Oscilloscope portability keeps Balfour Beatty Rail Infrastructure Services on track

Technology at Work

The portability of Fluke's latest color ScopeMeter® test tool and its ability to store screen traces for later downloading to a PC has proved a winner with Balfour Beatty Rail Infrastructure Services. The handheld oscilloscope is proving invaluable in saving time and manpower to troubleshoot trackside electrical problems on a section of the rail network managed from the London Bridge control center. These electrical faults commonly occur throughout much of the aging UK rail network.

There are two key areas where the recently acquired Fluke 199C Color ScopeMeter test tool is quickly paying back its outlay. Steve Kennedy, technical support manager at the Technical Investigation Group based at Hither Green explained, "The two applications where the portable meter has been first to show significant troubleshooting benefits are in identifying faulty traction immune-style transmitters, and in homing in on which of a large number of trackside facilities has a faulty signal transmitter. In the second application, an alternative approach to the portable oscilloscope would have been to purchase a spectrum analyzer, an eight-fold increase in cost."

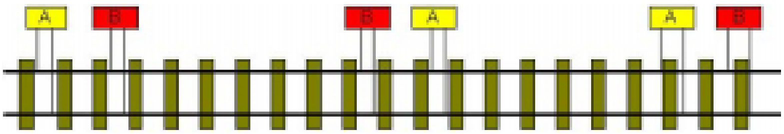
Train detection transmitters

It is vital that signalmen and the automated signal and points control systems are aware of the exact positioning of railway stock.

Thus each section of rail on the UP line and each section of rail on the DOWN line incorporates an electronic detection system, known as a "track circuit." Location cases at the trackside house the infrastructure for train detection, signalling and points control, as well as ancillary items such as power supply units and heaters.

Detection of a car on a section of track relies on a unique frequency signal that is generated, amplified and transmitted from a TI21-style unit in the location case, through a band pass filter, and out to the rail. Each section of rail is electrically isolated from the next. A different frequency is generated and transmitted to the next section of track, and these two unique frequencies are used alternately along the full length of the line. One pair of frequencies is used for the UP line and a different pair for the DOWN line.

When a car is on that section of track, the electric circuit is shunted between the two rails



via the steel wheels and axles. A trackside receiver analyzes the returned signal. Shunting of the circuit causes a relay to be de-energized, which in turn switches a 50 V or 110 V line circuit. This signal travels via a multi-core cable onto the train describer system to London Bridge, which controls this section of line, and to the local unmanned control room which can be used as a back-up if major problems arise at London Bridge. The de-energized relay also activates an interlocking system which automatically locks out functions such as the operation of points or the changing of lights to green in the same region as the train.

While the transmitters are well-built, rugged devices, many have been in service for a long time and inevitably are liable to develop faults. At the same time it is expensive to drop in replacement units. If the unit fails completely, a lock-out occurs and it is easy to detect that it is the transmitter which is at fault using a digital multimeter (DMM). The unit can be replaced by the maintenance worker. Some transmitter faults, however, cause an additional spurious signal to be generated. This also causes the receiver to activate a lock-out, but in this case, the fact that the transmitter is faulty is much more difficult to identify. The audible signal it generates still sounds the same, and application of a DMM will detect an ac signal with a peak-to-peak reading in the region of 15 V to 19 V – the normal range.

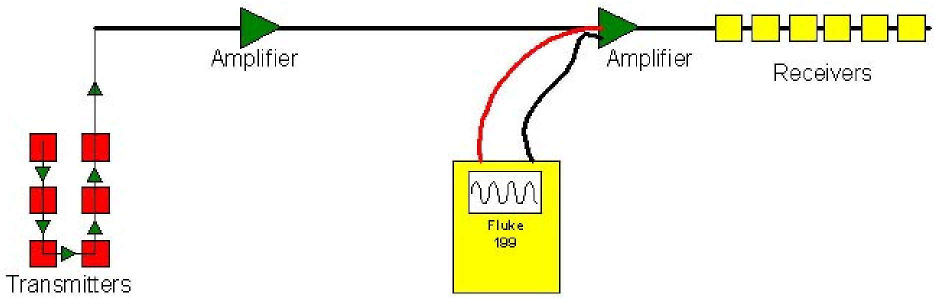
In the past, to identify a fault of this type, a suspected transmitter has normally been temporarily replaced and brought back to the workshop for analysis on the work bench. A bench oscilloscope trace is needed to detect a faulty signal. This obviously incurs a significant amount of time and cost. But with the recent advent of the portable Fluke 199C Color ScopeMeter test tool, troubleshooting can now take place trackside. The probes can be applied directly to the unit and the trace captured in the memory of the oscilloscope. The last 100 screens can be scrolled through and stored with a time stamp. Faulty units can be immediately identified on location and the results, which have been captured by the portable scope, can be downloaded to a PC at the end of a shift and the trace added into a maintenance report. This provides both a permanent record and a basis for repair work.

Frequency-division multiplex

An even more complex task and more valuable contribution to troubleshooting is now being made by the Fluke portable scope by analyzing signals being transmitted to London Bridge on a broadband network. A single pair of wires carries signals from a large number of trackside interfaces which can signal simultaneously. In one example in the Hither Green area the total wire length is 5 miles from the London Bridge control room, while in other instances it may be up to 50 miles long. (e.g. in some Victoria systems).

The bandwidth on the line is divided into a number of frequency channels using a method called frequency-division multiplexing (FDM); each channel being allocated to carrying a signal from a particular unit located alongside the track. By measuring its channel frequency one can uniquely identify a device.

As most of the infrastructure is in exposed metal trackside cabinets it is not only subject to changes of temperature and humidity, it is also vulnerable to lightning strikes. All of these can lead to signaling faults. Vandalism is another source of problems, as are deterioration in the carrier cable. On average, four or five faults of this type occur each month.



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At each interface with the trackside equipment there is a "hand cut read" device and a transmitter which reads or writes signals at the unit's designated channel frequency. In the past, when a unit failed it typically took an average of 12 hours for a maintenance person to walk the signal line, checking each unit one-by-one until the fault was found. Now a rapid solution to the problem is available using the Fluke ScopeMeter test tool.

A sample of the wave trace on the network is captured on the portable oscilloscope in the local unmanned control room and stored. This is then downloaded in the office onto a PC where it can be quickly analyzed by the Fast Fourier Transform software available with the ScopeMeter test tool. A missing or reduced channel frequency can be quickly identified, immediately highlighting the site of the malfunctioning unit. Alternatively the amplitude of the signals can be quickly visualized and measured, another indication of a potential fault on the network. Again, the channel frequency identifies the location of the faulty unit. Induced interference and mains hum on the line can be simply ignored.

According to Steve Kennedy, "Longs Limited, our local Fluke distributor, was particularly supportive. The company helped us not only to choose the right equipment for the job, but also provided guidance on its use. The key benefits of the ScopeMeter include the opportunity to carry a full powered 2.5 GS/s oscilloscope out to any site in any weather, and then to capture a sequence of traces. We can then not only bring this information back for further analysis, but we can also upload the traces into our reporting procedures. We have been able to purchase this functionality for around $3,000 – the FDM analysis by a spectrum analyzer would have involved an outlay in the region of $40,000 and the device would not have been portable."

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