

**ENHANCED SATELLITE PRECORRECTION (E.S.P)****E.S.P****Enhanced Satellite  
Precorrection**

<i>Version</i>	<i>Date</i>	<i>Product covered</i>	<i>Subjects</i>
<i>A</i>	<i>29/05/2017</i>	<i>XSSR-VYPx-xxx</i>	<i>First version</i>
<i>B</i>	<i>25/04/2018</i>	<i>XSSR-VYPx-xxx</i>	<i>Add Automatic E.S.P</i>

# ENHANCED SATELLITE PRECORRECTION (E.S.P)

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# ENHANCED SATELLITE PRECORRECTION (E.S.P)

## 1. INTRODUCTION

### 1.1 Purpose

The topic of this document is to present the way to manage the Enhanced Satellite Precorrection (E.S.P) system for the Vyper satellite modulator. The scenario in this document is focused to first describing the precorrection in general, before defining E.S.P and then finishing by explaining the setup required to process the E.S.P tool in the field.

### 1.2 Audience

This document has been written for customers who have to use the E.S.P tool for the Vyper Satellite modulator. Some chapters require some prerequisite knowledge in electronics.

### 1.3 Overview

Teamcast has developed a tool, E.S.P, to compensate the potential linear and non-linear distortions that have been introduced at the RF level between the modulator and the demodulator by the satellite transponder. The performance depends on the non-linear characteristics of the satellite transponder and the MODCOD used.

### 1.4 Covered products

Product family	Product references	Type
Vyper	XSSR-VYPx-2502	1RU DVB-S/DSNG/S2/S2X modulator, IF and L-Band outputs
Vyper	XSSR-VYPx-3xxx	1RU DVB-S/DSNG/S2/S2X modulator, IF and L-Band outputs

Note: software release of Vyper must be higher or equal at **S133Q**.

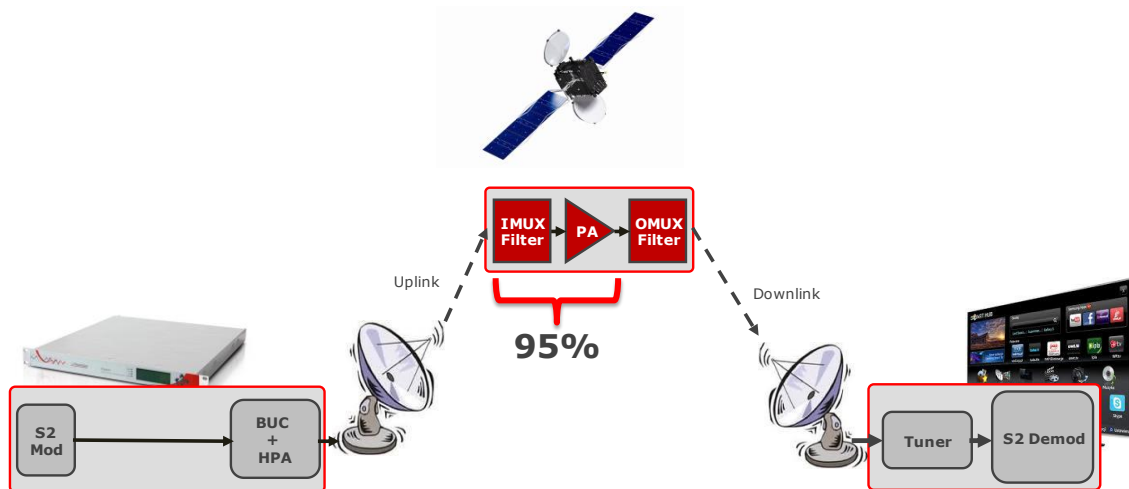
### 1.5 Associated documentations

- [D1] MPD-1412011, XSSx-VYPx-2502 User Manual
- [D2] MPD-1702132, XSSx-VYPx-30xx User Manual

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 1. The Origins of Distortion

Figure 1 shows a typical transmitter chain. Each of the different stages add distortion to the output that the system designer must cope with.



**Figure 1: Typical Transmission Chain**

A signal travels from the transmitting earth station, via:

- A modulator,
- Up Converter (BUC) and
- High Power Amplifier (HPA),

A signal travels in the satellite, via:

- An Input MULTiplexer (IMUX),
- Automatic Level Control (ALC),
- Travelling Wave Tube Amplifier (TWTA),
- Output MULTiplexer (OMUX)

A signal travels to the receiving earth station, via:

- A Low Noise Amplifier (LNA),
- Down Converter (LNB)
- Demodulator

In the uplink chain, the ground equipment is set to avoid any distortion which means that the HPA is backed off sufficiently to always operate in the linear part. Roughly, 95% of the distortions are introduced in the satellite: embedded IMUX/OMUX and HPA:

- **IMUX/OMUX:** Filter linear distortion is dependent on the frequency and the phase (Group Delay) of the signal.
- **HPA:** Amplifier non-linear distortion is dependent on the power of the signal: There are two precorrection curves AM/AM and AM/PM.

# ENHANCED SATELLITE PRECORRECTION (E.S.P)

## 1.1 Linear Precorrection

In a linear system, the sum of output signals is equal to the sum of the outputs generated by the individual inputs. Coaxial cables, passive electrical filters, antennas, and amplifiers operating in their linear region are just a few examples of linear systems. Linear systems can be described by their amplitude and phase as a function of frequency due to the linearity independent of the level of the input signal.

Furthermore, the overall amplitude and phase characteristic of a cascade of linear systems is easily calculated from the characteristics of the individual components.

NB: Instead of the phase as a function of frequency, it is common to use the group delay (variation).

For a linear transmission channel this requires that the amplitude and group delay should be constant over the frequency band of interest occupied by the signal. Representing the signal in the frequency domain, this means that all the frequency components of the signal are affected by the same gain and delay.

If this is not the case, then the waveform is distorted resulting in performance degradation for such a communication link.

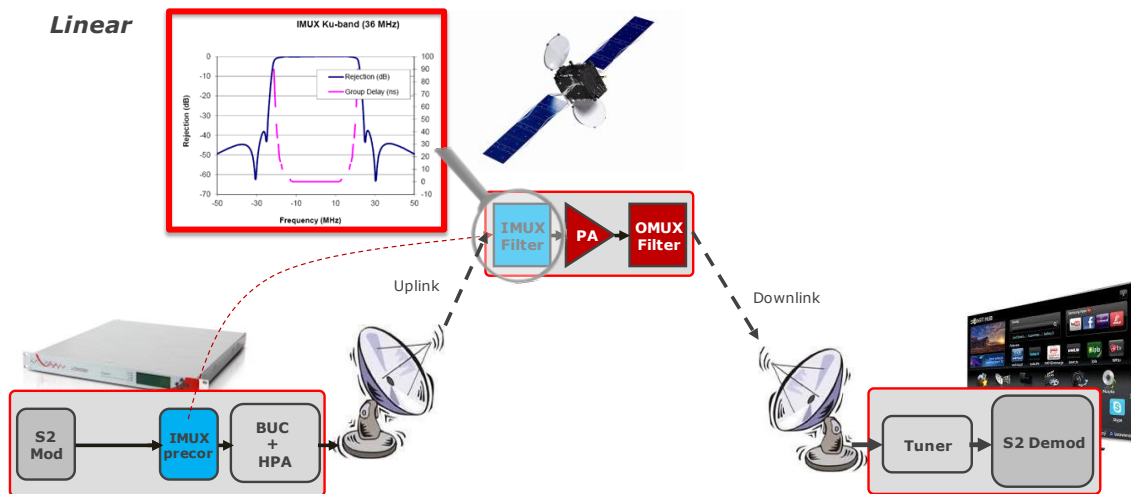


Figure 2: Linear distortion: IMUX

The Linear pre-correction tool compensates

- channel filter response (and sometime the signal tilt)
- Amplitude response and Group-delay

