input level is 0dBm. Operation supported between -10dBm and 10dBm. Marginal level warning (yellow) shown in the range from +/-9dBm to +/-10dBm. Levels beyond +/-10dBm are invalid (red indication).

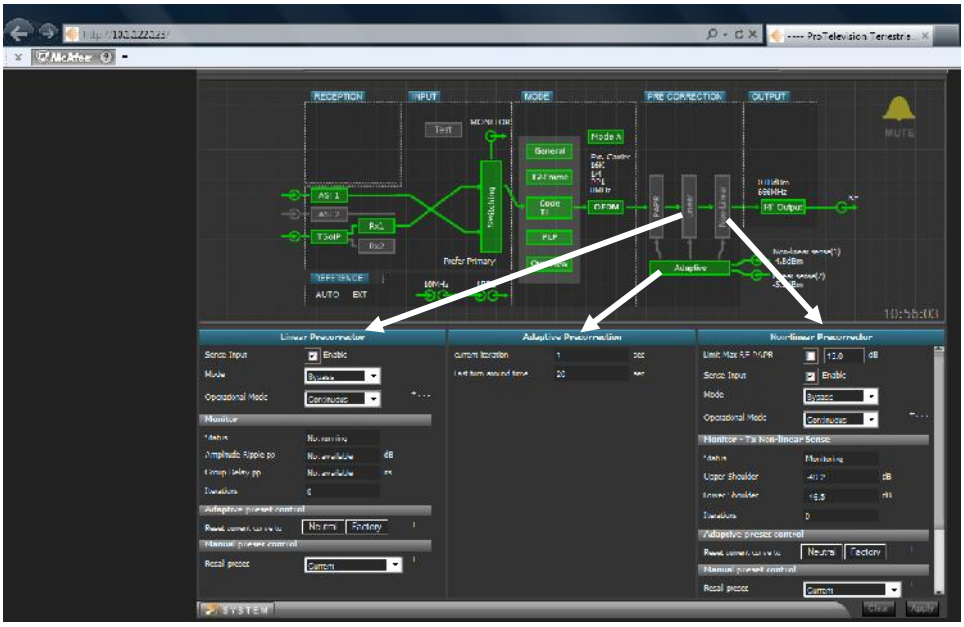
3.2 Preparation of web service interface

To prepare for configuration of the non-linear and linear adaptive precorrector from the Web GUI, proceed as follows:

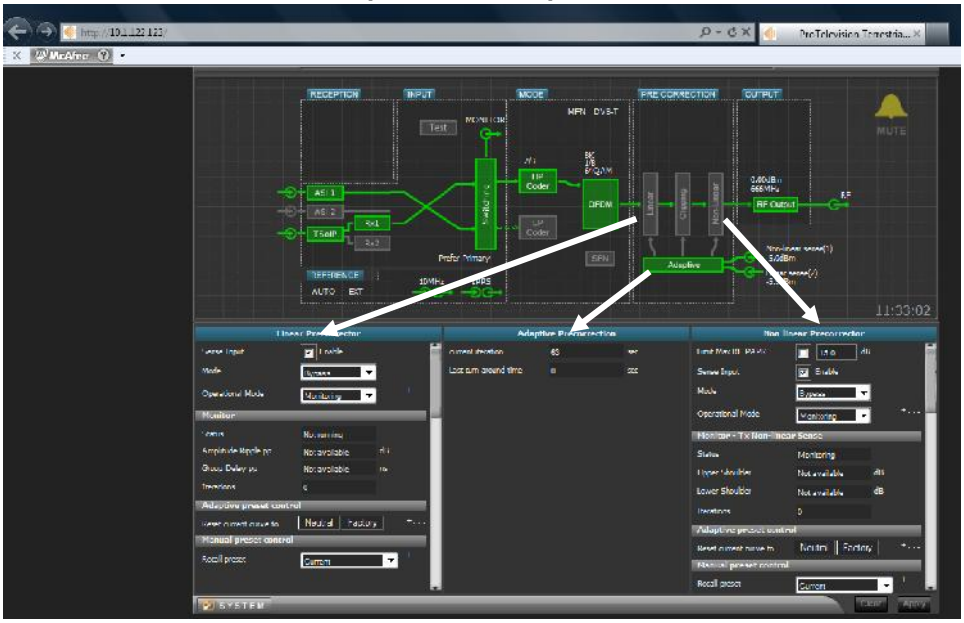
a) Drag the linear precorrector block to the configuration panel
b) Drag the non linear precorrector block to the configuration panel
c) Drag the adaptive precorrector block to the configuration panel (this panel provides status info only and it is therefore as such not strictly required for configuration of the adaptive system)

Note: the position of the 'Linear' block in the Web GUI schematic differs between the DVB-T2 mode and the other modulation standards:

DVB-T2 modulator:

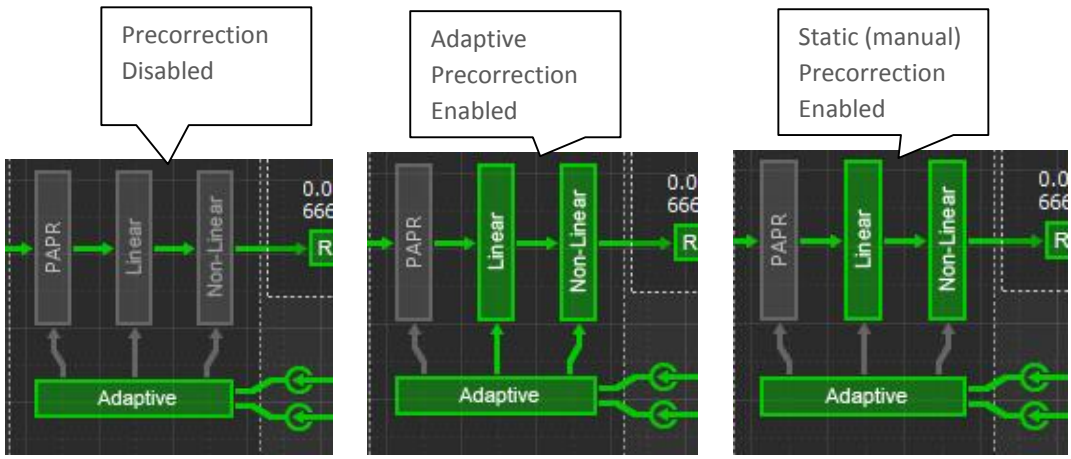


Other modulation standards (ISDB-T, ATSC):

