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HL9467 Broadband Z-matched Pick-off Tee

(Including the HL9467-PCIe7.0 model for PCIe® 7.0 compliance testing)

PRODUCT SUMMARY

The HL9467 series is an impedance-matched pick-off tee with a flat frequency response from DC up to 67 GHz on the thru line and 55 or 67 GHz bandwidth (-3 dB) on the pick-off line depending on the version selected..

It is suitable as a trigger source with minimum perturbation of the thru signal path.

Since the pick-off tee is bi-directional, a typical application is to inject noise on the pickoff port into the original signal. This is useful for compliance testing.

The PCIe7.0 version is optimized for 128 GT/s by using low dispersion transmission line technology. This part is optimized for sinusoidal interference (SI) injection used in PCIe® 7.0 compliance testing.

Digital oscilloscope applications include pre-scaler triggering, synchronization, and clock/data recovery.

Some specificatons are only applicable to matched pairs of devices and are labeled accordingly.

MODELS & OPTIONS

The following models are available:

HL9467, 67 GHz

HL9467-PCIe7.0, 67+ GHz on both paths

The following options and configurations are available for this product:

-M, matched pair

-U, unmatched part(s)

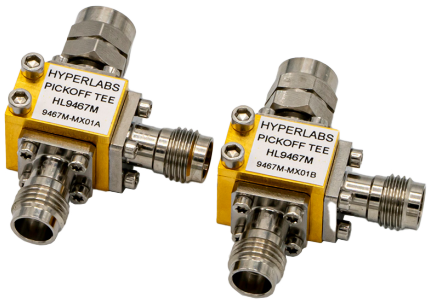
-JJJ, jack (female), all ports

-JPJ, jack (female) thru in and pick-off; plug (male) thru out

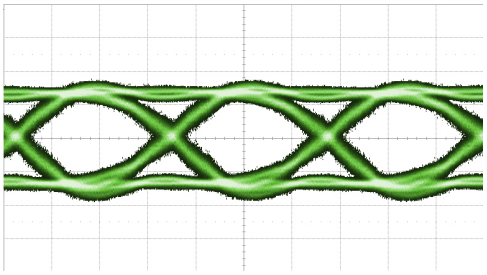
Key Features and Technical Specifications[1] (HL9467 shown)

Bandwidth	DC to 67 GHz, thru line DC to 55 GHz (3 dB), pick-off line
Insertion Loss	4.0 ± 0.75 dB, thru line 10.5 ± 1 dB, pick-off line See *Fig. 1*
Amplitude Match (opt. -M only)	± 0.25 dB See *Figs. 3-4*
Phase Match (opt. -M only)	± 2°, f = 10 GHz ± 5°, f = 20 GHz
Return Loss	< 20 dB, f ≤ 25 GHz, thru line < 15 dB, f > 25 GHz, thru line < 15 dB, f ≤ 30 GHz, pick-off line < 10 dB, f > 30 GHz, pick-off line *See Fig. 5*
Group Delay	≈ 115 ps, thru line (opt. -JJJ) ≈ 125 ps, thru line (opt. -JPJ) ≈ 125 ps, pick-off line (all opts.) *See Fig. 2*
Connectors	1.85 mm jack, all ports (opt. -JJJ) 1.85 mm jack, Thru 1 and Pick-off; 1.85 mm plug, Thru 2 (opt. -JPJ)
Unit Dimensions	30.75 x 24.23 x 13.59 mm 1.21” x 0.95” x 0.54”
RoHS Compliant	Yes
REACH Compliant	Yes

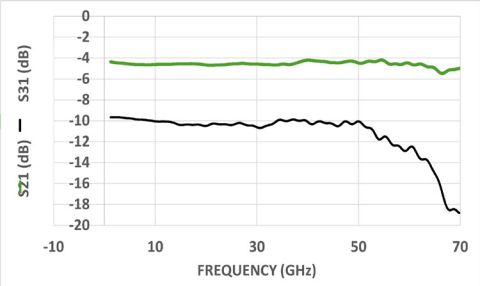
NOTE 1 - The specifications in this table are typical using the standard connector configuration (-JPJ, jack/plug/jack). Full specifications are available on page 2 of this datasheet.



HL9467, option -M-JPJ shown



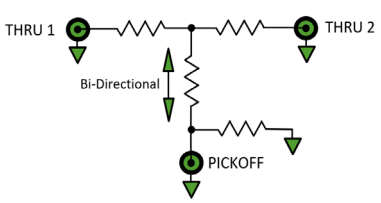
56 Gbps NRZ pattern on the Thru Out port of HL9467-JPJ; see also Figs. 7-18



Typical Insertion Loss on thru and pick-off lines of HL9467 (opt. -JPJ); see also Fig. 1

DEVICE PORT ASSIGNMENTS

For the purposes of this datasheet, the below port assignments are used.



