ELEKTRONIKA

ELQ 30A VDSL COPPER QUALIFIER
Appendix for Advanced Options
ESEL, DPBO, MUS, UPBO, VECTORING

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1 INTRODUCTION

The development of Triple Play services requires higher bandwidth. Broadband access technology is rapidly developed due to higher bandwidth demand. New technologies like ADSL2+ and VDSL2 have been developed in the recent years. Their purpose is to enable the installed copper cables to provide high-speed digital transmission.

System vendors have announced vectoring technology. Vectoring boosting VDSL2 data rates to some 100 megabits-per-second (Mbps) downstream and 40Mbps upstream over 400m. This compares to 50Mbps and 20Mbps, respectively, without vectoring.

Following the development of technologies Elektronika developed new advanced measuring options like:

ESEL Measurement up to 120 dB
For the programming of DSLAM when DPBO is applied

ESEL and MUS Dependent Templates
For the qualification of ADSL2+ and VDSL2 lines when DPBO is applied

UPBO
For the qualification of VDSL2 lines when UPBO is applied

VECTORING
For test of cables containing vectored groups

The purpose of this appendix is to introduce the use of advanced options and to explain their technical background.

2 DOWNSTREAM POWER BACK OFF (DPBO)

2.1 The Service Loss Problem

The development of Triple Play services requires higher bandwidth. Higher bandwidth and substantial performance gain can be reached by deploying DSLAM-s in a remote side cabinet near to the customer premises. There is no problem at clean networks (Figure 1) where all the customers are connected to the same local cabinet.

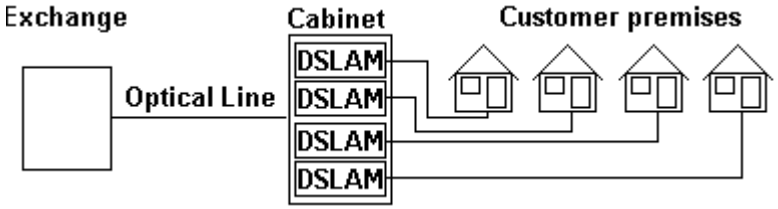


Figure 1

At mixed networks a part of subscriber lines are directly connected to the Exchange and others to the local DSLAM-s. Serious crosstalk problem and service loss may occur if the local DSLAM-s work with full power because in that case there is a considerable level difference between the directly connected and local lines at the flexibility point where the lines are adjoining.

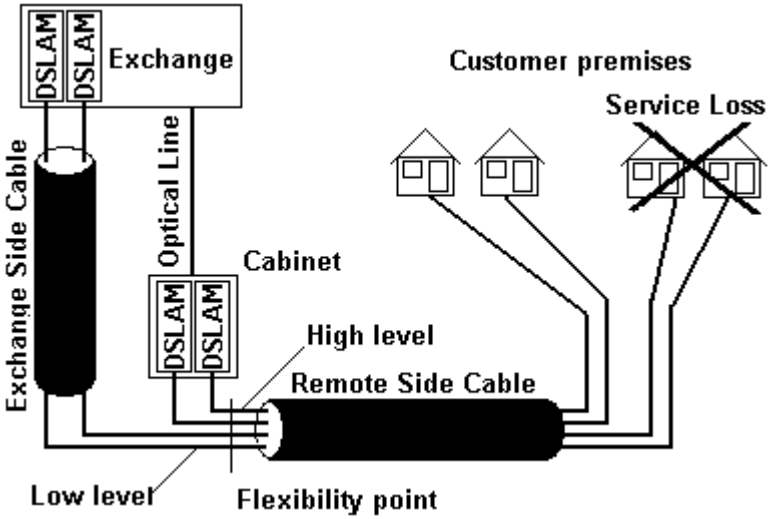


Figure 2

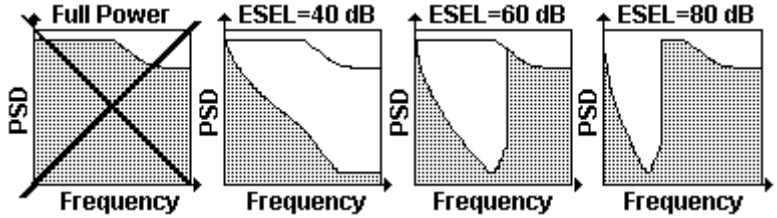
2.2 The Solution is DPBO

The generally accepted method to protect the directly connected customers is the use of Spectrum Shaping or other words Downstream Power Back Off (DPBO) at the local DSLAM-s in cabinet.

