

PRODUCT SUMMARY

The HL946x 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 GHz bandwidth (-3 dB) on the pick-off line.

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.

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

DEPLOYMENT NOTES

Some of the specifications in this datasheet are only applicable to matched pairs of devices and are labeled accordingly.

S-PARAMETERS

S-parameters are available on our website.

MODELS & OPTIONS

The following models are available:

- HL9462**, 26.5 GHz
- HL9464**, 40 GHz
- HL9465**, 50 GHz
- HL9467**, 67 GHz

The following options and configurations are available for this product:

- M**, matched pair
- U**, unmatched part(s)

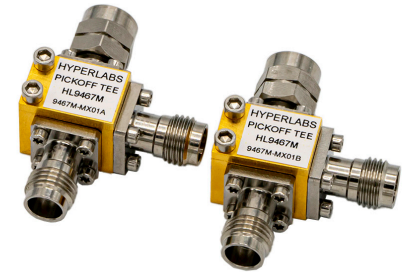
- JJJ**, jack (female), all ports
- JPJ**, jack (female) thru in and pick-off; plug (male) thru out

HL946x Broadband Z-matched Pick-off Tee (67 GHz)

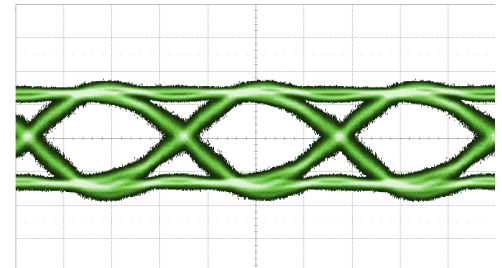
Key Features and Technical Specifications¹ (HL9467 shown)

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 10.0 ± 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

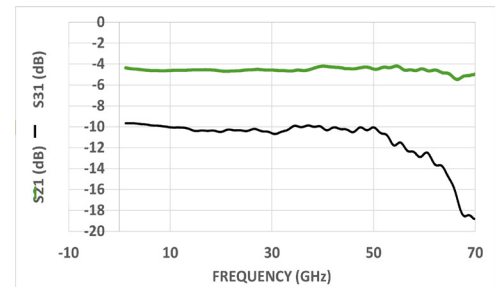
NOTE 1 - The specifications in this table are typical using the standard connector configuration (-JPJ, jack/plug/jack). Full specifications are available on page 2 of this datasheet.



HL9467, option -M-JPJ shown



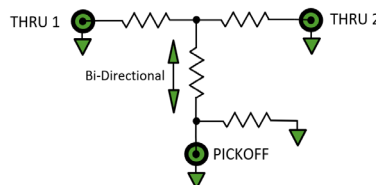
56 Gbps NRZ pattern on the Thru Out port of HL9467-JPJ; see also Figs. 13-24



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.



HL946x Full Specifications

Parameter	HL9462	HL9464	HL9465	HL9467	Comments
Bandwidth	DC to 26.5 GHz, thru and pick-off	DC to 40 GHz, thru and pick-off	DC to 50 GHz, thru and pick-off	DC to 67 GHz thru DC to 55 GHz pick-off	3 dB roll-off point, relative to nominal insertion loss
Amplitude Match See Figs. 2-3, 8-9	± 0.1 dB	± 0.1 dB	± 0.1 dB	± 0.25 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	3.5 ± 0.5 dB, thru 10.5 ± 1 dB, pick-off	3.5 ± 0.5 dB, thru 10.5 ± 1 dB, pick-off	3.5 ± 0.5 dB, thru 10.5 ± 1 dB, pick-off	4.0 ± 0.75 dB, thru 10.0 ± 1 dB, pick-off	All options
Return Loss, Thru See Figs. 4, 10	< 15 dB, thru	< 15 dB, f ≤ 30 GHz < 10 dB, f > 30 GHz	< 12.5 dB, f ≤ 35 GHz < 10 dB, f > 35 GHz	< 20 dB, f ≤ 25 GHz < 15 dB, f > 25 GHz	
Return Loss, Pick-off See Figs. 4, 10	< 20 dB, pick-off	< 20 dB, f ≤ 20 GHz < 15 dB, f > 20 GHz	< 20 dB, f ≤ 25 GHz < 15 dB, f > 25 GHz	< 15 dB, f ≤ 30 GHz < 10 dB, f > 30 GHz	
Rise Time	17.5 ps	9.0 ps	7 ps	5.2 ps	
Group Delay See Figs. 6, 12	130 ps, thru (opt.-JJJ) 110 ps, thru (opt.-JPJ) 140 ps, pick-off	110 ps, thru (opt.-JJJ) 90 ps, thru (opt. -JPJ) 120 ps, pick-off	125 ps, thru (opt.-JJJ) 115 ps, thru (opt.-JPJ) 125 ps, pick-off	115 ps, thru (opt.-JJJ) 125 ps, thru (opt.-JPJ) 125 ps, pick-off	
Max Input Power	+30 dBm (1 W)				
Impedance	50 Ω				All ports
Connectors	SMA, 3x jack SMA, jack/plug/jack	2.92 mm, 3x jack 2.92 mm, jack/plug/jack	2.4 mm, 3x jack 2.4 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)	1.23" x 0.90" x 0.54" 31.24 x 22.86 x 13.59 mm	1.10" x 0.90" x 0.54" 26.41 x 22.86 x 13.59 mm	1.29" x 0.95" x 0.54" 32.69 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	15 g (0.53 oz.)	12.5 g (0.44 oz.)	13.5 g (0.48 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.