HL9467 Full Specifications

Parameter	HL9467	HL9467-PCIe7.0	Comments
Bandwidth	DC to 67 GHz thru DC to 55 GHz pick-off	DC to 70 GHz thru DC to 70 GHz pick-off	3 dB roll-off point, relative to nominal insertion loss
Amplitude Match See *Figs. 2-3,8-9*	± 0.25 dB	± 0.5 dB	Matched pair (opt. -M) only
Phase Match	± 2.5°, f = 10 GHz ± 5°, f = 20 GHz		Matched pair (opt. -M) only
Insertion Loss See Figs. 1,7	4.0 ± 0.75 dB, thru 10.5 ± 1 dB, pick-off	4.0 ± 0.75 dB, thru 10.5 ± 1 dB, pick-off	All options
Return Loss, Thru See *Figs. 4,10*	< 20 dB, f ≤ 25 GHz < 15 dB, f > 25 GHz	< 20 dB, f ≤ 25 GHz < 15 dB, f > 25 GHz	
Return Loss, Pick-off See *Figs. 4,10*	< 15 dB, f ≤ 30 GHz < 10 dB, f > 30 GHz	< 15 dB	
Rise Time	5.2 ps	5.2 ps	
Group Delay *See Figs. 6,12*	115 ps, thru (opt.-JJJ) 125 ps, thru (opt-JPJ) 125 ps, pick-off	107 ps, thru (opt.-JJJ) 112 ps, thru (opt-JPJ) 112 ps, pick-off	
Max Input Power	+30 dBm (1 W)		
Impedance	50 Ω		All ports
Transmission Line	Microstrip	Stripline	
Connectors	1.85 mm, 3x jack 1.85 mm, jack/plug/jack	1.85 mm, 3x jack 1.85 mm, jack/plug/jack	opt. -JJJ opt. -JPJ
Dimensions (W x D x H)	1.21” x 0.95” x 0.54” 30.75 x 24.23 x 13.59 mm	1.21” x 0.95” x 0.54” 30.75 x 24.23 x 13.59 mm	Package including connectors
Weight	12.5 g (0.44 oz.)	12.5 g (0.44 oz.)	
Operating Temperature	-40° to +85° C		Case temperature
RoHS Compliant	Yes, assembled with lead-free solder		
REACH Compliant	Yes		
Warranty	1 year, repair or replacement; see website for details		

Note: All specifications are based on test results using the standard connector configuration (-JPJ). Specifications may vary slightly for other configurations.

HL9467 Plot Diagrams

Figures 1-6 show the typical insertion loss, return loss, VSWR, amplitude matching, and group delay plots for an HL9467.

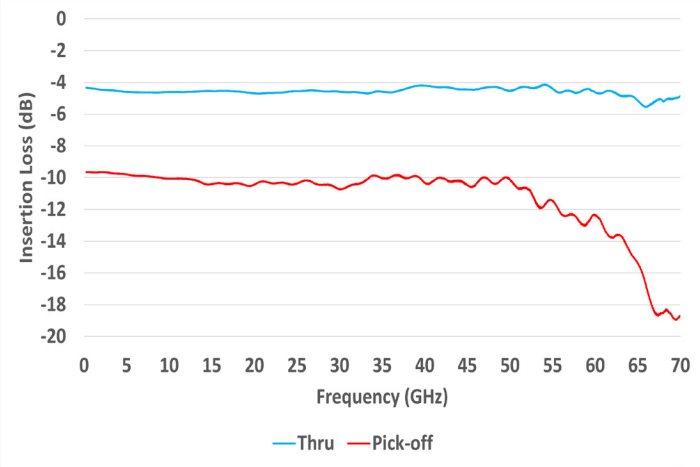


Figure 1: HL9467 Insertion Loss (-JPJ)

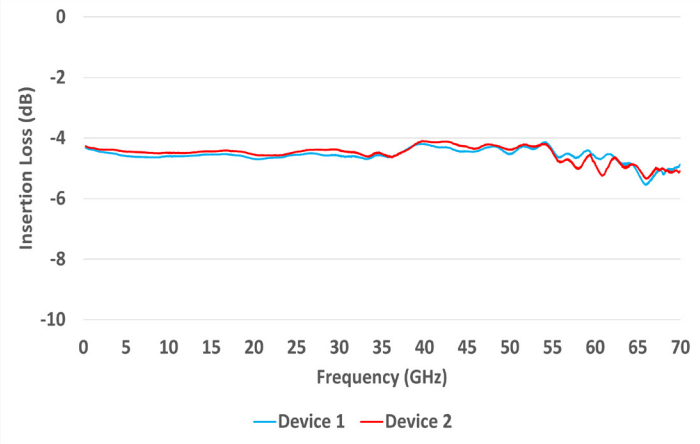


Figure 2: HL9467 Thru Amplitude Match (-JPJ)

