

Electrical Sampling Modules

► 80E10 • 80E09 • 80E08 • 80E07 • 80E06 • 80E04 • 80E03 • 80E02 • 80E01



TDR Modules: 80E10, 80E08 and 80E04

The 80E10, 80E08 and 80E04 are dual-channel Time Domain Reflectometry (TDR) sampling modules, providing up to 12 ps incident and 15 ps reflected rise time in the 80E10 (18 ps incident in 80E08 and 23 ps incident in 80E04). Each channel of these modules is capable of generating a fast step for use in TDR mode and the acquisition portion of the sampling module monitors the incident step and any reflected energy. The polarity of each channel's step can be selected independently. This allows for differential or common-mode TDR or S-parameters testing of two coupled lines, in addition to the independent testing of isolated lines. The independent step generation for each channel allows true differential measurements, which ensures measurement accuracy for differential devices.

The 80E10 and 80E08 are small form-factor, fully integrated, independent, 2-meter remote sampler systems, enabling location of the sampler near the DUT and ensuring the best signal fidelity. An optional 2-meter extender is available for 80E04. The modules characterize crosstalk by using TDR steps to drive one line (or line pair for differential crosstalk) while monitoring a second line (or line pair) with the other channel (or another module for differential crosstalk). The "filter" function on the 8200 and 8000 series mainframes can be used with TDR or crosstalk measurements to characterize expected system performance with slower edge rates.

► Features & Benefits

All Modules

Up to 70 GHz Bandwidth and 5 ps Measured Rise Time (10 to 90%)

Lowest Noise for Analysis –
450 μV_{RMS} at 60 GHz, 300 μV_{RMS} at 30 GHz

Remote Samplers^{*1} Enable Location of Sampler Near DUT and Ensure Best Signal Fidelity

Independent Sampler Des skew Ensures Easy Fixture and Probe De-embedding

Dual Channel (Except 80E01 and 80E06)

Precision Microwave Connectors (3.5 mm, 2.92 mm, 2.4 mm and 1.85 mm)

Probe Support (Except 80E06)

TDR Modules

15 ps Reflected True Differential Fully Integrated TDR Rise Time (12 ps Incident) and Feature Resolution below 1 mm

Efficient, Accurate, Easy-to-Use and Cost-effective S-parameters up to 50 GHz

► Applications

Impedance Characterization and S-parameter Measurements for Serial Data Applications

Advanced Jitter, Noise and BER Analysis

Channel and Eye Diagram Simulation and Measurement-based Spice Modeling

80E10, 80E08 and 80E04

High-performance TDR/T Measurements

Impedance Profile, Inductance, Capacitance and S-parameters

Transmission Line Quality, Impedance and Crosstalk

True Differential, Common Mode and Single-ended Measurements

Efficient Fault Isolation

80E09, 80E07, 80E06, 80E01

High-frequency, Low-noise Signal Acquisition

Fast Rise Time Measurements

Jitter Analysis and Waveform Analysis

80E03 and 80E02

Device Characterization, Transmission Quality, Waveform Parameters

Low Signal Measurements

^{*1} Integrated on 80E07-80E10 and optional on 80E01-80E04 and 80E06.

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All modules have independent incident step and receiver deskew to remove the effect of measurement fixtures and probes that enable faster and easier de-embedding of test fixtures. The 80E10 sampling modules provide an acquisition rise time of 7 ps, with up to 50 GHz user-selectable equivalent bandwidth (with 50, 40 and 30 GHz settings). The 80E08 sampling bandwidth is 30 GHz (user-selectable with 30 and 20 GHz settings), and 80E04 sampling bandwidth is 20 GHz. The 20 GHz P8018 single-ended and 18 GHz P80318 differential variable pitch TDR probes provide excellent performance and compliance, ensuring easy and accurate backplane and package measurements.