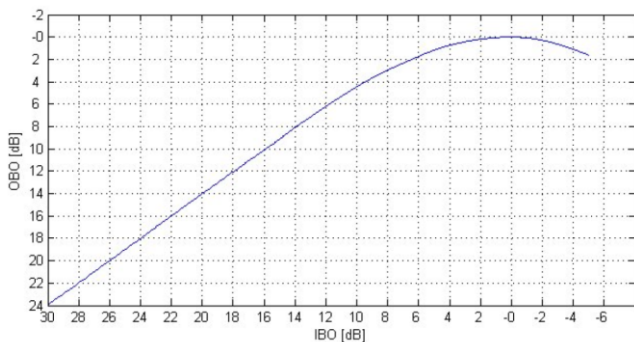
# ENHANCED SATELLITE PRECORRECTION (E.S.P)

## 1.2 Non-Linear Precorrection

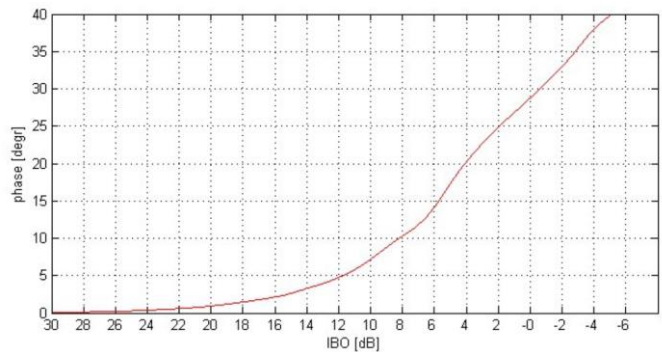
These distortions often arise due to nonlinearities in the amplitude and phase response of devices. A TWT amplifier on board a satellite typically operates close to saturation, resulting in non-linear behaviour. Amplitude variations of the input signal are compressed and the output waveform is distorted, resulting in overall link performance degradation. This degradation also results in InterSymbol Interference (ISI). ISI is a form of distortion of a signal that causes the previously transmitted symbols to have an effect on the currently received symbol. The end result is bit errors (BER).

To improve the transmission performance, one intentionally decreases the RF output power with respect to saturation, by reducing the amplifier drive power (Input Back Off, IBO). In this way, the amplifier operating point is moved into the linear region. However, increasing the IBO also causes a decrease in the useful RF power (Output Back Off, OBO), a fact that obviously tends to increase the BER. Therefore, there is a value of the IBO at which the link BER shows an absolute minimum; this is called the optimum IBO, to which the operating OBO corresponds.

The behaviour of an amplifier can be described in terms of the input/output power and phase relationship (see figures below) for a Continuous Wave (CW as used for the lineup) input signal (a modulated signal gives different result). The maximum output power is labeled as 0 dB IBO and OBO.



**Figure 3: AM-AM transfer function (TWTA)**



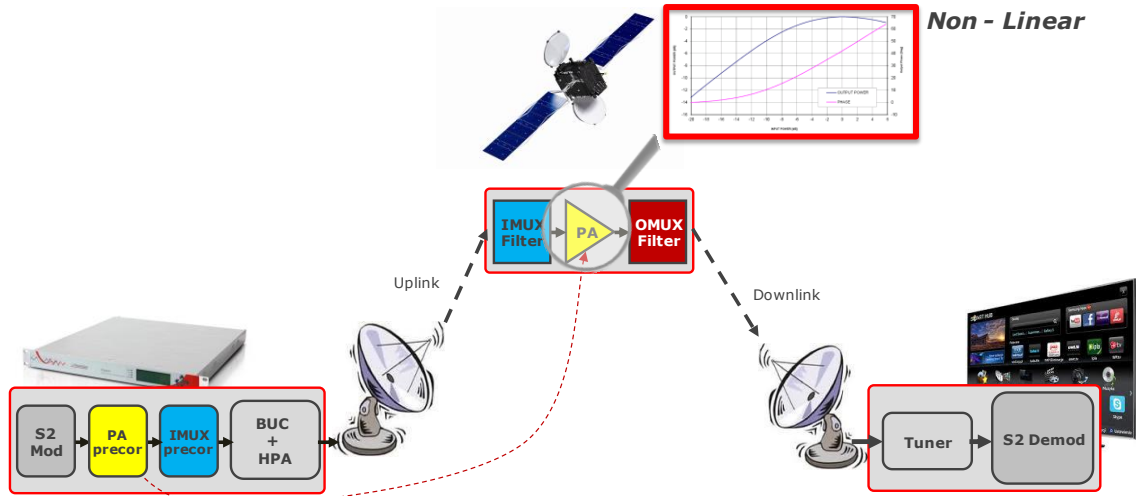
**Figure 4: AM-PM transfer function (TWTA)**

Ideally, the operating OBO should be as low as possible, for maximum utilization of the available RF power.

- QPSK and 8PSK modulated signals, as used for broadcasting, can be considered as nearly constant envelope signals and can be used close to or at saturation level.
- 16APSK, 32APSK and 64APSK modulated signals show envelope variations and are more sensitive to distortions introduced by channel non-linearity. Power efficiency of these modulation schemes can be improved for instance by applying pre-distortion on the transmit data, avoiding large input and output back-off values on the satellite transponder.

This optimum point is a trade-off between RF power on the one hand and intermodulation and distortion on the other hand.

**ENHANCED SATELLITE PRECORRECTION (E.S.P)**



**Figure 5: Non-Linear distortion: TWT**

The Non-Linear pre-correction tool compensates

- output power amplifier characteristics
- AM/AM and AM/PM

The effect of amplitude compression and phase rotation of a TWT Amplifier as a function of input level is clearly visible on the reception side where the C/N margin is decreased.

So for optimum power efficiency and maximum receive  $E_s/N_0$ , a TWT is operated close to saturation. Therefore, a large OBO value is not a good option to compensate non-linearity, especially when higher order modulations (e.g. 16APSK) are used as in DVB-S2/S2X systems. However QPSK and 8PSK can be operated close to or at saturation.

For these reasons, techniques other than an “easy” increase of OBO are preferred, improving uplink and downlink  $E_s/N_0$  and minimizing receiver (ISI) degradation.

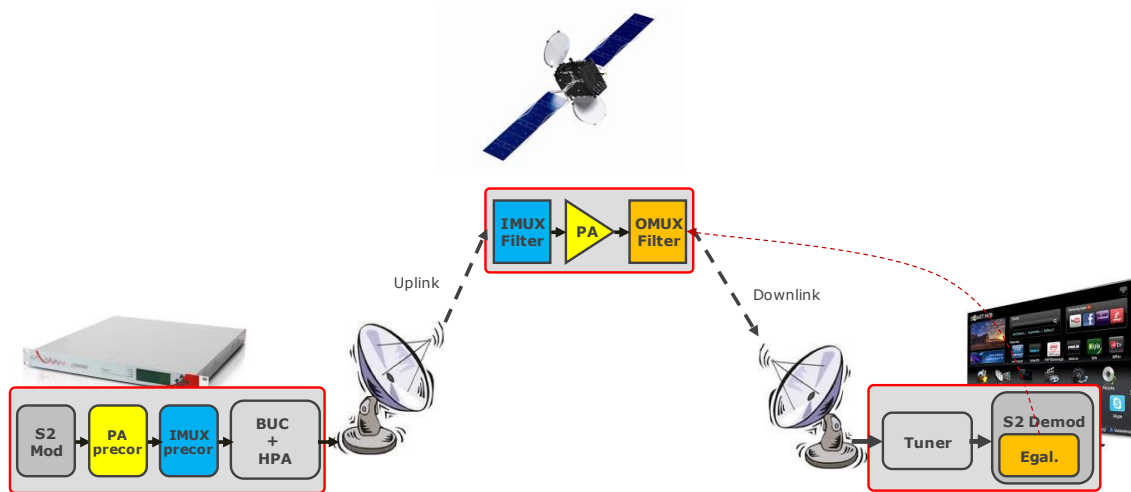
Predistortion can be designed to minimize the clustering and warping of the constellation introduced by a non-linearity instead of just linearizing the AM-AM and AM-PM transfer functions.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 1.3 Receive Side Equalization

It is important to note that right now, the current generation of chipsets supports an adaptive (=automatically adjusted) equalizer at the reception side. This equalizer compensates completely for distortions in a linear channel, so that back-to-back performance is restored even in the presence of severe amplitude and group delay distortions.

