HYPERLABS™
Innovation at Hyperspeed since 1992

HL9401 Broadband Balun (20 GHz)

Features and Technical Specifications

Bandwidth (3 dB)	100 MHz to 20 GHz
Amplitude Match	± 0.1 dB to 20 GHz, typical ± 0.5 dB to 20 GHz, max See *Fig. 1*
Phase Match	± 3°, f = 10 GHz, max ± 6°, f = 20 GHz, max See *Fig. 8*
Insertion Loss	6 dB, reference 7.5 dB, max[1] See *Figs. 1, 3-4*
Return Loss	> 14 dB, unbalanced port > 8 dB, balanced ports See *Figs. 2, 5*
Rise Time	17.5 ps
CMRR	> 25 dB, typical See *Fig. 6*
Group Delay	≈ 280 ps See *Fig. 7*
Max Input Power	1 W (+30 dBm)
Impedance	50 Ω In, 2 x 50 Ω Out
Connectors	SMA, 3x jack/female SMA plug connectors upon request
Dimensions	55.88 x 27.94 x 10.16 mm 2.20” x 1.10” x 0.40”
Weight	26 g (0.92 oz)
Temperature Limits	-40° to +100° C, operating
RoHS Compliant	Yes, assembled with lead-free solder
REACH Compliant	Yes
Warranty	1 year, see website

NOTE 1 - Curve fit using 6th order polynomial

PRODUCT SUMMARY

The HL9401 is a 180° signal splitter and combiner that offers industry-best amplitude and phase match over a bandwidth of 100 MHz to 20 GHz.

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

All specifications contained herein are typical unless otherwise noted.

When the device is used as a signal combiner using differential signals with unmatched source impedance, attenuators (3-6 dB) may be required to improve isolation.

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

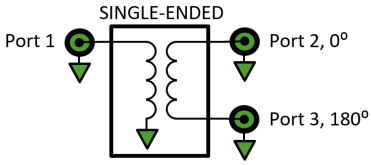
S-PARAMETERS

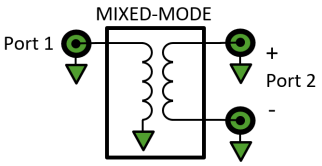
S-parameters for both single-ended and mixed-mode are available on our website.

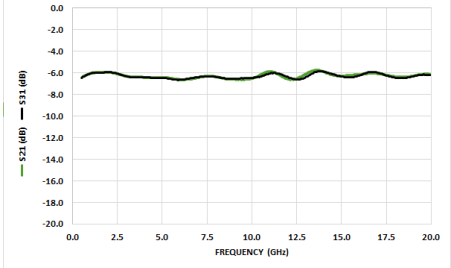
HL9401, standard configuration shown

DEVICE PORT ASSIGNMENTS

For the purposes of this datasheet and the S-parameter files available on our website, the below port assignments are used.







Typical HL9401 single-ended Insertion Loss

HL9401 Single-ended Insertion Loss and Return Loss

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

Figure 1 shows the insertion loss and amplitude match of an HL9401 in single-ended mode.

Figure 2 shows the return loss of all ports in single-ended mode.

