

## 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<br>± 0.5 dB to 20 GHz, max<br>See Fig. 1 |
| Phase Match        | ± 3°, f = 10 GHz, max<br>± 6°, f = 20 GHz, max<br>See Fig. 8         |
| Insertion Loss     | 6 dB, reference<br>7.5 dB, max <sup>1</sup><br>See Figs. 1, 3-4      |
| Return Loss        | > 14 dB, unbalanced port<br>> 8 dB, balanced ports<br>See Figs. 2, 5 |
| Rise Time          | 17.5 ps  |
| CMRR               | > 25 dB, typical<br>See Fig. 6                                       |
| Group Delay        | ≈ 280 ps<br>See Fig. 7   |
| Max Input Power    | 1 W (+30 dBm)  |
| Impedance          | 50 Ω In, 2 x 50 Ω Out  |
| Connectors         | SMA, 3x jack/female<br>SMA plug connectors upon request              |
| Dimensions         | 55.88 x 27.94 x 10.16 mm<br>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  |

#### 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

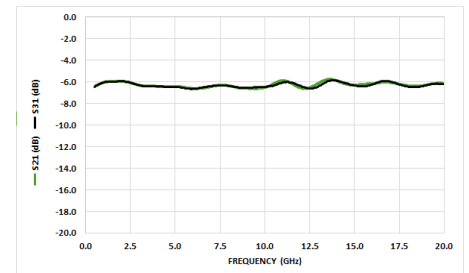
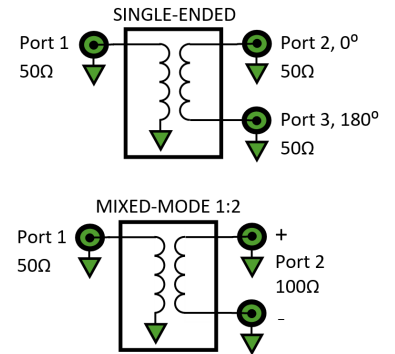
S-parameters for both single-ended and mixed-mode are available on our website.