Ideally this equalizer is there to compensate the OMUX filter. However, depending on the satellite used and also the distortions applied, the adaptive equalizer could compensate the global distortions introduced by the transmission.



**Figure 6: OMUX Linear distortion**

# ENHANCED SATELLITE PRECORRECTION (E.S.P)

## 2. TeamCast Precorrection Method: E.S.P

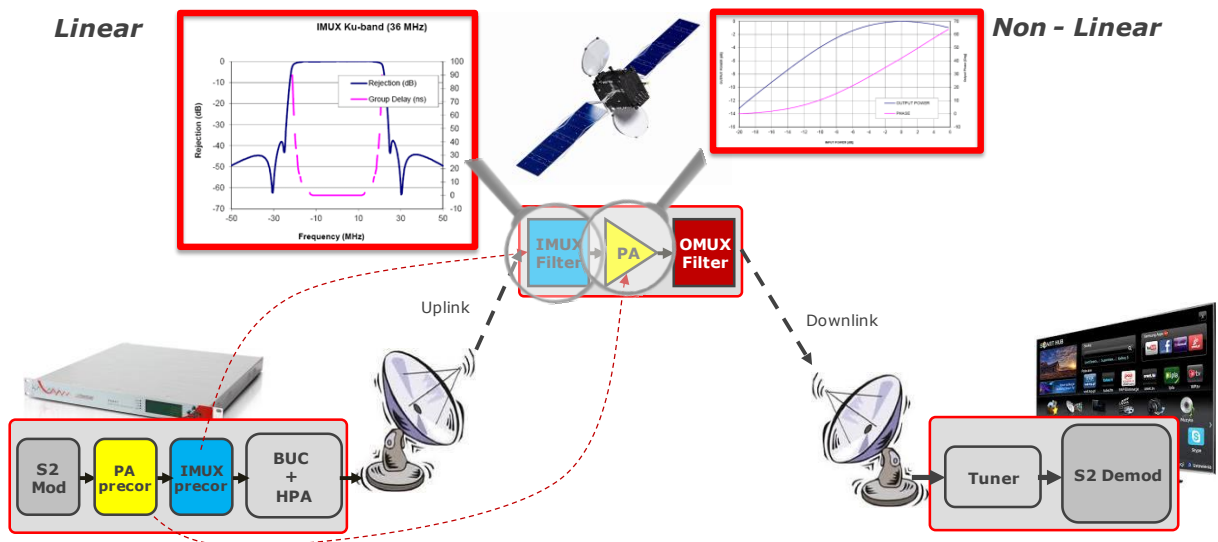
Users employing satellite modulation in a single carrier per transponder mode benefit the most from E.S.P. In this mode maximum power efficiency of the satellite link is achieved by running the satellite transponder at saturation. The Static precorrection technology of E.S.P, for **E**n

### hanced **S**atellite **P**recorrection, corrects group delay and removes the phase and magnitude non-linear distortions which are introduced by running a transponder at saturation. Higher order modulations, 16APSK and above, are particularly sensitive to these distortions and so E.S.P could yield large improvements in the satellite link margin.

So TeamCast DVB-S/S2/S2X modulators with the E.S.P capability, have both linear- and non-linear precorrection functions which can be individually enabled and disabled. The E.S.P installation described in this chapter prepares the modulators for the precorrection functionality.

### 2.1 Precorrection integration

The Figure 7 describes the precorrections chain in the TeamCast modules.



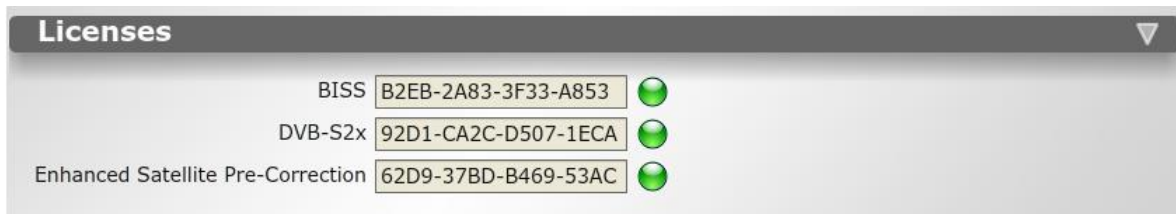
**Figure 7: Teamcast precorrections**

The modulator embeds both tools:

- Non-linear precorrection for embedded satellite HPA
- Linear precorrection for embedded satellite IMUX filtering

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

First of all, this feature requires a software license. So, the licenses status in the bottom part of the General panel on the Vyper GUI needs to be checked:



**Figure 8: license section**

Don't hesitate to contact your supplier to activate this feature.

The tool is then accessible in the "ESP" panel.

### 2.2 Requirements

As presented in the previous chapter, the digital pre-correction feature consists of two types of correction:

- Linear pre-correction,
- Non-linear pre-correction.

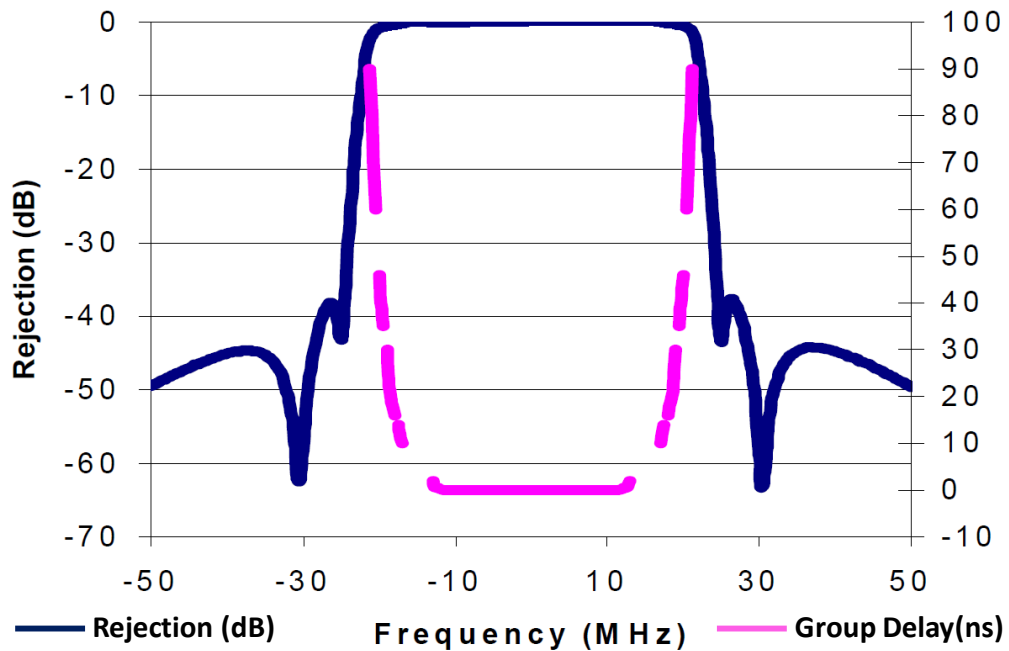
These features increase the efficiency of the satellite transmission by reducing the effect of the different distortions that happen on satellites.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 2.2.1 Requirement for Linear Precorrection

The Linear Pre-correction compensates the distortion caused by the Satellite IMUX filter. The main characteristics of this filter are the gain and group delay of the output compared to the input.