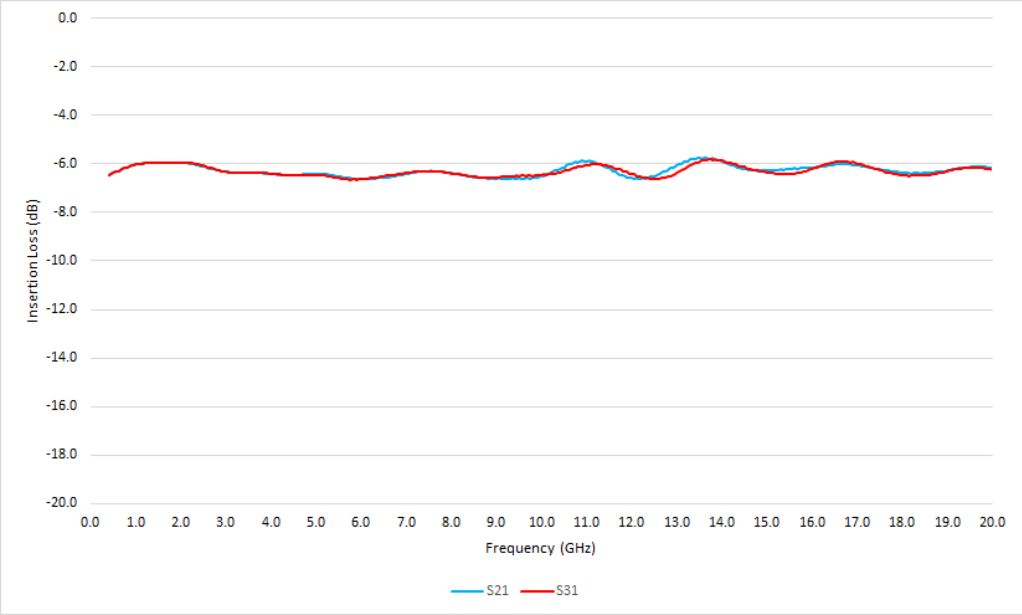


Figure 1: HL9401 Single-ended Insertion Loss

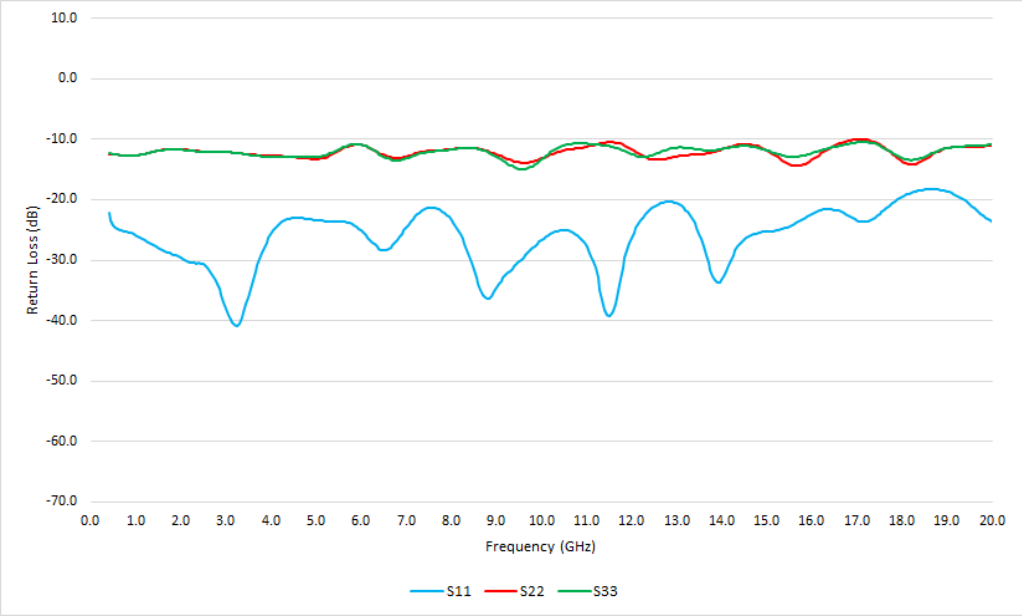


Figure 2: HL9401 Single-ended Return Loss

HL9401 Mixed-mode Insertion Loss

Mixed-mode Sparameters are useful for characterizing the performance of differential circuits such as broadband baluns.

Figures 3-4 show the insertion loss of an HL9401 balun in mixed mode to 20 GHz.

