HYPERLABS
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HL9407 Broadband Balun (67 GHz)

Features and Technical Specifications

Bandwidth (-3 dB)	5 MHz to 67 GHz
Amplitude Match	± 0.1 dB to 30 GHz ± 0.3 dB to 67 GHz See *Fig. 1* below
Phase Match	± 2-4° to 20 GHz ± 4-8° to 50 GHz See *Fig. 2* below
Rise time	< 5.2 ps
Insertion Delay	≈ 278 ps
Insertion Loss	-6 dB
Return Loss	See *Figs. 3-4* below
VSWR	See *Fig. 5* below
CMRR	> 70 dB at 10 MHz > 30 dB at 50 GHz See *Fig. 6* below
Eye Diagrams	See Figs. 8-13 below
Max Input Power	+30 dBm
Impedance	50 Ω In, 2 x 50 Ω Out
Connectors	1.85 mm; 3x Jack/Female
Dimensions	60.80 x 38.1 x 13.87 mm 2.39″ x 1.50″ x 0.55″
Weight	45 g (1.6 oz)
Temperature Limits	-40° to +100° C, operating
RoHS Compliance	Made with lead-free solder
Warranty	1 year, see website

PRODUCT SUMMARY

The HL9407 is a signal splitter and combiner that offers industry-best amplitude and phase match over a bandwidth of 5 MHz to 67 GHz (-3 dB).

It is suitable for use in 40 Gbps communications systems, high-speed analog-to-digital conversion, frequency response testing for differential devices, and many other applications.

DEPLOYMENT NOTES

Although the HL9407 ports are labeled as RF In/Out, this device is bidirectional and can be used either as a signal splitter or combiner.

If the DC voltage of the input or output is not zero, DC block capacitors are required.

ADDITIONAL DATA

Higher-resolution versions of the charts on the following pages are available on our website, along with S-parameter files with normal and mixed-mode data to 67 GHz.

HL9407 Bandwidth

Bandwidth for all HYPERLABS baluns is defined as the range of frequencies where insertion loss is within -3 dB of the reference level (-6 dB).

Figure 1 below shows better than -9 dB insertion loss up to 67 GHz when the device is used as a signal splitter.

HL9407 Amplitude Match

Amplitude match is a comparison between the signals on the RF Out +/- ports of a balun used as a signal splitter. This specification is derived from the insertion loss (in dB) measured on the output ports of the device.

Figure 1 below shows typical HL9407 insertion loss from 5 MHz to 67 GHz when the device is used as a signal splitter.

The amplitude balance can be seen by comparing the non-inverting output (blue trace), with the inverting output (red trace).