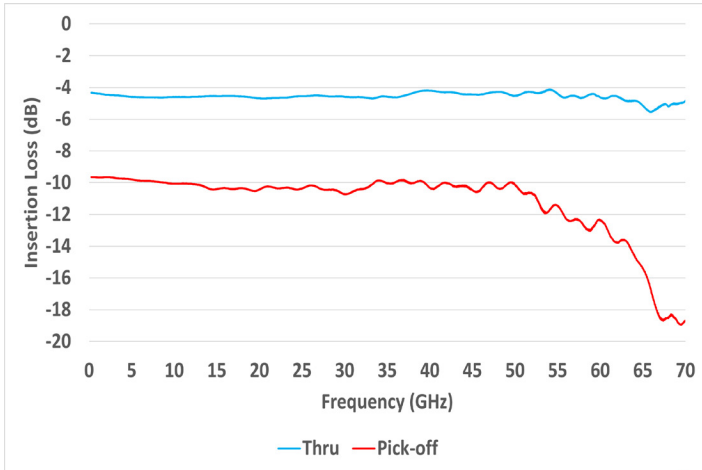


Figure 1: HL9467 Insertion Loss (-JPJ)

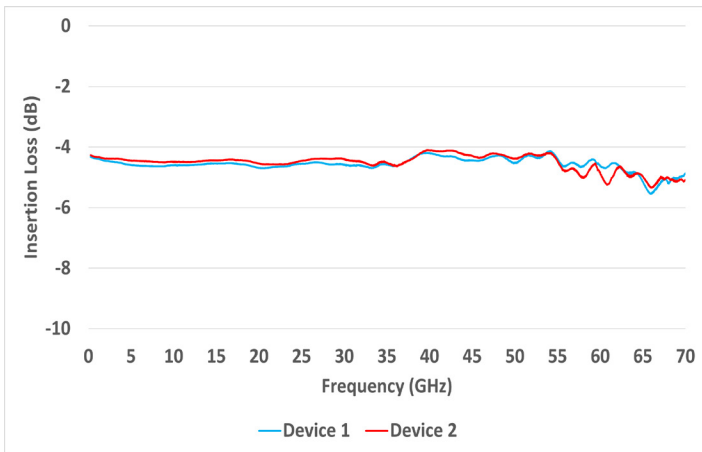


Figure 2: HL9467 Thru Amplitude Match (-JPJ)

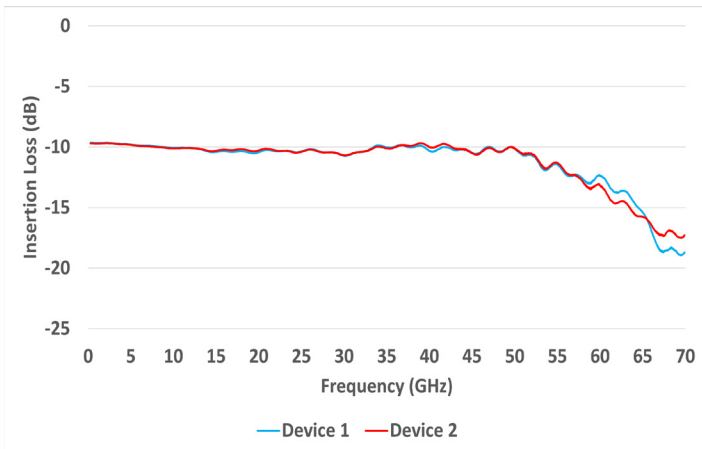


Figure 3: HL9467 Pick-off Amplitude Match (-JPJ)