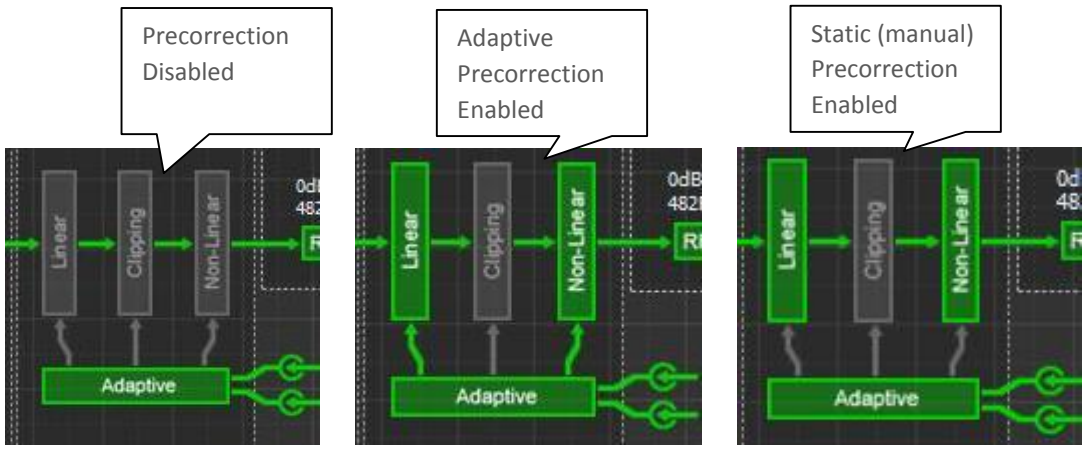


Depending on the current operational mode for the precorrector system, the linear and non-linear blocks may appear in grey or in green. When the precorrector function is disabled the respective block (linear and/or non-linear) is shown in grey. When the precorrector function is enabled the respective block (linear and/or non-linear) is shown in green color. When the active precorrector mode is ‘adaptive’ a green arrow will connect the Adaptive function block and the respective precorrector block. When the adaptive precorrector mode is ‘static’ (manual correction mode) the connection between the adaptive function block and the respective precorrector block is grayed out.

DVB-T2 modulator:

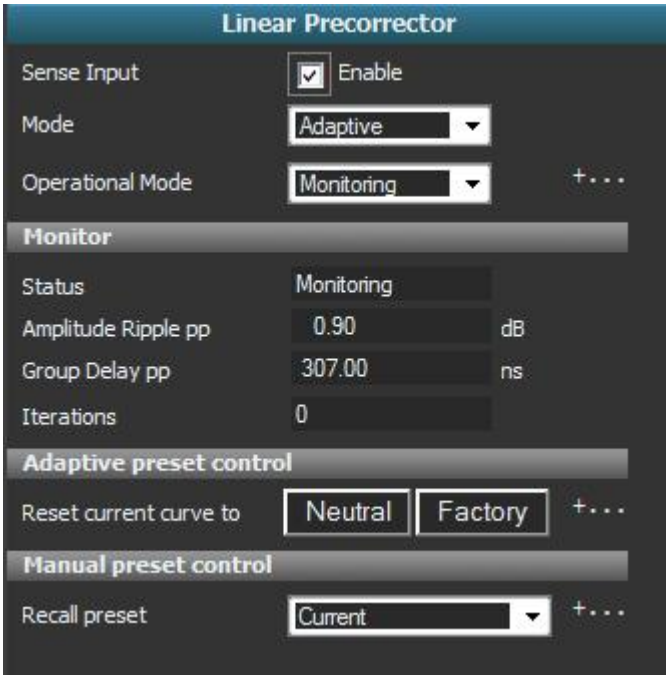


Other modulation standards (ISDB-T, ATSC):



3.3 Linear precorrector configuration

Status and control panel as seen by Web GUI login as ‘factory’ user



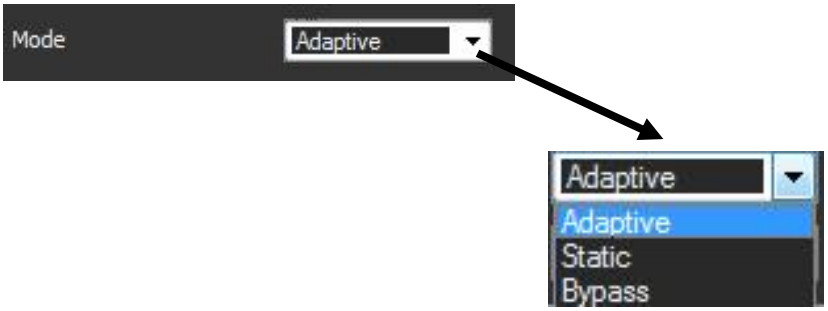
3.3.1 Sense Input Enable/Disable

A check box for enabling/disabling the linear sense input:

The sense input is as default enabled. The user may ‘disable’ the Linear corrector’s sense input if so desired. In the ‘disabled’ state the linear corrector will not consume processing resources. Therefore, a shorter iteration time for the non-linear corrector may be observed if the linear sense input is ‘disabled’ explicitly in a scenario where the linear corrector is not required to make new iterations in the adaptive mode.

3.3.2 Activation of linear adaptive precorrector

The linear precorrector system can operate in three different modes. The required mode is selected from the ***Mode*** 'drop-down' list



The available modes are:

- **Bypass:** No precorrection is applied to the RF output.
- **Static:** The manually defined linear precorrector characteristic is applied to the RF output. The manual precorrector characteristics must be generated and uploaded by means of the PC software package IMD Buster McTwo. *Note: The format used by the manual/static precorrector system is incompatible with the format and curves used and generated by the adaptive system. Data is therefore not interchangeable between the two systems.*
- **Adaptive:** The adaptive linear precorrector is activated. The current adaptive linear characteristic is applied to the RF output and maintained according to the adaptive precorrector operational mode selected (see 3.3.3 below for details).

3.3.3 Adaptive Linear precorrector operational mode

The adaptive Linear corrector can operate in five different modes The mode is selected from the ***Operational Mode*** 'drop-down' list

The available modes are:

- **Single:** A single iteration is completed after selection of 'Single' mode and the linear adaptive precorrector characteristic is updated accordingly. At the end of the single iteration the operational mode is automatically switched back to 'Monitoring' state.
- **Continuous:** Iterations are run continually after selection of 'Continuous' mode. The precorrector characteristic is updated after a completed iteration.
- **Run to target:** After selection of 'Run to target' mode the precorrector algorithm will run until the set threshold value(s) is/are obtained for amplitude ripple and/or group delay ripple. When/If the target is reached, the adaptive algorithm is stopped (automatically set to 'Monitoring' state).
- **Auto run:** After selection of 'Auto run' mode the precorrector algorithm will run until the set threshold value(s) is/are obtained for amplitude ripple and/or group delay ripple. When/If the target is reached the adaptive algorithm is stopped (automatically set to 'Monitoring' state).The adaptive precorrector algorithm will be automatically restarted in 'Auto run' mode in case the performance drops below the set threshold value(s) for amplitude ripple and/or group delay ripple subsequently.
- **Monitoring:** The current adaptive precorrector characteristic is applied to the RF output. The precorrector algorithm is stopped. Changes in transmitter characteristic will not be tracked by the precorrector.

3.3.4 Adaptive Linear precorrector threshold settings

The controls for setting the threshold values for the linear adaptive precorrector operational modes '*Run to target*' and '*Auto run'* are accessed by clicking the menu expansion (+…) control.

