ALM-3012

GNSS LNA-Filter Front-End Module
with optional Differential Outputs

Data Sheet

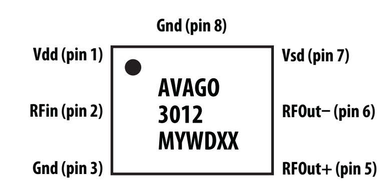
Description

Avago Technologies' ALM-3012 is an ultra low-noise GNSS (Global Navigation Satellite System) front-end module that combines a low-noise amplifier (LNA) with a GNSS FBAR post-LNA filter, supporting both GPS and GLONASS operating in 1565 ~ 1606 MHz frequency range. The module can be used both as a single-ended and pre-matched differential outputs. The LNA uses Avago Technologies' proprietary GaAs Enhancement-mode pHEMT process to achieve high gain with very low noise figure and high linearity. Noise figure distribution is very tightly controlled. A CMOS-compatible shutdown pin is included either for turning the LNA on/off, or for current adjustment. The integrated filter utilizes an Avago Technologies' leading-edge FBAR filter for exceptional rejection at Cellular, DCS, PCS and WLAN band frequencies. Bypass functionality with an external RF switch is possible with separate RF switching.

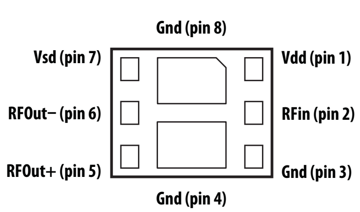
The ALM-3012 is usable down to 1.8 V operation. It achieves low noise figures and high gain even at 1.8 V, making it suitable for use in critical low power GNSS band applications.

Component Image

Surface Mount (2.5 x 2.0 x 0.90) mm^3 8-lead MCOB



TOP VIEW



BOTTOM VIEW

Note:
Package marking provides orientation and identification
"3012" = Product Code
"M" = Manufacturing location
"Y" = Year of manufacture
"D" = Date Code
"W" = Work week
"XX" = Last four digit of lot number

Features

- Very Low Noise Figure: 0.97 dB typ.
- Exceptional Cell/DCS/PCS/WLAN-Band rejection
- Advanced GaAs E-pHEMT & FBAR Technology
- Shutdown current : < 1 μA
- CMOS compatible shutdown pin (SD)
- ESD : > 3 kV at RFin pin
- 0.90 mm typ. package thickness
- Adjustable bias current via single control voltage pin
- Small package dimension: 2.5(L) x 2.0(W) x 0.9(H) mm^3
- Meets MSL3, Lead-free and halogen free

Specifications (Typical performance at 25° C)

At 1.575 GHz, Vdd = 2.7 V, Idd = 6.2 mA

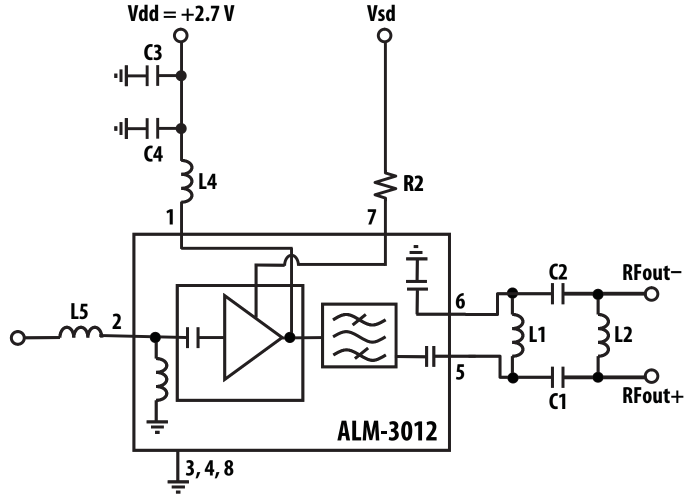
- Gain = 17.2 dB
- NF = 0.97 dB
- IIP3 = 0d Bm, IP1dB = -8 dBm
- S11 = -8 dB, S22 = -13 dB
- Rejection at 824 – 915 MHz: 73 dBc
- Rejection at 1710 – 1785 MHz: 64 dBc
- Rejection at 1850 – 1910 MHz: 72 dBc
- Rejection at 2400 – 2570 MHz: 74 dBc