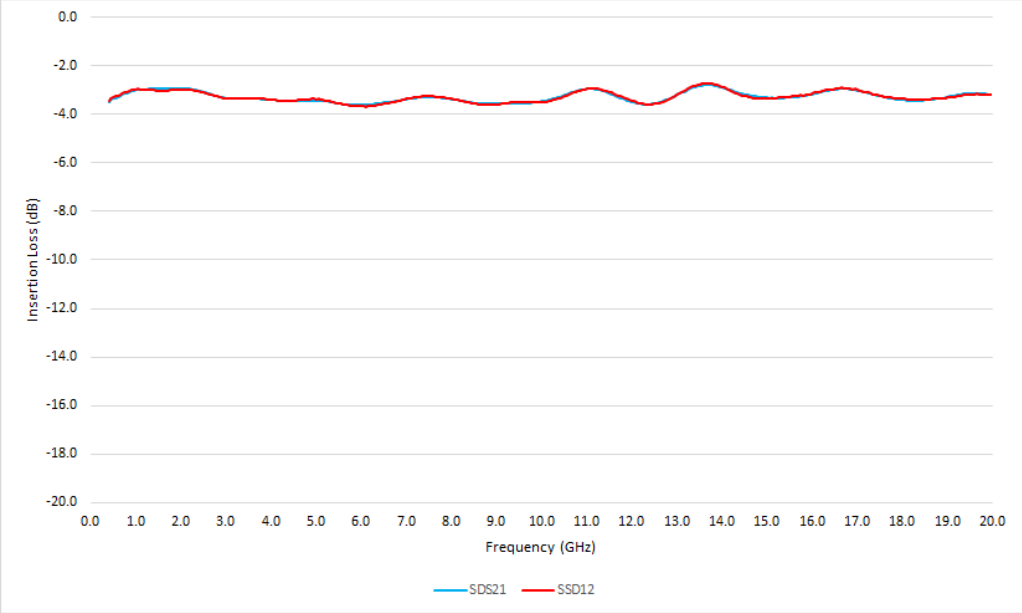


Figure 3: HL9401 Differential Mode Insertion Loss

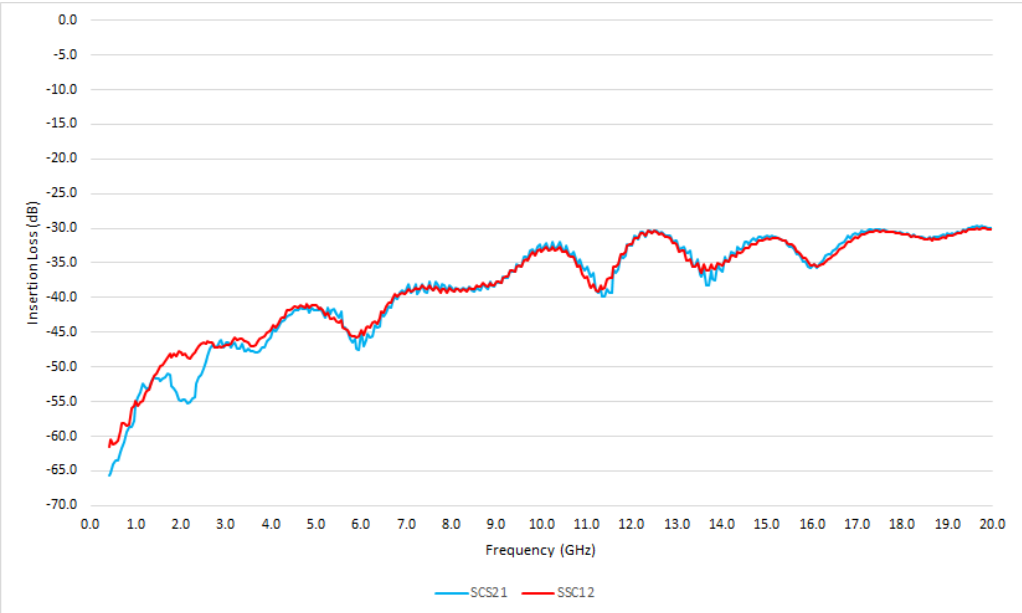


Figure 4: HL9401 Common Mode Insertion Loss

HL9401 Mixed-mode Return Loss

Figure 5 shows the typical mixed-mode return loss of the unbalanced and balanced ports of an HL9401 to 20 GHz.