Amplitude Ripple pp <
Level : control for setting the target threshold for the in-band amplitude ripple
Hysteresis: Control for setting the hysteresis for the automatic restart of the adaptive correction algorithm by 'Auto run' mode. In the example with a set level target of 0.5dB and a hysteresis of 0.2dB, the threshold for automatic restart is 0.7dB amplitude ripple.
Enable: check box for enabling/disabling the use of the in-band amplitude ripple as a target for the run to target and auto run modes.

Group Delay pp <
Level : control for setting the target threshold for the in-band group delay ripple
Hysteresis: Control for setting the hysteresis for the automatic restart of the adaptive correction algorithm by 'Auto run' mode. In the example with a set target of 25ns group delay ripple and a hysteresis of 10ns, the threshold for automatic restart is 35 ns group delay ripple.
Enable: check box for enabling/disabling the use of the in-band group delay ripple as a target for the run to target and auto run modes.

3.3.5 Linear precorrector monitor panel

The linear precorrector monitor panel provides information about the instantaneous operational status and performance values (when available). The display is updated once per iteration.

- **Status:** The status field shows the operational status for the linear precorrector system. The possible states are:
  - *Not running*: Linear precorrector operation is suspended. Linear precorrector sense input is 'disabled'
  - *Monitoring*: Linear static mode is selected or linear adaptive mode in operational mode 'monitoring' is selected. Amplitude ripple and group delay for linear sense input is displayed.
  - *Initializing <nn%>:* Indicates the progress of the initial data collection by adaptive linear in operational modes single, continuous, run to target and auto run. The initial data collection required by the adaptive linear corrector runs over five iterations counted from the selection of applicable operational mode and availability of valid linear sense input. *Note: For Bypass mode and Adaptive/Monitoring mode the display will proceed directly from 'Initializing' to 'Monitoring' state after a single data collecting iteration state without the indication of status in '%'*.
  - *Auto applying*: Indicates that adaptive linear system has passed the initialization stage. The linear adaptive precorrector characteristic is updated automatically every time an iteration is completed.
- Amplitude ripple pp: The measured amplitude ripple for the signal applied to the linear sense port. Displays the result of the last completed iteration by adaptive mode. Displays the instantaneous performance by 'Static' and 'Monitoring' mode (updated once per iteration/data sample.) Displays 'Not available' when precorrector status is 'not running' and while the precorrector is making initial data collection.
- Group delay pp: The measured group delay ripple for the signal applied to the linear sense port. Displays the result of the last completed iteration by adaptive mode. Displays the instantaneous performance by 'Static' and 'Monitoring' mode (updated once per iteration/data sample.) Displays 'Not available' when precorrector status is 'not running' and while the precorrector is making initial data collection.
- Iterations: Displays the number of adaptive linear precorrector iterations completed since reset of corrector characteristic or reboot of the unit.

3.3.6 Adaptive Linear precorrector reset functions

Subject to the logon status the adaptive linear precorrector control panel includes one or two controls for resetting the corrector characteristic.

:

- **Neutral:** The linear adaptive precorrector is instantly set to neutral characteristic when this control is operated. It is recommended to start the adaptive alignment from this neutral state. *Note: The 'Neutral' reset control is accessible only by logon as 'factory' user. Reset to 'Neutral' is normally not considered useful after a transmitter is installed and put in operation.*
- **Factory:** The 'Factory' curve reset is intended for instant return to the adaptive characteristic that matched the pre-corrected transmitter at time of delivery (modulator + amplifier + antenna filter). The factory characteristic must be saved explicitly by the transmitter manufacturer (see 3.3.7). The 'factory' curve reset is identical to the 'Neutral' reset if no factory curve has been saved.

Note: In addition to the 'Factory' reset described above up to ten additional precorrector characteristics can be memorized and recalled as part of the general modulator configuration preset. That is, the saved modulator configuration preset includes the adaptive precorrector characteristic that was in effect at the time when the preset was saved. The possibility to recall multiple modulator configurations including matching precorrector characteristic is of significant value if using the modulator for establishing an N+1 backup system.

3.3.7 Management of the linear ‘Factory’ reset

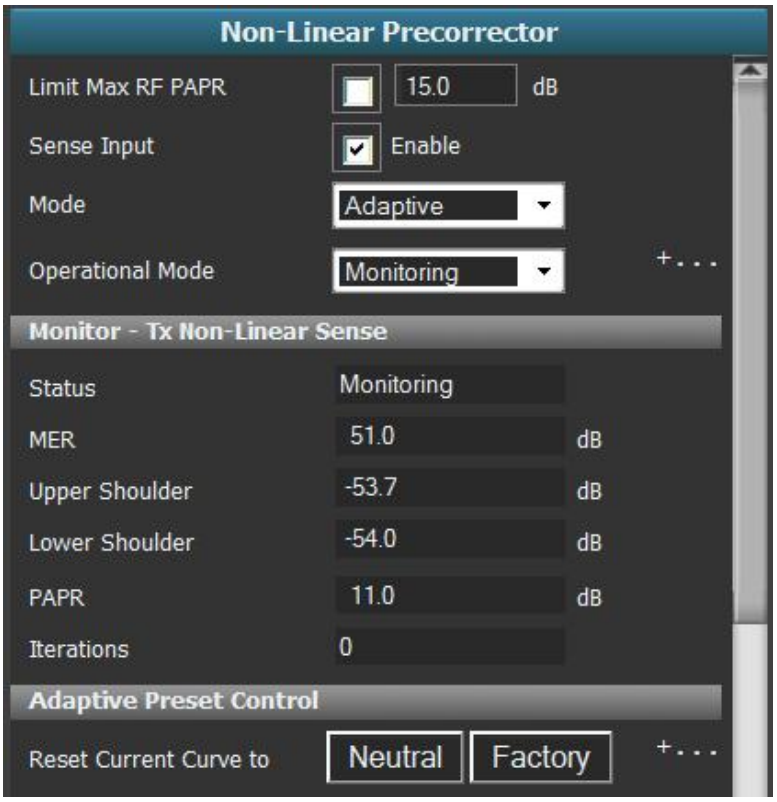
The controls for managing the characteristic for the ‘factory’ reset are accessed by clicking the menu expansion (+…) control (requires logon as ‘factory’ user).

- **Store:** Clicking the soft key ***[Store]*** will transfer the instantaneous characteristic present in the linear adaptive corrector to the ‘factory’ curve memory.
- **Clear Factory:** Clicking the soft key ***[Clear Factory***] will instantly load a neutral characteristic in the linear adaptive ‘factory’ curve memory.
- **Export:** Clicking the soft key ***[Export]*** will open a generic save-file-dialogue for saving the current characteristic of the ‘factory’ reset to an external file.
- **Import:** Clicking the soft key ***[Import]*** will open a generic open-file-dialogue for loading the characteristic of a previously saved ‘factory’ curve file to the internal ‘factory’ curve memory.

Note: The ‘Export’ / ‘Import’ functions may for example be useful for quickly setting multiple separate modulators to an identical initial precorrector characteristic. The characteristic is then distributed from a source modulator to the receiving modulators via an external memory medium.

