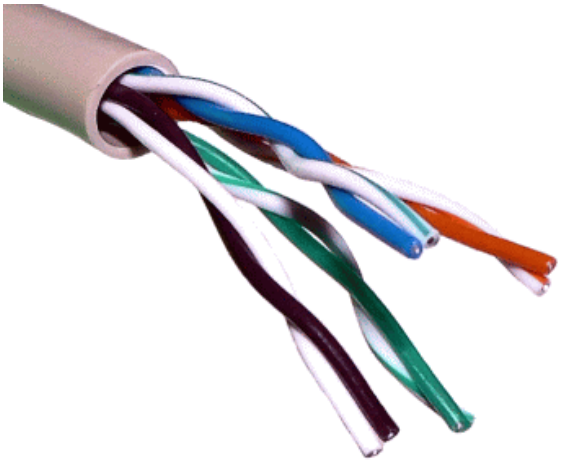
Diagnostics and preventative maintenance on old cabling

DDW-142

Twisted pair cables



Twisted pair cable consists of a pair of insulated wires twisted together. This type of cable has been used in telecommunication for many years. Cable twisting helps to reduce noise pickup from external sources and crosstalk within multi-pair cables.

Twisted pair cable is good for transferring balanced differential signals. The practice of transmitting signals differentially dates back to the early days of telegraph and radio. The importance of improved signal-to-noise ratio and reduction of crosstalk are particularly valuable in installations in harsh environments.

The most commonly used form of twisted pair is unshielded twisted pair (UTP). It is just two insulated wires twisted together. Many data communication cables and normal telephone cables are this type. Shielded twisted pair(STP) differs from UTP in that it has a foil jacket that helps prevent crosstalk and noise from external sources. In data communications there is a cable type called FTP (foil shielded pairs) which consists of four twisted pair inside one common shield (made of aluminium foil).

Westermo has for some time offered Industrial Ethernet extension solutions allowing companies to create high speed Ethernet links by reusing existing cabling. This solution obviously saves much time and money at the installation phase of a network but the use of old cables with uncertain routing and old joins may be perceived as a maintenance risk.

What can be done to mitigate these risks?

There are several ways to do this. Firstly the creation of a resilient network structure with diverse routing will ensure that a single point of failure in a network will not result in downtime. The next option is to ensure that any link is not at the extreme of performance and the final method is to maintain constant monitoring of the quality of the link.

Cabling and EMC

In order to reduce emission significantly, the use of shielded cabling proves to be far the most straight forward solution. But balanced transmission or balanced transmission plus shielding are two different means to achieve good EMC performance. With a well balanced system, will shielding really be necessary? Will STP always give better EMC performance than UTP? The answer is not clear and depends on application. Both cable types have their good and bad properties. Since the line interface of SHDSL is perfectly balanced you can almost state that there is no need for shielding at all.

Characteristics of a cable that affects the reach

Resistance It is measured in ohm/km and varies with the wire s material and cross section. The resistance of the cable is evident from the data sheet for each cable. At low transmission rates it is the resistance that sets the limitations.

Capacitance As the conductors in the cable are isolated from each other they will generate a capacitive effect between each other. The twisted pair, conductor material and any screen will also have an effect. The capacitance attenuates the signals differently at different frequencies. Capacitance is measured in pF/m and a guideline value for a good data cable is approximately 50–70 pF/m. At high transmission rates it is the capacitance that sets the limitations.

Attenuation states the cable s overall attenuation of the signal from the transmitter to the receiver. Cable attenuation is stated in dB/km and increases with ascending frequency. An increase in attenuation of 3 dB represents a halving of the output

Line performance

When measuring a line for its capability to transmit data we often use the term Signal to Noise Ratio (SNR). SNR is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal):

$$\mathrm{SNR} = \frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}},$$

SNRs are often expressed using the logarithmic decibel scale. In decibels, the SNR is defined as

$$\mathrm{SNR_{dB}} = 10\log_{10}\left(\frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}}\right) = P_{\mathrm{signal,dB}} - P_{\mathrm{noise,dB}},$$

This makes understanding whether a link will be good very easy to see. Obviously the higher the difference between the power of signal and the power of the noise the more likely it is that the system will work. So a system with an SNR of 10dB will be much more reliable than one with an SNR of only 3dB. With SHDSL systems low SNR values will also result in lower data-rates.

Variation in SNR

The SNR of a system is likely to vary over time. This is because there are variables that affect the power of the noise and signal.