Application

- GNSS Front-end Module

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model = 50 V
ESD Human Body Model = 250 V
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Application Circuit (Differential output)



Absolute Maximum Rating[1] T_A=25° C

Symbol	Parameter	Units	Absolute Maximum
Vdd	Device Drain to Source Voltage[2]	V	4.0
Idd	Drain Current[2]	mA	15
$P_{in,max}$	CW RF Input Power (Vdd = 2.7 V, Idd = 6.2 mA)	dBm	15
P_{diss}	Total Power Dissipation[4]	mW	60
T_j	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to 150

Thermal Resistance

Thermal Resistance [3]
(Vdd = 2.7 V, Idd = 6.2 mA)
θ_{jc} = 92°C/W

Notes:
1. Operation of this device in excess of any of these limits may cause permanent damage.
2. Assuming DC quiescent conditions.
3. Thermal resistance measured using Infra-Red measurement technique.
4. Board (module belly) temperature T_B is 25° C. Derate at 10.4 mW/°C for T_B > 144° C.

Product Consistency Distribution Charts[1,2]

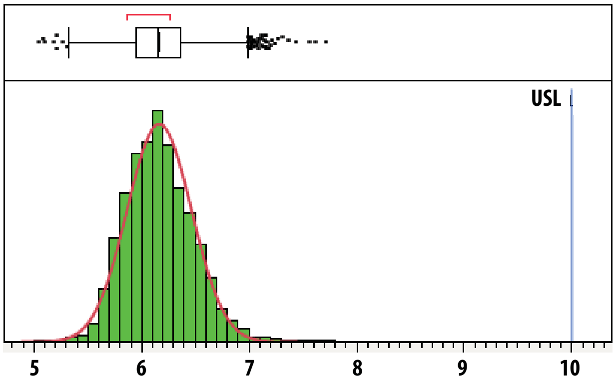


Figure 1. Idd at 1.575 GHz; USL = 10 mA, nominal = 6.2 mA

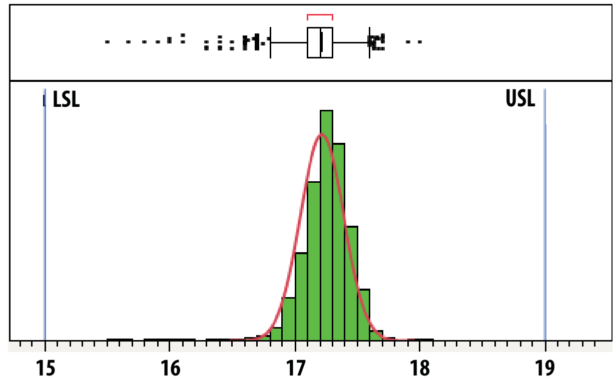


Figure 2. Gain at 1.575 GHz; LSL = 15 dB, USL = 19 dB, nominal = 17.2 dB

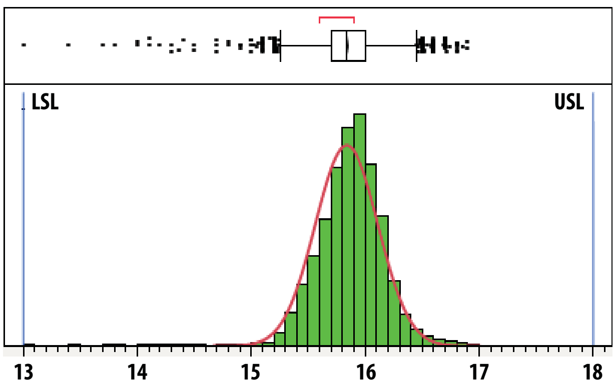


Figure 3. Gain at 1.6017 GHz; LSL = 13 dB, USL = 18 dB, nominal = 15.8 dB

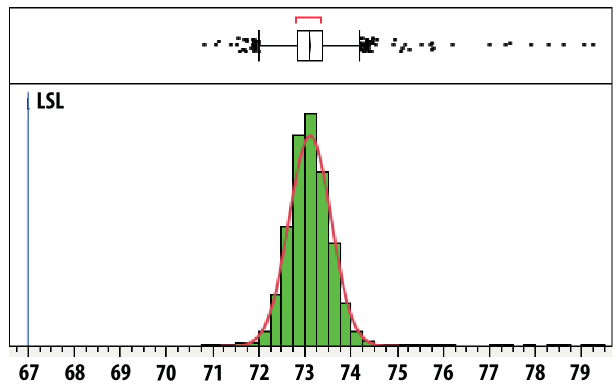


Figure 4. Rejection at 915 MHz relative to 1.575 GHz; LSL = 67 dBc, nominal = 73.1 dBc

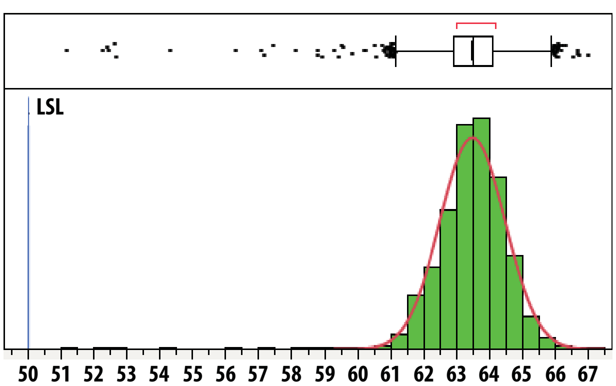


Figure 5. Rejection at 1710 MHz relative to 1.575 GHz; LSL = 50 dBc, nominal = 63.5 dBc

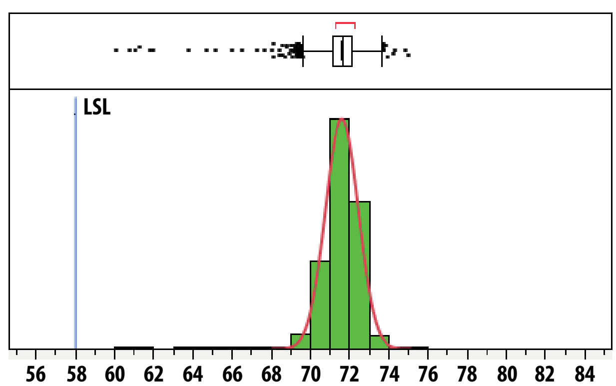


Figure 6. Rejection at 1850 MHz relative to 1.575 GHz; LSL = 58 dBc, nominal = 71.6 dBc

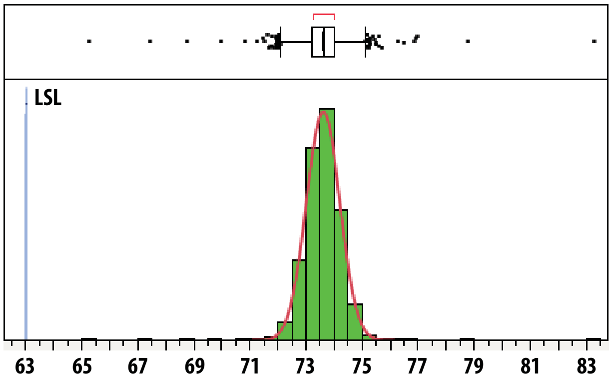


Figure 7. Rejection at 2400 MHz relative to 1.575 GHz; LSL = 63 dBc, nominal = 73.6 dBc