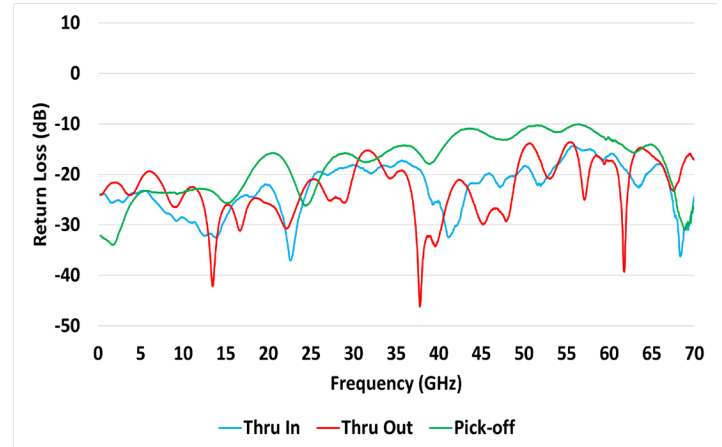


Figure 4: HL9467 Return Loss (-JPJ)

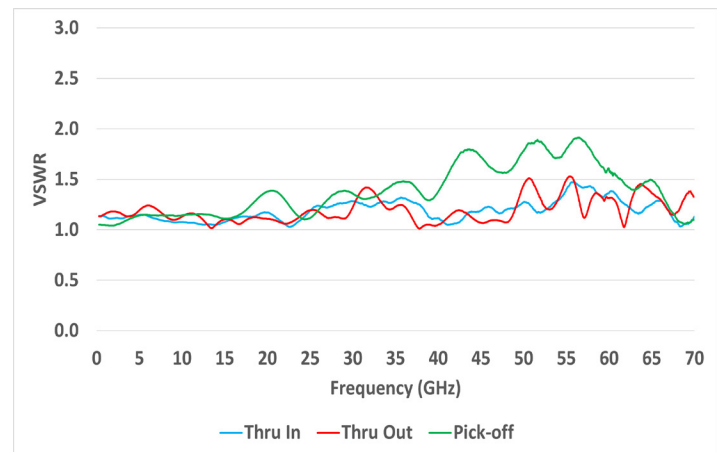


Figure 5: HL9467 VSWR (-JPJ)

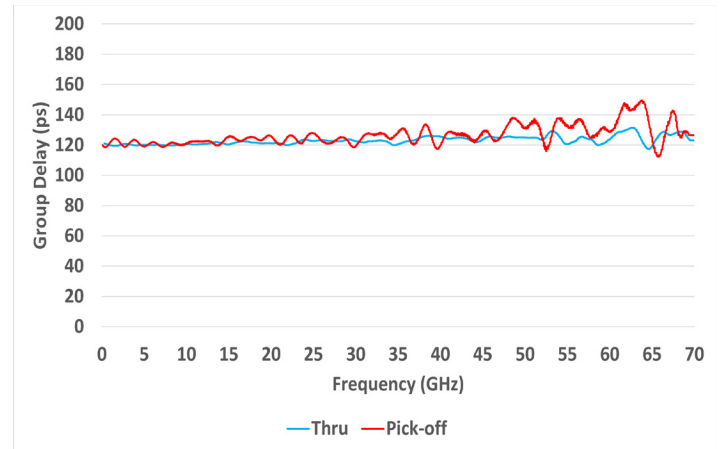


Figure 6: HL9467 Group Delay (-JPJ)



HL9465 Plot Diagrams

Figures 7-12 show the typical insertion loss, return loss, VSWR, amplitude matching, and group delay plots for an HL9465. The plots for the HL9462 and HL9464 will be similar through their respective frequency bandwidths.

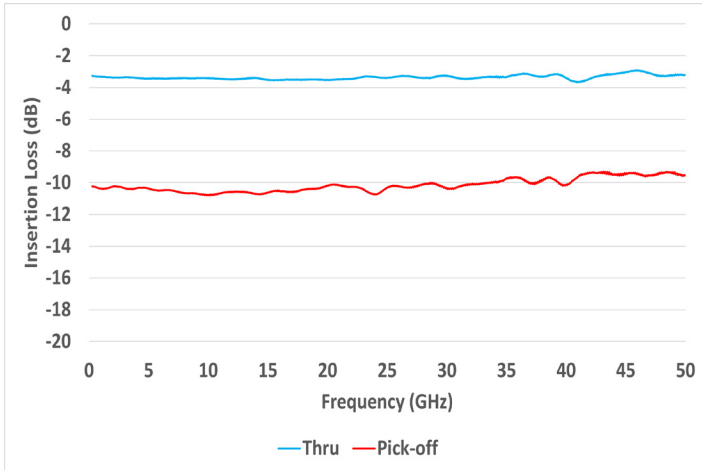


Figure 7: HL9465 Insertion Loss (-JPJ)