When the user employs these modules with Tektronix IConnect® TDR and VNA software, he or she can acquire up to 1,000,000 data points and obtain up to 50 GHz differential, mixed-mode and single-ended S-parameters. IConnect also enables impedance, S-parameters and eye diagram compliance testing as required by various serial data standards, as well as full channel analysis, Touchstone (SnP) file output and SPICE modeling for gigabit interconnects.

Sampling Modules: 80E09, 80E07, 80E06, 80E03, 80E02 and 80E01

The 80E09 and 80E07 are dual-channel modules with remote samplers, capable of $450 \mu\text{V}_{\text{RMS}}$ noise at 60 GHz sampling bandwidth and $300 \mu\text{V}$ at 30 GHz sampling bandwidth. Each small form-factor remote sampler is attached to a 2-meter cable in order to minimize the effects of cables, probes and fixtures, allow close location of the sampler to the DUT and ensure best signal fidelity. User-selectable bandwidth settings (60/40/30 on 80E09 and 30/20 on 80E07) offer optimal noise/bandwidth trade-off.

80E06 and 80E01 are single-channel, 70+ and 50 GHz bandwidth sampling modules. 80E06 provides the widest measurement bandwidth and fastest rise time measurements with world-class signal fidelity. Both 80E06 and 80E01 provide a superior maximum operating range of $\pm 1.6 \text{ V}$. Both of these modules can be used with the optional 2-meter extender cable, which ensures superior signal fidelity and measurement flexibility.

The 80E03 and 80E02 are dual-channel, 20 GHz and 12.5 GHz sampling modules. These sampling modules provide an acquisition rise time of 17.5 ps or less for 80E03 and 28 ps for 80E02. An optional 2-meter extender cable is available for these modules.

When used with Tektronix 80SJNB Jitter, Noise and BER software, these modules enable separation of both jitter and noise into their components, understand precise causes of eye closure and obtain highly accurate extrapolation of BER and 3-D eye contour. When used with 82A04 phase reference module, timebase accuracy can be improved down to $200 \text{ fs}_{\text{RMS}}$ jitter, which together with the $300 \mu\text{V}$ noise floor and 14-Bits of resolution ensures the highest signal fidelity for the measured signals.

► Characteristics

► Electrical Sampling Module Characteristics

| | Application Type | Channels | Input Impedance | Channel Input Connector | Bandwidth ^{*2} |
|-------|--|----------|-----------------|---|--------------------------------|
| 80E10 | True differential TDR, S-parameters and fault isolation | 2 | 50 ±1.0 Ω | 1.85 mm female, precision adapter to 2.92 mm included with 50 Ω SMA termination | 50/40/30 GHz ^{*3, *4} |
| 80E09 | High-frequency, low-noise signal acquisition and jitter characterization | 2 | 50 ±1.0 Ω | 1.85 mm female, precision adapter to 2.92 mm included with 50 Ω SMA termination | 60/40/30 GHz ^{*3, *4} |
| 80E08 | True differential TDR and S-parameters | 2 | 50 ±1.0 Ω | 2.92 mm female | 30/20 GHz ^{*3, *4} |
| 80E07 | Optimal noise/performance trade-off for jitter characterization | 2 | 50 ±1.0 Ω | 2.92 mm female | 30/20 GHz ^{*3, *4} |
| 80E06 | High-speed electrical device characterization | 1 | 50 ±0.5 Ω | 1.85 mm female, precision adapter to 2.92 mm included with 50 Ω SMA termination | <i>70+ GHz</i> |
| 80E04 | TDR impedance and crosstalk characterization | 2 | 50 ±0.5 Ω | 3.5 mm female | 20 GHz ^{*3} |
| 80E03 | Device characterization | 2 | 50 ±0.5 Ω | 3.5 mm female | 20 GHz ^{*3} |
| 80E02 | Low-level signals | 2 | 50 ±0.5 Ω | 3.5 mm female | 12.5 GHz ^{*3} |
| 80E01 | High-frequency, high maximum operating range signal acquisition | 1 | 50 ±0.5 Ω | 2.4 mm female, precision adapter to 2.92 mm included with 50 Ω SMA termination | 50 GHz |

^{*2} Values shown are warranted unless printed in an italic typeface, which represents a non-warranted characteristic value that the instrument will typically perform to.