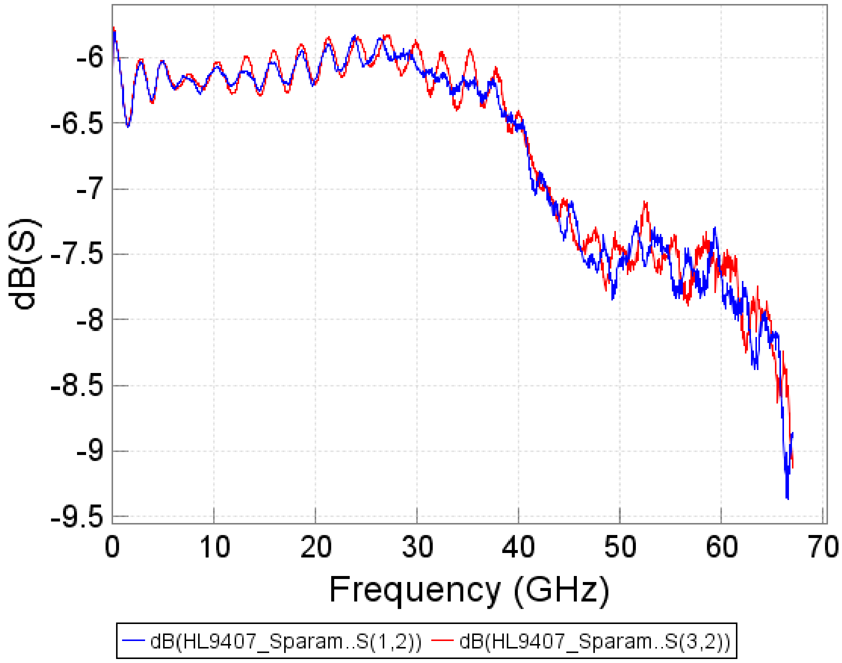

Figure 1: Typical insertion loss and amplitude match of the HL9407 RF Outputs when used as a signal splitter

When the HL9407 is used as a combiner, mixed mode parameters provide additional information on device performance.

For more on the HL9407 performance as a signal combiner, please see the section titled "HL9407 Mixed Mode Data".

HL9407 Phase Match

The HL9407 is a 180° balun, so the phase match of the RF Out+ and RF Out- ports is specified to degrees from 180°.

Match is dependent on the delay of the output ports. For example, 2 degree mismatch at 10 GHz requires the delays be within ≈ 0.5 ps of each other. Phase mismatch increases with frequency.

Figure 2 below shows phase mismatch between the RF Outputs from 5 MHz to 67 GHz. The vertical range is 0-12°.

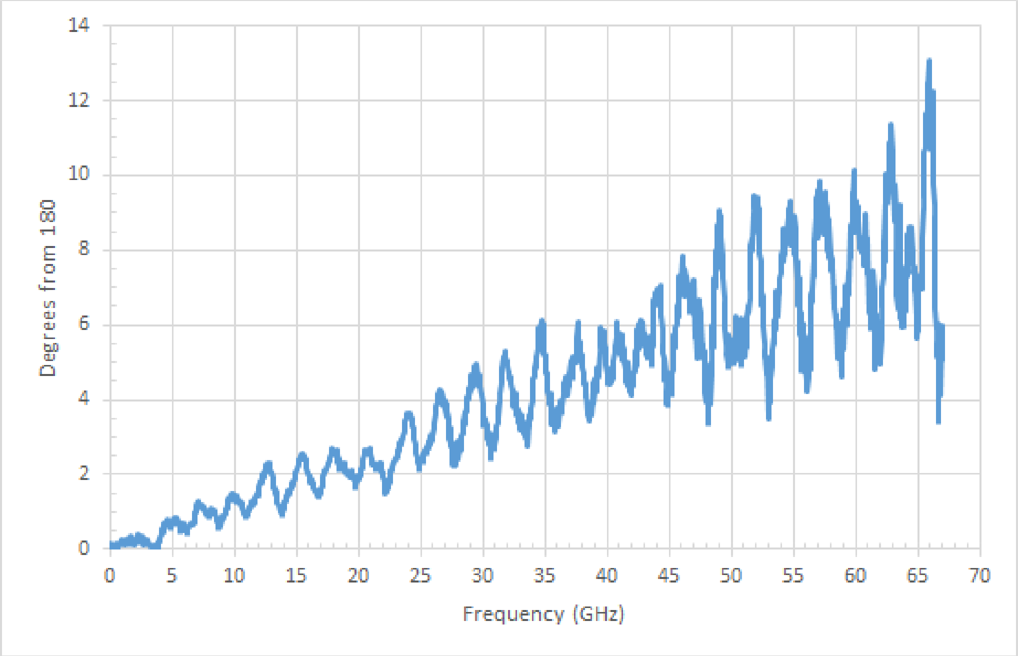

Figure 2: HL9407 phase match, represented as degrees from 180°

HL9407 Return Loss

Figure 3 shows the return loss on the HL9404 RF Input of a device used as a signal splitter. *Figure 4* shows the return loss on the RF Output+ port of a device used as a signal combiner. In both cases, bandwidth is from 5 MHz to 40 GHz.