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

NOTE 1 - Curve fit using 6th order polynomial

## 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.

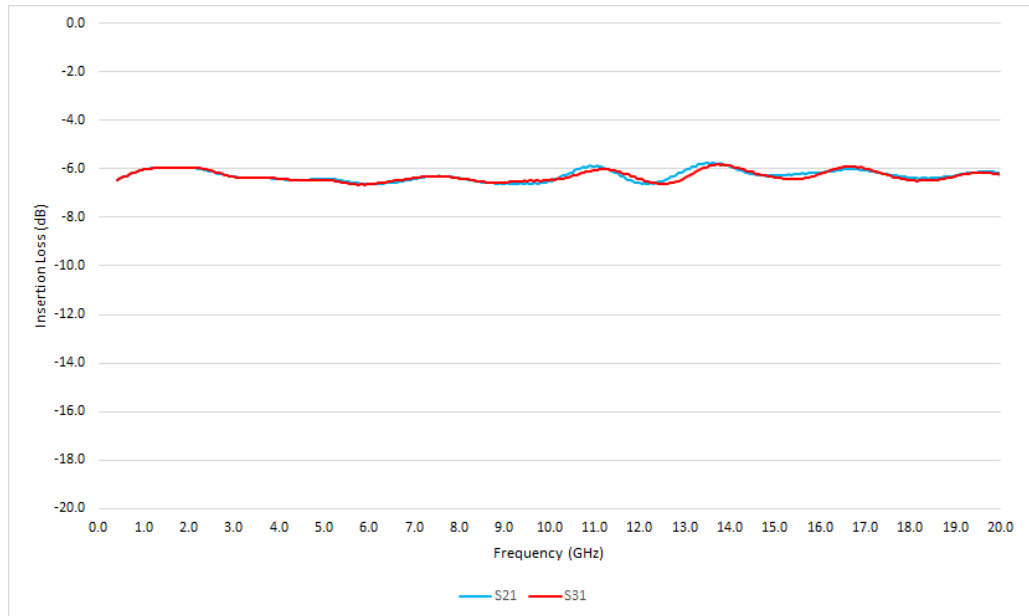


Figure 1: HL9401 Single-ended Insertion Loss

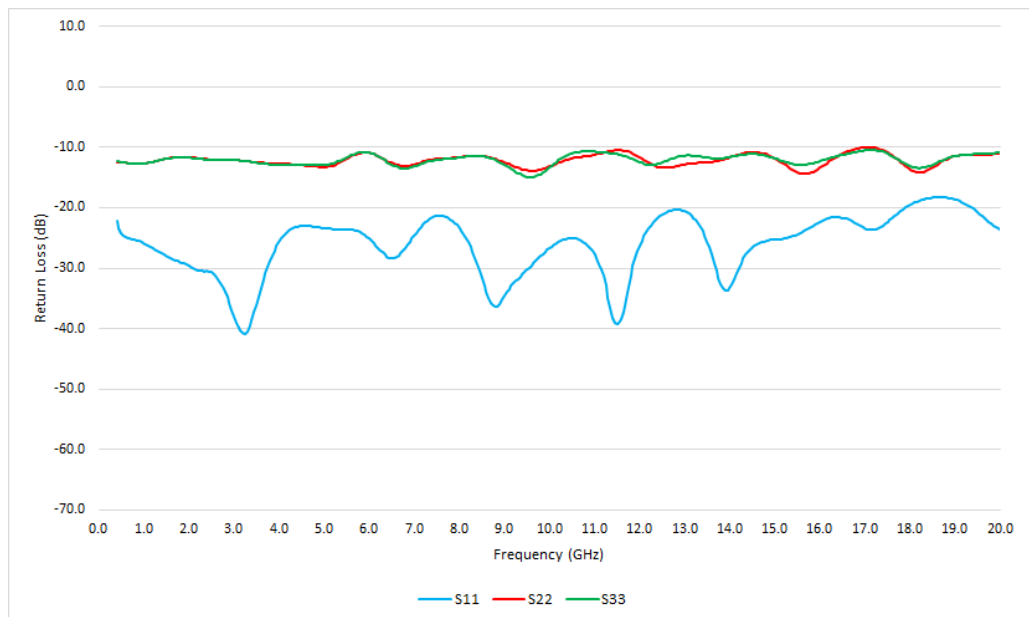