^{*3} Calculated from 0.35 bandwidth rise time product.

^{*4} User-selectable.

Electrical Sampling Modules

► 80E10 • 80E09 • 80E08 • 80E07 • 80E06 • 80E04 • 80E03 • 80E02 • 80E01

► Electrical Sampling Module Characteristics (continued)

| | Rise Time (10% to 90%) | Dynamic Range | Offset Range | Maximum Operating Voltage | Maximum Non-destruct Voltage, DC+AC _{pk-pk} | Vertical Number of Digitized Bits |
|-------|---------------------------|------------------------|--------------|---------------------------------|---|--------------------------------------|
| 80E10 | 7 ps ^{*5} | 1.0 V _{pk-pk} | ±1.1 V | ±1.1 V | 2.0 V | 14-Bits full scale |
| 80E09 | 5.8 ps ^{*5} | 1.0 V _{pk-pk} | ±1.1 V | ±1.1 V | 2.0 V | 14-Bits full scale |
| 80E08 | 11.7 ^{*5} | 1.0 V _{pk-pk} | ±1.1 V | ±1.1 V | 2.0 V | 14-Bits full scale |
| 80E07 | 11.7 ^{*5} | 1.0 V _{pk-pk} | ±1.1 V | ±1.1 V | 2.0 V | 14-Bits full scale |
| 80E06 | 5.0 ps ^{*5} | 1.0 V _{pk-pk} | ±1.6 V | ±1.6 V | 2.0 V | 14-Bits full scale |
| 80E04 | ≤17.5 ps | 1.0 V _{pk-pk} | ±1.6 V | ±1.6 V | 3.0 V | 14-Bits full scale |
| 80E03 | ≤17.5 ps | 1.0 V _{pk-pk} | ±1.6 V | ±1.6 V | 3.0 V | 14-Bits full scale |
| 80E02 | ≤28 ps | 1.0 V _{pk-pk} | ±1.6 V | ±1.6 V | 3.0 V | 14-Bits full scale |
| 80E01 | 7 ps ^{*5} | 1.0 V _{pk-pk} | ±1.6 V | ±1.6 V | 2.0 V | 14-Bits full scale |

^{*5} Calculated from 0.35 bandwidth rise time product.

► Electrical Sampling Module Characteristics (continued)

| | Vertical Sensitivity Range | DC Vertical Voltage Accuracy, Single Point, within ±2 °C of Compensated Temperature | Typical Step Response Aberrations ^{*6} | RMS Noise ^{*6} |
|-------|-------------------------------|---|--|---|
| 80E10 | 10 mV to 1.0 V full scale | ± [2 mV + 0.007 (Offset) + 0.02 (Vertical Value – Offset)] | <i>±1% or less over the zone 10 ns to 20 ps before step transition; +6%, –10% or less for the first 400 ps following step transition; +0%, –4% or less over the zone 400 ps to 3 ns following step transition; +1%, –2% or less over the zone 3 ns to 100 ns following step transition; ±1% after 100 ns following step transition</i> | 50 GHz: 600 μV, ≤700 μV 40 GHz: 370 μV, ≤480 μV 30 GHz: 300 μV, ≤410 μV |
| 80E09 | 10 mV to 1.0 V full scale | ± [2 mV + 0.007 (Offset) + 0.02 (Vertical Value – Offset)] | <i>±1% or less over the zone 10 ns to 20 ps before step transition; +6%, –10% or less for the first 400 ps following step transition; +0%, –4% or less over the zone 400 ps to 3 ns following step transition; +1%, –2% or less over the zone 3 ns to 100 ns following step transition; ±1% after 100 ns following step transition</i> | 60 GHz: 450 μV, ≤600 μV 40 GHz: 330 μV, ≤480 μV 30 GHz: 300 μV, ≤410 μV |

^{*6} Values shown are warranted unless printed in an italic typeface, which represents a non-warranted characteristic value that the instrument will typically perform to.

