PPM-350 SERIES MEASUREMENT TECHNIQUES

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The PPM-350 PON Power Meter Series (PPM-350B/PPM-350C) is specially designed to measure all passive optical network (PON) signals (downstream and upstream) and to provide the pass/fail status. This application note explores some key elements and measurement techniques specific to PON that are used by the PPM-350 Series to obtain the most accurate results.

Measuring Three Signals—Pass-Through Method

The pass-through method is the only way to simultaneously measure the upstream (one signal) and downstream (one or two signals) transmissions. Since the optical network terminal (ONT) in a PON only transmits when it receives the request from the optical line terminal (OLT), the ONT's transmitter shuts down as soon as the ONT is disconnected. With this in mind, we designed the PPM-350 Series with a built-in splitter that enables the signals to pass through; 10% of the signal is extracted and sent to the detectors, while the remaining portions pass through, thus enabling simultaneous measurement of all three signals. The PPM-350 Series is also calibrated taking into account that only a portion of the signal is actually measured.

The induced insertion loss in such a measurement is 1.5 dB, including the connectors.

Combined Downstream Signals

A PON can also transmit two downstream signals with different power levels at different wavelengths (e.g., a 1550 nm analog cable television (CATV) signal whose power level is as high as 23 dBm can travel on the same fiber as a 1490 nm signal with a power level as low as +4 dBm). In order to properly measure such a combination of signals, the PPM-350 Series uses individual filters and detectors.

Measuring Upstream Signals

The 1310 nm upstream signal of the ONT only transmits during predetermined time slots that are allocated and managed via the OLT. For example, at activation, while no 1310 nm upstream data is effectively sent by the customer, the ONT can reply to the OLT polling with a single cell (424 bits), indicating that it does not need to allocate further time slots at this time. Recommendation G.983 for broadband passive optical network (BPON) and G.984 for gigabit-capable passive optical network (GPON) imposes a restriction that each ONT transmitter be polled at least once every 100 ms or less; on the other hand, the recommendation IEEE 802.3ah for Ethernet-based passive optical network (EPON) imposes this restriction at 50 ms or less.

The following table includes PON network configurations supported by the PPM-350 Series:

Configuration	Standard	Upstream Baudrate	Bytes	Bits	Approx. Duration
BPON	ITU 983	155 Mbit/s	55	440	2.83 μs
BPON	ITU 983	622 Mbit/s	55	440	700 ns
GPON	ITU 984	1.24 Gbit/s	64	512	411 ns
EPON	IEEE 802.3ah	1.24 Gbit/s	64	640*	512 ns

**Uses 8B/10B encoding*

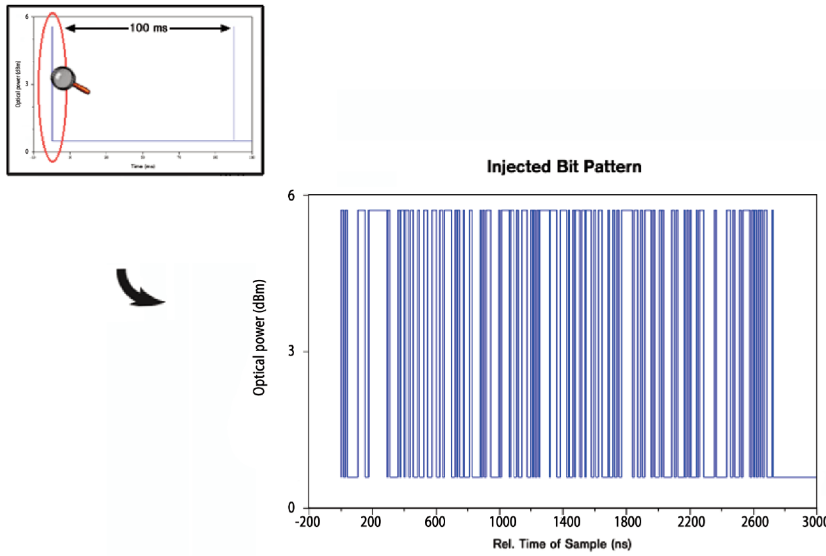

Figure 1. Zoom showing the bit pattern of a single cell (scrambled data at approximately 50% duty cycle)–per 100 ms polling period

The figure above shows a graphical representation of the transmitter when it is set to transmit at +3 dBm. Normally, when a transmitter is set at +3 dBm, it means that its average power when transmitting a reasonably balanced signal (~50% duty cycle) is +3 dBm and, consequently, the peak level (corresponding to the “ones”) will be at approximately +6 dBm.

For a power meter to correctly read that +3 dBm power, it must be able to measure the signal only while it is active (i.e., it must not take into account the power between the allocated slots). A normal power meter would only average out the power read during its sampling period and would produce a reading of about 40 dB below the actual power.

Considering this, different methods can be used to properly measure the upstream signal. A simple approach would consist in sampling the signal with a high-bandwidth detector and holding the maximum read value or peak power. The transmitter power can then be deduced by subtracting 3 dB from the recorded value. However, this technique presents many drawbacks, such as high pattern dependency; high sensitivity to high-speed electronic component tolerances; reduced dynamic range due to higher electronic bandwidth requirements and a tendency of the circuit to detect and misinterpret noise as a peak, thus producing erroneous power readings.

In contrast, the PPM-350 Series relies on a proprietary, patented* approach that measures the average power during the active transmission phases of the transmitter under test. Therefore, the power read by the PPM-350 Series is the actual power that the transmitter under test is set to transmit at.

Conclusion

PON systems bring several new challenges to optical testing, including optical power measurements. In order to properly measure all the optical signals, different approaches can be used. EXFO’s solution, used in the PPM-350 Series, enables users to simultaneously measure all the signals using a simple, reliable and accurate approach.

**US Patent 7, 187, 861; German Utility Patent 20 2004 021 208, 0 and subject of several national entries in other countries under the patent cooperation treaty.*

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