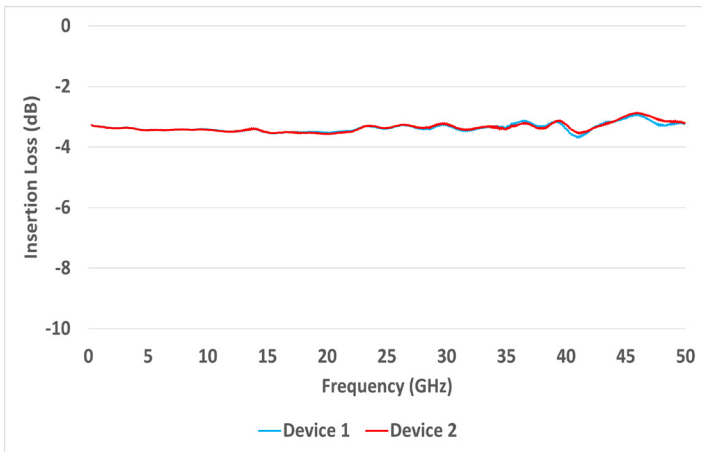


Figure 8: HL9465 Thru Amplitude Match (-JPJ)

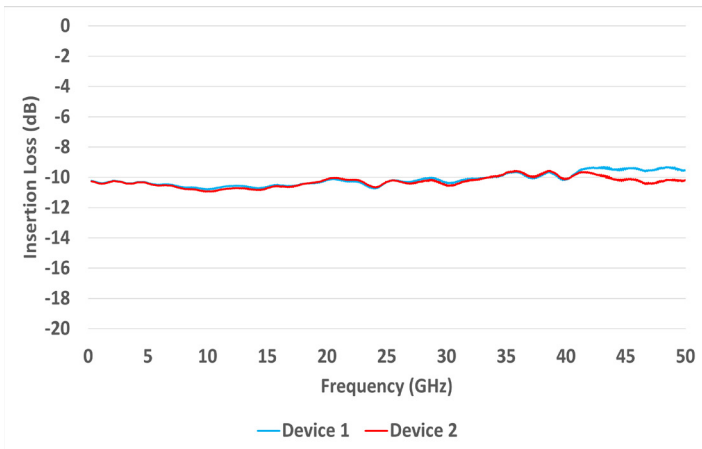


Figure 9: HL9465 Pick-off Amplitude Match (-JPJ)

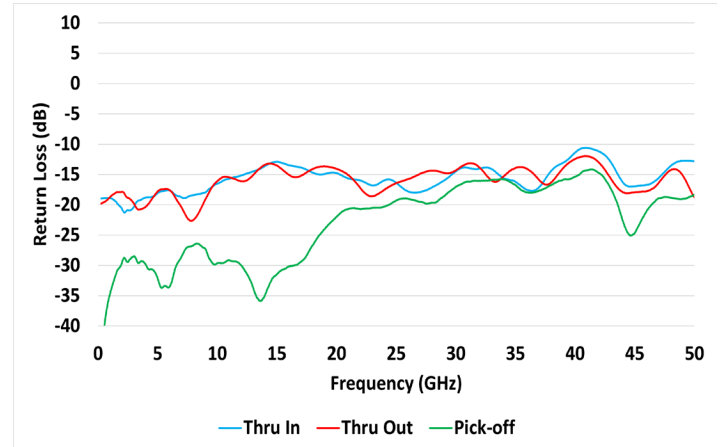


Figure 10: HL9465 Return Loss (-JPJ)

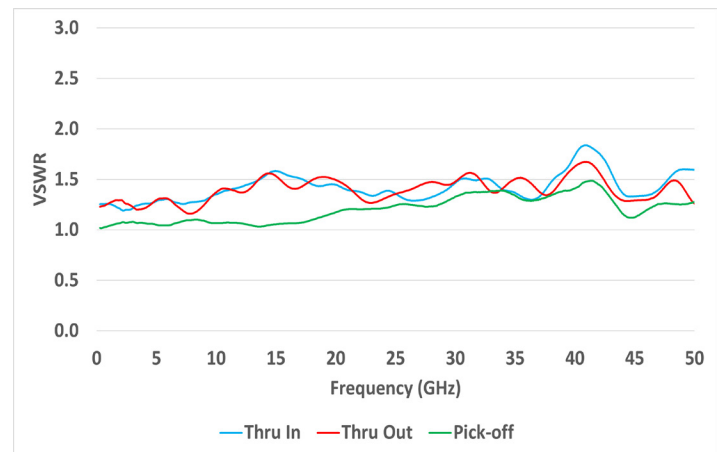


Figure 11: HL9465 VSWR (-JPJ)

