ADVANCED TECHNOLOGY

AN INTRODUCTION TO A NEW MICRO-REFLECTION LOCATION TECHNOLOGY

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AN INTRODUCTION TO AN ENTIRELY NEW TYPE OF NETWORK TRAFFIC COMPATIBLE TIME DOMAIN REFLECTOMETER – THAT CAN BE USED ON ACTIVE PLANT WITHOUT ANY SIGNAL DISRUPTION

OVERVIEW

This paper describes a new technology that for the first time allows the technician to precisely measure the distance to impedance mismatches in the HFC network without affecting any active network traffic.

/ DESIGNED AS A PNM COMPANION TOOL

The proactive network maintenance (PNM) initiatives being deployed throughout the industry to identify sources of micro-reflections have proven to be a game changer in how the HFC network is maintained. The ability to direct a technician to a specific location in the plant to start the troubleshooting process provides the opportunity for significant operational savings and improved problem resolution times.

There is, however, room for improvement when it comes to providing technicians with tools to perform the necessary field troubleshooting. In situations where technicians are dispatched to locations with no clearly visible damage to the plant and corresponding source of micro-reflection, the lack of existing tools to non-intrusively troubleshoot the network can be frustrating. Furthermore, the lack of clear visibility and the inability to test for the impairment location can result in many perfectly functioning cable spans, connectors, and passive devices being unnecessarily replaced, because the technician has no choice other than to guess where the problem is actually located.

To address this issue, and to provide the technician with companion PNM field troubleshooting tools, Arcom Digital has developed a new and innovative Network Traffic Compatible (NTC) Time Domain Reflectometer (TDR). NTC TDR enables the technician to easily and accurately measure the distance to the source of the micro-reflection problem – and it allows them to work with the confidence that the identified device or cable being fixed or replaced is the exact source of the problem.

This new test equipment is termed NTC TDR because it is able to operate on an active plant without disrupting or being disrupted by any of the traffic or transmitted data. Traditional TDRs employed in the industry are very inaccurate in the presence of AC power, so they require the technician to disconnect the network in order to use. This practice is obviously not consistent with the customer experience demanded today.

TROUBLESHOOT WITHOUT DISCONNECTING THE NETWORK

The NTC TDR is completely different from this status quo. The NTC TDR calculation of the time distance and corresponding physical distance to the impedance mismatch is based on an autocorrelation process which utilizes very low level non-intrusive spread spectrum signals transmitted in the return path in the forward.

An illustration of how the device operates and connects to the network is provided in Figure 1. Here, a spread spectrum signal is input through an amplifier return in test port, the signal travels through the network to the next amplifier where, due to the presence of the diplex filter, the probing signal can go no further. The signals are then reflected back at all points not having a perfect 75 ohm match and the reflected signal is detected and measured at a second return out test port. (For simplification, in Figure 1 only one reflected signal is shown.)