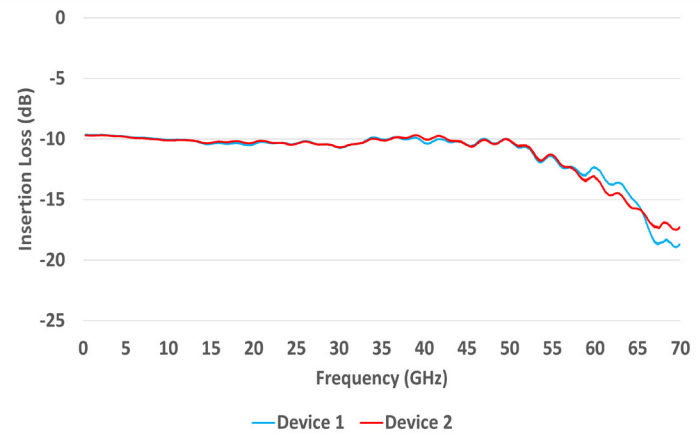


Figure 3: HL9467 Pick-off Amplitude Match (-JPJ)

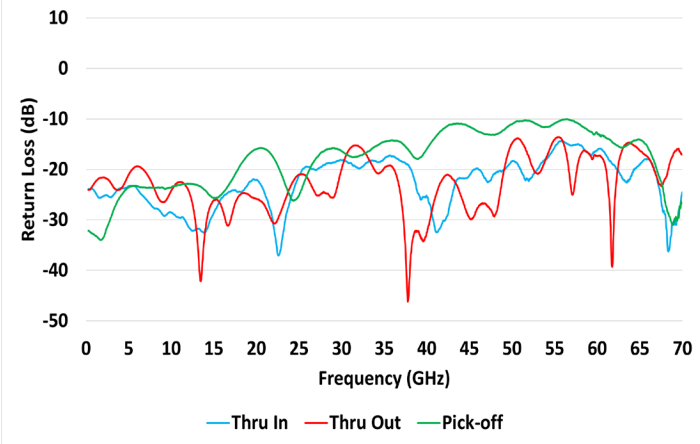


Figure 4: HL9467 Return Loss (-JPJ)

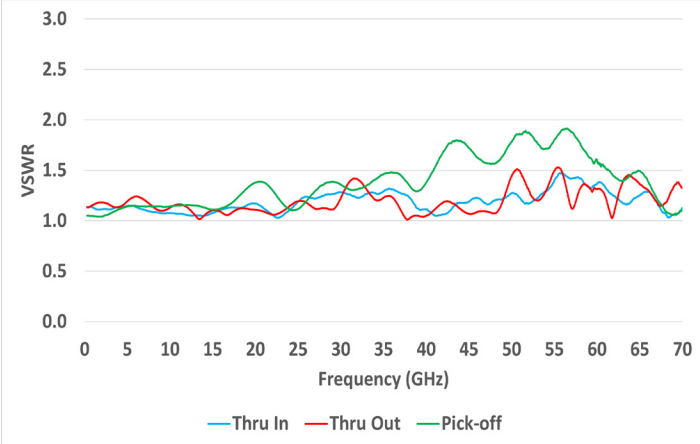


Figure 5: HL9467 VSWR (-JPJ)

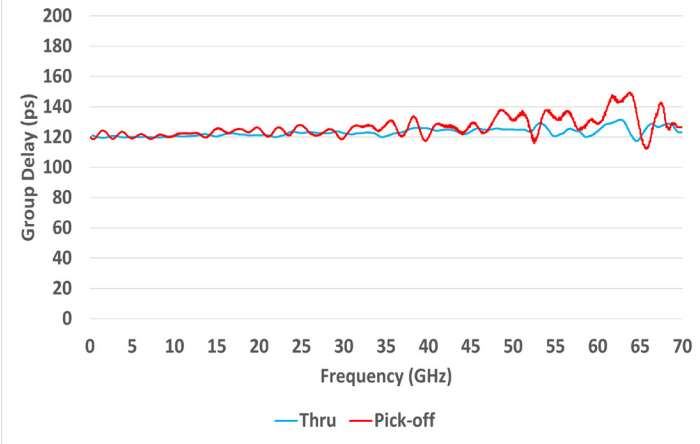


Figure 6: HL9467 Group Delay (-JPJ)

HL9467-PCIe7.0 Plot Diagrams

Figures 7-12 show the typical insertion loss, return loss, VSWR, amplitude matching, and group delay plots for an HL9467-PCIe7.0.