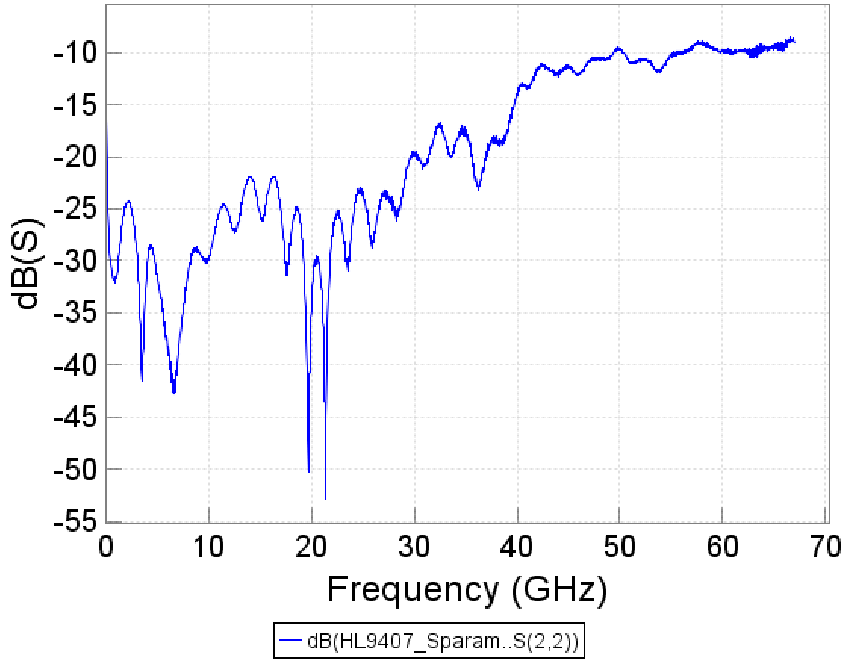

Figure 3: Typical return loss on RF In port of the HL9407

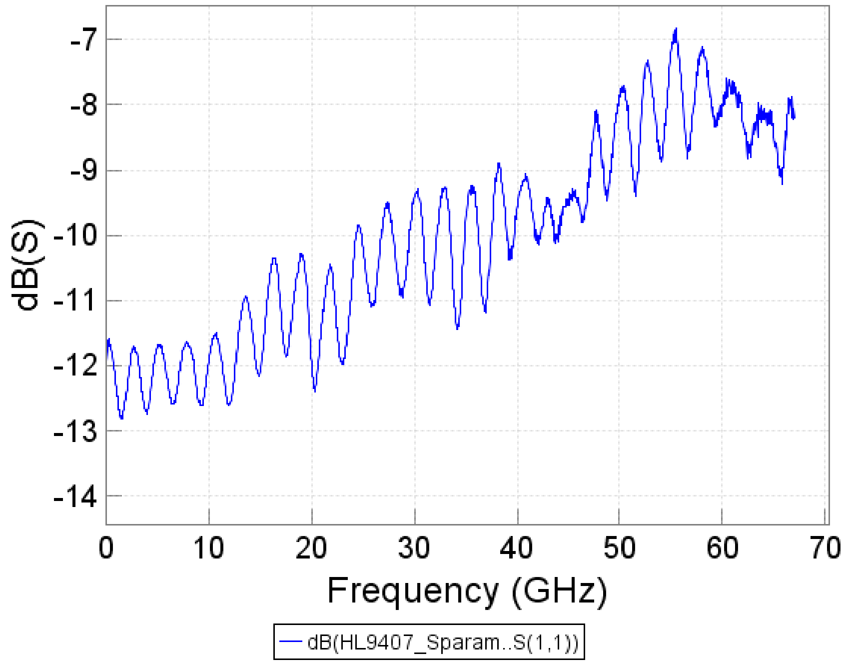

Figure 4: Typical return loss (S11) on the HL9405 RF Output+ ports

HL9407 VSWR

The typical Voltage Standing Wave Ratio (VSWR) of the HL9407 is shown in *Figure 5* below.