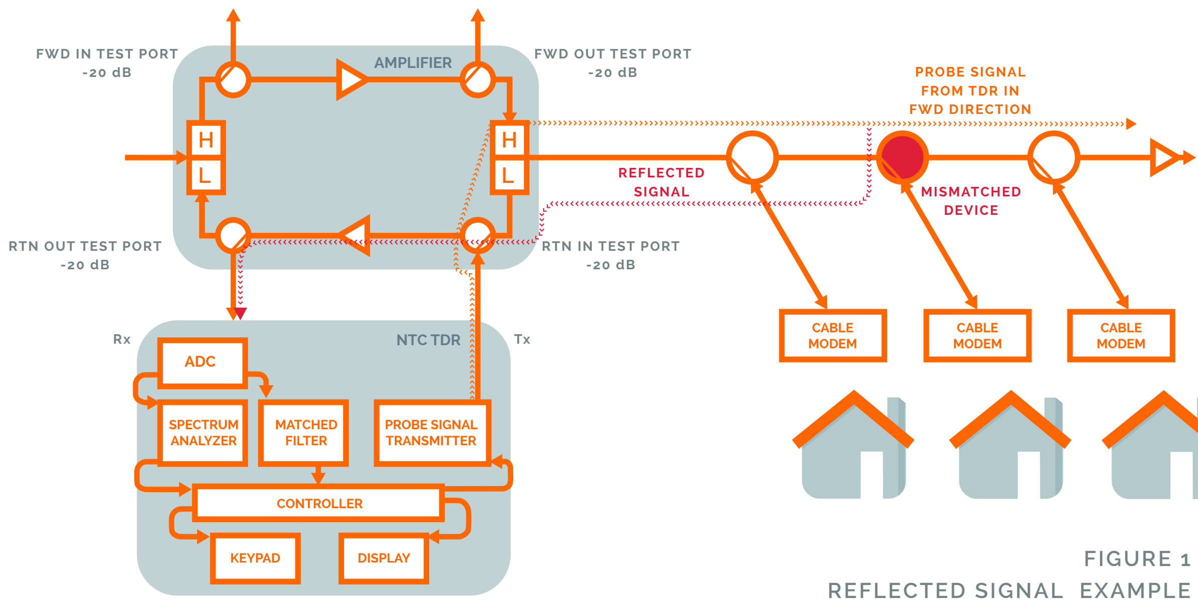


FIGURE 1
REFLECTED SIGNAL EXAMPLE

The NTC TDR output display screen is shown below. The screen is unique in that it presents easily understandable visualizations of return loss across the measured span. This output format is a significant improvement over other TDRs, which simply provide difficult-to-interpret impedance bumps indicating shorts or opens.

THE FIRST TWO-PORT TDR

FIGURE 2
LINE PASSIVE
CONNECTION DIAGRAM

There are a few more details behind the NTC TDR that are important to understand. Unlike other TDRs, the NTC TDR is a two-port device. This provides a mechanism for important control and measurement of signal level and also allows the device to operate in the presence of active return traffic.

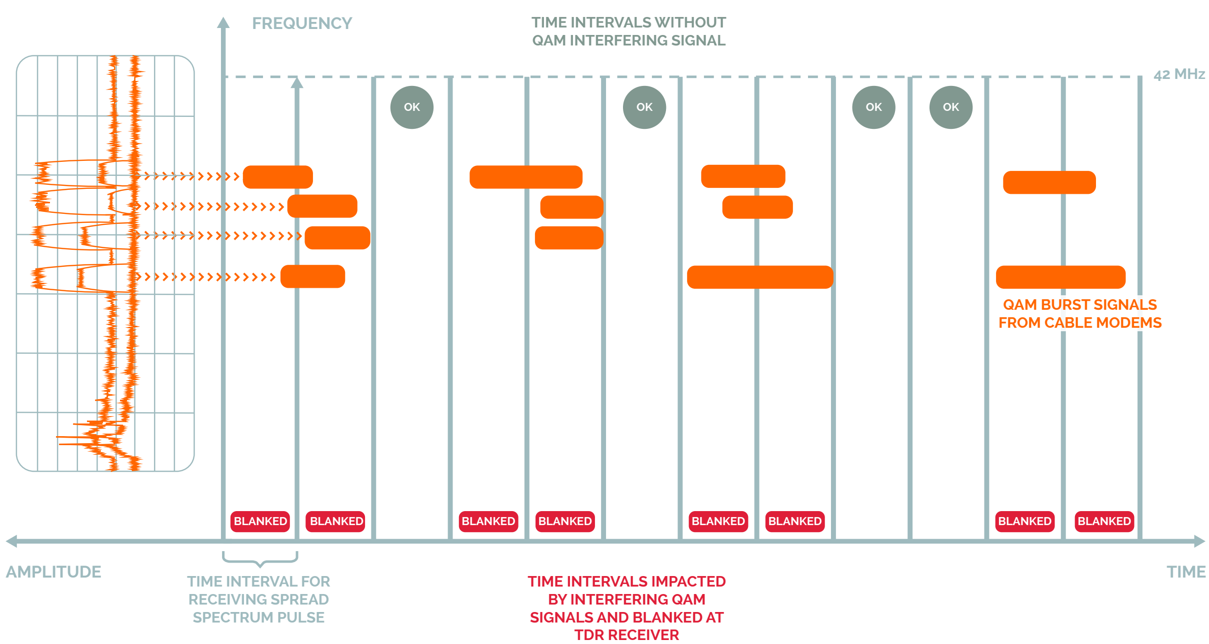
It is obviously important that the NTC TDR does not in any way disrupt return signal quality. From the DOCSIS specification, in order not to affect signal quality any signal needs to be at least -25dBc relative to the return QAMs so as not to impair CNR/SNR. As such, allowable transmit levels are extremely low level and range from and are limited to -10dBmV to +10dBmV (typically -30dBc to -50dBc) – ensuring that the spread spectrum signal will not be network affecting. A built-in spectrum analyzer provides a simple one button means of confirmation.

