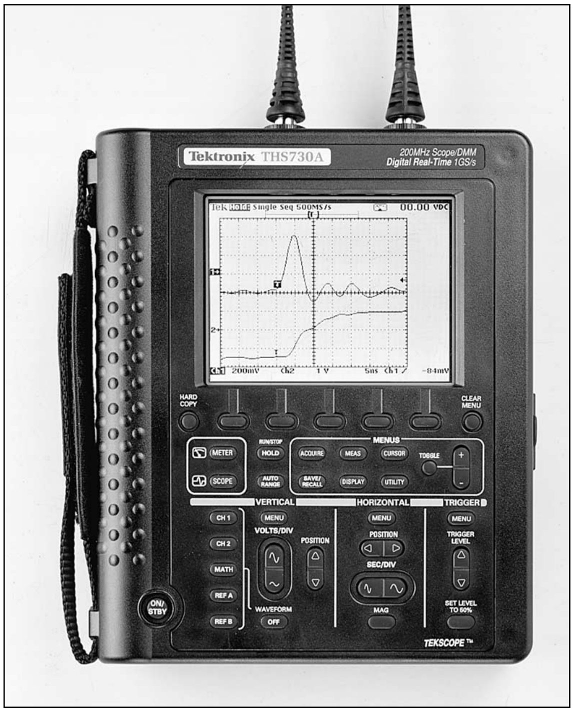
Application Note

Using The THS730A And WaveStar™ Software To Investigate Carrier-Band Networks



The Tektronix THS730A 200 MHz Handheld Digital Oscilloscope.

Designing and testing communication networks often requires the use of portable test equipment along with the need to document the results. In this application brief, the THS730A Handheld Oscilloscope is used in conjunction with Tektronix WaveStar™ Waveform Capture Software to capture, document, and analyze communication signals from carrier-band networks. WaveStar is a Microsoft Windows™ 3.1 application that allows Tektronix digital oscilloscopes to capture, organize, annotate, analyze, and archive waveforms and settings.

Understanding Carrier-Band Networks

Carrier-band networks are intended for connecting devices in a manufacturing cell for particular processes or operations – such as a group of machine tools or a robot assembly operation.

Computer stations on carrier-band networks are connected by 75-ohm cable systems (see Figure 1). The main cable that carries signals is called the "trunk cable." Devices called "taps" are used to get signals from the trunk to network stations and from network stations to the trunk. Cables that connect taps to stations are called "drop cables." Repeaters allow the network to be expanded to accommodate more stations. Everything in the cable system must be terminated in 75 ohms to avoid signal reflections.

Signals traveling through carrier-band networks are attenuated not only by the impedance of the cable, but also each time they pass through a tap. Signal strength is typically measured in dBmV (decibel millivolts)[1]. Network stations transmit signals at 63 to 66 dBmV. Taps attenuate the signal 20 dBmV and the smallest signal level a station can detect reliably is 10 dBmV.

Besides attenuation, there are a number of other signal characteristics that are important for carrier-band networks.

- **Return Loss** is the amount of reflection of a cable, tap, or the entire wiring system. The maximum amount of return loss allowable on the trunk cable and taps for reliable network operation is –22 dB.
- High-frequency signals are attenuated more in cable systems than low-frequency signals. The difference in amplitudes is called **tilt.** The amount of tilt that can be tolerated in an entire length of cable, regardless of frequency, is 3.5 dB. To determine the amount of cable that can be used in a network cable system, therefore, the attenuation at both 5 and 10 MHz must be known. For example, if a particular cable has 1.2 dB attenuation at 5 MHz and 1.5 dB at 10 MHz for 100 meters of cable, the maximum length can be:

(maximum cable length) x (1.5 dB – 1.2 dB)/100 meters = 3.5dB

maximum cable length = 1,167 meters

- High-frequency signals also travel faster than low-frequency signals. If signals traveling at different rates are added together, as they are in the cable, the points where the signals cross zero volts are slightly shifted from where they should be. This time shift is called jitter or **dispersion.** Dispersion makes the reception of signals difficult and can produce errors.
- **Noise** is the unwanted electrical signals induced into the cable from outside sources such as welding equipment, electrical motors turning on and off, or any process that has an electric arc. For reliable signal reception, the maximum amount of noise allowed is –10 dBmV. Reliable signal reception is usually determined from the signal-to-noise ratio. For example, if the smallest detectable signal level is 10 dBmV (= 3.16 mV_{p-p}) and the noise level is –10 dBmV (= 0.316 mV_{p-p}), the signal-to-noise ratio is 3.16/0.316 = 10 to 1.