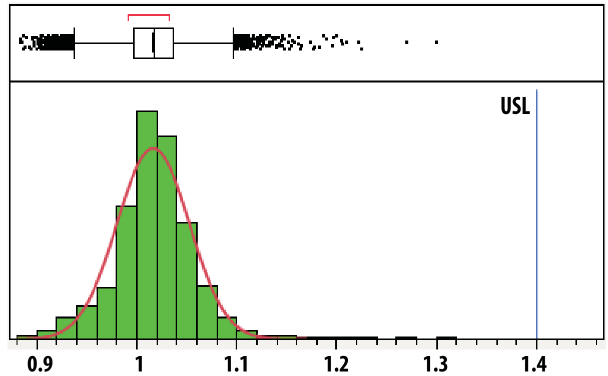


Figure 8. NF at 1.575 GHz; USL = 1.4 dB, nominal = 0.97 dB

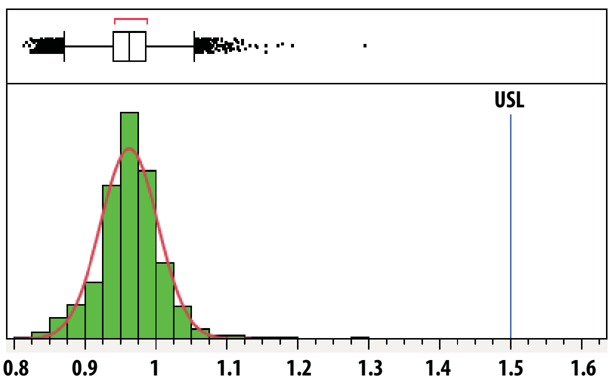


Figure 9. NF at 1.6017 GHz; USL = 1.5 dB, nominal = 1.08 dB

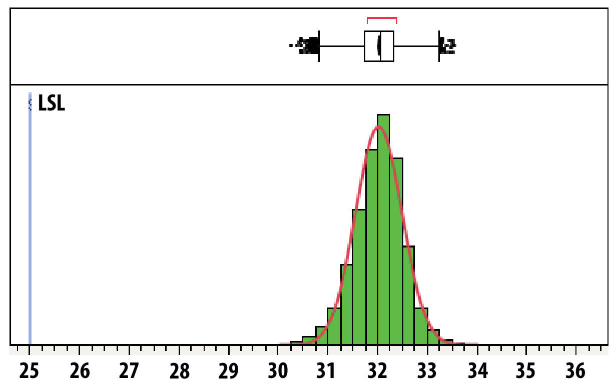


Figure 10. CMRR at 1.575 GHz, Vdd = 2.7V ; LSL = 25 dB, nominal = 32 dB

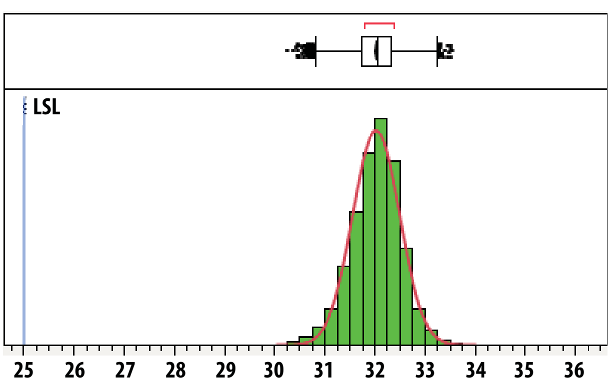


Figure 11. CMRR at 1.575 GHz, Vdd = 1.8 V; LSL = 25 dB, nominal = 33 dB

Notes:

1. Distribution data sample size is 7000 samples taken from 4 filter wafers and 2 LNA wafers. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
2. Measurements are made on a production test board, which represents a trade-off between optimal Gain, NF, IIP3, IP1dB, VSWR, Rejection, Amplitude and Phase Difference and CMRR. Circuit trace losses (except for NF) have not been de-embedded from actual measurements.

