

Copper Qualification for Telecom Lines: Contemporary and future-proof health check for twin copper wires

Network providers canvass their customers with new services such as IPTV (Internet TV), Voice over IP (VoIP, Internet telephony) and modern DSL techniques such as VDSL2, ADSL2/2+ or SHDSL.

But not every line to the end consumer meets the rising demands for offering the promised performance. Consequently, what is needed are measuring instruments offering the field technicians the required range of functions for reliably checking the quality of the Internet connection.

New DSL variants such as VDSL2

How people use the Internet has changed radically from the start of the data super-highway through to today's time. What began with a brief, initial e-mail between two researchers in what was then ARPANET has now developed further to become an extensive and broadly used range of applications comprising communication and entertainment. Now, more and more people use IPTV offerings in HD quality (HDTV) and Internet telephony (VoIP), causing, amongst other things, higher data traffic. In addition, transmission technologies are changing constantly. New interfaces and protocols are being standardised regularly. Even today, the new DSL variants such as multi-band VDSL2 mean that a high-performance transmission technology exists, bringing with it, however, diverse new challenges: Crosstalk occurs more frequently owing to the higher transmission frequencies (up to 30 MHz) and the generally unfavourably laid lines. Overlap occurs with other frequencies, e.g. even CB radio.

The Triple-Play Package

The result is a higher quality demand of the twin copper wire which was originally designed for a far lower utilisation and transmission technologies which are now long outmoded. Thus network providers and servicing technicians must be able to check lines reliably for suitability so as to be able to offer their customers the entire portfolio of entertainment and communication functionalities, e.g. as "Triple-Play Package" (telephone, Internet and TV), with the same, high quality. Thus, in order to ensure customer satisfaction, network operators require measurement technologies designed for these current and future challenges, which analyze critical line characteristics and indicate improvement potentials.

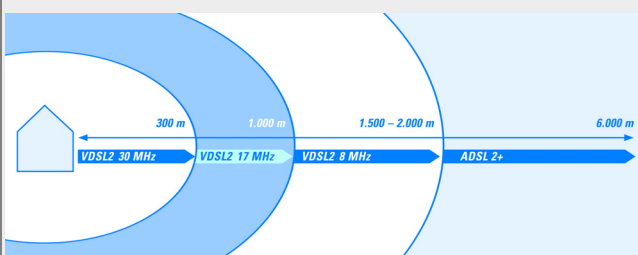


Figure 1: xDSL coverage.

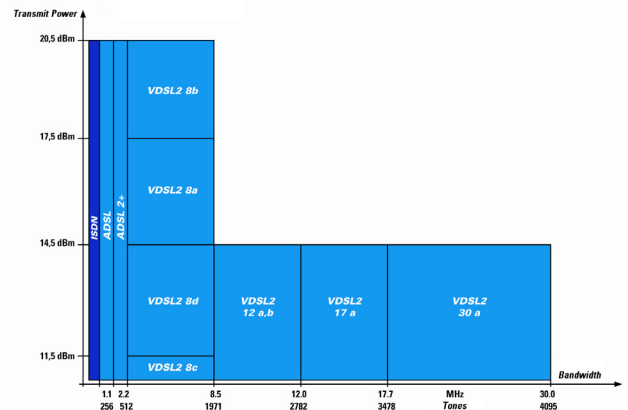


Figure 2: xDSL frequency spectrum.

About us

intec Gesellschaft für Informationstechnik mbH is developing high-quality products for the international telecommunications market for more than 20 years and is one of the leading suppliers of xDSL, ISDN and IP measurement technology in Europe today. The successful ARGUS measurement equipment enables its users to conveniently and safely commission and troubleshoot xDSL and ISDN accesses as well as those services that are based on these interfaces such as VoIP and IPTV. ARGUS testers are designed to meet the day-to-day needs of staff in the field; consequently intec development focus on ensuring high-quality measurement in a compact device that is exceptionally uncomplicated to use. The portfolio of ARGUS testers, software and analysers benefits from continual further development and is kept up-to-date with support for the latest standards for all the common access types and protocols as well as for the newest features of the Next Generation Networks (NGN) and Triple Play. Throughout the world, numerous telecommunication companies have come to appreciate and rely on the advantages offered by intec equipment; to name just a few Deutsche Telekom, Saudi Telecom, Telefonica, KPN, British Telecom and Telekom Austria.



