HYPERLABS™
Innovation at Hyperspeed since 1992

HL9403 Drop-in Broadband Amplitude- and Phase-matched Balun

The HL9403 is the first-ever drop-in broadband balun with ± 0.25 dB amplitude and ± 0.5 degree phase matching from 5 MHz to 20 GHz.

This balun is designed to be installed directly onto printed circuit boards, offering unmatched onboard performance, size, and efficiency.

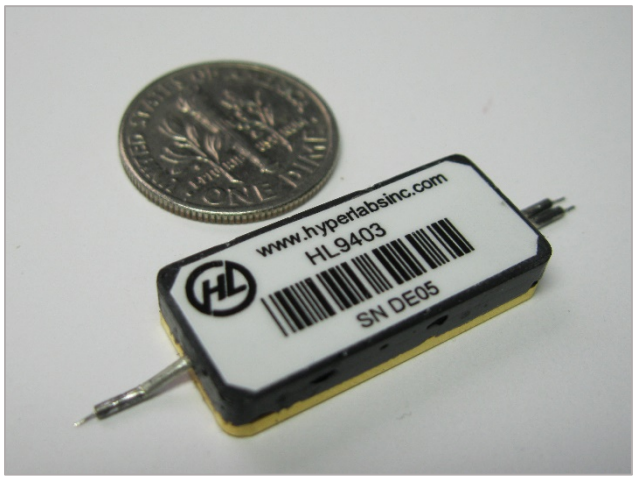

Figure 1: HL9403 with Drop-in Configuration

Applications for the HL9403

- Signal integrity testing
- Serial data link measurement
- Analog to digital conversion
- High-linearity down-converter sampling modules

Features and Technical Specifications

Bandwidth (-3 dB)	5 MHz to 20 GHz
Amplitude Matching	± 0.25 dB
Phase Balance	± 0.5 degrees
Risetime	< 17.5 ps
Insertion Delay	196 ps
Insertion Loss	-6 dB, see *Figures 4-5* on following page
Return Loss	See *Figure 6* on following page
Impedance	50 Ω
Dimensions (excluding leads)	22.35 x 11.43 x 4.57 mm 0.88” x 0.45” x 0.18”
Weight (excluding leads)	4.4 g 0.16 oz
Temperature Limits	0° to +40° C, operating -40° to +85° C, storage
Warranty	1 year, repair or return at the sole discretion of HYPERLABS, Inc.

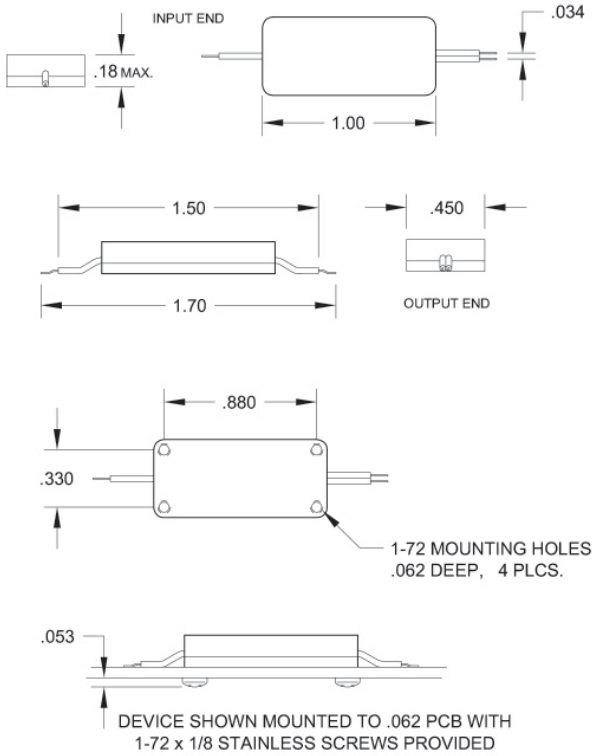

Figure 2: Dimensional Drawing of the HL9403

Deployment Notes and Recommendations

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

Testing Methololgy

The HL9403 is a drop-in component, so a test fixture was required to connect it to a network analyzer.

For questions about the performance of the HL9403 in a different testing environment, please contact us.

HL9403 RF Output Measurements

In *Figure 3* below, the insertion loss of the RF Outputs of the HL9403 is measured from 5 MHz to 20 GHz. The vertical axis is dB (0 to -10).

The blue trace is the Non-inverting (+) Output (S21), and the red trace is the Inverting (-) Output (S31).