3.4 Non-Linear precorrector configuration

Status and control panel as seen by Web GUI login as 'factory' user



3.4.1 Limit Max RF PAPR

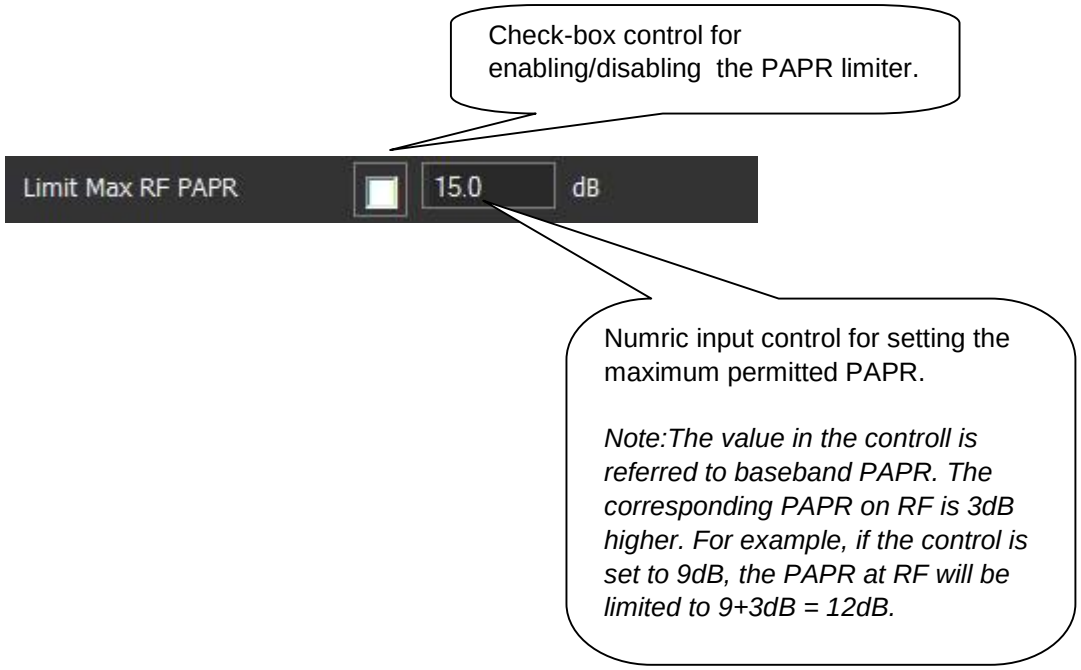
The RF output delivered by the modulator is in the natural state with no precorrection is applied, characterized by a peak-to-everage-power-ratio (PAPR) that is given by the modulation standard. The RF amplifier in the transmitter will typically clip and/or compress the higher power peaks of the signal; the compression is caused by the amplifier non-linearity while the clipping is given by the peak power maximum supported by the RF amplifier's DC supply.

The adaptive non-linear precorrector identifies the amplfifier's compression versus peak power level and compensates by expanding the signal with a magnitude that correspond to the compression. This is a perfectly normal inherent function of a non-linear precorrector system. The expansion of the signal is seen on the modulator RF output as an increase in the PAPR compared to the PAPR of the natural uncorrected RF signal.

The increase of PAPR in the precorrected signal is a perfectly normal characteristic for the precorrector . Notice also that the PAPR on the output of the amplifier will never be higher[3] than the natural PAPR that charactersizes the modulation format. However, the increased PAPR on the amplfier input (modulator output) may for cartain amplfiier designs not be tolerated well. In such cases the maximum permitted PAPR into the amplifier can be managed/limited by using the 'Limit Max RF PAPR' function. Notice though that the limitation should not restrict the PAPR more than absoluteley necessary for protecting the amplifier input. The limitation of PAPR on

[3] Clipping of the highest peaks in the transmitter amplifier means that the PAPR on the output of the amplifier is lower than the inherent PAPR of the signal in the given modulation standard.

the modulator output will reduce the potential performance of the non-linear precorrection meaning that a lower precorrected performance in terms of shoulders/MER will be obtained compared to the scenario where the PAPR limiter is not used.



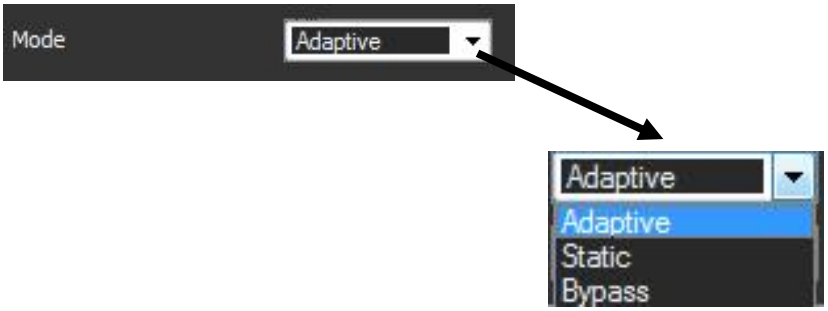
3.4.2 Sense Input Enable/Disable

A check box for enabling/disabling the non- linear sense input:

The sense input is as default enabled. The user may ‘disable’ the non-linear corrector’s sense input if so desired. In the ‘disabled’ state the non-linear corrector will not consume processing resources. Therefore, a shorter iteration time for the linear corrector may be observed if the linear sense input is ‘disabled’ explicitly in a scenario where the non-linear corrector is not required to make new iterations in the adaptive mode.

3.4.3 Activation of non-linear adaptive precorrector

The non-linear precorrector system can operate in three different modes. The required mode is selected from the ***Mode*** 'drop-down' list



The available modes are:

- **Bypass:** No precorrection is applied to the RF output.
- **Static:** The manually defined non- linear precorrector characteristic is applied to the RF output. The manual precorrector characteristics must be generated and uploaded by means of the PC software package IMD Buster McTwo. *Note: The format used by the manual/static precorrector system is incompatible with the format and curves used and generated by the adaptive system. Data is therefore not interchangeable between the two systems.*
- **Adaptive:** The adaptive non-linear precorrector is activated. The current adaptive non-linear characteristic is applied to the RF output and maintained according to the adaptive precorrector operational mode selected (see 3.4.4 below for details).

3.4.4 Adaptive Non-Linear precorrector operational mode

The adaptive Non-Linear corrector can operate in five different modes The mode is selected from the ***Operational Mode*** 'drop-down' list

The available modes are:

- **Single:** A single iteration is completed after selection of 'Single' mode and the non- linear adaptive precorrector characteristic is updated accordingly. At the end of the single iteration the operational mode is automatically switched back to 'Monitoring' state.
- **Continuous:** Iterations are run continually after selection of 'Continuous' mode. The precorrector characteristic is updated after a completed iteration.