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Test functions on access installation

The popular way for testing an xDSL connection is to connect the test unit instead of the modem and synchronise it with the distant station - the normal procedure for installing a new connection. After successful synchronisation, it is possible to conduct a series of measurement routines. This includes testing the most important DSL parameters (e.g. current bit rate, maximum possible bit rate, signal-to-noise ratio, line attenuation, signal attenuation and output power) and error counters such as CRC (Cyclic Redundancy Check), HEC (Header Error Checksum), FEC (Forward Error Correction). If these values are satisfactory, the installer can initially state that the line is OK. However, if problems and irregularities occur even at this point, the servicing technician can now evaluate even other results, seek out malfunctions and assess the line quality.

Informative results even without synchronisation

Previously, when the field technician has been unable to replace the customer's modem with the measuring instrument, no synchronisation with the distant station is possible and the fault finding is aborted.

However, it is now possible to investigate the physical characteristics and possible fault sources on the twin copper wire even without synchronisation.

Simply connect the test unit either directly, or by using a high impedance probe, to an existing connection between the modem and DSLAM (see figure 3).

This passive connection will minimise the disturbance to the line and allow more precise testing of the copper wires.

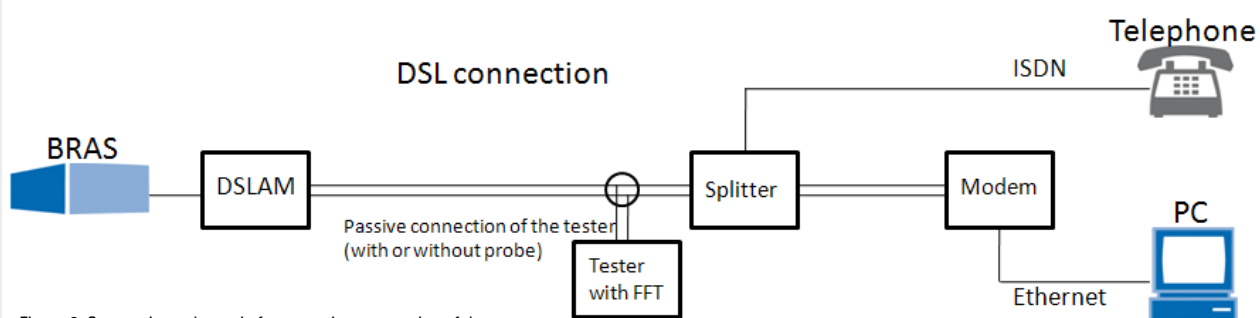


Figure 3: Connection schematic for a passive connection of the tester.

Bridged Taps

Correct in-house cabling plays an important role in particular in the case of VDSL2. At the high frequencies, even a few metres of stub line (e.g. to a telephone socket in another room) lead to clear reductions in the achievable data rate. However, these stub lines can be detected very well with Hlog/tone graphics (amplitude share of the transmission function). Besides the stub lines, detection of interference sources which couple into the line and impair performance is becoming more and more important since, for instance, pulse disturbance sources may lead to major dropouts in the case of IPTV. One initial approach is to measure the so-called QLN/tone graphics (Quiet Line Noise-empty-channel noise).

The new multimedia services

As standard, a PPP connection should be able to be set up and it must be possible to conduct IP tests for all conventional services, which includes testing the pure data transport services, such as FTP and HTTP, the form of upload and download tests, in addition to tests in respect of availability and quality for the new multimedia services such as Voice over IP (VoIP) and Video-on-Demand (VoD) in addition to IPTV.

If there is reason to believe that sync losses or errors occur sporadically for instance, it may even be necessary to conduct long-term analyses of the line or service.

The following test functions are now possible thanks to this new form of connection:

Determining the interface

Analysis with a line scope similar to an oscilloscope allows you to determine how the line is used. For instance, is the line a pure ISDN line or is there also an ADSL, VDSL or SHDSL connection? By analysing the signal in the time range (see figure 4), it is possible to establish whether high-frequency signals exist on the line. Using FFT analysis (Fast-Fourier Transformation), it is possible to diagnose whether the connection is an ISDN UK0 or possibly a 2 MBit/E1 connection and what DSL variant is used. In order to detect particularly weak signals, the signal gain can be increased and the frequency/time range can be changed for the display.