Classical IMUX curves are shown in the figure below:



**Figure 9: IMUX filter curves**

The IMUX filter can be characterized with

- **an Amplitude .csv file**
- **a Group Delay .csv file.**

To be uploaded to the modulator, these files must respect a specific syntax and the following precisions:

- 0.001dB for amplitude,
- 0.001ns for group delay.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

Two examples are available below with center frequency = 1600 MHz and bandwidth = 27.5 MHz:

- **Amplitude file**

Frequency(MHz), Amplitude(dB)

1583.5,-1.3  
1585,-0.6  
1586.5,-0.2  
1589.5,-0.05  
1592.5,-0.2  
1595.5,-0.4  
1598.5,-0.65  
1601.5,-0.9  
1604.5,-1.15  
1607.5,-1.25  
1610.5,-1.3  
1612.5,-1.32  
1615,-1.4  
1616.5,-1.8

- **Group delay:**

Frequency(MHz), GDelay(ns)

1583.5,53  
1585,32  
1586.5,20  
1589.5,9  
1592.5,5  
1595.5,3  
1598.5,1.2  
1601.5,0  
1604.5,1  
1607.5,3  
1610.5,6  
1612.5,12  
1615,27  
1616.5,50

NB: The modulator will analyse the file to check the syntax.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 2.2.2 Requirement for Non-Linear pre-correction

As described previously, the Non-Linear Pre-correction compensates the distortion caused by the Satellite power amplifier. To be efficient, the amplifier usually operates close to its saturation point. This leads to distortion.

An example of the characteristics of the amplifier is shown in the figure below:

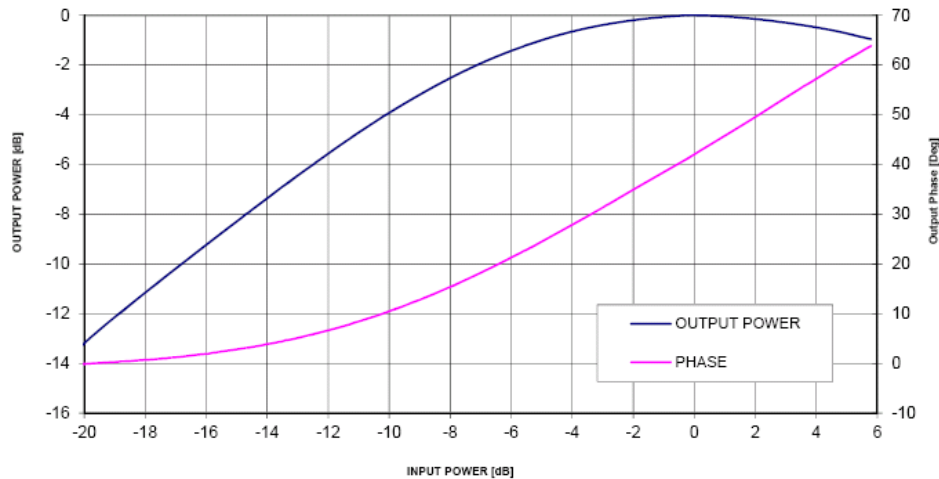


Figure 10: HPA filter curves

The amplifier can be characterized with

- an AM/AM .csv file
- an AM/PM .csv file.

To be uploaded to the modulator, these files must respect a specific syntax.

The constraints are:

- Amplitude:
  - 0.001dB precision,
  - [-30dB, +10dB] range,
- Phase:
  - 0.001° precision for phase,
  - [0°, 180°] range for phase
- IBO:
  - 0.1dB precision,
  - [0, 30.0] range.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

Two examples are available below:

- **AM/AM**

Am(dB), Am(dB)

-19.5,-17.682  
-19.375,-17.567  
-19.25,-17.452  
-19.125,-17.334  
-19,-17.214  
-18.875,-17.092  
-18.75,-16.972  
-18.625,-16.851  
-18.5,-16.726  
-18.375,-16.602  
-18.25,-16.48  
-18.125,-16.358  
-18,-16.234

- **AM/PM**

Am(dB), Pm(deg)

-19.5,-0.609  
-19.375,-0.639  
-19.25,-0.638  
-19.125,-0.627  
-19,-0.617  
-18.875,-0.625  
-18.75,-0.617  
-18.625,-0.613  
-18.5,-0.614  
-18.375,-0.625  
-18.25,-0.641  
-18.125,-0.65  
-18,-0.655

NB: The modulator will analyse the file to check the syntax.

## ***ENHANCED SATELLITE PRECORRECTION (E.S.P)***

### **2.2.3 Remarks:**

The description files need to meet the following requirements:

- At least 32 points are needed
- The number of points of the group delay response does not have to be equal to the number of points of the amplitude response.
- The frequency points do not have to be identical
- The frequency range of the amplitude and group delay files does not need to be centered around 0 Hz; an absolute shift to any RF or L-band center frequency is allowed, as long as this shift is equal for both curves and this center frequency corresponds to the specified frequency offset.

In addition, the following operational parameters controlling the exact location and bandwidth of the transmit signal inside the transponder bandwidth must be determined:

- Symbol rate
- Frequency offset
- Roll-off factor

# ENHANCED SATELLITE PRECORRECTION (E.S.P)

## 3. Automatic E.S.P

As described below, the main "issue" for the satellite precorrection is to know the transponder characteristics.

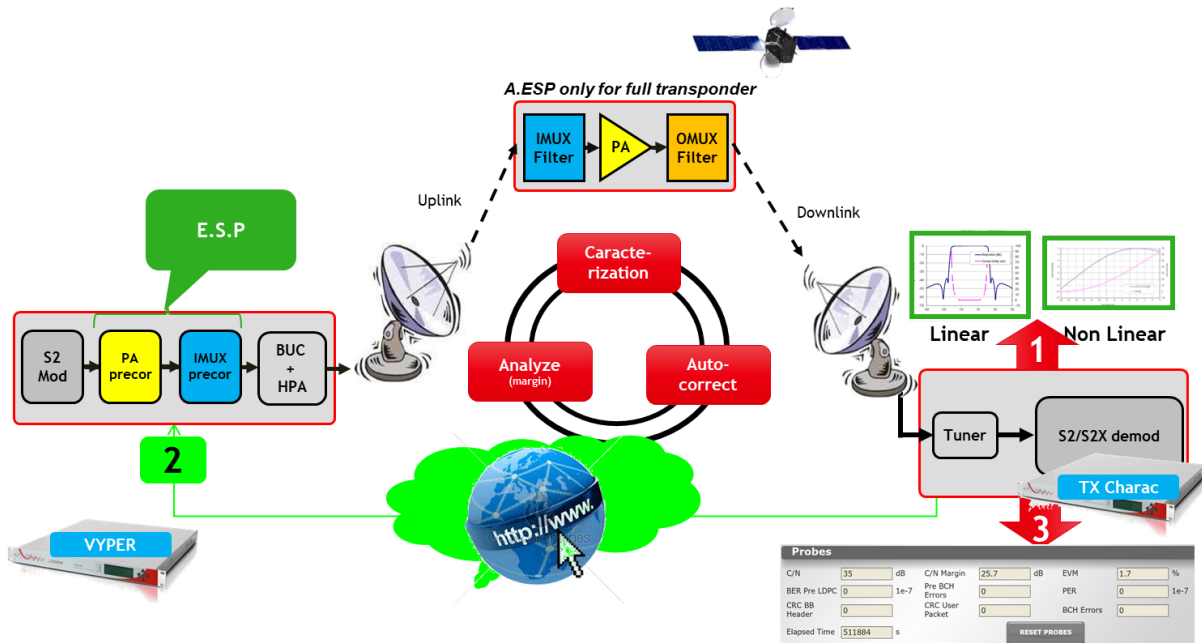
An automated process is introduced to generated automatically the files:

- 1/ for linear predistortions
  - an Amplitude .csv file
  - a Group Delay .csv file.
- 2/ for nonlinear predistortions:
  - an AM/AM .csv file
  - an AM/PM .csv file.

To extract these curves, we designed a dedicated product: RX Transponder Characterization.