► Electrical Sampling Module Characteristics (continued)

| | Vertical Sensitivity Range | DC Vertical Voltage Accuracy, Single Point, within ± 2 °C of Compensated Temperature | Typical Step Response Aberrations ⁶ | RMS Noise ⁶ |
|-------|----------------------------|--|--|--|
| 80E08 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 \text{ (Offset)} + 0.02 \text{ (Vertical Value - Offset)}]$ | <i>$\pm 1\%$ or less over the zone 10 ns to 20 ps before step transition; +6%, -10% or less for the first 400 ps following step transition; +0%, -4% or less over the zone 400 ps to 3 ns following step transition; +1%, -2% or less over the zone 3 ns to 100 ns following step transition; $\pm 1\%$ after 100 ns following step transition</i> | 30 GHz: 300 μV , $\leq 410 \mu\text{V}$ 20 GHz: 280 μV , $\leq 380 \mu\text{V}$ |
| 80E07 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 \text{ (Offset)} + 0.02 \text{ (Vertical Value - Offset)}]$ | <i>$\pm 1\%$ or less over the zone 10 ns to 20 ps before step transition; +6%, -10% or less for the first 400 ps following step transition; +0%, -4% or less over the zone 400 ps to 3 ns following step transition; +1%, -2% or less over the zone 3 ns to 100 ns following step transition; $\pm 1\%$ after 100 ns following step transition</i> | 30 GHz: 300 μV , $\leq 410 \mu\text{V}$ 20 GHz: 280 μV , $\leq 380 \mu\text{V}$ |
| 80E06 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 \text{ (Offset)} + 0.02 \text{ (Vertical Value - Offset)}]$ | <i>$\pm 5\%$ or less for first 300 ps following step transition</i> | 1.8 mV, $\leq 2.4 \text{ mV}$ (maximum) |
| 80E04 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 \text{ (Offset)} + 0.02 \text{ (Vertical Value - Offset)}]$ | <i>$\pm 3\%$ or less over the zone 10 ns to 20 ps before step transition; +10%, -5% or less for the first 300 ps following step transition; $\pm 3\%$ or less over the zone 300 ps to 5 ns following step transition; $\pm 1\%$ or less over the zone 5 ns to 100 ns following step transition; 0.5% after 100 ns following step transition</i> | 600 μV , $\leq 1.2 \text{ mV}$ (maximum) |
| 80E03 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 \text{ (Offset)} + 0.02 \text{ (Vertical Value - Offset)}]$ | <i>$\pm 3\%$ or less over the zone 10 ns to 20 ps before step transition; +10%, -5% or less for the first 300 ps following step transition; $\pm 3\%$ or less over the zone 300 ps to 5 ns following step transition; $\pm 1\%$ or less over the zone 5 ns to 100 ns following step transition; $\pm 0.5\%$ after 100 ns following step transition</i> | 600 μV , $\leq 1.2 \text{ mV}$ (maximum) |

⁶ Values shown are warranted unless printed in an italic typeface which represents a non-warranted characteristic value that the instrument will typically perform to.

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► 80E10 • 80E09 • 80E08 • 80E07 • 80E06 • 80E04 • 80E03 • 80E02 • 80E01