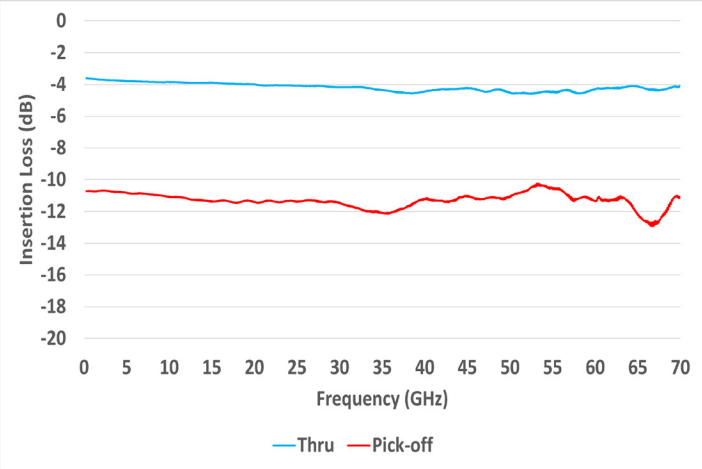


Figure 7: Insertion Loss (-JPJ)

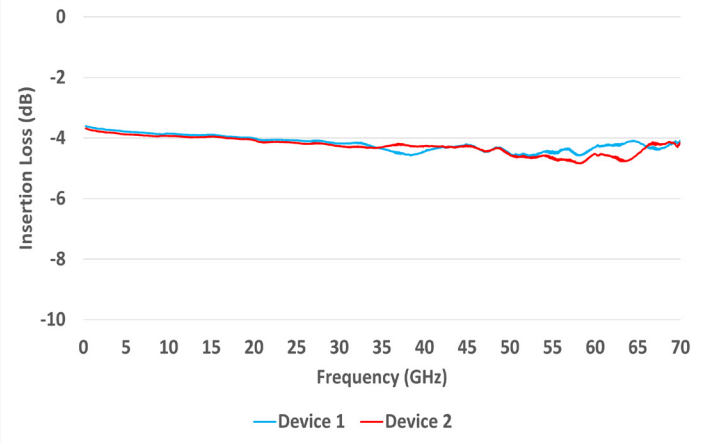


Figure 8: Thru Amplitude Match (-JPJ)

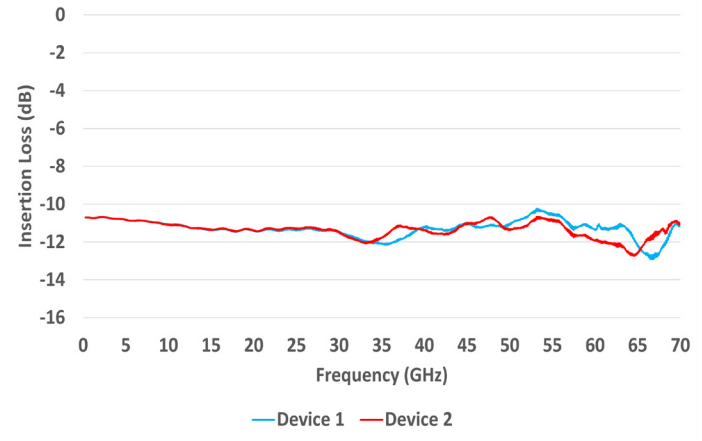


Figure 9: Pick-off Amplitude Match (-JPJ)

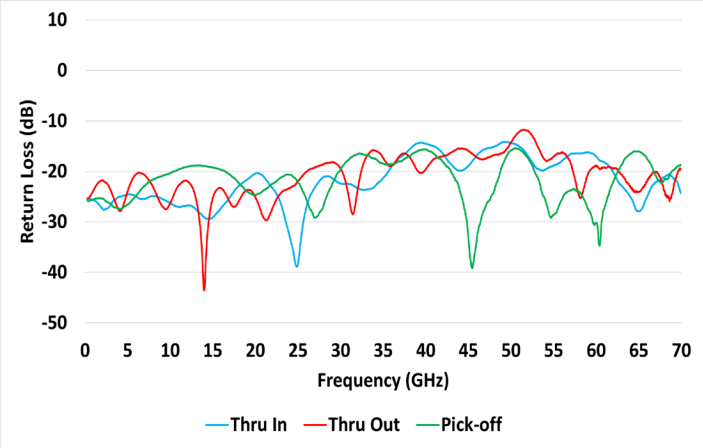


Figure 10: Return Loss (-JPJ)

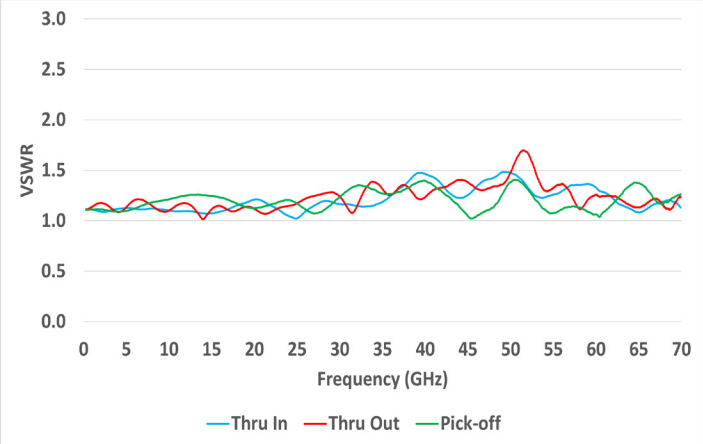


Figure 11: VSWR (-JPJ)