The blue and orange traces show typical VSWR on the RF In and RF Out+ ports, respectively.

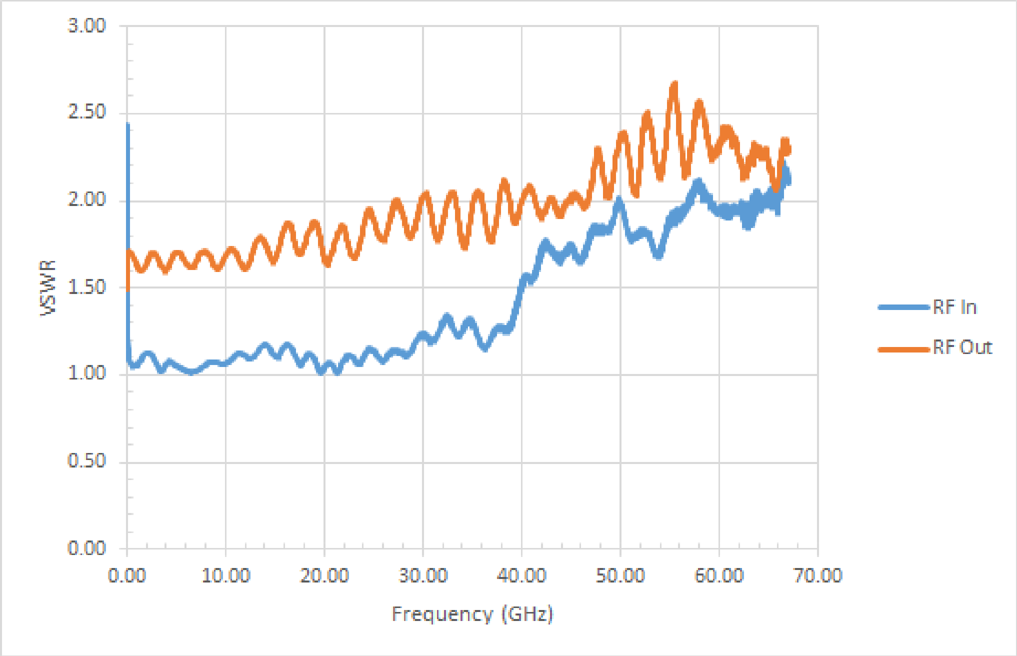

Figure 5: Typical VSWR of HL9407 RF Input and RF Out+

HL9407 CMRR

The exceptional Common Mode Rejection Ratio (CMRR) of the HL9407 allows it to be used as a signal combiner as well as a splitter.

Figure 6 shows the CMRR of the HL9407 when used to combine a differential signal from a 50 GHz VNA source.