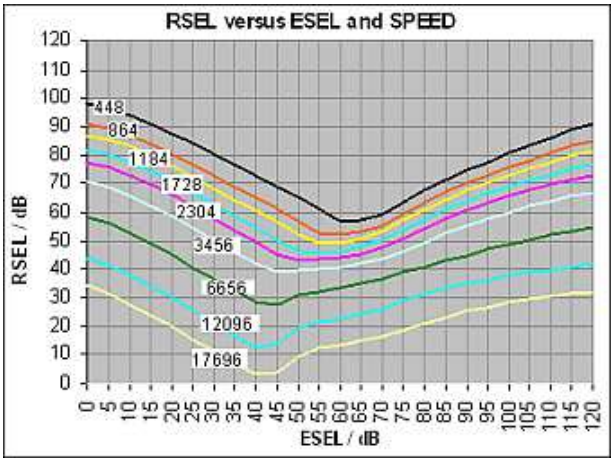
The amount of DPBO changes with the electric length of the exchange side cable and the frequency. Electric length=attenuation at 1 MHz. Here it is named as ESEL (Exchange Side Electric Length).

In case of long Exchange Side cable the usable frequency range is limited for the directly connected customers because beyond a Maximal Usable Frequency (MUF) the level falls below the Minimum Usable Signal (MUS). For frequencies over MUF the Exchange cannot allocate any bits any more, there is no need for power reduction.

The effect of Spectrum Shaping (DPBO) is illustrated in the next figure in case of different ESEL-s



The maximum electrical length of a remote side line (RSEL) is shown in the next figure



The ESEL and MUS Dependent Templates options provide templates and RSEL calculations for the local lines when DPBO is applied

2.3 Local DSLAM Programming

The key points in local DSLAM programming is the prediction of the attenuated transmitter signal. The predicted attenuation should be calculated by means of an ITU-T cable model using four parameters:

- ESEL (Exchange Side Electrical Length),
- A, B and C constants

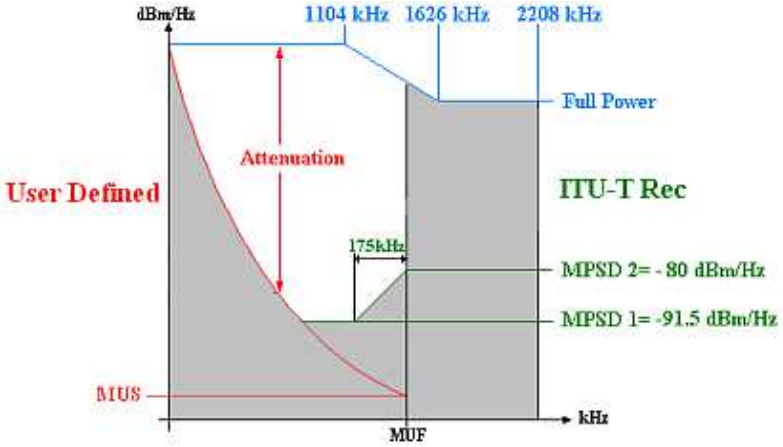
$$\text{Attenuation} = (A + B*\sqrt{f} + C*f) * ESEL$$

The ESEL depends on the physical length while the other three parameters characterize the frequency behavior of the Exchange Side Cable. The value of ESEL is equal with the measured attenuation of Exchange Side Cable at 1 MHz between the Exchange and local DSLAM.