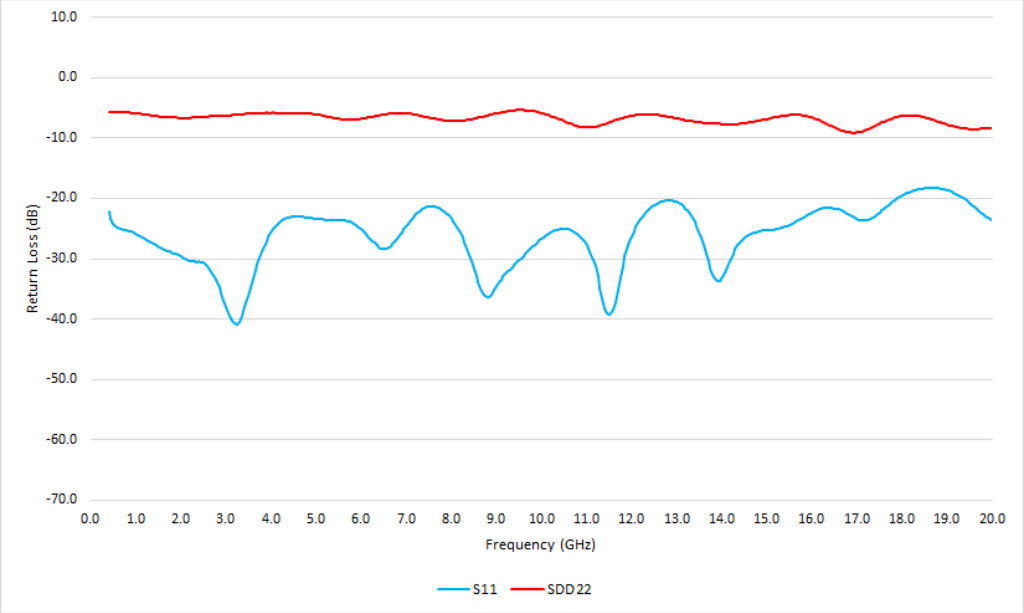


Figure 5: HL9401 Mixed-mode Return Loss

HL9401 Common-mode Rejection Ratio

Figure 8 shows the typical common-mode rejection ratio (CMRR) of an HL9401.

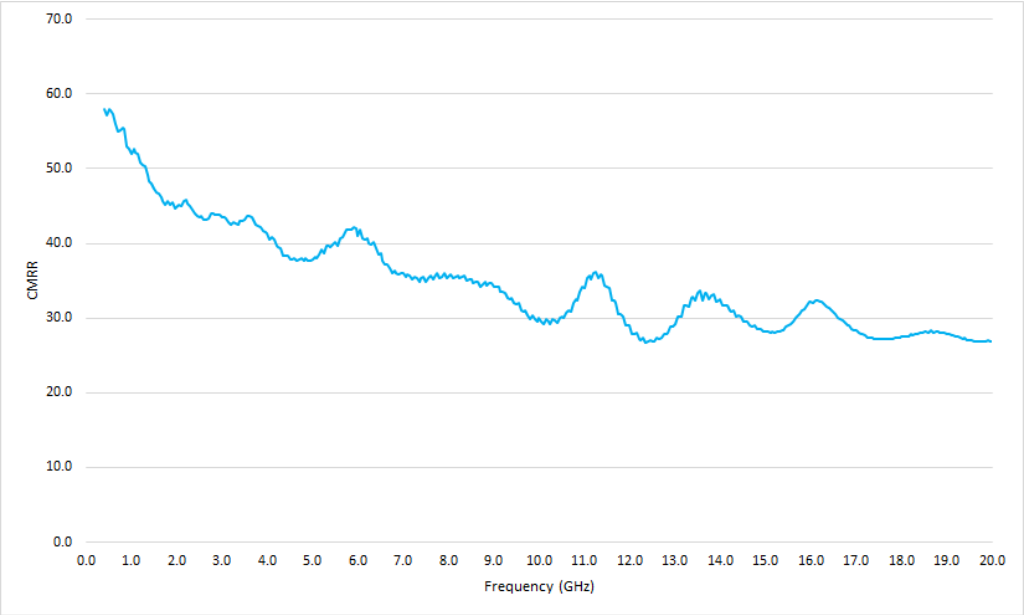


Figure 6: HL9401 Common Mode Rejection Ratio (CMRR)

HL9401 Group Delay and Phase Match

Figure 6 shows the typical group delay of an HL9401 used as a signal splitter. The average slope of the phase mismatch, shown in *Figure 7*, is equal to the group delay mismatch.