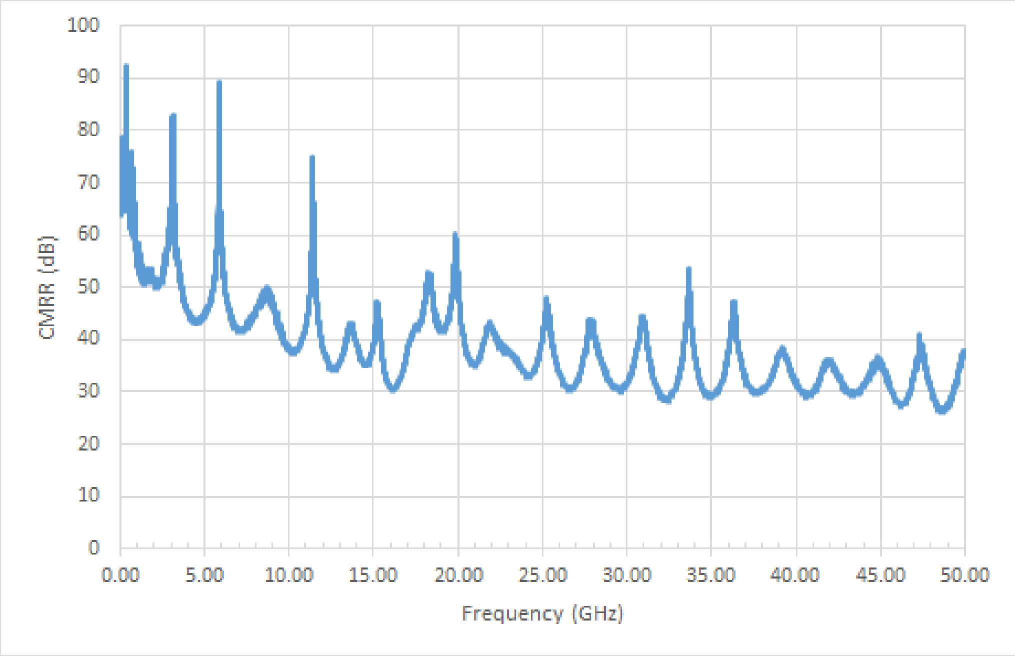

Figure 6: HL9407 CMRR (to 50 GHz)

HL9407 Mixed Mode Data

The unique design of HYPERLABS baluns allows the HL9407 to be used as a signal combiner as well as a signal splitter.

In combiner mode, the balun converts a differential source signal into a single-ended output, minimizing common mode noise and harmonic distortion.

For this reason, HL9407 combiner performance is best characterized from mixed-mode S-parameters using a 4-port VNA as a differential source.

Full mixed-mode data for the HL9407 is found in the S-parameters file available on the HY-PERLABS website. *Figure 7* below shows the mixed-mode measurements of a typical HL9407