In case of long Exchange Side cable the usable frequency range is limited for the directly connected customers because beyond a Maximal Usable Frequency (MUF) the level falls below the Minimum Usable Signal (MUS). For frequencies over MUF the Exchange cannot allocate any bits any more, there is no need for power reduction.

In this way higher data rate can be reached on lines connected to the local DSLAM without disturbing the lines directly connected to the exchange

Additionally, a few refinements are added (MPSD 1, MPSD 2) to avoid unnecessary degradation of the Remote Side performance.



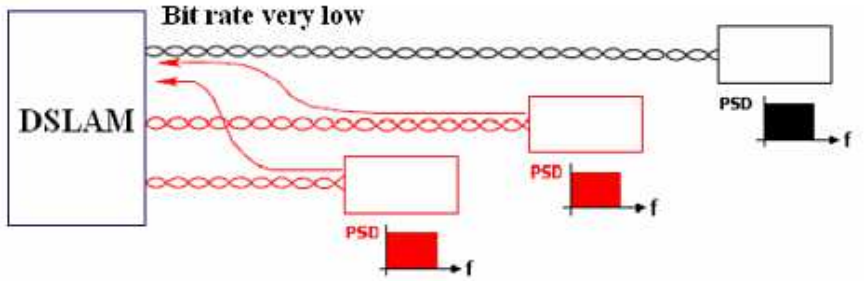
According to the ITU-T recommendations the ESEL should be measured up to 120 dB. Due to the noises the traditional loss measuring methods are not applicable over 80 dB.

The ESEL option provides special test method for ESEL measurement up to 120 dB.

3 UPSTREAM POWER BACK OFF (UPBO)

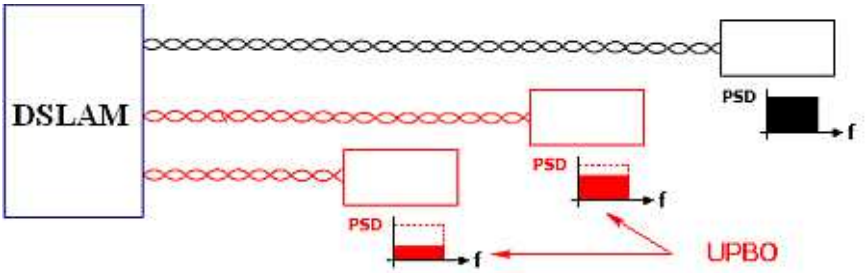
3.1 The Upstream Bit Rate Problem

Very high-speed digital subscriber line (VDSL) upstream data transmission in a distributed environment suffer from relatively strong far-end crosstalk generated by the shorter lines in the binder.



3.2 The Solution is UPBO

To secure the capacity on lines of all lengths, the transmit power of shorter lines should be reduced. This power reduction is known as upstream power back off or UPBO.



The UPBO option provides achievable upstream data rate calculations when UPBO is applied.

4 VECTORING

4.1 The Cross Talk Problem

The bit rate of VDSL2 lines is limited by the crosstalk noise. Typical a cable bundle comprises several tens to several hundred copper pairs.

The signal-to-noise ratio on each pair dictates the overall achievable data rate to the user and on short loops it is the crosstalk that is the main noise culprit.

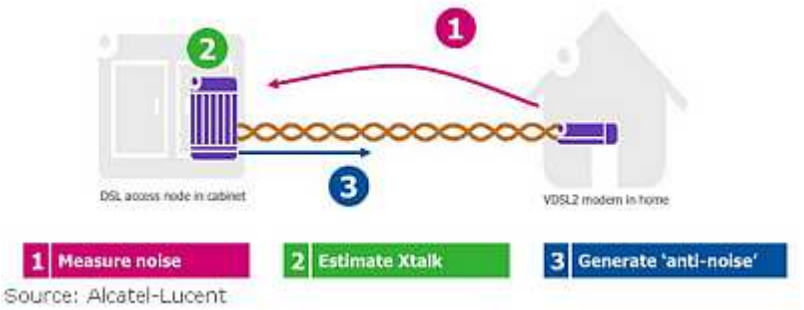
4.2 The Solution is Vectoring

The term vectoring refers to the digital signal processing (DSP) computations involved to cancel the crosstalk between the pairs of a group of lines. Lines belonging to a vectored group should be controlled by the same computer.