- **Run to target:** After selection of 'Run to target' mode the precorrector algorithm will run until the set threshold value(s) is/are obtained for shoulder level and/or MER. When/If the target is reached, the adaptive algorithm is stopped (automatically set to 'Monitoring' state).
- **Auto run:** After selection of 'Auto run' mode the precorrector algorithm will run until the set threshold value(s) is/are obtained for for shoulder level and/or MER. When/If the target is reached the adaptive algorithm is stopped (automatically set to 'Monitoring' state).The adaptive precorrector algorithm will be automatically restarted in 'Auto run' mode in case the performance drops below the set threshold value(s) for shoulder level and/or MER subsequently.
- **Monitoring:** The current adaptive precorrector characteristic is applied to the RF output. The precorrector algorithm is stopped. Changes in transmitter characteristic will not be tracked by the precorrector.

3.4.5 Adaptive Non-Linear precorrector threshold settings

The controls for setting the threshold values for the non- linear adaptive precorrector operational modes '*Run to target*' and '*Auto run'* are accessed by clicking the menu expansion (+…) control.

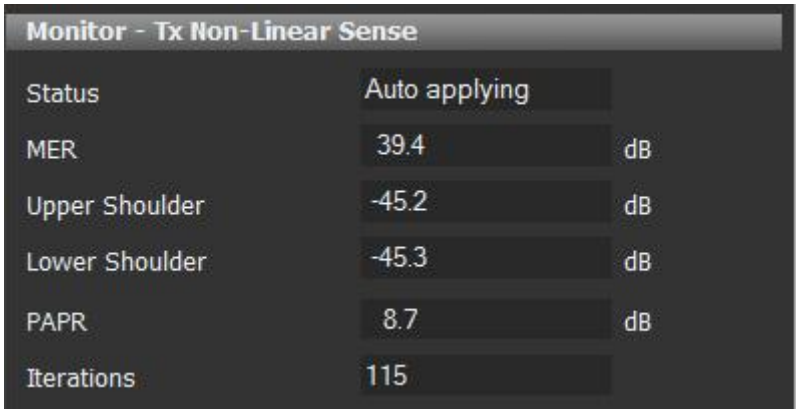
MER >
Level: control for setting the target threshold for MER performance
Hysteresis: Control for setting the hysteresis for the automatic restart of the adaptive correction algorithm by 'Auto run' mode. In the example with a set MER target of 37dB and a hysteresis of 3dB, the threshold for automatic restart is 34dB MER.
Enable: check box for enabling/disabling the use of MER as a target for the run to target and auto run modes.

Upper Shoulder <
Level: control for setting the target threshold for Upper Shoulder performance
Hysteresis: Control for setting the hysteresis for the automatic restart of the adaptive correction algorithm by 'Auto run' mode. In the example with a set target of -41dB upper shoulder level and a hysteresis of 3dB, the threshold for automatic restart is -38dB upper shoulder level.
Enable: check box for enabling/disabling the use of upper shoulder performance as a target for the run to target and auto run modes.

Lower Shoulder <
Level: control for setting the target threshold for Lower Shoulder performance
Hysteresis: Control for setting the hysteresis for the automatic restart of the adaptive correction algorithm by 'Auto run' mode. In the example with a set target of -41dB lower shoulder level and a hysteresis of 3dB, the threshold for automatic restart is -38dB Lower shoulder level.
Enable: check box for enabling/disabling the use of Lower shoulder performance as a target for the run to target and auto run modes.

3.4.6 Non-Linear precorrector monitor panel

The Non-linear precorrector monitor panel provides information about the instantaneous operational status and performance values (when available). The display is updated once per iteration.



- **Status:** The status field shows the operational status for the Non-linear precorrector system. The possible states are:
  - *Not running*: Non-Linear precorrector operation is suspended. Non- linear sense input is 'disabled'
  - *Monitoring*: Non-Linear static mode is selected or Non-Linear adaptive mode in operational mode 'monitoring' is selected. MER and Upper/Lower shoulder performance for Non-Llinear sense input is displayed.
  - *Initializing:* Indicates the non-linear corrector is in the state of initial data collection by adaptive non-linear in operational modes single, continuous, run to target and auto run. The initial data collection required by the adaptive non-linear corrector runs over one preliminary 'iteration'.
  - *Auto applying*: Indicates that adaptive non-linear system has passed the initialization stage. The non-linear adaptive precorrector characteristic is updated automatically every time an iteration is completed.

- **MER:** The measured MER value for the signal applied to the non-linear sense port. Displays the result of the last completed iteration by adaptive mode. Displays the instantaneous performance by ‘Static’ and ‘Monitoring’ mode (updated once per iteration/data sample.) Displays ‘Not available’ when precorrector status is ‘not running’ and while the precorrector is making initial data collection.
- **Upper Shoulder:** The measured level for the upper spectrum shoulder of the signal applied to the non-linear sense port. Displays the result of the last completed iteration by adaptive mode. Displays the instantaneous performance by ‘Static’ and ‘Monitoring’ mode (updated once per iteration/data sample.) Displays ‘Not available’ when precorrector status is ‘not running’ and while the precorrector is making initial data collection.
- **Lower Shoulder:** The measured level for the lower spectrum shoulder of the signal applied to the non-linear sense port. Displays the result of the last completed iteration by adaptive mode. Displays the instantaneous performance by ‘Static’ and ‘Monitoring’ mode (updated once per iteration/data sample.) Displays ‘Not available’ when precorrector status is ‘not running’ and while the precorrector is making initial data collection.
- **PAPR:** The measured PAPR of the signal applied to the non-linear sense port. Displays the result of the last completed iteration by adaptive mode. Displays the instantaneous performance by ‘Static’ and ‘Monitoring’ mode (updated once per iteration/data sample.) Displays ‘Not available’ when precorrector status is ‘not running’ and while the precorrector is making initial data collection. *Note: The PAPR measurement is referred to baseband. The actual PAPR of the RF signal is thus 3dB higher than the displayed value.*
- **Iterations:** Displays the number of adaptive non- linear precorrector iterations completed since reset of corrector characteristic or since reboot of the unit.

3.4.7 Adaptive Non-Linear precorrector reset functions

Subject to the logon status the adaptive non-linear precorrector control panel includes one or two controls for resetting the corrector characteristic.

:

- **Neutral:** The non-linear adaptive precorrector is instantly set to neutral characteristic when this control is operated. It is recommended to start the adaptive alignment from this neutral state. *Note: The 'Neutral' reset control is accessible only by logon as 'factory' user. Reset to 'Neutral' is normally not considered useful after a transmitter is installed and put in operation.*
- **Factory:** The 'Factory' curve reset is intended for instant return to the adaptive characteristic that matched the pre-corrected transmitter at time of delivery (modulator + amplifier). The factory characteristic must be saved explicitly by the transmitter manufacturer (see 3.4.8). The 'factory' curve reset is identical to the 'Neutral' reset if no factory curve has been saved.

Note: In addition to the 'Factory' reset described above up to ten additional precorrector characteristics can be memorized and recalled as part of the general modulator configuration preset. That is, the saved modulator configuration preset includes the adaptive precorrector characteristic that was in effect at the time when the preset was saved. The possibility to recall multiple modulator configurations including matching precorrector characteristic is of significant value if using the modulator for establishing an N+1 backup system.