Figure 2: HL9401 Single-ended Return Loss

## 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.

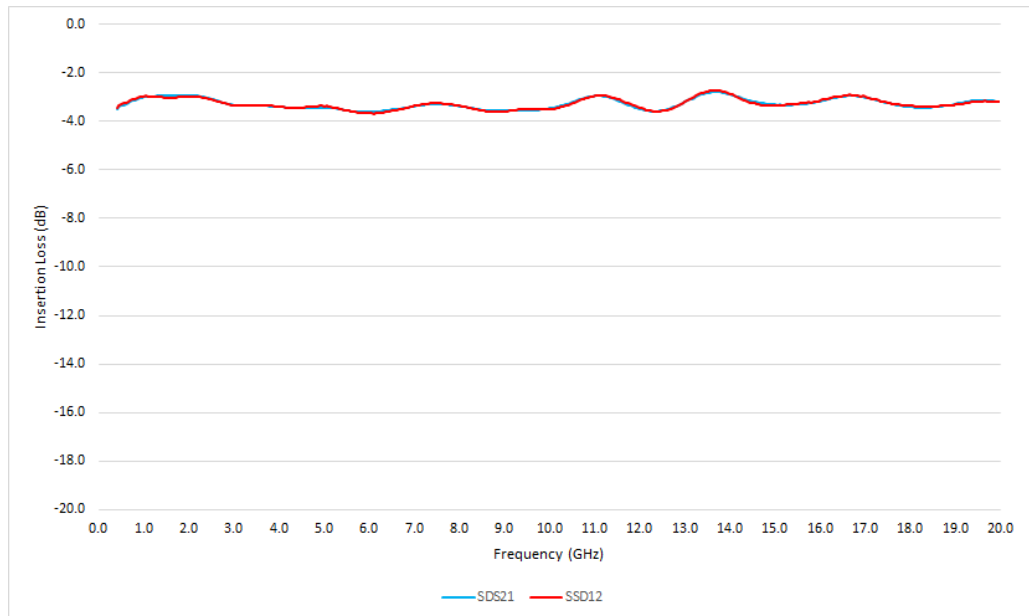


Figure 3: HL9401 Differential Mode Insertion Loss

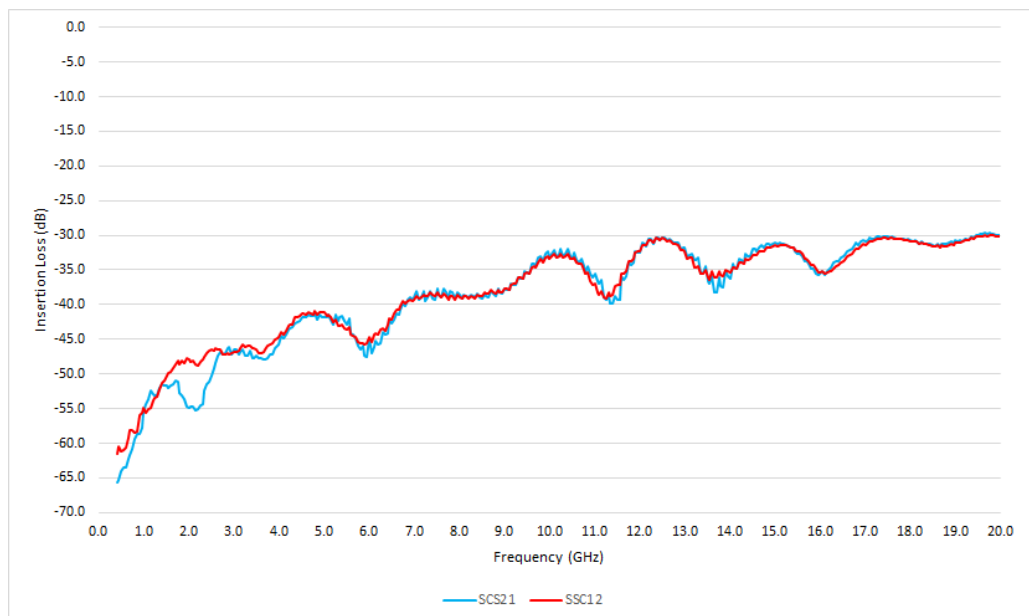


Figure 4: HL9401 Common Mode Insertion Loss