► Electrical Sampling Module Characteristics (continued)

| | Vertical Sensitivity Range | DC Vertical Voltage Accuracy, Single Point, within ± 2 °C of Compensated Temperature | Typical Step Response Aberrations ^{*6} | RMS Noise ^{*6} |
|-------|----------------------------|---|--|--|
| 80E02 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 (\text{Offset}) + 0.02 (\text{Vertical Value} - \text{Offset})]$ | $\pm 3\%$ or less over the zone 10 ns to 20 ps before step transition; <i>+10%, -5% or less for the first 300 ps following step transition;</i> $\pm 3\%$ or less over the zone 300 ps to 5 ns following step transition; $\pm 1\%$ or less over the zone 5 ns to 100 ns following step transition; $\pm 0.5\%$ after 100 ns following step transition | 400 μV , $\leq 800 \mu\text{V}$ (maximum) |
| 80E01 | 10 mV to 1.0 V full scale | $\pm [2 \text{ mV} + 0.007 (\text{Offset}) + 0.02 (\text{Vertical Value} - \text{Offset})]$ | $\pm 3\%$ or less over the zone 10 ns to 20 ps before step transition; <i>+12%, -5% or less for the first 300 ps following step transition;</i> <i>+5.5%, -3% or less over the zone 300 ps to 3 ns following step transition;</i> $\pm 1\%$ or less over the zone 3 ns to 100 ns following step transition; $\pm 0.5\%$ after 100 ns following step transition | 1.8 mV, $\leq 2.3 \text{ mV}$ (maximum) |

► TDR System (80E10, 80E08 and 80E04 only)

| | 80E10 | 80E08 | 80E04 |
|----------------------------------|--|--|--|
| Channels | 2 | 2 | 2 |
| Input Impedance | 50 Ω nominal | 50 Ω nominal | 50 Ω nominal |
| Channel Input Connector | 1.85 mm | 2.92 mm | 3.5 mm |
| Bandwidth | 50 GHz | 30 GHz | 20 GHz |
| TDR Step Amplitude | 250 mV (polarity of either step may be inverted) | 250 mV (polarity of either step may be inverted) | 250 mV (polarity of either step may be inverted) |
| TDR System Reflected Rise Time | <i>15 ps</i> | <i>20 ps</i> | <i>28 ps</i> |
| TDR System Incident Rise Time | <i>12 ps</i> | <i>18 ps</i> | <i>23 ps</i> |
| TDR Step Deskew Range | <i>$\pm 250 \text{ ps}$</i> | <i>$\pm 250 \text{ ps}$</i> | $\pm 50 \text{ ps}$ |
| TDR Sampler Deskew Range | <i>$\pm 250 \text{ ps}$</i> | <i>$\pm 250 \text{ ps}$</i> | <i>+100 ns -500 ps (slot deskew only)</i> |
| TDR Step Maximum Repetition Rate | 200 kHz | 200 kHz | 200 kHz |

^{*6} Values shown are warranted unless printed in an italic typeface which represents a non-warranted characteristic value that the instrument will typically perform to.

► Physical Characteristics for Electrical Sampling Modules

| | Dimensions (mm/in.) | | | Weight (kg/lbs.) |
|--------------------|---------------------|--------|---------|------------------|
| | Width | Height | Depth | Net |
| 80E10 ⁷ | 55/2.2 | 25/1.0 | 75/3.0 | 0.175/0.37 |
| 80E09 ⁷ | 55/2.2 | 25/1.0 | 75/3.0 | 0.175/0.37 |
| 80E08 ⁷ | 55/2.2 | 25/1.0 | 75/3.0 | 0.175/0.37 |
| 80E07 ⁷ | 55/2.2 | 25/1.0 | 75/3.0 | 0.175/0.37 |
| 80E06 | 79/3.1 | 25/1.0 | 135/5.3 | 0.4/0.87 |
| 80E04 | 79/3.1 | 25/1.0 | 135/5.3 | 0.4/0.87 |
| 80E03 | 79/3.1 | 25/1.0 | 135/5.3 | 0.4/0.87 |
| 80E02 | 79/3.1 | 25/1.0 | 135/5.3 | 0.4/0.87 |
| 80E01 | 79/3.1 | 25/1.0 | 135/5.3 | 0.4/0.87 |

⁷ Remote sampler module characteristics.