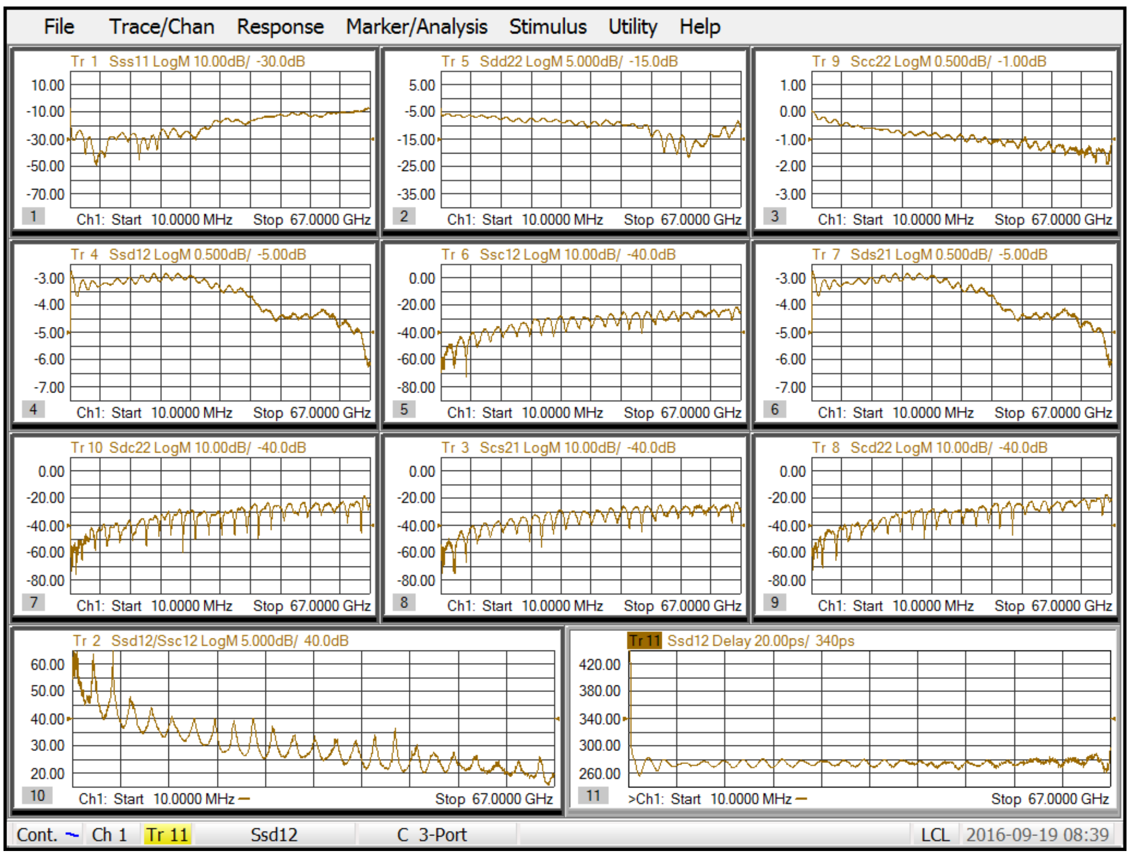

Figure 7: Mixed mode data for the HL9407 measured on a VNA with differential source to 67 GHz

unit.

HL9407 Eye Diagrams

The following pages contain pseudo-random binary sequence (PRBS) eye diagrams for the HL9407. Measurements were taken at 10 Gbps, using long (31-bit) and short (7-bit) patterns.

Figure 8: 10 Gbps PRBS pattern as applied to the HL9407 RF In port

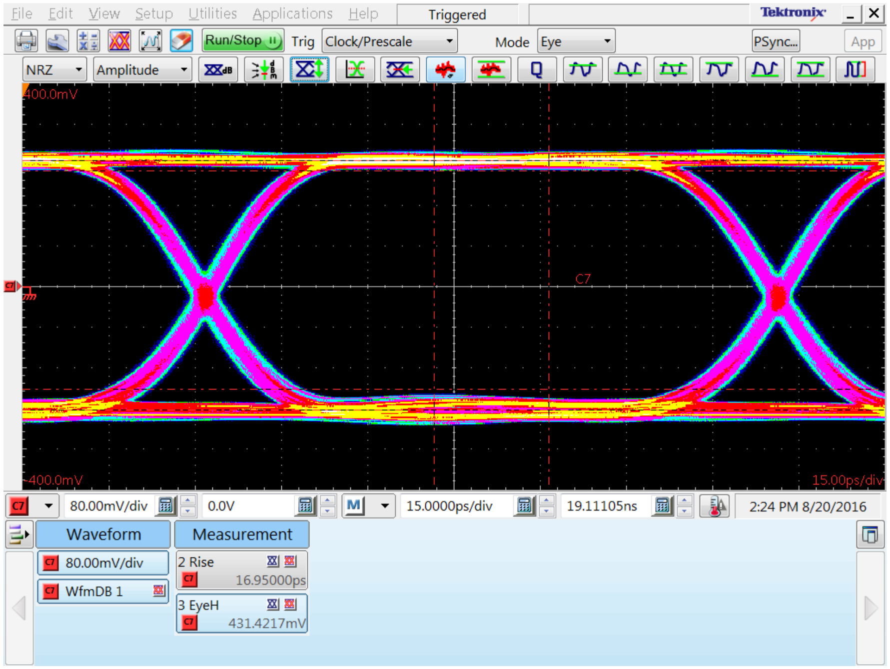

Figure 9: Eye diagram (10 Gbps, 7-bit pattern) of the HL9407 RF In port

HL9407 Eye Diagrams (cont.)