3.4.8 Management of the Non-linear ‘Factory’ reset

The controls for managing the characteristic for the ‘factory’ reset are accessed by clicking the menu expansion (+…) control (requires logon as ‘factory’ user).

- **Store:** Clicking the soft key ***[Store]*** will transfer the instantaneous characteristic present in the non-linear adaptive corrector to the ‘factory’ curve memory.
- **Clear Factory:** Clicking the soft key ***[Clear Factory***] will instantly load a neutral characteristic in the non-linear adaptive ‘factory’ curve memory.
- **Export:** Clicking the soft key ***[Export]*** will open a generic save-file-dialogue for saving the current characteristic of the non-linear adaptive ‘factory’ reset to an external file.
- **Import:** Clicking the soft key ***[Import]*** will open a generic open-file-dialogue for loading the characteristic of a previously saved non-linear adaptive ‘factory’ curve file to the internal ‘factory’ curve memory.

Note: The ‘Export’ / ‘Import’ functions may for example be useful for quickly setting multiple separate modulators to an identical initial precorrector characteristic. The characteristic is then distributed from a source modulator to the receiving modulators via an external memory medium.

3.5 Adaptive Clipper operation

3.5.1 General information

For any practical application, the limiting factor in respect to peak power for the complete television transmitter is given by the transmitter's RF power amplifier. It is not economically feasible, nor necessary from a practical performance viewpoint, to back-off the RMS power relative to the amplifiers clipping point by the full inherent PAPR of the given modulation standard. As an example, an amplifier handling a COFDM spectrum with high inherent PAPR (about 15dB for T and T2) is not expected to be operated at an RMS power 15dB below the amplifiers clipping point. Typically the amplifier is perhaps driven to an RMS power about 6-7 dB below the clipping point meaning the PAPR is reduced to about 8-9dB out of the amplifier .That is, although the PAPR on the amplifier input is 15dB, the clipping of the highest peaks in the amplifier will cause a reduced PAPR on the amplifier output.

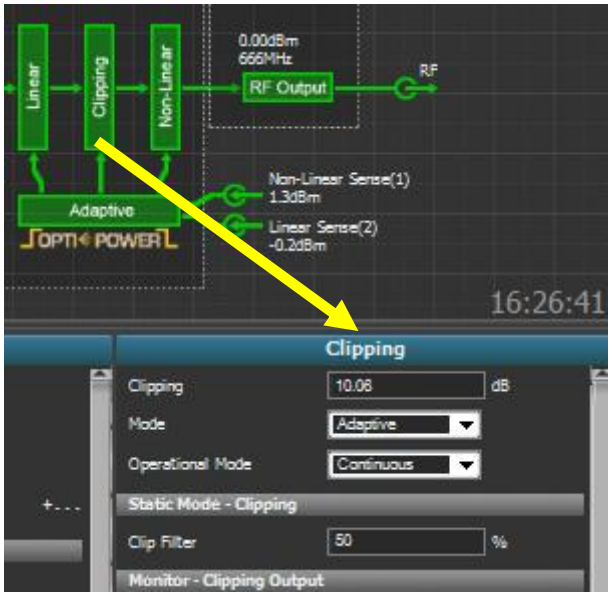
For performance reasons (MER optimization) it may be preferable to clip the signal in the modulator at a point just below the point where the amplifier clips the signal. That is, the modulator establishes a clipping point just fractionally earlier than the point where the amplifier will clip the signal. The clipping in the modulator is a managed process that may even allow for various optimal distributions frequency wise of the noise inherently generate by the clipping. Also, the clipping of the signal by the modulator will only affect the performance for the exact duration in time where the instantaneous power of the signal exceeds the set clipping threshold. If the clipping takes place in the amplifier the effect on the performance may be prolonged (fractions of a second) after the instantaneous power of the signal has dropped below the clipping point again; the amplifier requires time to recover from the clipped signal state.

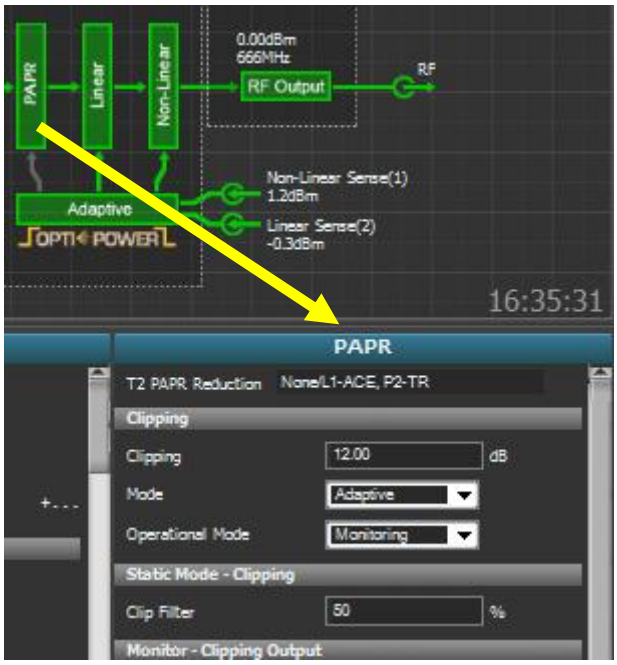
The modulator clipper function discussed here manages the clipping point relative to the PAPR measured on the output of the transmitter amplifier. That is, if the signal on the output of the transmitter amplifier is clipped to a PAPR of for example 9dB when the modulator's clipper is not managing the clipping, the managed PAPR at the same signal point will be observed to be fractionally lower when the modulator's managed clipping is activated (for example 8.5dB). In the scenario outlined, the PAPR measured directly out of the modulator (input of the amplifier) may be several dB higher than the limit set for the amplifier's output PAPR by the managed clipper. The higher PAPR observable on the amplifier input is a normal effect of the non-linear precorrector compensating the compression in the amplifier of instantaneous power levels below the clip point. Although not necessarily seen as an intuitive characteristic, this is a perfectly normal status for the input signal to the amplifier and it is in no way an indication that the managed clipping is not controlling the PAPR (the managed clipping is designed to operate relative to the amplifier output). It is simply an indication that the identified compression in the amplifier is being compensated by the non-linear precorrector function to provide a linear response all the way up to the peak power that can be delivered on the output of the amplifier.

As explained above the managed clipper discussed here cannot and shall not work as function to manage the PAPR that is measurable directly in the modulator output signal (input of amplifier). If it is required to limit the PAPR out of the modulator (Input of amplifier) to a given maximum value, the PAPR limiter function described in section 3.4.1 must be used.