### 3.1 A.E.S.P Setup

Below the global overview of our Automated E.S.P process:



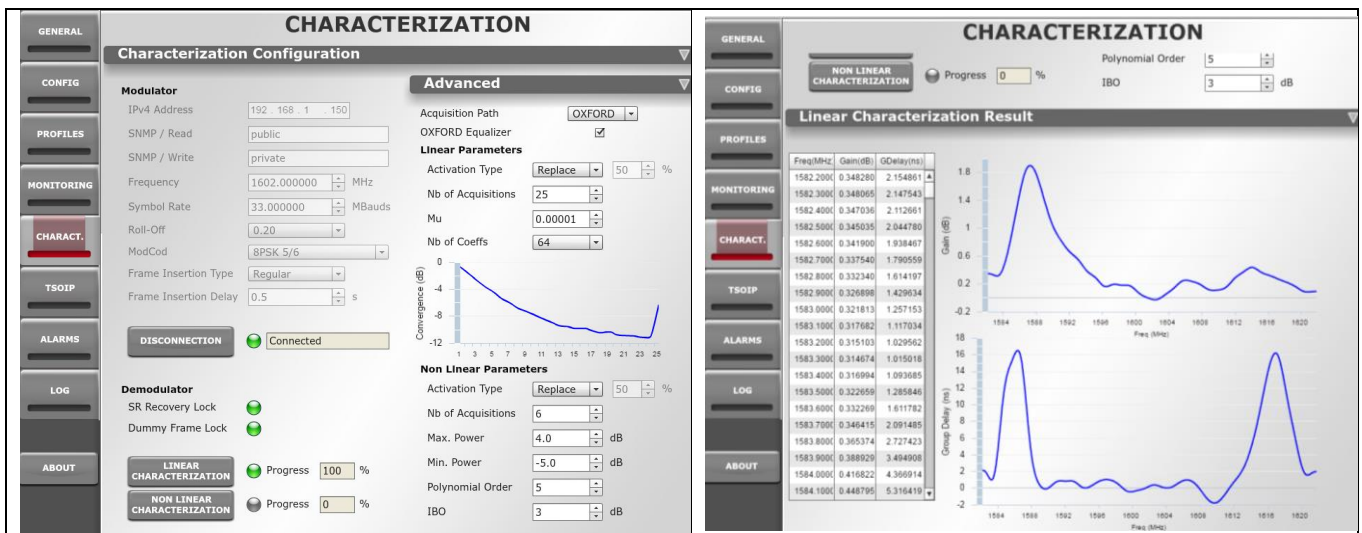
- A Vyper with E.S.P option activated
- A Transponder Characteristics Definer (TCD) is used for A.ESP as a dedicated S2/S2X professional satellite demodulator for Characterization of the satellite transponder to compute Linear and Non-Linear curves thanks to the received signal
  - Analyze the signal quality and measure the results with dedicated probes
    - o C/N

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

- C/N Margin
- EVM
- BER before Viterbi
- BER after Viterbi
- PER
- Remote Control & Adjustment of Vyper ESP
- Possibility to demodulate and stream ASI and IP contents

The GUI is quite easy to set:

- CONFIG
  - where the frequency of the satellite beam to correct is enter
  - where the standard as well as the symbol rate could be forced
- MONITORING
  - where the signal could be analysed: lock status, probes values
- CHARACT
  - where the linear/non-linear configuration are defined
  - algorithms processes can be displayed
  - linear/non-linear curves can be displayed as well as



The first step is to create an IP link between the TCD and the Vyper used to broadcast over the right transponder.

So, the both products must be on the same IP sub network.

A – On the Vyper:

- 1 – check ESP license is available on the Vyper
- 2 – check on the ESP tab on the modulator, that remote access is possible

B – on the Transponder Characteristics Definer

- 3 – enter the IP address of the modulator
- 4 – enter the right SNMP read/write password (default is public/private)
- 5 – click on CONNECTION button, if all is ok, you must be "Connected" with green led as shown above.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)


In this case, the Demodulator status must be green with:

- SR recovery clock: mean the synchronization is valid
- Dummy frame lock: mean the demodulator receives the Dummy Frames used to analyze the received signal

Note: depending on other receiver/demodulator on the network, some errors could be detected due to the dummy frames used.

For the configuration advanced mode allows some adjustments as:

Acquisition Path <span style="float: right;">OXFORD ▾</span> OXFORD Equalizer <input type="checkbox"/>	<ul style="list-style-type: none"> <li>- Acquisition Path – only Oxford (no change)</li> <li>- Equalizer (on / off) – to estimate the gain of the linear precorrection</li> </ul>
---	---

<b>Linear Parameters</b> Activation Type <span style="float: right;">Replace ▾ 50 ▴ ▾ %</span> Nb of Acquisitions <span style="float: right;">25 ▴ ▾</span> Mu <span style="float: right;">0.00001 ▴ ▾</span> Nb of Coeffs <span style="float: right;">64 ▴ ▾</span> 	<ul style="list-style-type: none"> <li>- Type: Replace (start with transparent curve, after process replace the embedded curve or Update (start with current curve and update the Vyper curve)</li> <li>- Number of acquisition</li> <li>- Mu: the lower is it, slower the system is but more independent of noise</li> <li>- Coefficients: 64 or 128 (256 is unstable)</li> <li>- Convergence</li> </ul>
--	---

<b>Non Linear Parameters</b> Activation Type <span style="float: right;">Replace ▾ 50 ▴ ▾</span> Nb of Acquisitions <span style="float: right;">6 ▴ ▾</span> Max. Power <span style="float: right;">4.0 ▴ ▾ dB</span> Min. Power <span style="float: right;">-5.0 ▴ ▾ dB</span> Polynomial Order <span style="float: right;">5 ▴ ▾</span> IBO <span style="float: right;">1 ▴ ▾ dB</span>	<ul style="list-style-type: none"> <li>- Type Replace (start with transparent curve, after process replace the embedded curve or Update (no working))</li> <li>- Number of acquisition</li> <li>- Max (4dB by default, to reduce if curve is inconsistent)</li> <li>- Min (Interest to reduce in 32APSK)</li> <li>- Polynomial (5 by default, 3 if curves are not smoothed)</li> <li>- IBO used only to calculate the precorrection, independent to curve estimation</li> </ul>
---	---

After finishing these adjustments, algorithms can be performed:

- Click on the LINEAR CHARACTERIZATION
- Click on the NON-LINEAR CHARACTERIZATION

Depending on the status, curves are displayed and E.S.P can be performed. Please contact the support team for more details:

<b>CUSTOMER SUPPORT</b>	
Tel. + 33 (0)2 23 25 26 80	Email: <a href="mailto:support@enensys.com" style="color: blue; text-decoration: underline;">support@enensys.com</a>
Fax. + 33 (0)2 23 25 26 85	

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 4. Advanced E.S.P management on modulator side

In parallel to the automatic mode, there is the possibility to have on the modulator side:

- A full monitoring of the curves applied
- A full control for a static application/adjustment

#### 4.1 E.S.P Settings

The user interface panel below allows the user to upload four different **.csv** files to describe the characteristics of the transponder and the IBO used (see definition chapter §1.2). CVS files generated with the characteristic transponder receiver.



The 4 files are not mandatory and check boxes let you choose the files you want to upload.