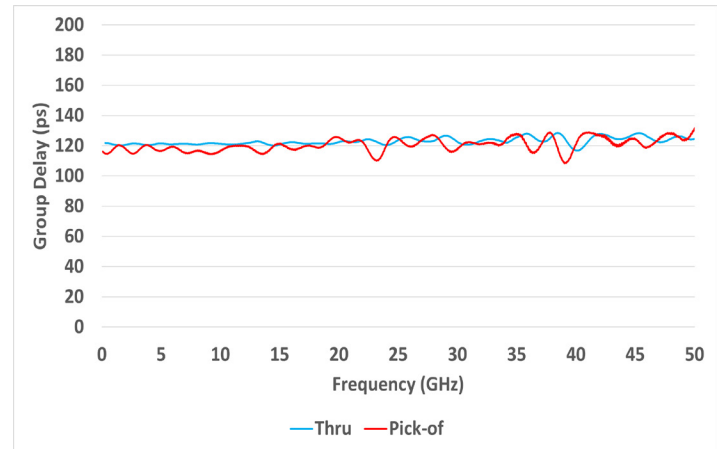


Figure 12: HL9465 Group Delay (-JPJ)

HL9467 Eye Diagrams

The eye diagrams in *Figures 13-15* show a PRBS31 pattern at 28 Gbps. 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.