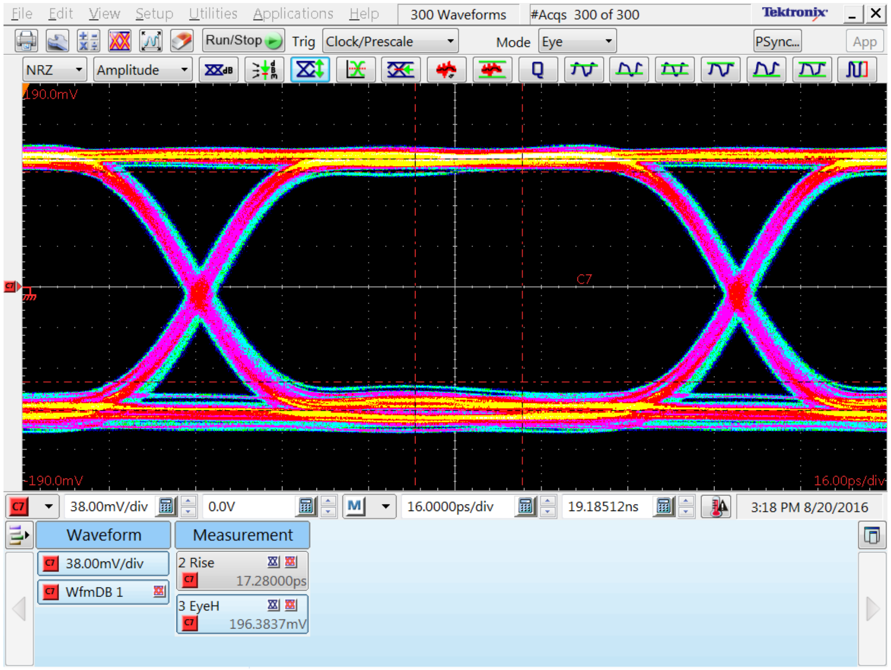

Figure 10: Eye diagram (10 Gbps, 7-bit pattern) of the HL9407 RF Out+ (non-inverting) port

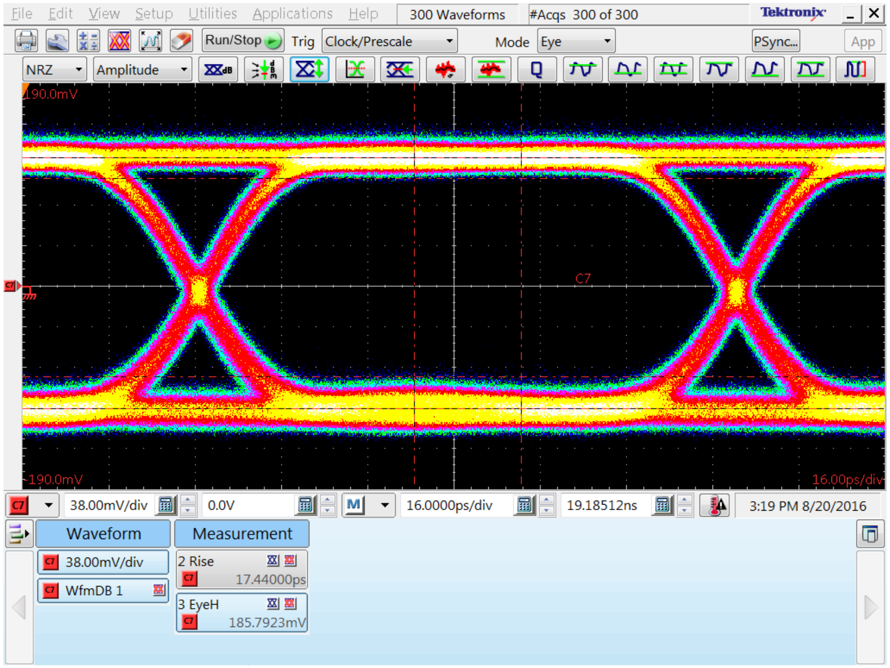

Figure 11: Eye diagram (10 Gbps, 31-bit pattern) of the HL9407 RF Out+ (non-inverting) port

HL9407 Eye Diagrams (cont.)