### Precorrection Settings

**Linear Precorrection Settings**

Amplitude File **BROWSE**  ok

File Name

Group Delay File **BROWSE**  ok

File Name

**Non Linear Precorrection Settings**

AM/AM File **BROWSE**  ok

File Name

AM/PM File **BROWSE**  ok

File Name

IBO  dB

**IMUX**

**HPA**

**NORMALIZE** File Processed Status:  ok

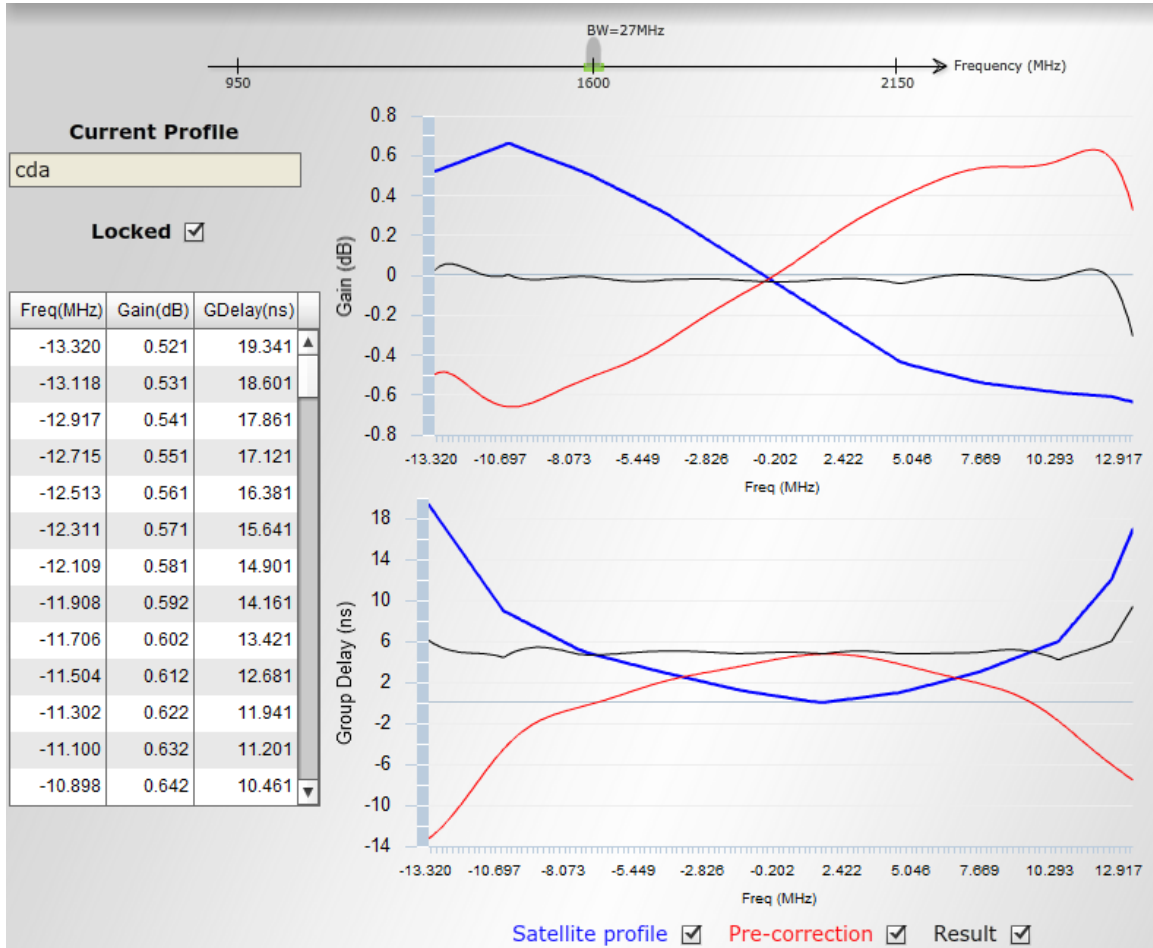
**Figure 11: Precorrection Settings**

The "NORMALIZE" button verifies the files' (IMUX/HPA descriptions) syntax and value ranges.

## *ENHANCED SATELLITE PRECORRECTION (E.S.P)*

Below is an example for the linear precorrection where a frequency gives amplitude (Gain in dB) and the Group Delay (GDelay in ns) even if the files loaded present a different frequency for the amplitude and the Group Delay.

A "clever" interpolation is applied to generate only one file:



**Figure 12: Result of files normalization**

NB: if there is no transponder description file available, do not select the file downloading. In this case a transparent curve ( $y=x$ ) will be loaded in the tool.

Depending on the files used (syntax), the File Processed Status can give different messages as

1. inProgress: normalization is in progress
2. Ok: no error, all files are well processed,
3. errorCannotOpenFile: file is not there
4. errorParseFile: there are some errors in the syntax
5. errorIncoherentFrequencyRanges: no continuous frequency values
6. errorIncoherentAmplitudeRanges: amplitude values not in [-30dB, +10dB] range

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 4.2 Profile Management

This user interface panel allows the user to save the settings in a profile. This profile summarizes in one file the characteristics of your transponder. It can be recalled, renamed, deleted and exported...



Figure 13: Precorrection Profile Management

NB: The result of the normalization process is stored in the modulator.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 4.3 Linear Precorrection

The Linear precorrection panel is shown below.

The frequency axis shows the consistency between the output spectrum bandwidth (in grey) and the .csv file data ranges:

- If red: spectrum bandwidth overlaps the .csv file range,
- If green: spectrum bandwidth is included in .csv file range.

Values of the .csv files previously loaded are available in the table and in the blue curves.

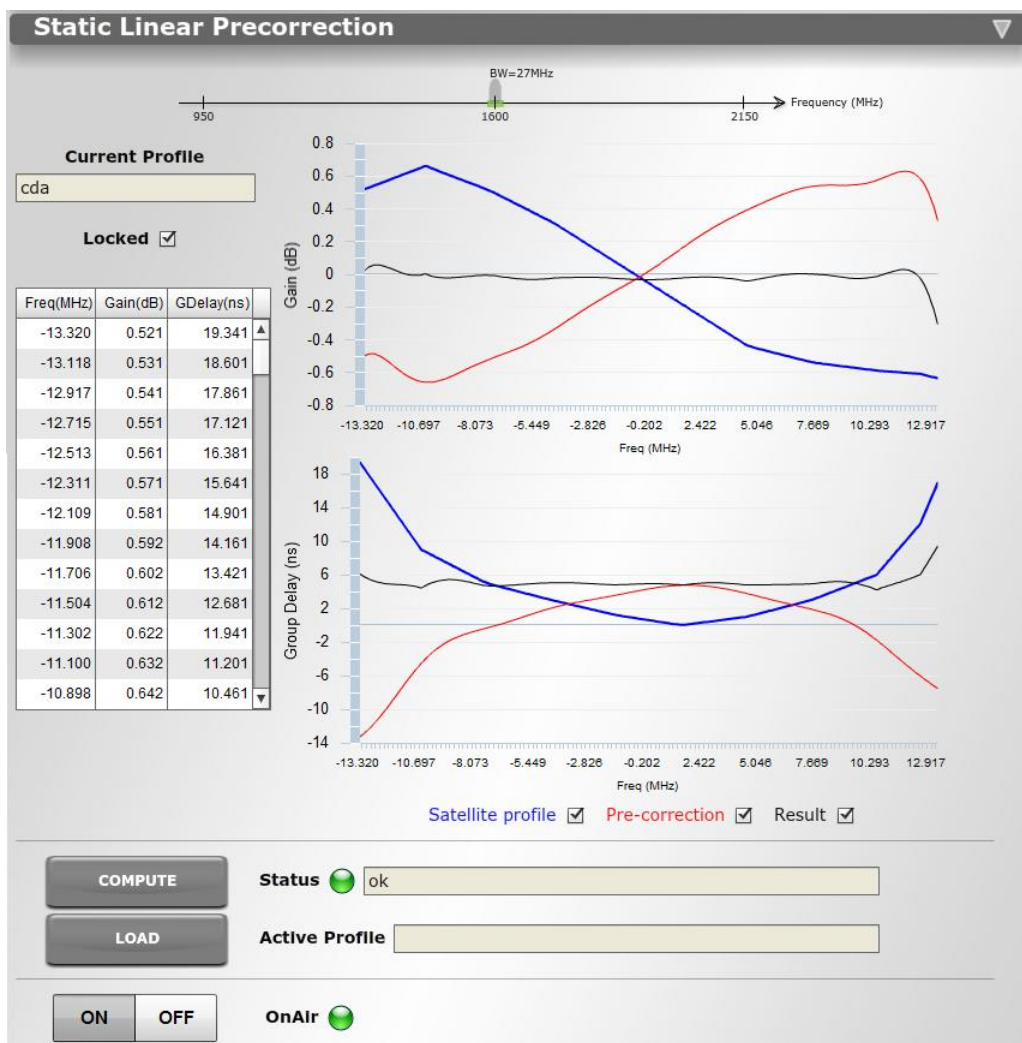


Figure 14: Static Linear Precorrection

After uploading the description curves of the transponder, the normalized curves are displayed.