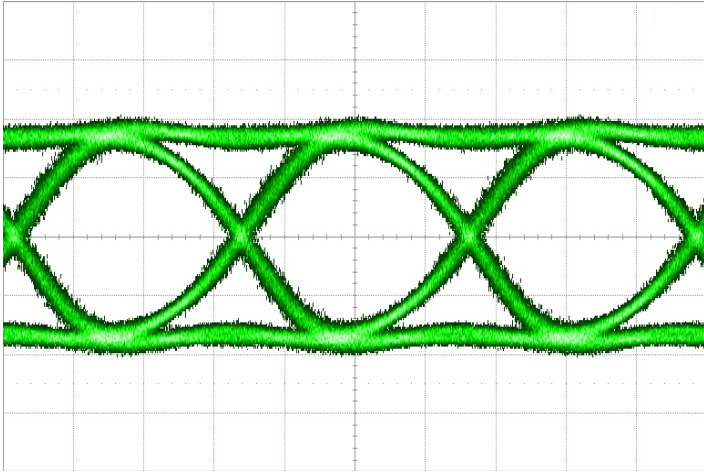


Figure 13: 28 Gbps PRBS31 pattern on RF In

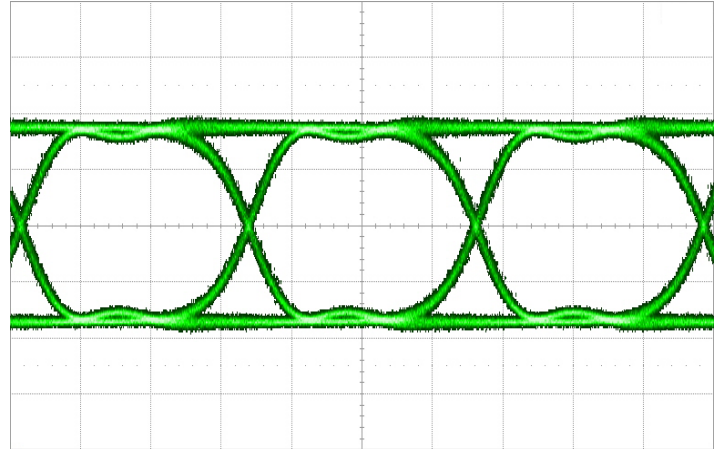


Figure 16: 12.5 Gbps PRBS31 pattern on RF In

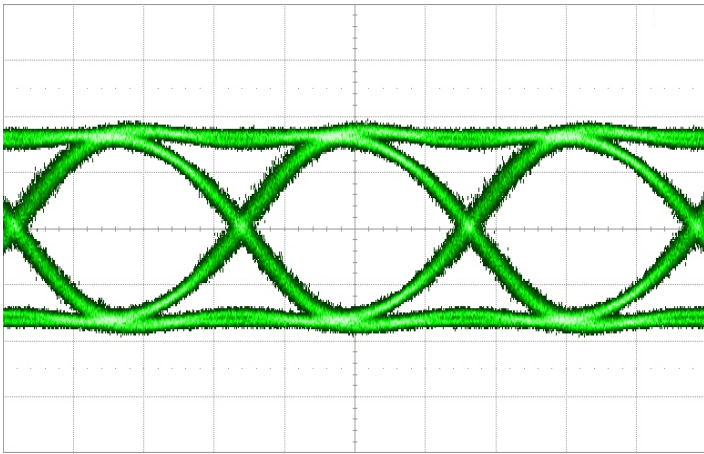


Figure 14: 28 Gbps PRBS31 pattern on Thru Out

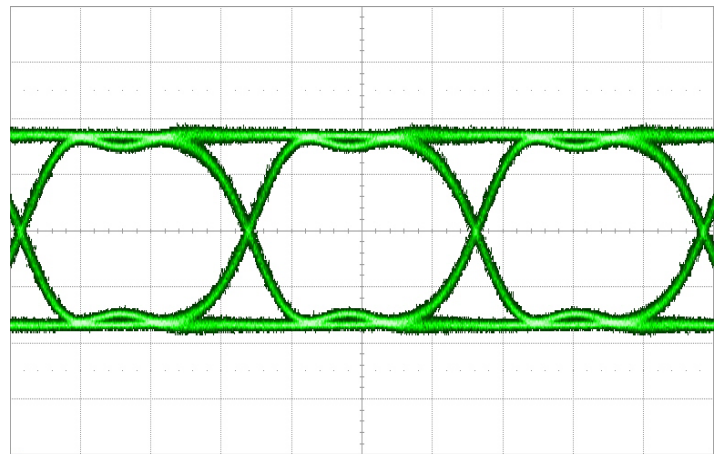


Figure 17: 12.5 Gbps PRBS31 pattern on Thru Out

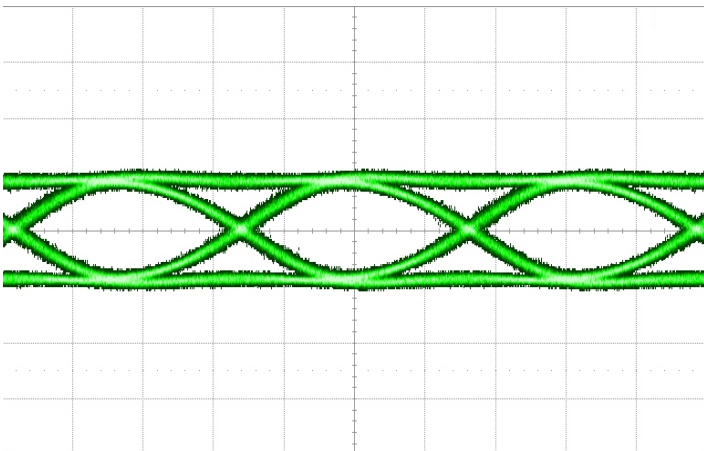


Figure 15: 28 Gbps PRBS31 pattern on Pick-off

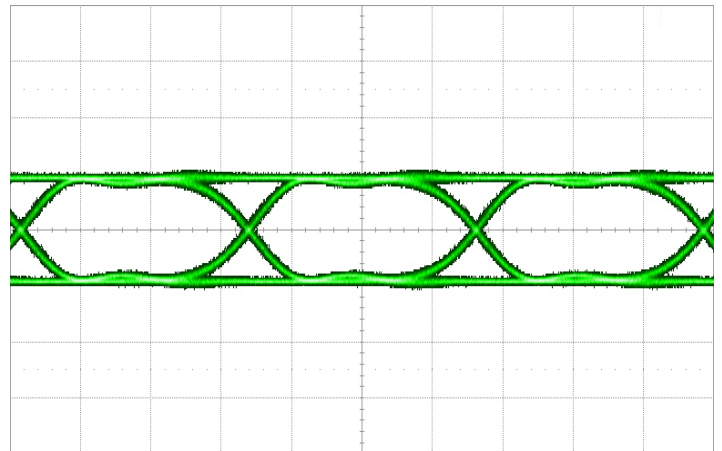


Figure 18: 12.5 Gbps PRBS31 pattern on Pick-off

HL9467 Eye Diagrams

The eye diagrams in *Figures 19-21* show an NRZ pattern at 56 Gbps. 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 Gbps. 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.