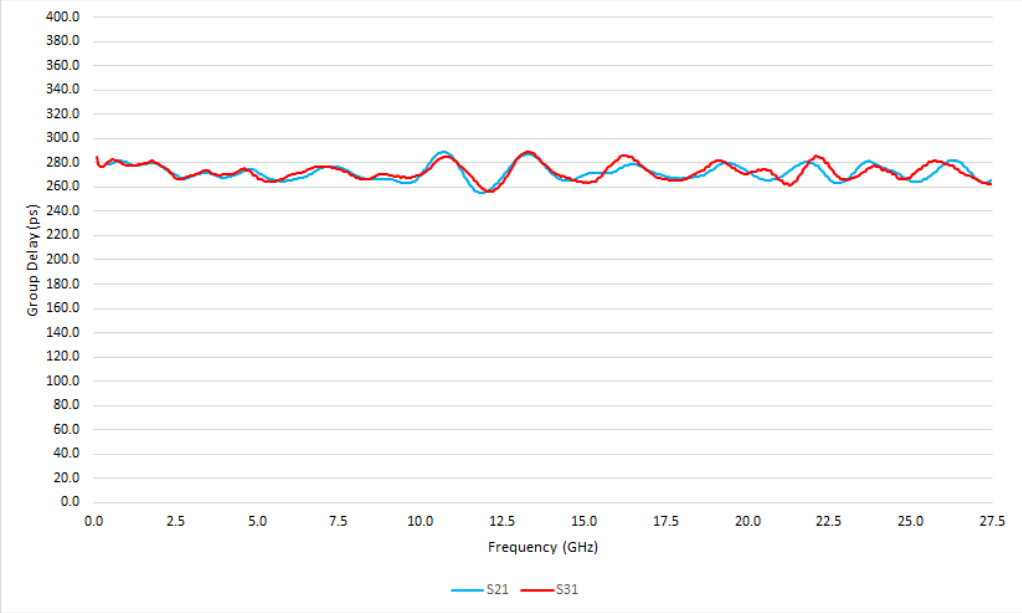


Figure 7: HL9401 Single-ended Group Delay

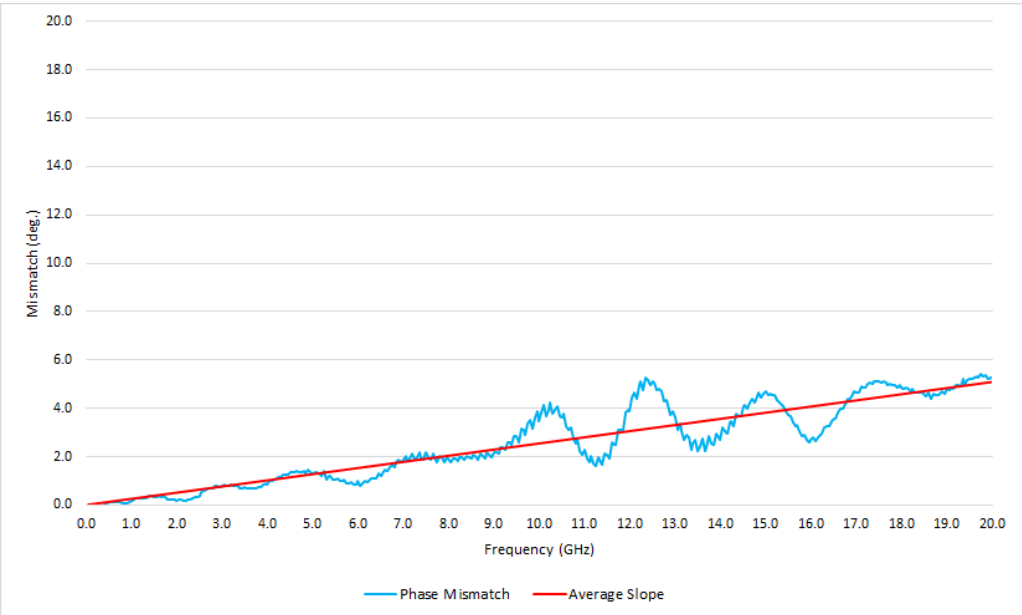


Figure 8: HL9401 Phase Mismatch

HL9401 Eye Diagrams

The eye diagrams in *Figures 9-11* show a PRBS31 pattern at 28 Gpbs. The input signal has amplitude of 372 mV and is shown at 100 mV/div. The inverting and non-inverting outputs are shown at 51 mV/div.