**The frequency scale is automatically adjusted at  $\pm BW/2$**   
**No curves are displayed if the frequency set in the modulator is not the same as required in the curves description.**

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

Depending on the curves used, the compute of these linear curves can give different messages as

1. inProgress: algorithm compute is in progress
2. Ok: no error, linear precorrection can be applied
3. errorFrequencyOrBandwidthChangeDetected: the center frequency set for the modulator is not the same as in the curves description
4. errorBandwidthVsCurvesMinMaxFrequency: not enough dots regarding the frequency range and the bandwidth set in the modulator.
5. errorUnlockedCurveDetected: any curves modifications must be validated
6. errorMissingNormalizedFile: no input curves or normalization was not applied
7. errorNewNormalizedFile: new input curves
8. errorAlgoCannotConvergeVsCurves: embedded algorithms cannot converge with the current curves loaded. So curve adjustments are mandatory.

NB: The user can manually change the IMUX characteristics by unchecking the "locked" box and:

- Using Numeric stepper in the table,
- Dragging and dropping points on the blue curves.

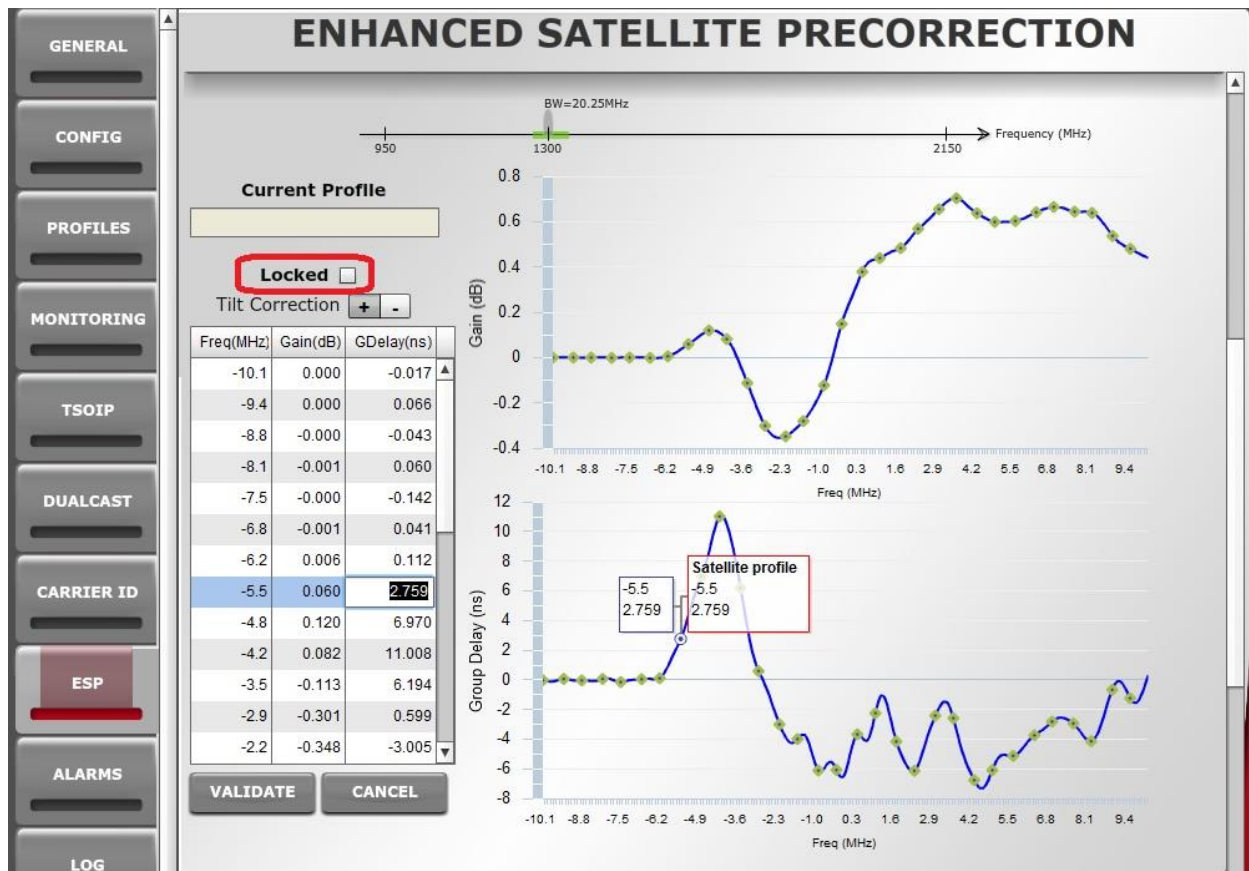


Figure 15: Static Precorrection manual adjustment

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

After modifying the curves, click on

- CANCEL to go back to initial curves
- VALIDATE

Do not forget to store the result by using another profile name.

⇒ Current Profile will be upgraded

This action is quite useful to avoid any confusion between the profile displayed on the screen and the profile currently embedded and running inside the modulator.

### 4.4 Non-Linear Precorrection

The Linear precorrection panel is shown below.