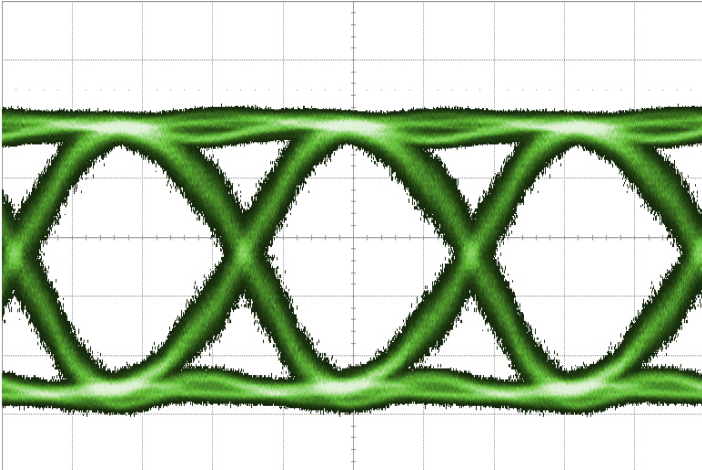


Figure 19: 56 Gbps NRZ pattern on RF In

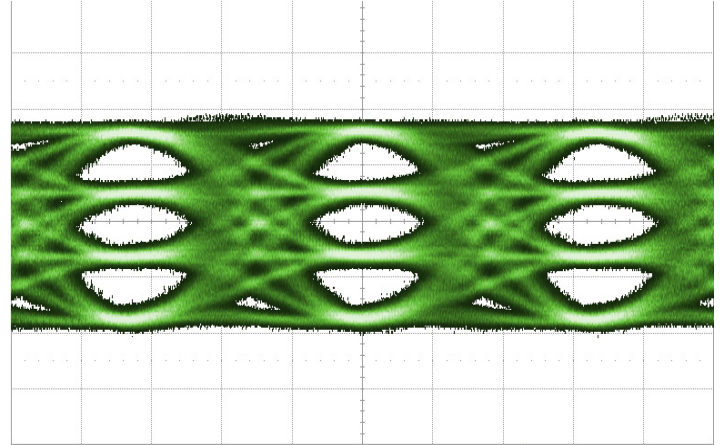


Figure 22: 112 Gbps PAM4 pattern on RF In

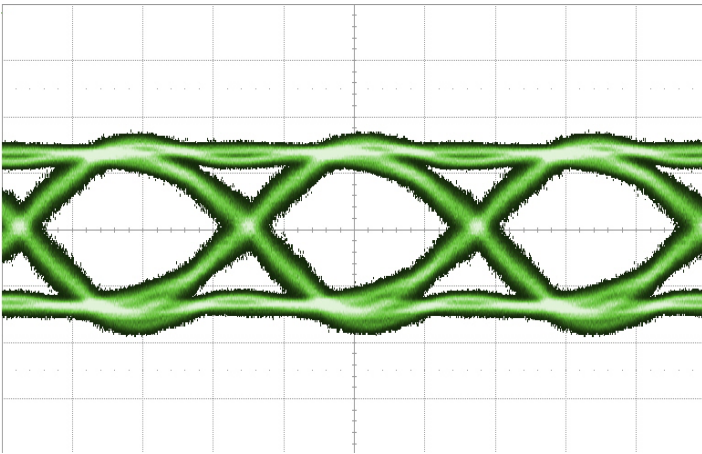


Figure 20: 56 Gbps NRZ pattern on Thru Out

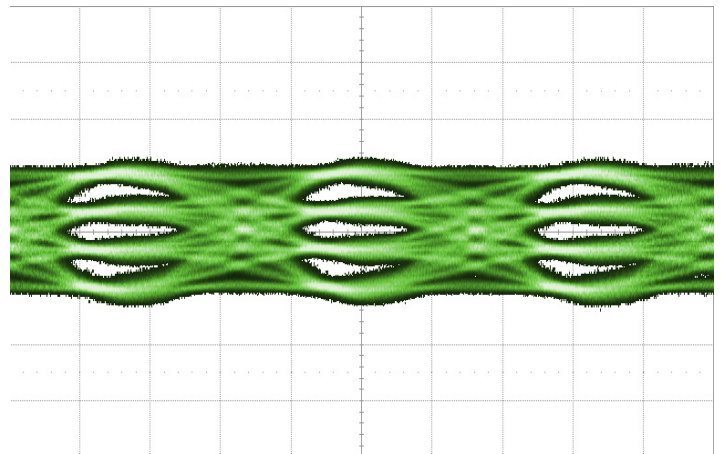


Figure 23: 112 Gbps PAM4 pattern on Thru Out