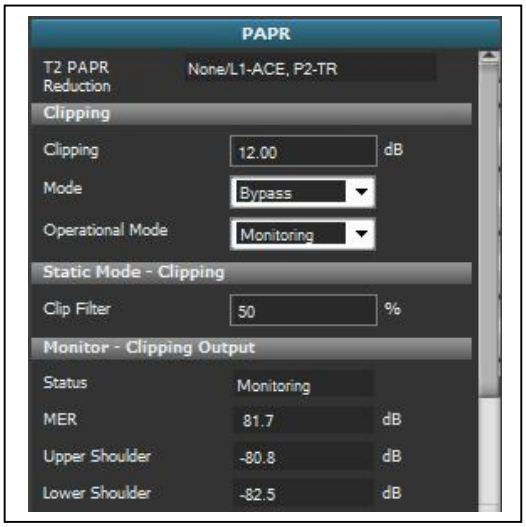
3.5.2 Access to clipper control panel

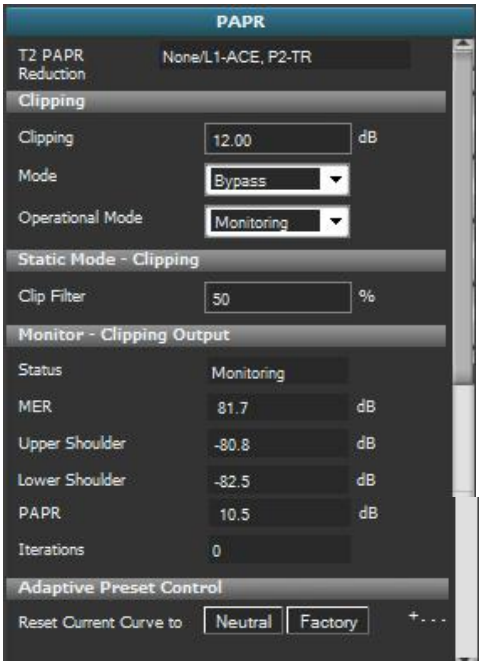
The control and status panel for the clipper function is accessed by dragging the clipper block to the lower half of the WEB GUI (note: the identical function is in combination with the DVB-T2 modulator accessed through the PAPR block).





3.5.3 Clipper control panel overview



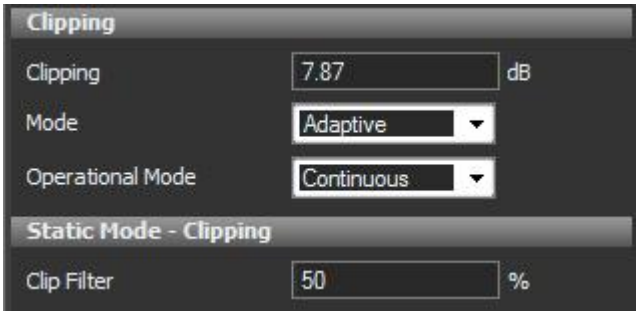


3.5.3.1 T2 PAPR Reduction (DVB-T2 only)

Status field displaying the current status of ACE and TR based PAPR control. The following states are possible:

Status display	Definition
None	No ACE or TR based correction
None/L1-ACE,P2-TR	No ACE or TR based correction of payload carrying symbols ACE correction of L1 symbol TR correction of P2 symbol

3.5.3.2 Clipping control panel

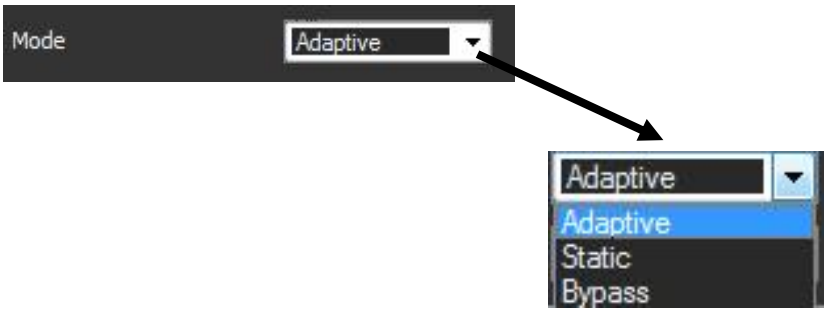


Clipping

Control for setting the clipper level by static (manual) clipper mode. The control shows the instantaneous clipper value by adaptive clipper mode.

Mode

The clipper system can operate in three different modes. The required mode is selected from the ***Mode*** 'drop-down' list

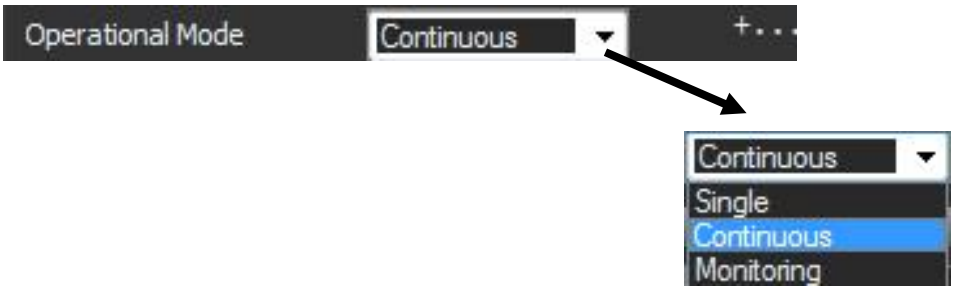


The available modes are:

- **Bypass:** No clipping is applied
- **Static:** The clipper level configured through the separate control 'Clipping' is applied.
- **Adaptive:** The adaptive clipper mode is activated. The current clipper value is applied and maintained according to the adaptive precorrector operational mode selected (see next page).

Operational Mode

The adaptive clipper can operate in three different modes The mode is selected from the ***Operational Mode*** 'drop-down' list



The available modes are:

- **Single:** A single iteration is completed after selection of 'Single' mode and the adaptive clipper characteristic is updated accordingly. At the end of the single iteration the operational mode is automatically switched back to 'Monitoring' state.
- **Continuous:** Iterations are run continually after selection of 'Continuous' mode. The adaptive clipper characteristic is updated after a completed iteration.
- **Monitoring:** The current adaptive clipper characteristic is applied. The clipper algorithm is stopped. Changes in transmitter characteristic will not be tracked by the clipper.

Static Mode - Clipping

Control for setting the clipper's noise distribution by static (manual) clipper mode. The range is from 0 to 100 [%] in steps of 1%.. Setting 0% corresponds to a uniform distribution of the energy form the clipper noise below, inside and above the channel. Setting 100% corresponds to transfer of the clipper noise energy from below and above the channel into the channel itself. This setting is suitable for optimizing the suppression of noise in the sidebands when it is preferred to prioritize minimum out of band noise from the clipping (at expense of in-band performance).

3.5.4 Level definition

The point of clipping relative to average power level for the signal processed can be set by dragging the clipper block to the configuration panel. The Clipper level control can be set in the range

The adaptive clipper function included with the precorrector system in the PT3756 OptiPower™ edition allows a fully automated optimization/limitation of the transmitter's peak-to-average-power-ratio PAPR for best possible MER performance.

When the clipper is disabled the output from the Product Family product will exhibit a PAPR equivalent to the inherent PAPR for the modulation format when the unit is configured/operated as a modulator. When the unit is configured as repeater or transposer the PAPR of the processed signal may be limited by headroom constraints in equipment prior to the repeater or transposer input. In the latter scenario the PAPR measured on the RF output may therefore be lower than the inherent PAPR for the modulation format in question even when the clipper is off.