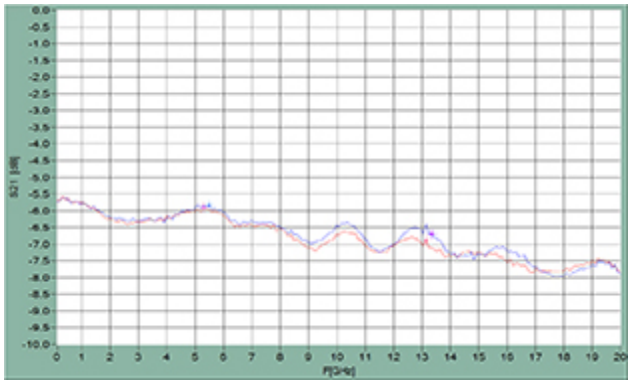

Figure 3: Insertion Loss (S21 and S31) Measurements of the HL9403 RF Outputs

In *Figure 4*, the HL9403 is used in combiner (reverse balun) mode. Return loss of the Non-inverting (blue, S22) and Inverting (red, S33) Outputs is shown from 5 MHz to 20 GHz. The vertical axis is dB (0 to -40).

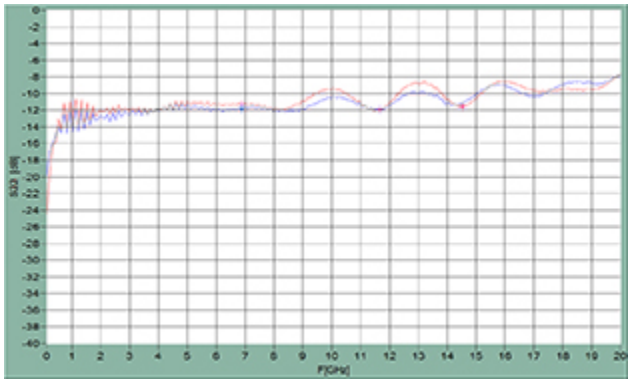

Figure 4: Return Loss (S22 and S33) Measurements of the HL9403 RF Outputs

HL9403 RF Input Measurements

In *Figure 5*, return loss (S11) is measured on the RF Input of the HL9403 from 5 MHz to 20 GHz. The vertical axis is dB (0 to -40).

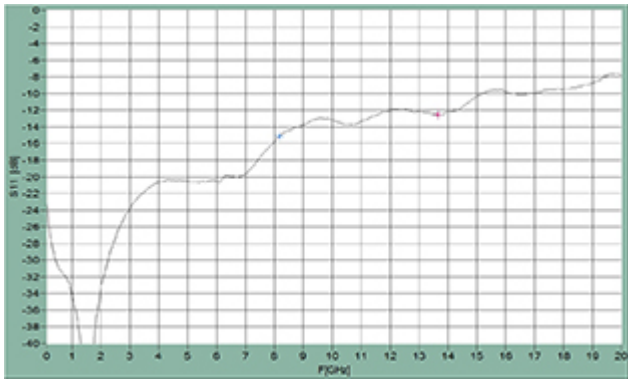

Figure 5: Return Loss (S11) Measurement of the HL9403 RF Input

Figure 6 shows the common-mode rejection ratio of the HL9403 when used in combiner mode. The horizontal axis is frequency (5 MHz to 20 GHz), while the vertical is dB (0 to -60).

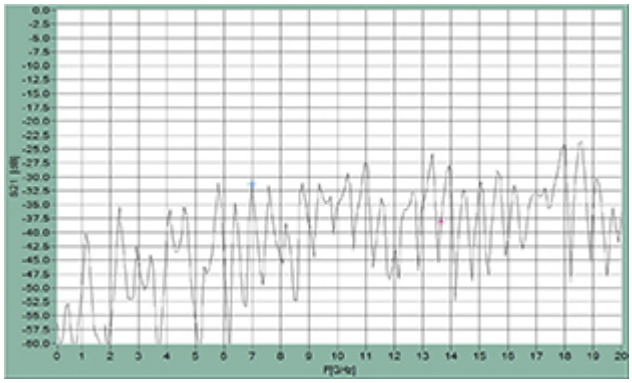

Figure 6: CMRR Measurement of the HL9403

HL9403 Time Domain Measurements

Figure 7 shows a positive going input signal risetime of 34.08 ps and a time window delay of 37.25 ns.

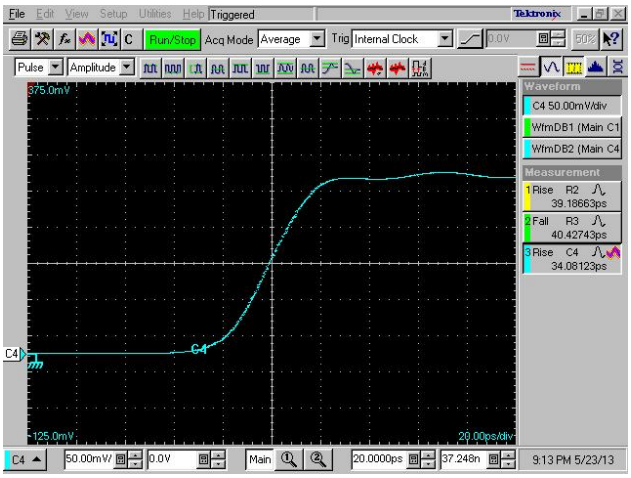

Figure 7: Positive Going Input Signal of the HL9403 Measured in the Time Domain

Figure 8 shows that the Non-inverting (yellow trace) and Inverting (green) Output signals have a risetime of 39.18 ps and a falltime of 40.42 ps, respectively. The time window delay is 37.53 ns.