## 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.

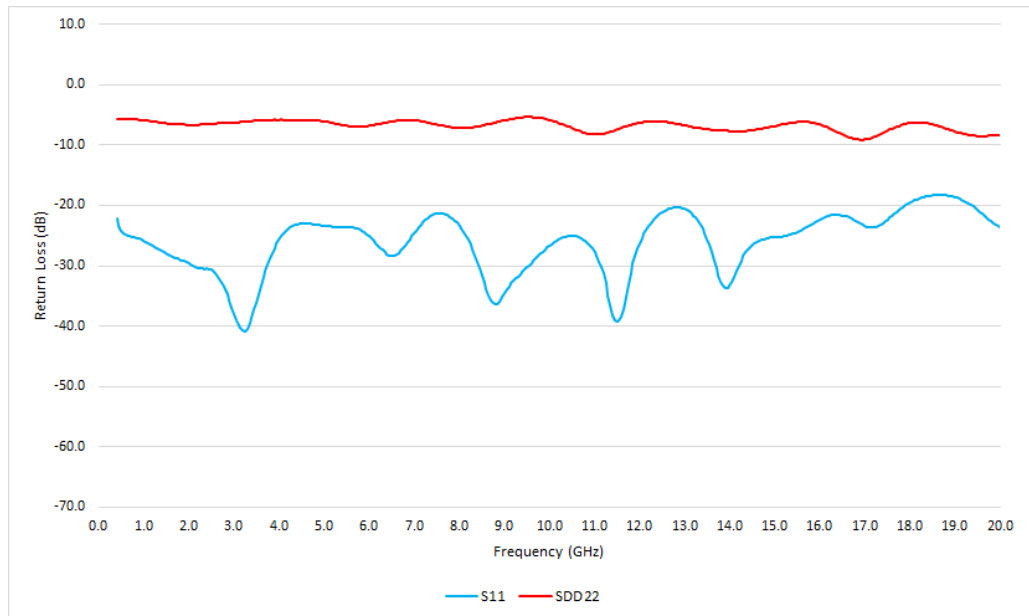


Figure 5: HL9401 Mixed-mode Return Loss

## HL9401 Common-mode Rejection Ratio

Figure 6 shows the typical common-mode rejection ratio (CMRR) of an HL9401.

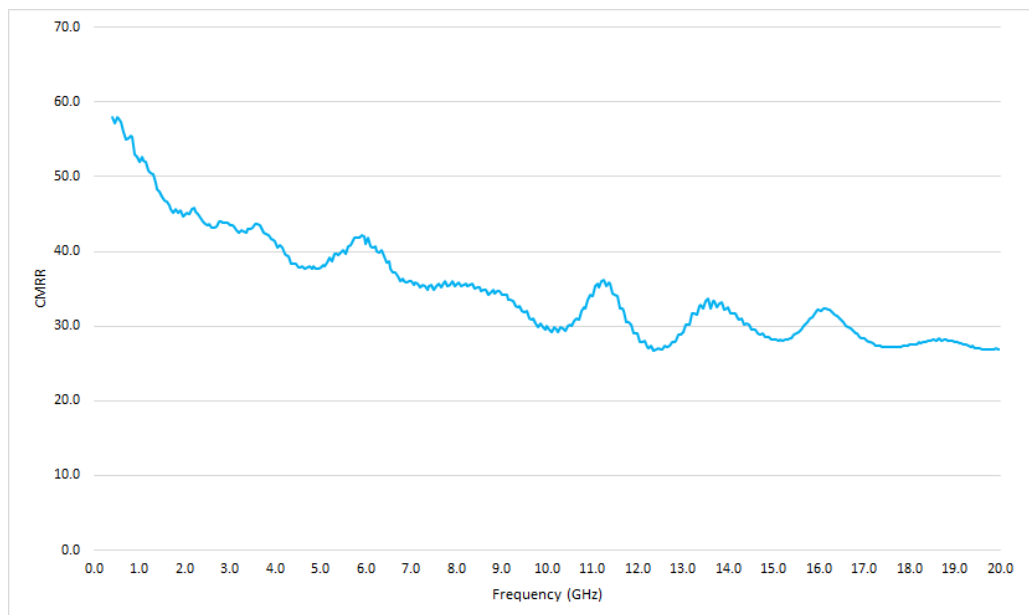


Figure 6: HL9401 Common Mode Rejection Ratio (CMRR)