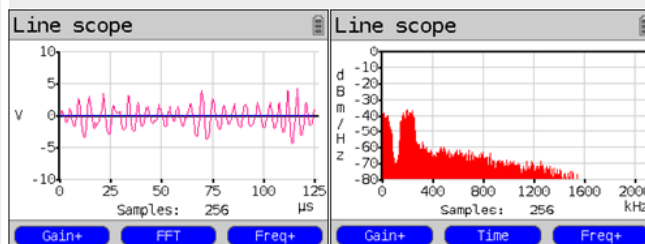


Figure 4: Line scope in the time range (left) and frequency range [FFT] (right). Example of an ADSL2+(Annex B) connection.

Identification of DSL pilot tones

In order to test whether a customer modem is connected at all, it is possible to test whether DSL pilot tones are sent. Missing pilot tones indicate a problem with the connection and should thus be excluded at the start.

Illustration of the entire synchronisation process

It is advisable to evaluate the entire synchronisation process (see figure 5) in order to identify errors and disturbance sources more precisely.

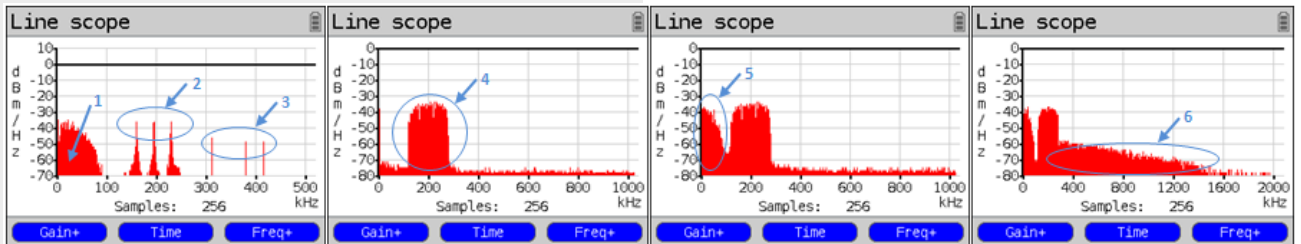


Figure 5: ISDN (1) and pilot tones (2, 3), the modem attempts to synchronise; the modem sends the upstream (4), the test unit is located very near to the modem since the upstream signal is very large; ISDN (5) is added; the DSLAM responds, the downstream (6) can be seen, this is ADSL2+ (Annex B) and a long line.

Providing an even more detailed appraisal of the line behaviour, this also allows interference sources such as crosstalk on adjacent lines to be identified. If, for instance, a previously unused neighbouring line in the customer's house is to be used for the first time, it is possible to test to what extent this line has been influenced by the line already active. For this purpose, one connects the tester to the neighbouring line and compares the line scope result (see figure 6) with the already tested results of the existing line. This allows crosstalk (owing to the similar pattern) or even an interference source (runaway value in the signal (1)) at a specific frequency to be identified.

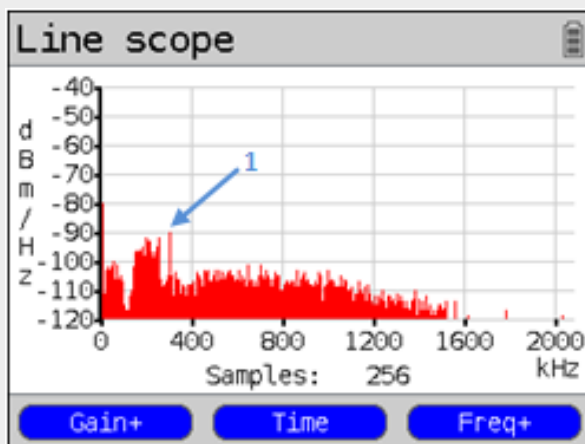


Figure 6: Analysis result with cross talk and disturbance source (1) on a neighbouring line.