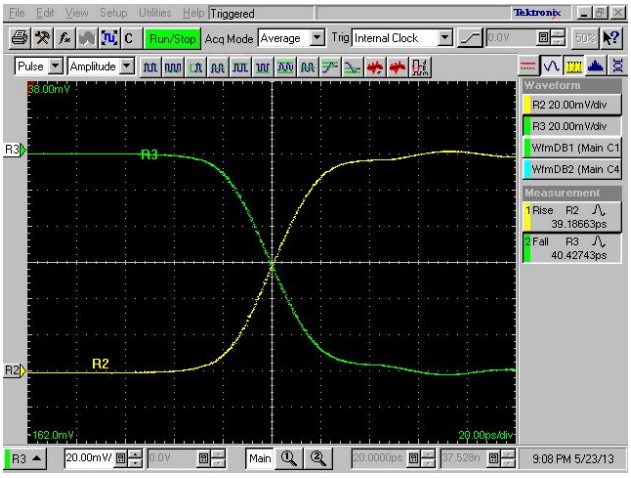

Figure 8: Non-inverting and Inverting Outputs of the HL9403 Measured in the Time Domain

These data demonstrate a risetime of 8.2 ps and a falltime of 12.8 ps, derived using the root of the difference of squares and the 17.5 ps risetime of a Tektronix 80E02 Sampling Head.

The insertion delay is 196 ps, taken by subtracting the insertion delay of two SMA adapters (84 ps total) in the test fixture from the measured delay of 280 ps.

HL9403 Eye Diagrammer Measurements

Figure 9 shows an eye diagram of a 10 GBit/s Pseudo-Random Bit Sequence (PRBS) used as the input signal for testing the HL9403.

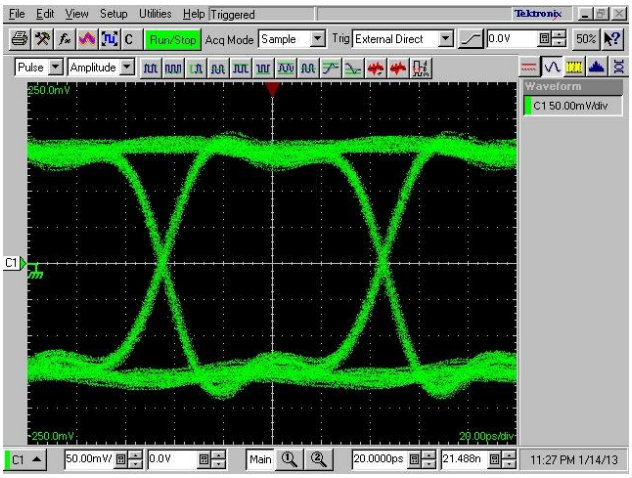

Figure 9: Eye Diagram of the HL9403 Interfaced with a 10 Gbit/s PRBS

In *Figure 10*, the same 10 Gbit/s PRBS was used. The Non-inverting (+) and Inverting (-) RF Outputs are shown in yellow and green, respectively.

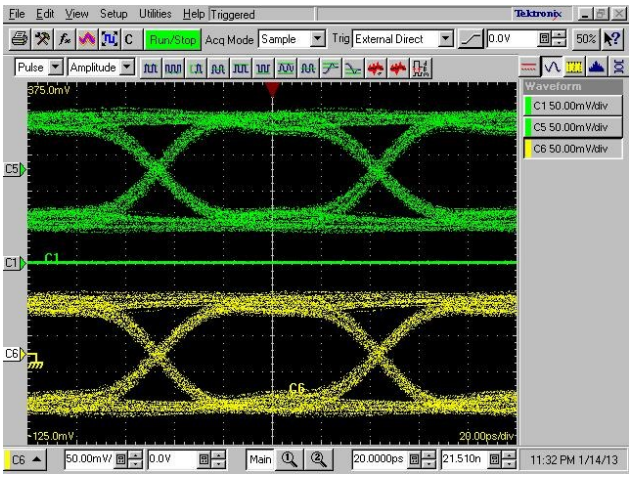

Figure 10: Eye Diagram of the HL9403 Interfaced with a 10 Gbit/s PRBS