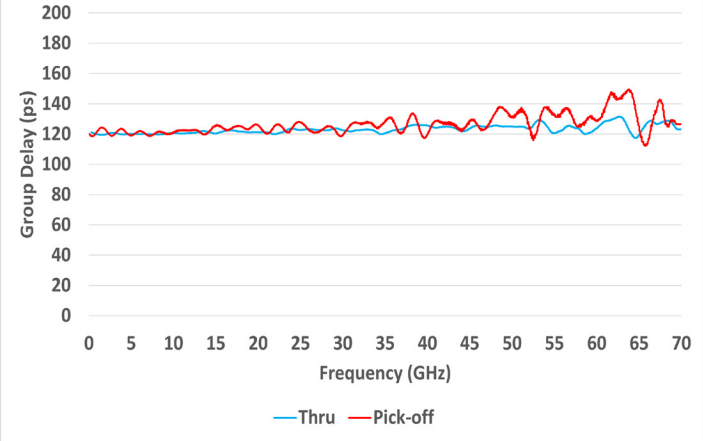


Figure 12: Group Delay (-JPJ)

HL9467 Eye Diagrams

The eye diagrams in *Figures 13-15* show a PRBS31 pattern at 28 Gpbs. The input signal has a 1.53 V amplitude and is shown at 450 mV/div. The thru and pick-off outputs are shown at 275 mV/div.

Figures 16-18 were generated by a PRBS31 pattern at 12.5 Gbps. The input signal has amplitude of 1.49 V and is shown at 450 mV/div. The thru and pick-off outputs are shown at 275 mV/div.