The Application

RELCOM Inc., located in Forest Grove, OR, manufactures taps, connectors, terminators,

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1 0 dBmV = 1 mV swing across 75 ohms.

repeaters, modems, and network monitoring equipment for carrier-band networks. Steve Coan, Engineer for RELCOM, uses the Tektronix THS730A Handheld Digital Oscilloscope for both equipment design in the lab and troubleshooting in the field. A typical troubleshooting job in the field finds him testing RELCOM taps for return loss, noise, tilt, and jitter. In the lab, Steve uses the Tektronix scope to verify that critical tap parameters such as insertion loss, trunk-to-drop attenuation, drop-to-trunk attenuation, drop-to-drop isolation, ground current isolation, surge protection, and other mechanical considerations are within specifications.

A recent problem at a paper mill in Longview, WA found Steve using the THS730A to isolate and examine reflections occurring on their carrier-band trunk line. By examining these signals, Steve suspected that the reflection was caused by unterminated ports on the network taps. A visual inspection proved this to be the case. With WaveStar software, Steve was able to document the waveform and provide the client with an accurate record of what such problems look like (Figure 2).

According to Steve, "WaveStar lets me organize waveforms, screen shots, instrument settings, and notes in a lab notebook format. I can then display and analyze the waveforms as graphs or in tables. Plus, I can cut, copy, and paste notebook data to other Windows applications through the Windows Clipboard."

WaveStar supports both RS-232 and GPIB interfaces, allowing Steve to use the RS-232 capability to download waveforms, setups, and screen captures. He can display a table of 22 key measurement parameters on selected waveforms and export these tables from a PC in two popular spreadsheet formats – .csv and .xls.

In power applications, WaveStar allows users to perform harmonic analysis (showing up to 51 harmonics) of voltage, current, and/or power waveforms for power quality applications.

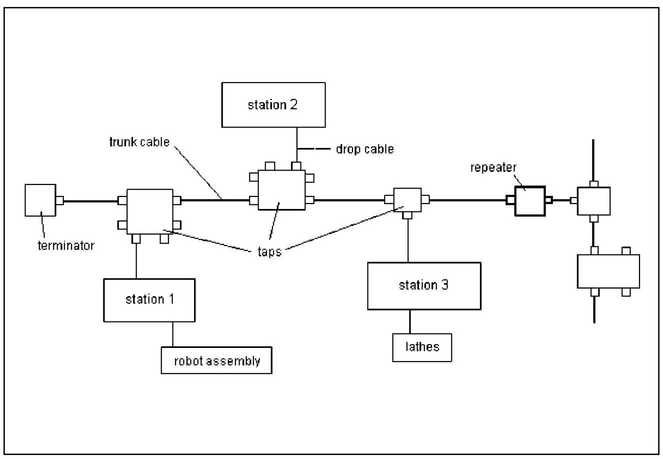

Figure 1. Block diagram of typical carrier-band network.

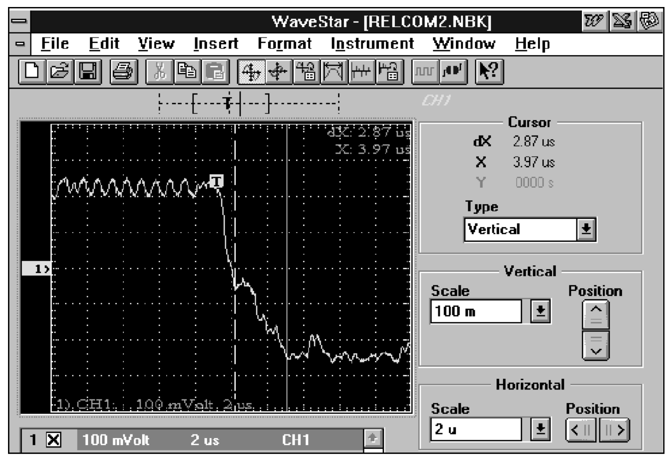

Figure 2. WaveStar display of the captured waveform.

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From other areas, contact: Tektronix, Inc. Export Sales, P.O. Box 500, M/S 50-255, Beaverton, Oregon 97077-0001, USA (503) 627-1916

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