Many cables contain joins which over time can corrode introducing greater line resistance. Moisture can also enter cabling over time and this again affects the impedance of a line. Both of these factors will reduce the signal power on the line. Noise can be introduced into a system by many means. If your cable is in a bundle of unused cables then the noise level caused by crosstalk is low, however at some point in time other lines could start to be used hence an increase in the noise. Noise could also be introduced by operating machinery and so could be worse at some times of day.

What this picture builds is one of risk for a marginal solution. The system may work perfectly when installed but after a period of time problems may be experienced.

Noise margin

The noise margin is the difference between the required SNR for a certain bit rate, and the actual SNR. When the SHDSL connection data rate is set to auto (auto-negotiation mode), the operator can configure a reliable (10dB), normal (6dB) or high speed mode (3dB). In reliable mode noise margin gives robustness against SNR fluctuations. Specifying a large noise margin may imply that a low data rate is negotiated.

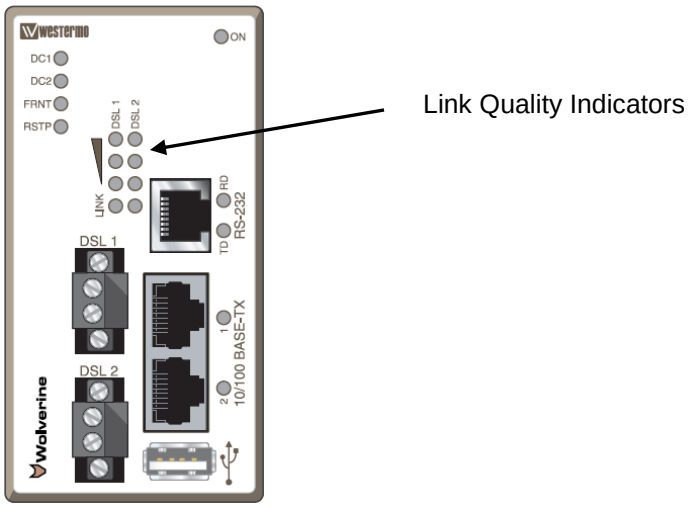
G.HS Threshold

The G.HS threshold setting is only needed if the units are located in a noisy environment with SHDSL line cables of good quality. With this setting it is possible to change SHDSL negotiation parameters in a way that meets the environmental characteristics.

Monitoring SNR

The Westermo DDW-142 is designed to constantly monitor the SNR of the communication line so providing a method of checking for any degradation of the line.

The simplest solution for monitoring this is the LEDs provided on the front of the DDW-142



Links below 3dB Unstable	Links below 5dB Marginal	Links below 9dB Normal	Links above 10dB Strong

By simply recording the level of the signal periodically degradation could be noted. At this point either a preventative maintenance program could be started or more advanced logging could be activated within the unit.

Remotely Monitoring SNR

The DDW-142 is a fully managed network device and supports Simple Network Management Protocol (SNMP).

By setting up and using a Network Management tool values within the Management Information Base (MIB) of the DDW-142 can be monitored and logged.

The DDW-142 supports relevant parts of RFC 4319 HDSL2/SHDSL MIB:

hdsl2ShdslSpanConfTable,
hdsl2ShdslSpanStatusTable,
hdsl2ShdslInventoryTable
hdsl2ShdslSpanConfProfileTable

Variables showing the SNR of each line can be monitored.

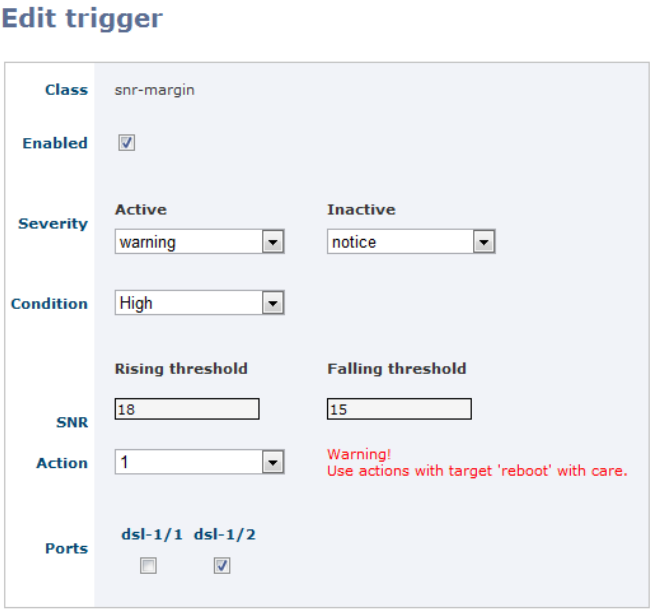
Alarms

The DDW-142 utilises the Westermo WeOS network operating system which allows for a range of Alarm sources to be easily supported. Amongst these sources is the SHDSL/xDSL SNR-margin which triggers in the event that SNR margins fall below a configured threshold.