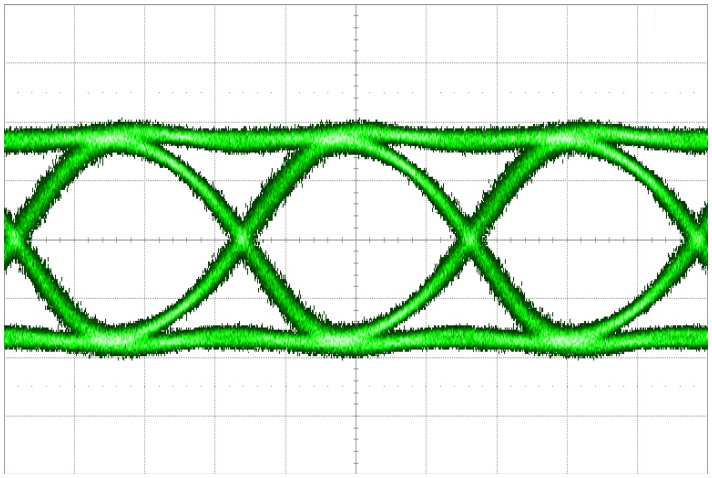


Figure 13: 28 Gbps PRBS31 pattern on RF In

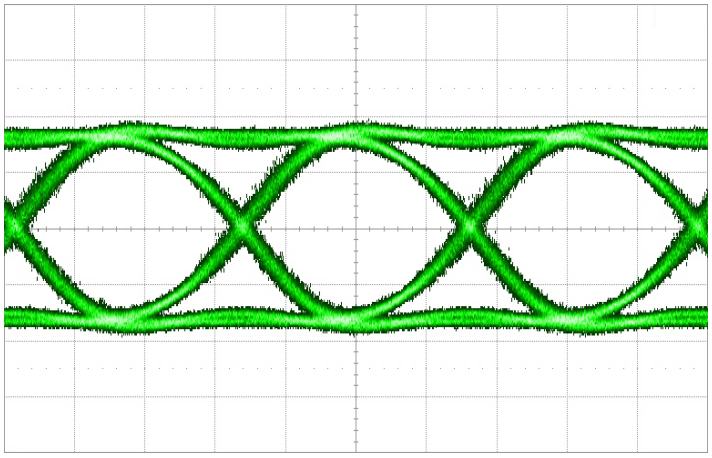


Figure 14: 28 Gbps PRBS31 pattern on Thru Out

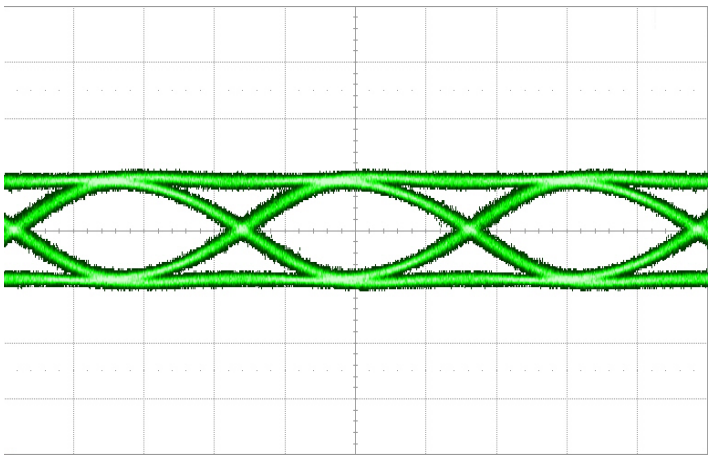


Figure 15: 28 Gbps PRBS31 pattern on Pick-off

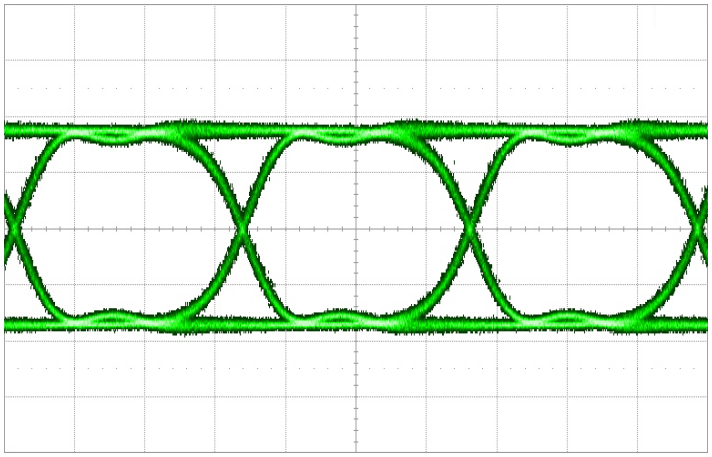


Figure 16: 12.5 Gbps PRBS31 pattern on RF In

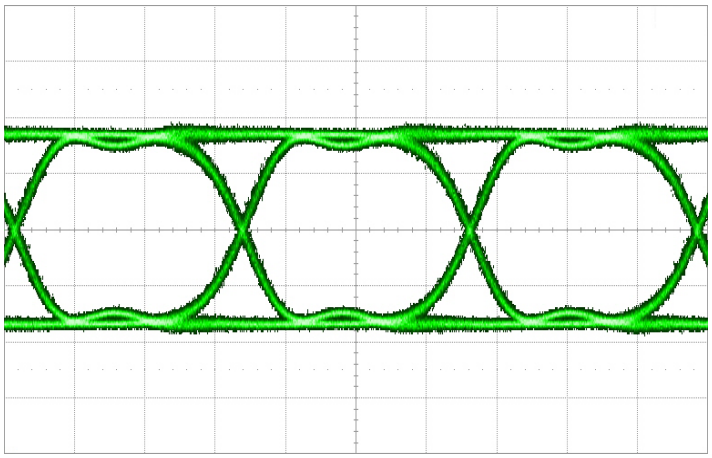


Figure 17: 12.5 Gbps PRBS31 pattern on Thru Out

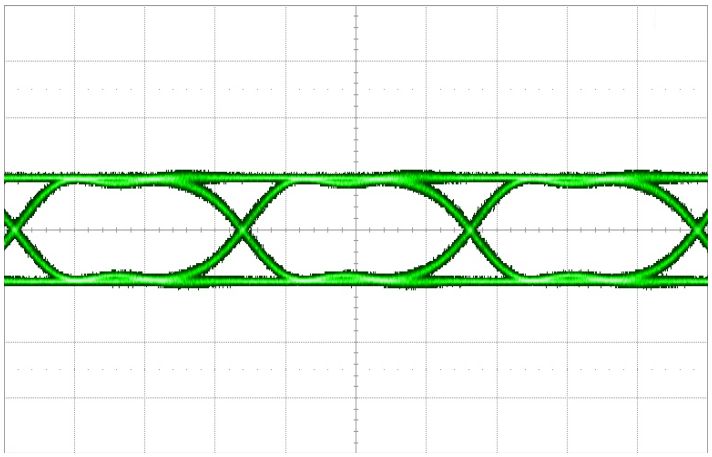


Figure 18: 12.5 Gbps PRBS31 pattern on Pick-off

HL9467 Eye Diagrams

The eye diagrams in *Figures 19-21* show an NRZ pattern at 56 Gpbs. The input signal has a 809 mV amplitude and is shown at 150 mV/div. The thru and pick-off outputs are 575 and 370 mV respectively at the 150 mV/div scale.

The eye diagrams in *Figures 22-24* show a PAM4 pattern at 112 Gpbs. The input signal has a 844 mV amplitude and is shown at 198 mV/div. The thru and pick-off outputs are 578 and 389 mV respectively at the 198 mV/div scale.