Although the highest power peaks for multicarrier COFDM formats like DVB-T and MediaFLO reach a level about 15dB over the signals average RMS power the high peaks have limited energy content. The peaks are therefore not of immediate danger to the safe operation of a power amplifier following the modulator output even in the normal case where the average power setting for the amplifier is not backed off with the full PAPR relative to the peak power rating for the amplifier. The highest peaks are simply clipped by the power amplifier. However, a performance improvement and an extension of amplifier lifetime may be obtained if the peaks are limited to a point just below the amplifiers clip point by the clipper function of the Product Family product. When the clipping is done by the Product Family the following characteristics are obtained:

a) The potential short time effect on the amplifier characteristic after a power peak is eliminated; the clipping in the Product Family is an instant process with no subsequent effect on the signal processing characteristic.
b) The unavoidable noise that results from the clipping may, when the clipping takes place in the Product Family, be distributed as preferred by use of the ‘soft clipper’ function (see below). When the clipping occurs in the amplifier the noise resulting from the clipping will be distributed evenly below, within and above the used channel. When using the clipper function of the Product Family the noise may be displaced from the upper and lower sideband of the channel to minimize disturbance of adjacent channels.
c) By clipping the signal in the Product Family product any possible degradation of amplifier life time by repeated peak power stress is minimized.

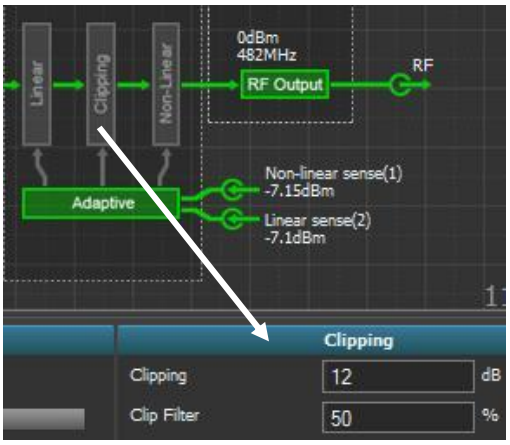
3.6 Operation of the clipper function

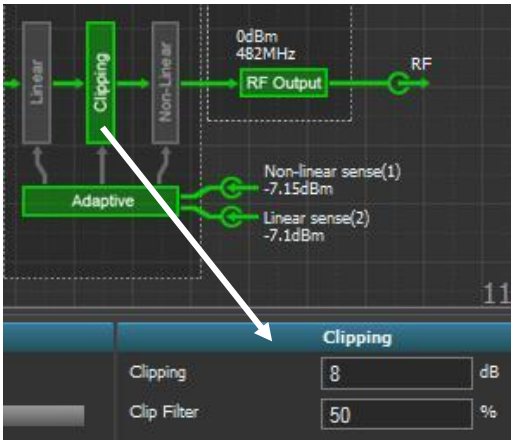
3.6.1 Level definition

The point of clipping relative to average power level for the signal processed can be set by dragging the clipper block to the configuration panel. The Clipper level control can be set in the range from 12dB to 2dB. This setting refers to the baseband processing which is equivalent to a range from 15dB to 5dB for the actual RF output (the addition to the signal of a single CW carrier, the local oscillator used in the up-conversion process, corresponds to an increase of the PAPR by 3dB).

For practical reason the clipper function is considered ‘active’ whenever the clip point is set to a value lower than 12dB irrespective of the actual PAPR format for the modulation standard in use. When set to the ‘active’ state the clipper is shown in green color in the block schematic. When the clipper is inactive it is shown in grey.

Clipper in the inactive ‘off’ state (12dB): **Clipper active (PAPR setting 8dB):**

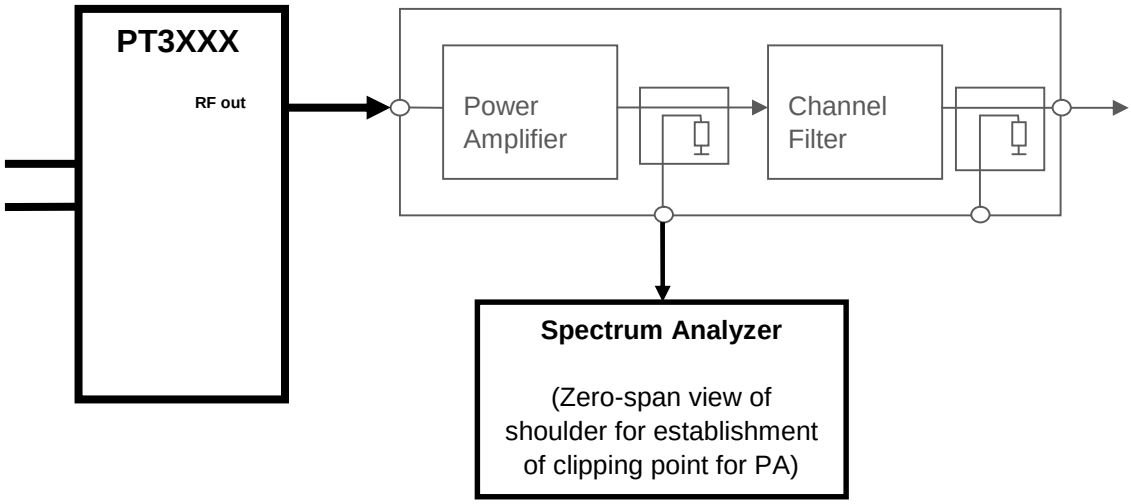




3.6.2 Identification of optimal clipper setting

The optimal clipper setting can be identified by monitoring the output of the power amplifier using a spectrum analyzer. The steps are as follows:

a) Ensure that the clipper initially is set to 12dB
b) Ensure that the clip filter is initially set to 0%..
c) Configure the spectrum analyzer for zero-span operation with the view focused on either the upper or lower shoulder of the signal. A resolution of 0.1dB to 0.5dB per division is recommended. Maintaining the original level in the form of a second trace on the analyzer (clear-write → View) is recommended for easy identification of change in the shoulder level.
d) Now, gradually increase the level of clipping applied by the Product Family product (12→11,5→11→10,5→10……..etc). When an increase of the shoulder level observed on the spectrum analyzer is <u>just</u> noticed it shows that the clipping applied by the Product Family is now limiting the peaks to a point fractionally below the clip point of the amplifier itself. Although the point will be individual from amplifier to amplifier and dependent on the actual average power level and peak power rating of the amplifier the point is typically found around of a clipper setting between 8 to 6 dB.



3.6.3 Selection of clipper softness (clip filter)

The clip filter setting may be varied according to preferences between 0% and 100%. The 100% setting provides for maximum suppression of the clipper noise from the sidebands (lower and upper adjacent channel) while the tradeoff is a reduction of the in-band MER performance.

This page is intentionally left blank.

4 Document History

Rev.:	Date:	Name:	Details:
1.0	October 20, 2015	HSO	First release of the document

This is the last page of the document.