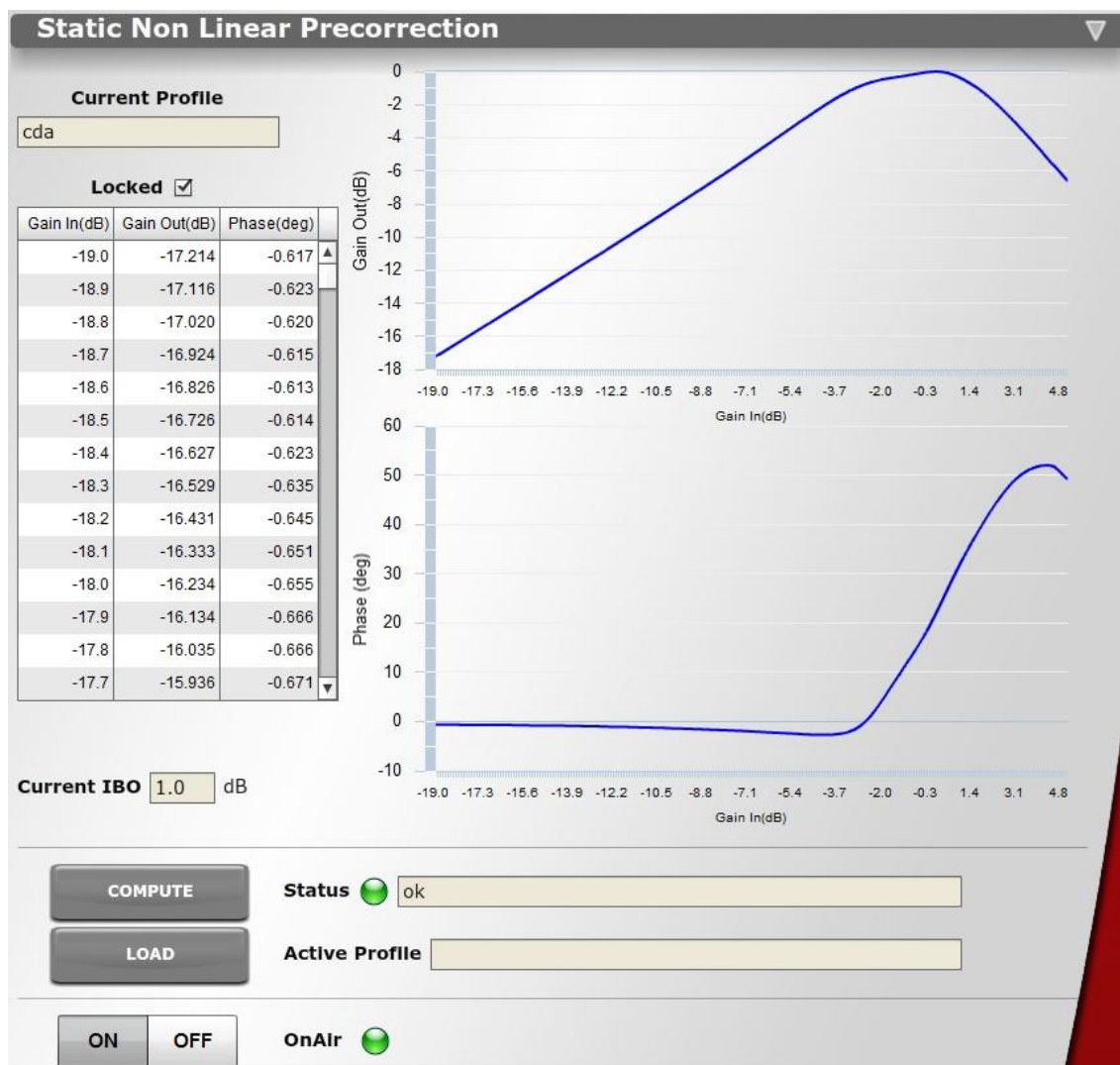


Figure 16: Static Non Linear Precorrection



The same step by step processes is applied.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

Values of the csv files previously loaded are available in the table and in the blue curves.

The user can manually change the amplifier characteristics by unchecking the "locked" box and:

- Using Numeric stepper in the table
- Dragging and dropping points on the blue curves

After the "COMPUTE" action, the computation status is given and the impact on the constellation can be seen in the monitoring panel. The figure below shows:

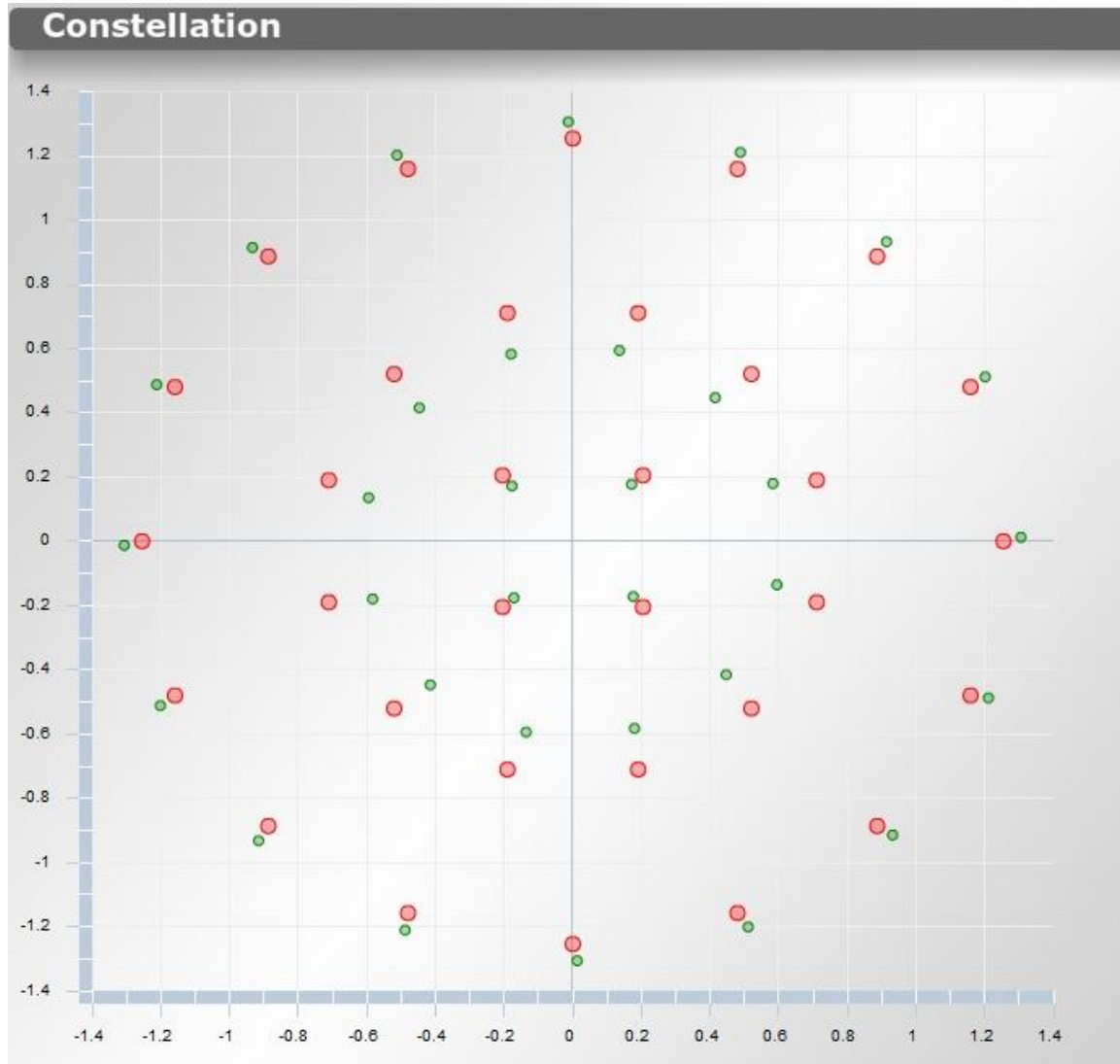
- in red, the 32APSK theoretical constellation,
- in green, the computed 32APSK constellation.

Depending on the curves used, the result of these non-linear curves can give different messages as

1. inProgress: algorithm computation is in progress
2. Ok: no error, non-linear precorrection can be applied
3. errorAlgoCannotConvergeVsCurves: embedded algorithms cannot converge with the current curves loaded. So curve adjustments are mandatory.
4. errorUnlockedCurveDetected: any curves modifications must be validated
5. errorMissingNormalizedFile: no input curves or normalization not applied
6. errorNewNormalizedFile: new input curves
7. errorAmamDecrease: curve behaviour not coherent
8. errorAmamIncreasingUpToOne: error of curve normalisation, should less than 1
9. errorAmamNotStrictlyIncreasing: error phase variations, should be monotonous
10. errorAmamDiscontinuity: strange variations for the AM-AM curve
11. errorAmpmDiscontinuity: strange variations for the AM-PM curve

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

In this example, we can see the increase of amplitude on the last circle in order to compensate the amplifier saturation. To keep the same mean power on the analogue signal, the amplitude of the other circles is decreased.



**Figure 17: Constellation with Non Linear Precorrection**

The user can use the "LOAD" button to install the nonlinear precorrection parameters on the modulator.

The ON/OFF buttons activate or deactivate the nonlinear precorrection on the RF output.

## ENHANCED SATELLITE PRECORRECTION (E.S.P)

### 4.5 Typical results: Example with a DTH transponder in India



Pay attention of this point because the precorrection tool could bring no gain when this tool is used with a well performing receiver/demodulator.

Setup of the modulator:

- Roll off at 10%,
- Current Symbol rate at 32.72MBaud with an objective: reach 35.99MHz

Goal:

Increase the C/N Margin by +1dB compared to the current solution to be able to use a more efficient MODCOD.

Setup on the receiver side:

A traditional IRD is connected to an antenna (80cm) and a consumer LNB  
 ⇒ a STB environment as a typical consumer would have

NB: the embedded equalizer cannot be switched off, it is always activated.

Results:

Teamcast: ESP OFF	Teamcast: ESP ON
13.8 dB	14.4 dB
13.7 dB	14.1 dB
13.1 dB	13.6 dB
12.8 dB	14.0 dB

**Figure 18: Measurement Results**

Conclusion:

With the E.S.P tool, the performance of the TeamCast modulator is slightly better than the current implementation used by the customer, even though the current implementation already uses pre-correction.

## 5. Support contacts

CUSTOMER SUPPORT	
Tel. + 33 (0)2 23 25 26 80	Email: <a href="mailto:support@enensys.com">support@enensys.com</a>
Fax. + 33 (0)2 23 25 26 85	