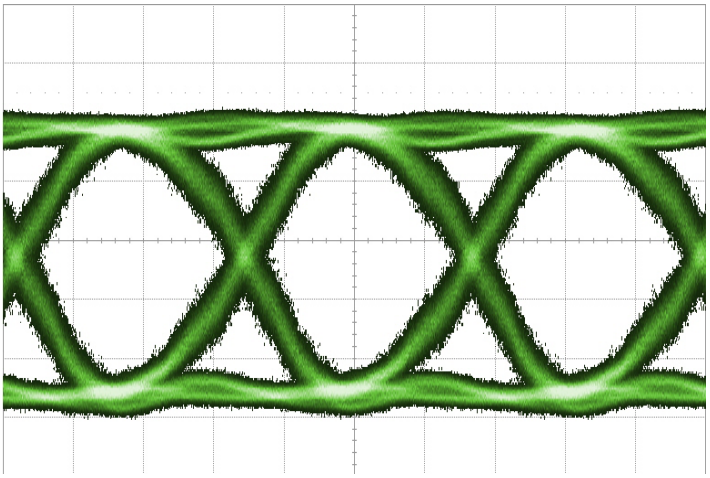


Figure 19: 56 Gbps NRZ pattern on RF In

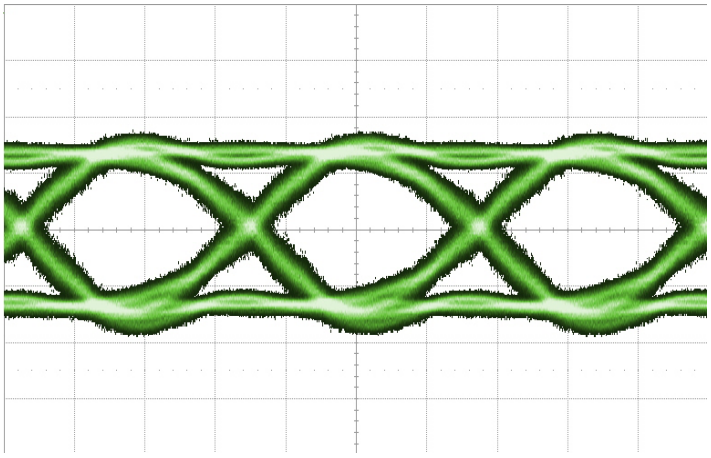


Figure 20: 56 Gbps NRZ pattern on Thru Out

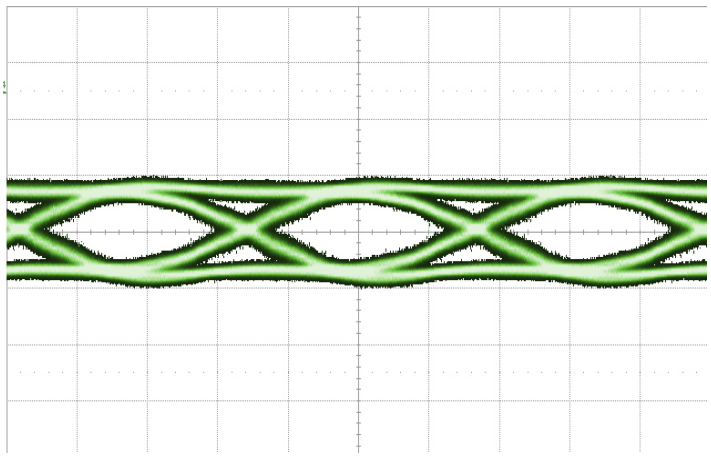


Figure 21: 56 Gbps NRZ pattern on Pick-off Out

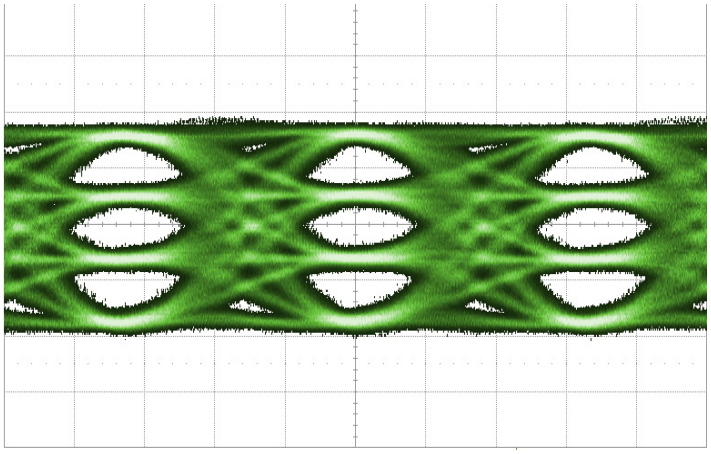


Figure 22: 112 Gbps PAM4 pattern on RF In

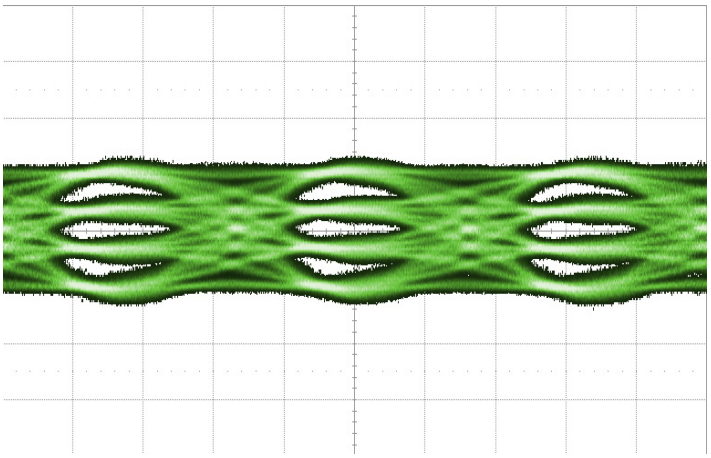