How does it Work?

1.) Measure noise
2.) Estimate the crosstalk coupling between the pairs in the group.
3.) Generate an anti-noise signal in the DSLAM to null the crosstalk on each line.

These steps are repeated for each line therefore the process may take some minutes.

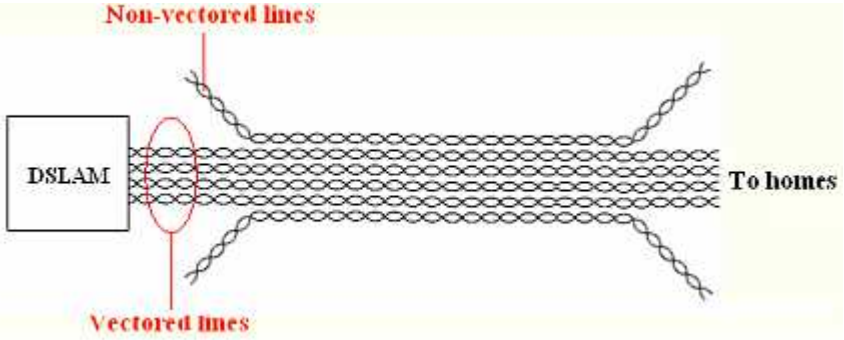


Vectoring boosts VDSL2 data rates. Achievable data rates over 400 m: 100 Mbps downstream and 40 Mbps upstream.

The efficacy of vectoring can be characterized with the Vectoring Gain. Vectoring gain=data speed with vectoring/data speed without vectoring

The achievable vectoring gain is: 1,5 to 2,2

Typical cable bundles contain vectored and non-vectored lines.



The vectoring method:

- Cancels the crosstalk noise inside the vectored group but it
- Doesn't cancel the alien noises coming from the non-vectored lines.

The operation of vectored group can be interrupted if the alien noise exceeds a certain limit therefore the traditional test methods are not applicable for the measurement of non-vectored lines because they usually disturb or destroy the operation of vectored group.

The VECTORING option provides non-disturbing measuring methods for the test of cables containing vectored groups.

5 USE OF ESEL MEASUREMENT OPTION

The purpose of ESEL option is to measure the electrical length of exchange side cable up to 120 dB. (Electrical length = Loss at 1 MHz)
In case of long exchange side cables the loss measurement at 1 MHz is problematic due to the crosstalk noises.
At the lower part of the frequency range (where the cable attenuation is relatively low) the S/N ratio is generally high the accuracy of loss measurement is satisfactory.
At the upper part of the range where the S/N ratio is low the accuracy of loss measurement is generally not satisfactory.

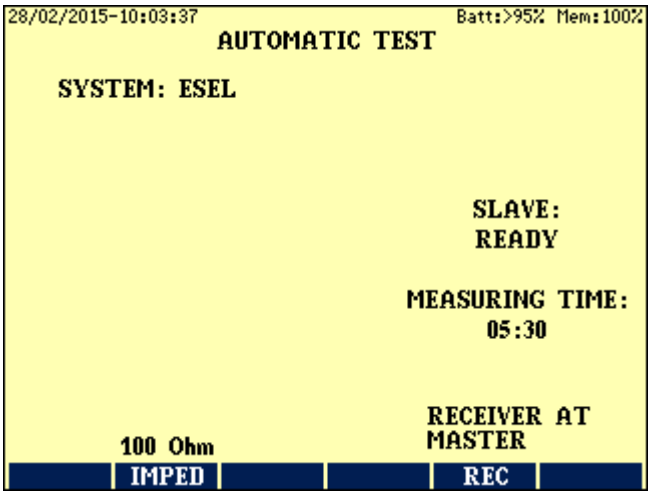
During the ESEL measurement ELQ 30A performs selective loss and noise measurements over the 1 MHz frequency range and calculates the S/N ratio for each test frequencies. At the upper part of the frequency range where the accuracy of loss measurement wouldn't be satisfactory ELQ 30A applies extrapolation.