When setting up the SNR-margin trigger in WeOS the important settings are the SNR thresholds. You simple enter the rising threshold if you wish to be informed of an improving SNR situation and the falling threshold if you wish to know about degradation of the line.

The WeOS CLI can also be used to set up these alarms

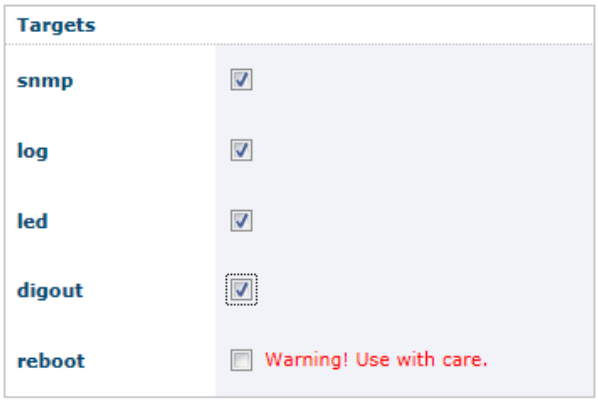
In this example an SNR-margin trigger is created for DSL ports 1/1 and 1/2, with falling threshold 4 dB and rising threshold 6 dB.



wolverine:/#> **configure**
wolverine:/config/#> **alarm**
wolverine:/config/alarm/#> **trigger snr-margin**
Created trigger 2
wolverine:/config/alarm/trigger-2/#> **port 1/1-1/2**
wolverine:/config/alarm/trigger-2/#> **threshold falling 4 rising 6**
wolverine:/config/alarm/trigger-2/#> **end**
wolverine:/config/alarm/#> **show**
Trigger Type Enabled Action Source
==
1 power YES 1 1 2
2 snr-margin YES 1 1/1 1/2
wolverine:/config/

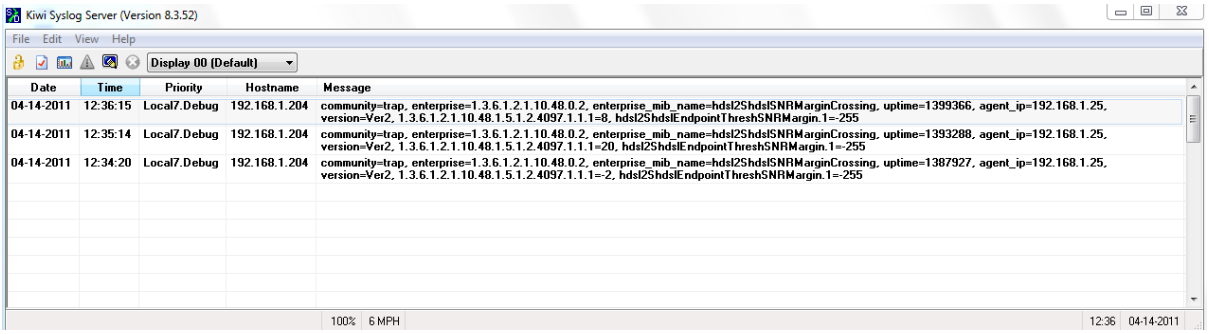
Actions

In WeOS different action profiles can be created these action profiles can then be used together with alarms and alarm events.



Actions that can be taken are

1) An SNMP Trap is sent to a designated trap receiver.



In WeOS it is possible to configure two different trap host addresses.

2) A log can be made to a file in the DDW-142 unit itself or a packet can be sent to an external server using the syslog function.

3) The Digital output can be triggered – this could be connected to a digital input on a PLC or RTU.

Preventative maintenance

Once a pattern of SNR variation can be established it may be possible to improve the situation by taking actions to reduce noise levels or to repair line connections. Cable joins can be remade, sections of cables could be moved to avoid noise sources or even replaced. If diverse paths and network resilience protocols are in use then this maintenance can be carried out without network downtime.

Conclusion

SHDSL technology is a fantastic time and money saver however in many industries reliability is also a key requirement. By monitoring the SNR on the line and employing resilient networking technology SHDSL solutions on old cabling can be used even in mission critical systems.