PSD test with the aid of DMT

If the servicing technician suspects that there is a fault but he has no valid proof to date, he should analyse the transmit power on the line via tone (PSD - Power Spectral Density) and the DMT tones. The result of this test is measurement of the signal or noise on the line and more precise identification of crosstalk and disturbance sources (see figure 7). In the example illustrated for instance, it would not have been possible to detect the very weak interference source at 1500 kHz (3) before DMT analysis. The crosstalk (1) and the interference source (2) at approx. 300 kHz can now be seen far more clearly.

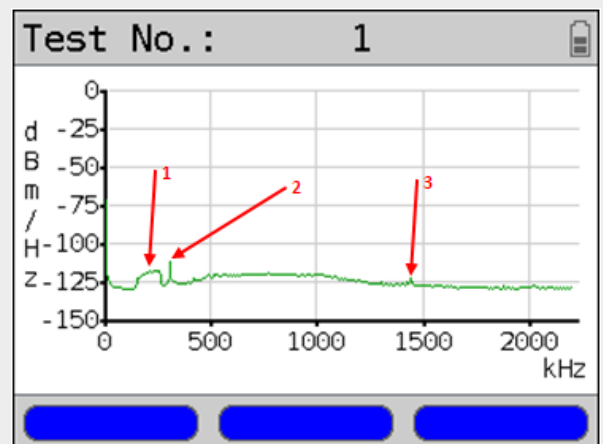


Figure 7: DMT analysis results with crosstalk (1) and interference sources (2, 3).

Signal-to-Noise-Ratio-Margin

If the tester replacing the modem is active, the technician, with the aid of DMT analysis, can even determine the line quality on the basis of the signal-to-noise ratio margin (SNRM - Signal-to-Noise-Ratio-Margin). The major advantage is that not only noise but also the intensity of the noise can be analysed.

The greater the spacing between the minimum and maximum signal curve, the higher will be the signal-to-noise-ratio margin and, subsequently, the higher will be the maximum achievable data rate on the line (see figure 8).

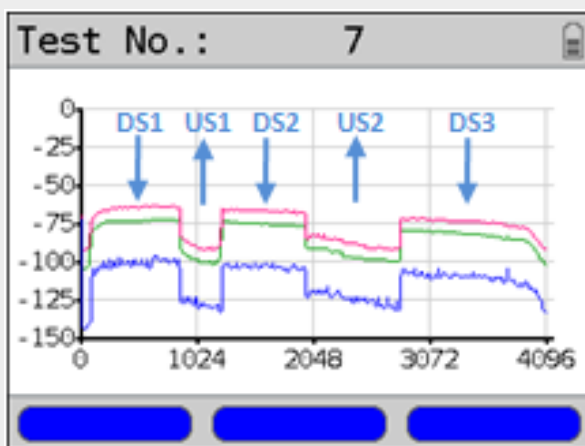


Figure 8: Determining the signal-to-noise ratio, green = average SNRM, blue = minimum SNRM, red = maximum SNRM, in addition, three downstream (DS1 to DS3) and two upstream bands (US1 and US2) can be seen, for example VDSL2 in accordance with profile 17 a (i.e. with 17 MHz).

Upshot:

These new test functions on the twin copper wire are becoming more and more important for installers so that line problems can be precisely detected and remedied. Whether fast troubleshooting of a performance failure on customer premises or preventively before installing an Internet connection. Network operators can thus guarantee the performance of their Internet offerings in the long term and customers benefit from more stable and more high-performance networks meeting the risen demands of modern Internet applications.

ARGUS®

testing the telecom network



Figure 9: ARGUS 145 plus: VDSL2-, ADSL-, SHDSL, Triple Play-, ISDN-, POTS- and copper combination tester.



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Overview of combined testers

All copper test functions mentioned in the article, including QLN and Hlog per tone, in addition to DMT scope and DMT analysis, can be used with various hand-held testers of intec Gesellschaft für Informationstechnik mbH. The easy-to-use and flexible combination testers of the ARGUS brand offer servicing technicians precisely the right tools for measurements on ADSL, VDSL2, SHDSL, Ethernet, ISDN and analogue connections, thus allowing testing of the services offered via the line, such as HTTP, FTP, VoIP, IPTV and a great deal more. They unite test functions for an extremely wide variety of requirements in a compact and handy housing.