At ESEL measurement two instruments should be used connected to the central and remote ends of the tested line. One of them is working as transmitter the other one as receiver.

5.1 Test Procedure

Preparing the Measurement

- Enter **MAIN MENU/MASTER/ESEL-MEASUREMENT** option and then the following display appears:

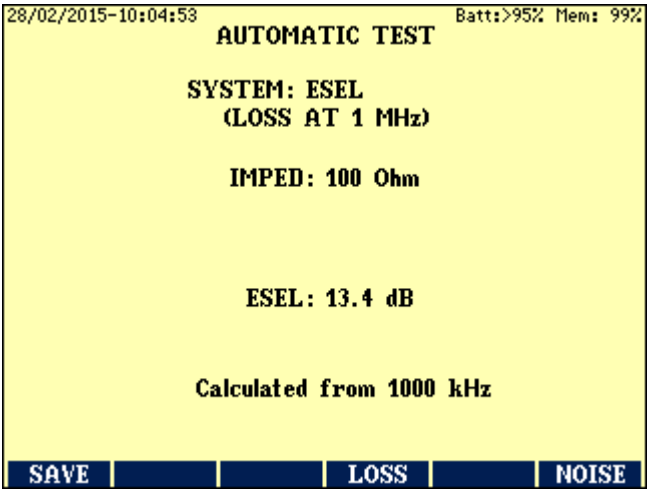


- Pressing the **REC (F5)** key set the proper location of receiver.

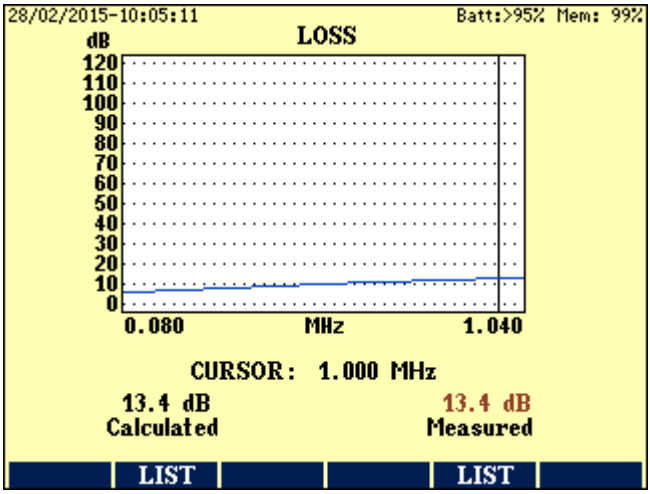
  Important Note:
  The ESEL measurement is performed in Master-Slave mode.
  The Master unit can be placed to any ends of the tested line but the receiver should be always at the remote end !!
- Press the **IMPED (F2)** key and enter the required line impedance
- Start the ESEL measurement with the **START/STOP** key when the **SLAVE: READY** indication appears

5.2 Test Results

When the measurement completed the result display appears showing the ESEL value and the frequency over which the loss values are calculated with extrapolation.