As an alternative connection methodology, the NTC TDR can be connected directly to a line passive where the forward and return connection is made by using a -20dB 2-port test probe connected directly to the center conductor via the seizure screw access port, as shown in Figure 2.

ADVANCED SIGNAL PROCESSING TECHNOLOGY

A second important ability provided by the two-port device is the coherent accumulation of samples for the autocorrelation function (implemented as a matched filter) during time periods of absent return traffic. As described, the NTC TDR operates utilizing very small signal levels. The -30dBc signals are further attenuated through test port loss, cable loss, and device insertion loss for both the transmitted and reflected signal. These very low level signals would be masked and obliterated by high-level active return traffic. As such, the internal spectrum analyzer is used as shown in Figure 3 as a gating tool to ensure autocorrelation signal samples are only accumulated during the quiet periods when QAM signals are not present. This entire described process occurs within one second.

FIGURE 3
GAITING SCHEMA



EXTREMELY HIGH ACCURACY AND RESOLUTION IS ACHIEVED

Since a wideband signal is utilized for the NTC TDR, very high levels of accuracy and resolution are realized. With the 5-42 MHz return, resolution of approximately 10 feet and accuracy of 1 foot is achieved. For 65 MHz returns in Europe and possibly in the future in the United States, resolution and accuracy will be improved twofold.

Field results are shown in Figure 4, along with a network map of the span being tested. The presence of network maps can further assist the technician in visualizing what the NTC TDR screen is displaying. Typical line passive return loss is approximately 16dB. The user can easily see where a device has deteriorated return loss, and can also match these device display peaks with the expected return loss characteristics of the span.

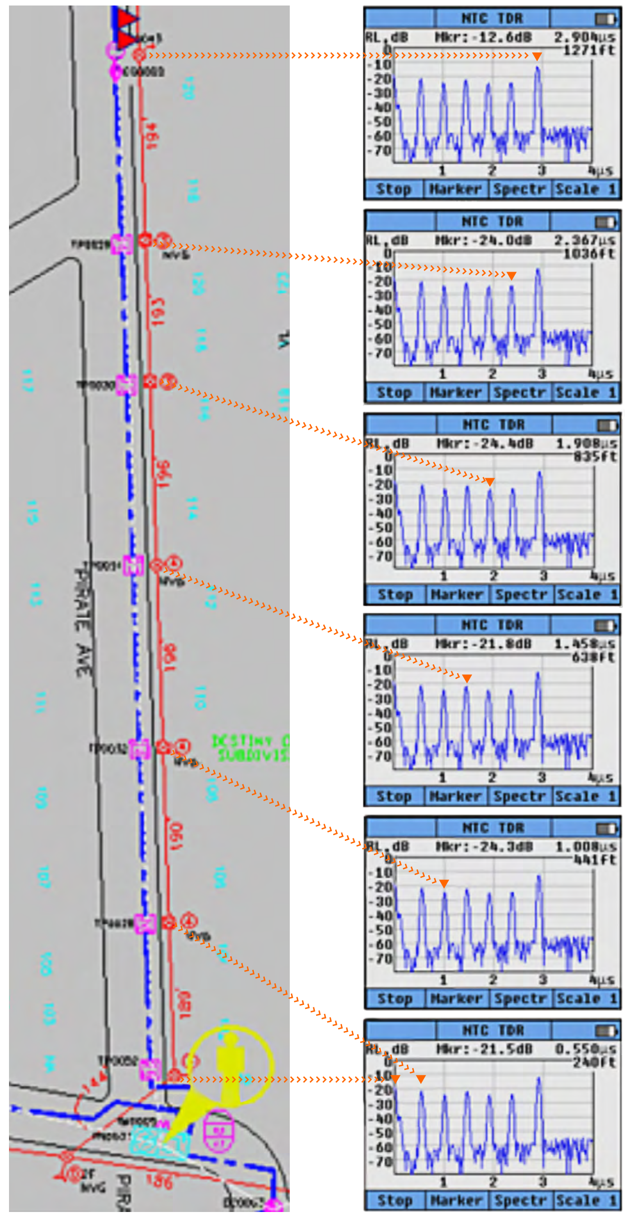
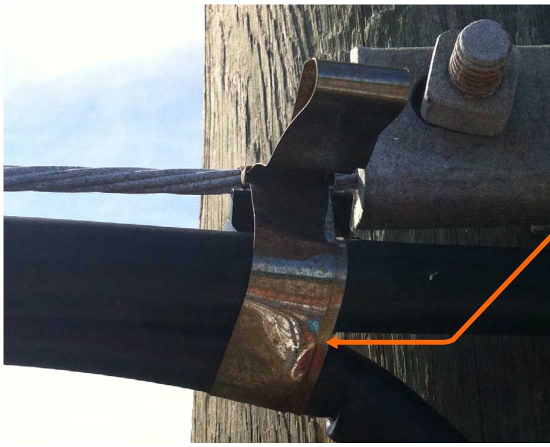