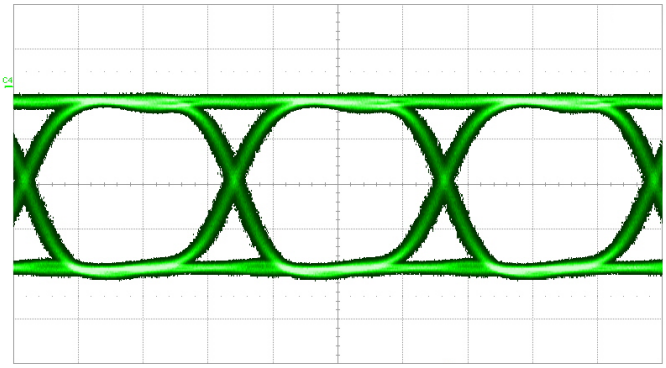


Figure 9: 28 Gbps PRFBS31 pattern on input

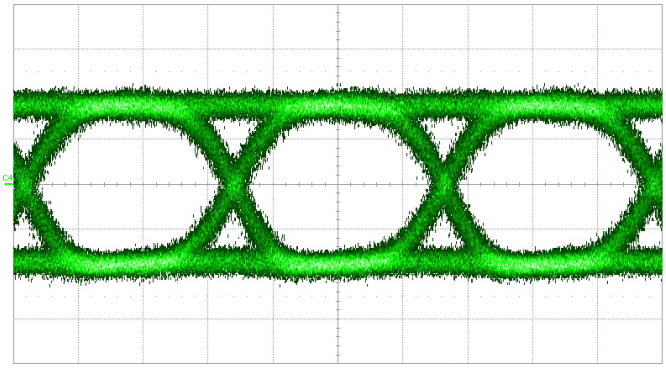


Figure 10: 28 Gbps PRBS31 pattern on non-inverting output

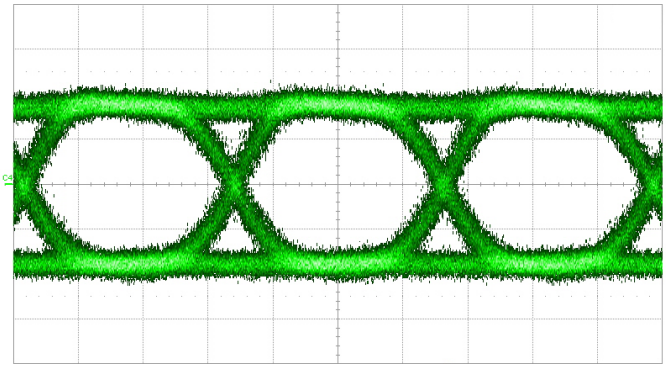


Figure 11: 28 Gbps PRBS31 pattern on inverting output

HL9401 Dimensional Drawing

Figure 12 shows a mechanical drawing of an HL9401. Unless otherwise noted, all units are in inches.

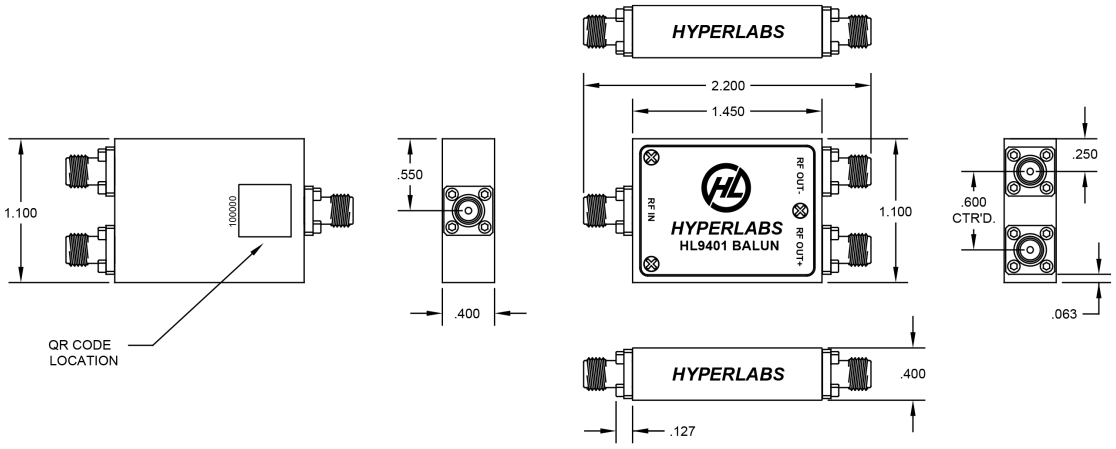


Figure 12: HL9401 mechnical drawing