Pressing the **LOSS (F4)** key the results of loss measurement appear in graphic form



The results are available also in numeric form using the **F2**or **F5** key.
Return to the ESEL-RESULT display ESC key

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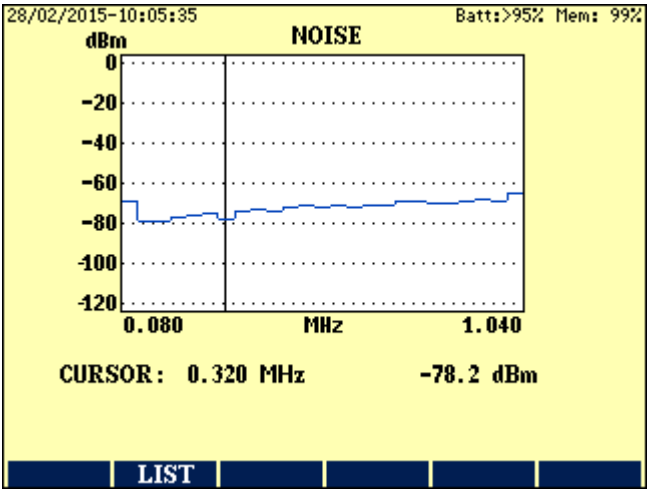
Pressing the **NOISE (F6)** key the results of noise measurement appears in graphic form.



The result is available also in numeric form using the **LIST (F2)** key.

6 USE OF THE OTHER ADVANCED OPTIONS

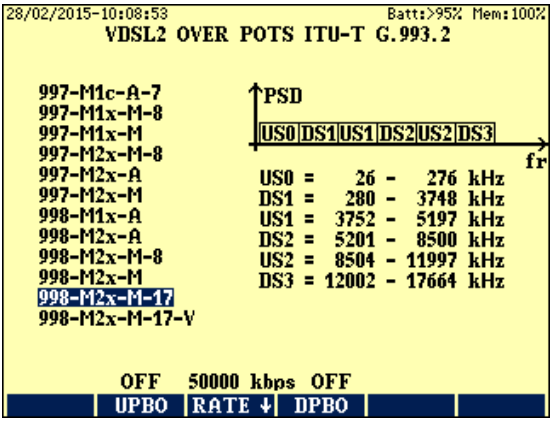
6.1 System Selection

- Enter the corresponding ADSL2+ or VDSL2 menu
- Draw the highlight to the required system with the ↑↓ keys.

Notes

1.) The UPBO key appears only when a 17 MHz system selected

2.) Select the “V” marked system if the cable bundle of tested line contains vectored group. In this case ELQ 30A applies special test methods.

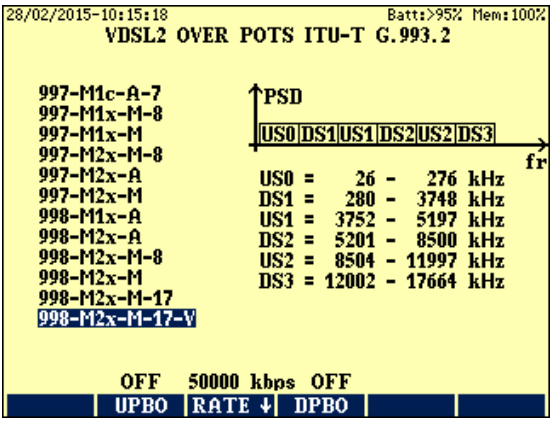


Rate selection

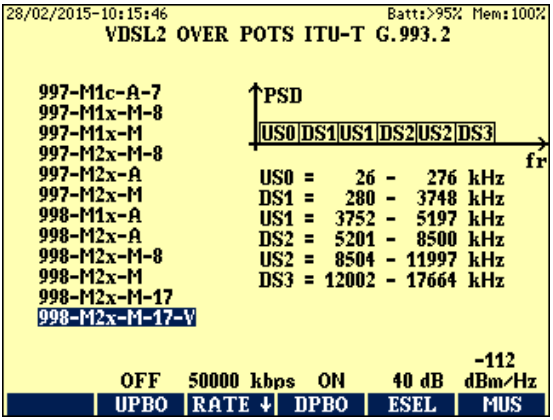
- Press the **RATE ↓ (F3)** key
- Select the required data rate with the ↑↓ keys and press ENTER