► Ordering Information

80E10

Dual-channel, 50 GHz True Differential TDR Sampling Module with Remote Samplers.

Includes: User manual, certificate of traceable calibration standard, two precision adapters to 2.92 mm included with 50 Ω SMA terminations.

80E09

Dual-channel, 60 GHz Sampling Module.

Includes: User manual, certificate of traceable calibration standard, two precision adapters to 2.92 mm included with 50 Ω SMA terminations.

80E08

Dual-channel, 30 GHz True Differential TDR Sampling Module with Remote Samplers.

Includes: User manual, certificate of traceable calibration standard, two 50 Ω SMA terminations.

80E07

Dual-channel, 30 GHz Sampling Module.

Includes: User manual, certificate of traceable calibration standard, two 50 Ω SMA terminations.

80E06

70+ GHz Electrical Sampling Module.

Includes: User manual, calibration data report, precision adapter to 2.92 mm with 50 Ω SMA termination.

80E06X2 – Bundled ordering configuration provides two 80E06 modules.

80E04

Dual-channel, 20 GHz True Differential TDR Sampling Module.

Includes: User manual, calibration data report, two 50 Ω SMA terminations.

80E03

Dual-channel, 20 GHz Sampling Module.

Includes: User manual, calibration data report, two 50 Ω SMA terminations.

80E02

Dual-channel, 12.5 GHz Sampling Module.

Includes: User manual, calibration data report, two 50 Ω SMA terminations.

80E01

Single-channel, 50 GHz Sampling Module.

Includes: User manual, calibration data report, precision adapter to 2.92 mm included with 50 Ω SMA termination.

80E01X2 – Bundled ordering configuration provides two 80E01 modules.

Service Options

Opt. C3 – Three years of calibration service.

Opt. C5 – Five years of calibration service.

Opt. D1 – Calibration data reports (not available with 80E07-80E10).

Opt. D3 – Three years of calibration data reports.

Opt. D5 – Five years of calibration data reports.

Opt. R3 – Extended repair warranty to three years.

Opt. R5 – Extended repair warranty to five years.

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▶ 80E10 • 80E09 • 80E08 • 80E07 • 80E06 • 80E04 • 80E03 • 80E02 • 80E01

Other Accessories

Sampling Module Extender Cable (2-meter Length) – Order 80N01 (not for use with 80E07-80E10).

2X Attenuator (SMA Male-to-Female) – Order 015-1001-01.

5X Attenuator (SMA Male-to-Female) – Order 015-1002-01.

Adapter (2.4 mm Male to 2.92 mm Female – Can Also Be Used as 1.85 mm Male to 2.92 mm Female) – Order 011-0157-00.

P8018 – 20 GHz Single-ended TDR Probe. 80A02 module (below) recommended for static protection of the sampling or TDR module.

P80318 – 18 GHz Differential TDR Probe. 80A02 module (below) recommended for static protection of each channel of the sampling or TDR module.

80A02 – EOS/ESD Protection Module (1 channel). P8018 or P80318 TDR probe (above) recommended.

Interconnect Cables (Third Party)

Tektronix recommends using quality high-performance interconnect cables with these high bandwidth products in order to minimize measurement degradation and variations. The W.L. Gore & Associates' cable assemblies, accessible at <http://www.gore.com/tektronix>, are compatible with the 2.92 mm, 2.4 mm and 1.85 mm connector interface of the 80Exx modules. Assemblies can be ordered by contacting Gore at the URL above.

Calibration Kits and Accessories (Third Party)

To facilitate S-parameter measurements with these electrical modules and IConnect® software, we recommend precision calibration kits, adapter kits, connector savers, airlines, torque wrenches and connector gauges from Maury Microwave. These components, accessible at www.maurymw.com/tektronix.htm, are compatible with the 2.92 mm, 2.4 mm and 1.85 mm connector interface of the 80Exx modules. Calibration kits and other components can be ordered by contacting Maury Microwave at the URL above.

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Updated 12 May 2006

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