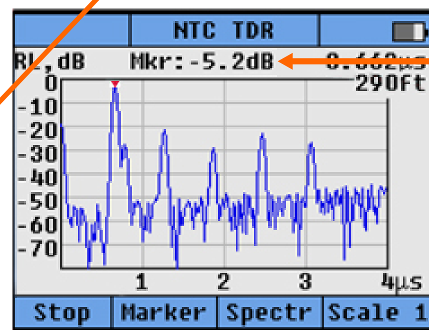
FIGURE 4
VISIBILITY TO ALL PASSIVES AND RL ACROSS THE SPAN

EASILY UNDERSTOOD RETURN LOSS INDICATION

AT THIS RETURN PORT, THE NEXT PEAK SHOWED UNNACCEPTABLE RETURN LOSS OF -5dB

IT WAS A BROKEN CABLE AT THE NEXT DEVICE AFTER THE NODE





Additional field results are provided in Figure 5 showing a different leg with poor return loss of 5dB. This was at the next device from the connection point. The technician simply went to the next passive and noticed that the cable was kinked – and effected repair.

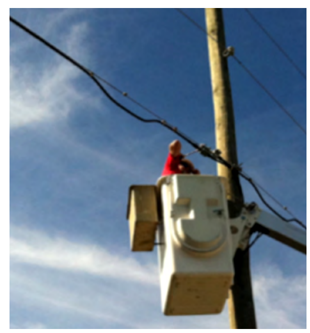


FIGURE 5
EASILY FIND AND FIX THE PROBLEM

The NTC TDR provides the technician with visibility to all linear distortions and provides the ability to test a leg unobtrusively prior to making a repair or changing out equipment. The NTC TDR is implemented in the Arcom Digital Quiver®, which also contains Xcor® technology that allows for measuring time distance to non-linear distortions such as Common Path Distortion (CPD) and overloaded amplifiers. This one device can be used as a PNM companion tool – to exactly locate the distance to both linear and non-linear distortions. This significantly increases the technician efficiency by providing them with a tool to accurately and quickly respond to and fix problems they have been dispatched to fix.

CONCLUSIONS

- The NTC TDR was designed specifically to assist the technician in troubleshooting locations identified by PNM tools.
- This new technology operates without adversely affecting traffic on the network, and it can be used without disconnecting the plant – a practice that is not consistent with quality of service expectation of customers.
- The display and autocorrelation output indicates return loss across the entire cable span, a very technician friendly and universally understood output.
- The NTC TDR technology is implemented in Quiver®, and can be used in companion with the Xcor® technology which indicates the exact distance to non-linear distortions.

.01 A PNM companion tool implemented within Quiver.

.02 A test equipment paradigm shift, stop measuring - start locating.

.03 One fault identification device can now identify both linear and non-linear distortions.

.04 A new tool to better identify impairments and to better troubleshoot the network.

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