6.2 DPBO Parameter Setting

- Switch the DPBO in with the **DPBO (F4)** key



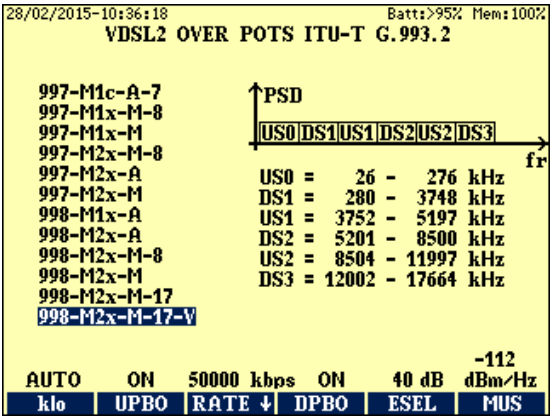
Press the **ESEL (F5)** key and enter the required ESEL value



- To modify the default MUS value press the **MUS (F6)** key and enter the required MUS value

6.3 UPBO Parameter Setting

- Switch the UPBO in with the **UPBO (F2)** key



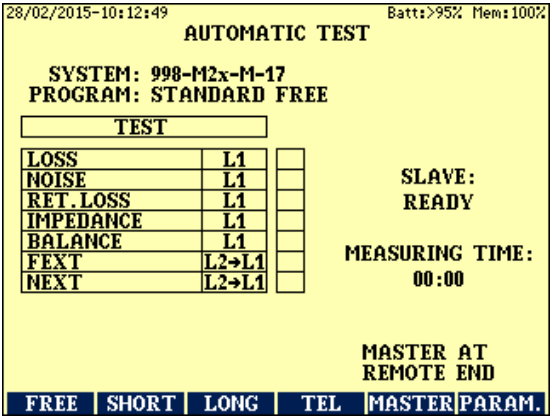
The amount of UPBO changes:

- Automatically with the Electrical Length of loop (Loss at 1 MHz) or
- According to a user predicted value.

Setting a predicted KL value

- Press the **klo (F1)** key and enter the required value.

When the parameter setting is completed press ENTER again and the following display appears:



6.4 Selection of Measurements to be Performed

The measurements of the test program can be selected with the function keys **F1** to **F3**

To avoid the interference with the operating pairs the master position should
be declared. It can be changed with the **MASTER (F5)** key.

Important note:
If the cable bundle of tested line contains vectored group and therefore the “V” marked system is selected ELQ 30A applies different special test signals at the two ends of the line. In case of incorrect position setting the test signals may disturb or interrupt the operation of vectored group !

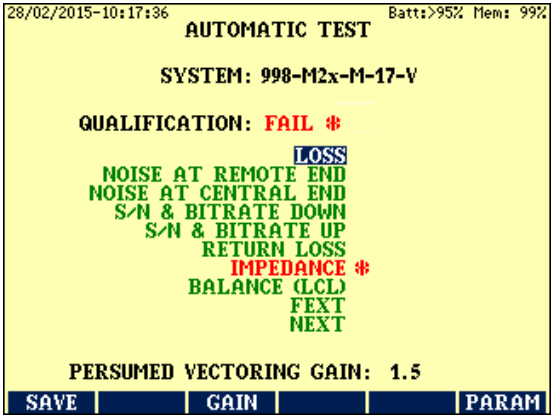
6.5 Running the Program

The program can be started or aborted by the **START/STOP** key.

Before starting the program be sure that the master and slave instruments have the same software version and the slave is ready!

Test Results

When the test program is completed a short form result page appears with immediate **PASS/FAIL** information and with the list of detailed result pages.



Displaying the Detailed Result Pages

- Draw the highlight on the required result page by using the ↑/↓ keys
- Press **ENTER** (To return press **ESC**)

The achievable data rate calculation is based on four basic data:
-Measured loss
-Measured Noise
-DN and UP stream powers specified in ITU and DT norms
-The expected vectoring gain (default=1.5)

- To modify the default GAIN value press the **GAIN (F3)** key and enter the required new value

Notice:

Some results of special vectoring test method contain approximations.