Figure 23: 112 Gbps PAM4 pattern on Thru Out

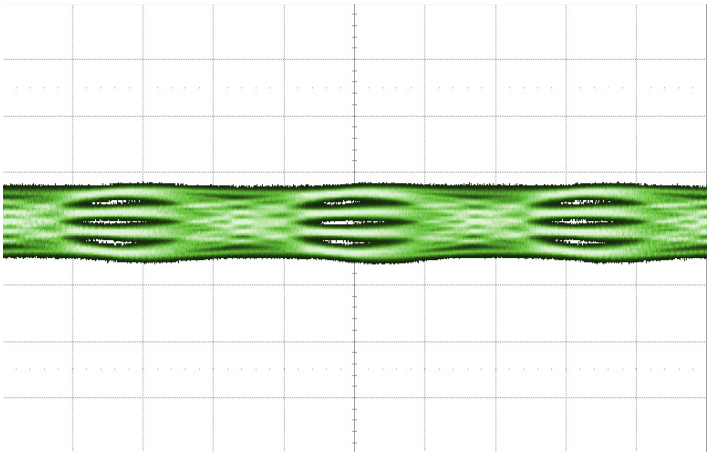


Figure 24: 112 Gbps PAM4 pattern on Pick-off Out

HL9467 Dimensional Drawing

Figure 25 shows a mechanical drawing of an HL9467, option -JPJ. Unless otherwise noted, all units are in inches.

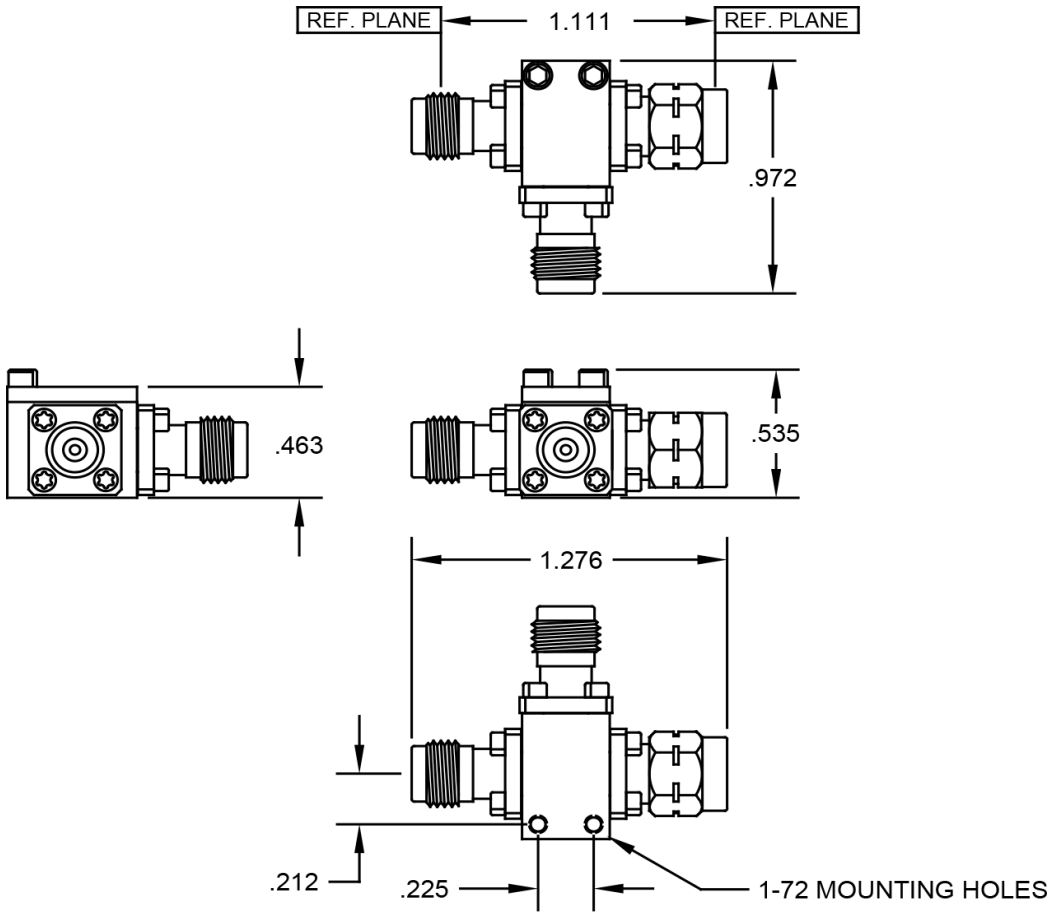


Figure 25: HL9467 mechnical drawing (opt. -JPJ)