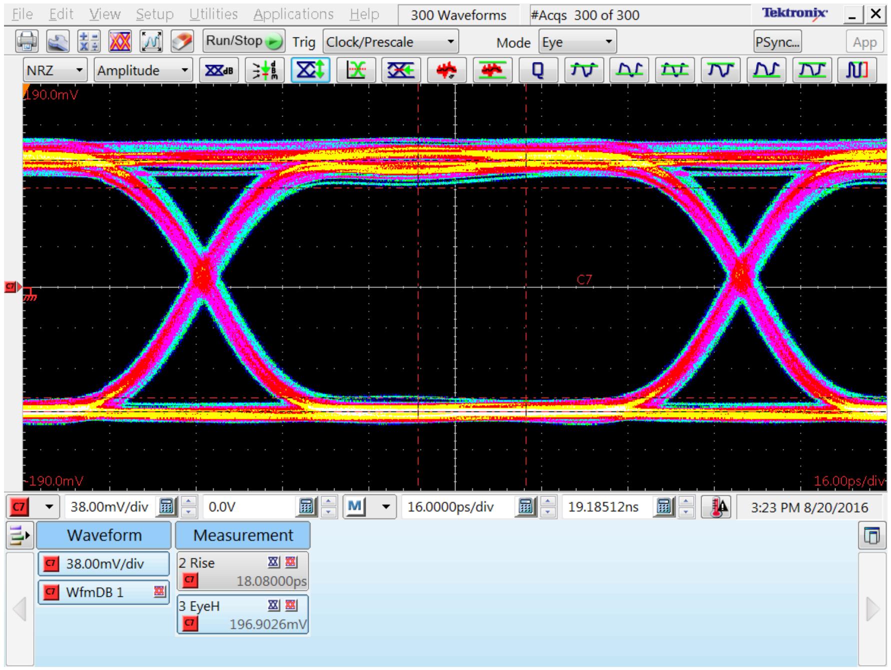

Figure 12: Eye diagram (10 Gbps, 7-bit pattern) of the HL9407 RF Out- (inverting) port

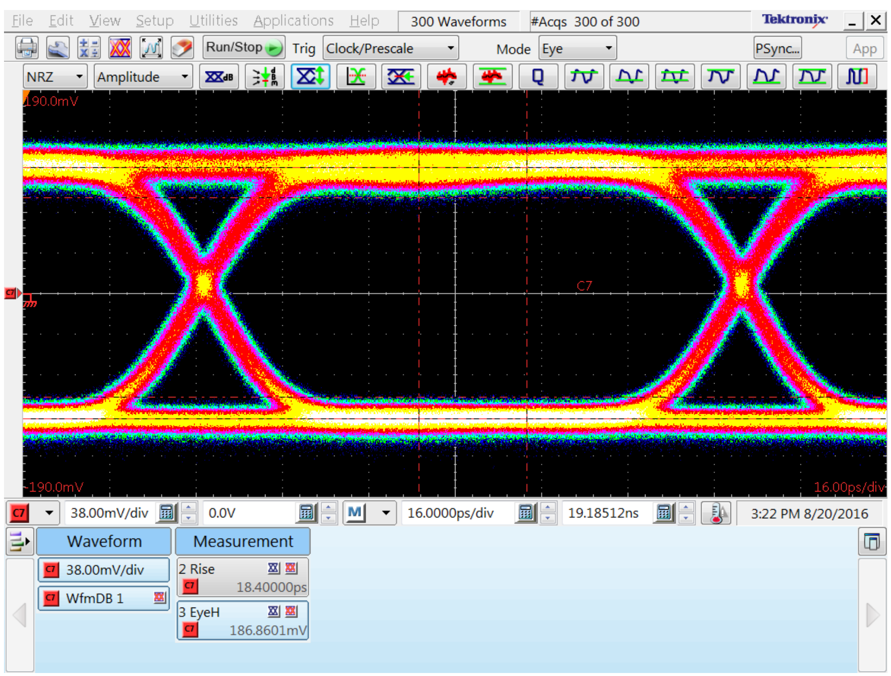

Figure 13: Eye diagram (10 Gbps, 31-bit pattern) of the HL9407 RF Out- (inverting) port