## 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.

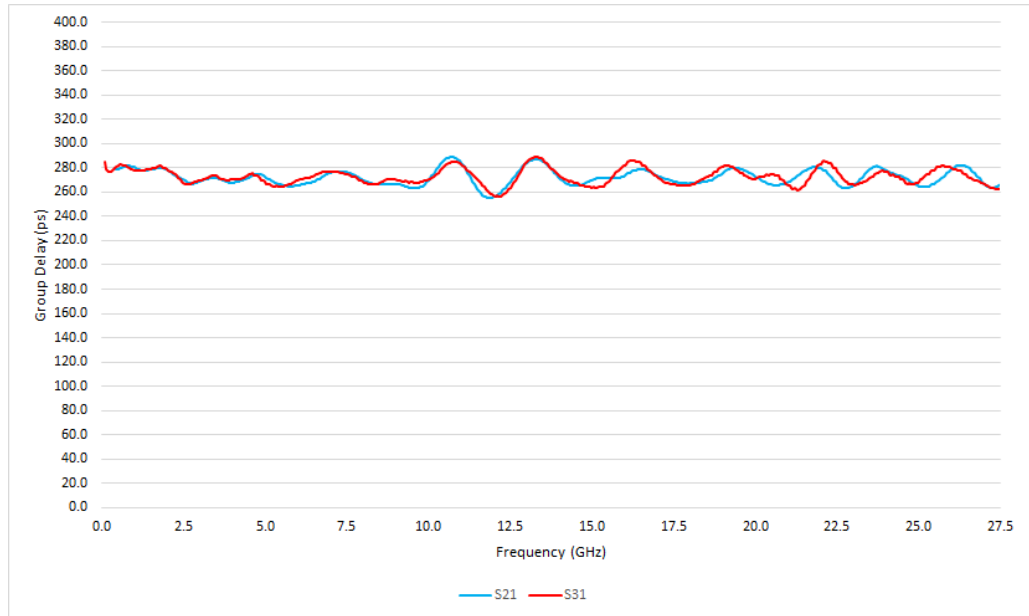


Figure 7: HL9401 Single-ended Group Delay

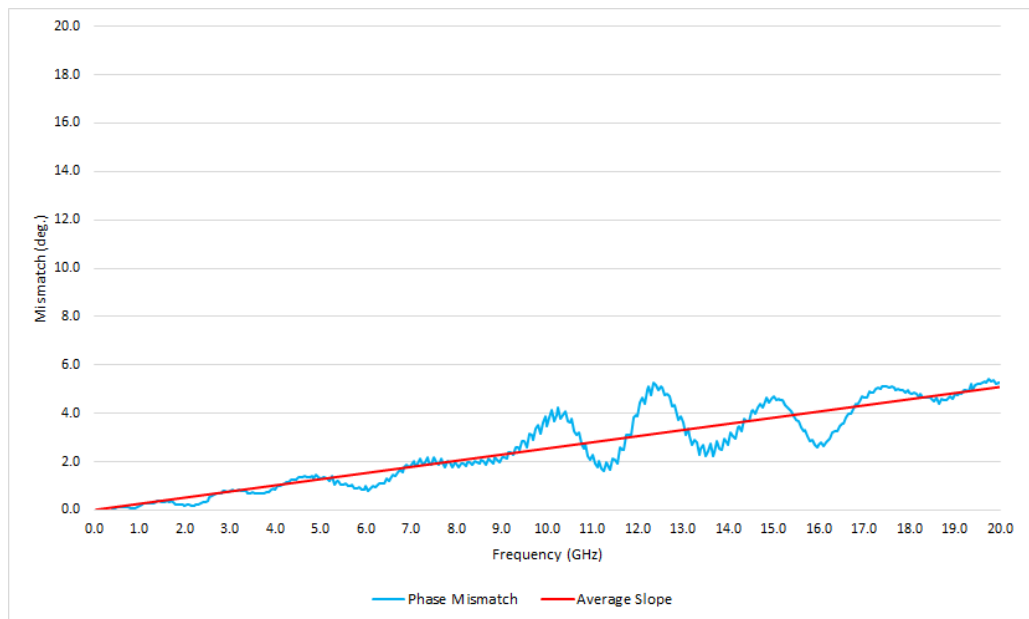
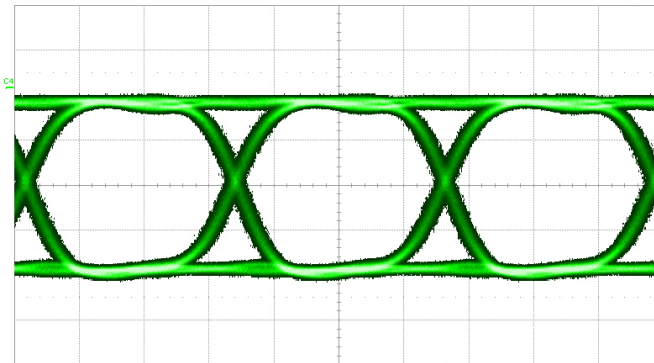