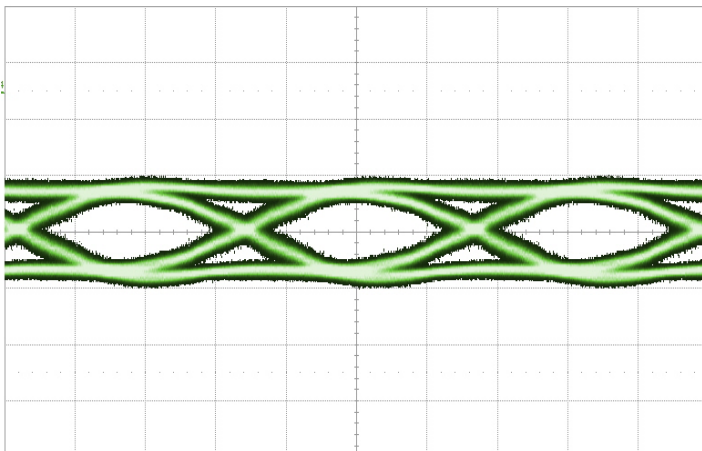


Figure 21: 56 Gbps NRZ pattern on Pick-off Out

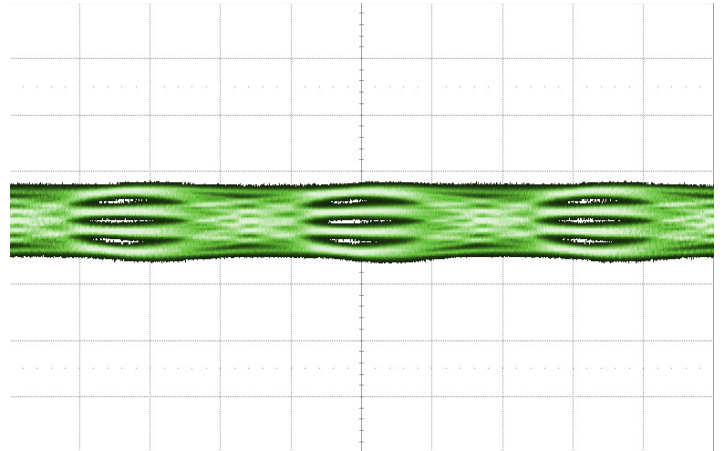


Figure 24: 112 Gbps PAM4 pattern on Pick-off Out

HL9467 Dimensional Drawing

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

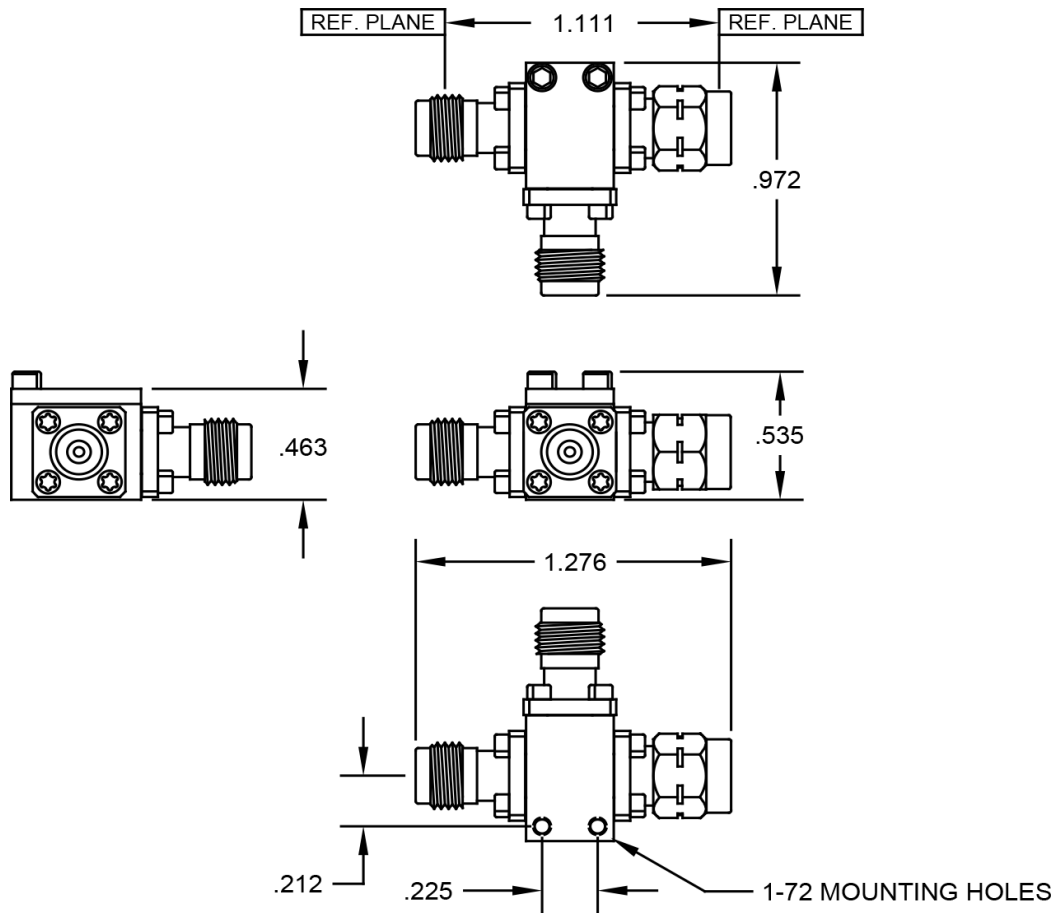


Figure 25: HL9467 mechanical drawing (opt. -JPJ)