Figure 8: HL9401 Phase Mismatch

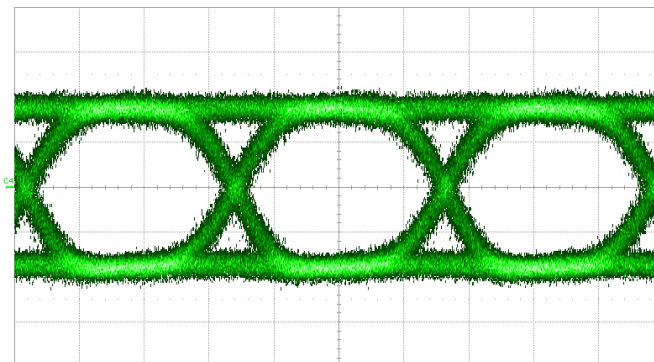


## HL9401 Eye Diagrams

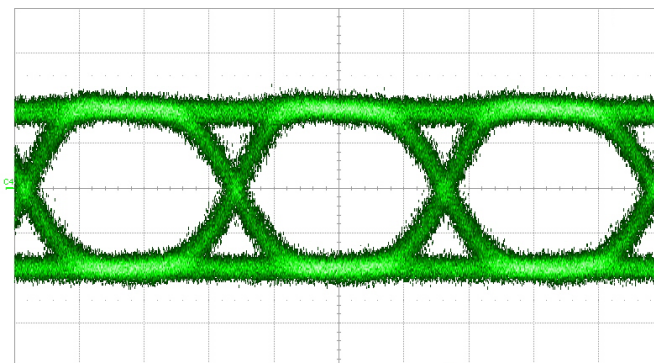
The eye diagrams in *Figures 9-11* show a PRBS31 pattern at 28 Gpbs. The input signal has amplitude of 372 mV and is shown at 100 mV/div. The inverting and non-inverting outputs are shown at 51 mV/div.



*Figure 9: 28 Gbps PRBS31 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.

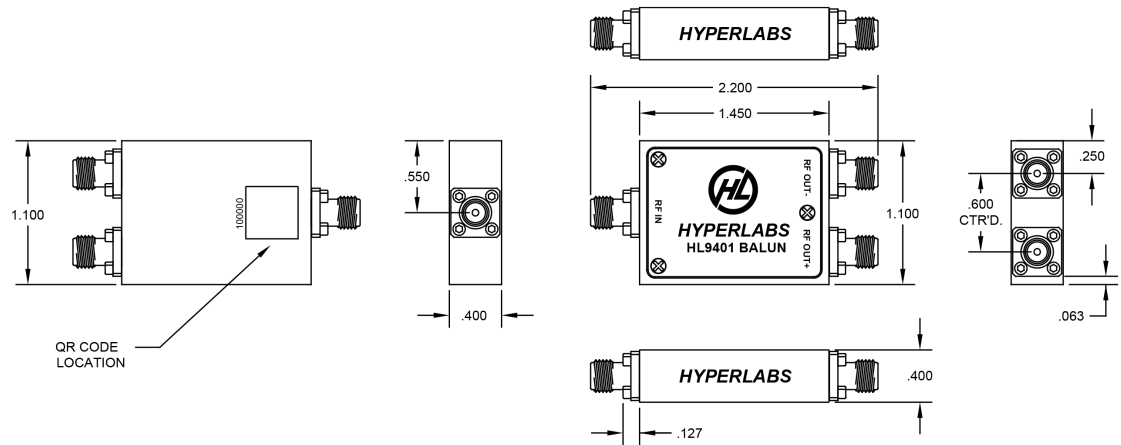


Figure 12: HL9401 mechanical drawing