Electrical Specifications

T_A = 25° C, Freq = 1.575 GHz and 1.6017 GHz, measured on differential output board as in Figure 12.

Table 1. Performance at Vdd = Vsd = 2.7 V, Idd = 6.2 mA (R2 = 3.3 kOhm) nominal operating conditions

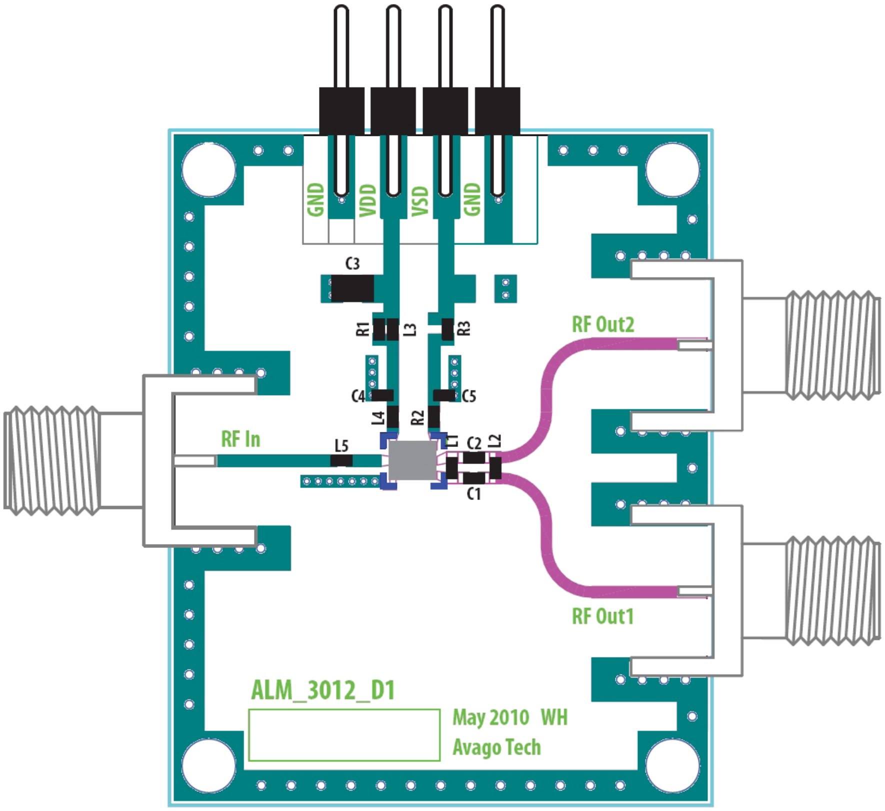
			At 1.575 GHz			At 1.6017 GHz		
Symbol	**Parameter and Test Condition**	**Unit**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**
Passband Performance								
G[1]	Gain	dB	15	17.2	19	13	15.8	18
NF[2]	Noise Figure	dB	–	0.97	1.4	–	1.08	1.5
IP1dB	Input 1dB Compressed Power	dBm	–	-8	–	–	-8	–
IIP3[3]	Input 3rd Order Intercept Point (2-tone at Fc +/- 2.5MHz)	dBm	–	0	–	–	0	–
S11	Input Return Loss	dB	–	-8	–	–	-8	–
S22 / S33	Output Return Loss (RFOut+/RFOut-)	dB	–	-13	–	–	-8	–
S12	Reverse Isolation	dB	–	-30	–	–	-31	–
CMRR	Common mode rejection ratio	dB	25	32	–	25	33	–
Idd	Supply DC current at Shutdown (SD) voltage Vsd = 2.7 V	mA	–	6.2	10	–	–	–
Ish	Shutdown Current at Vsd = 0 V	µA	–	0.5	–	–	–	–
Out of Band Performance								
B5/CDMA/GSM850/B8/ GSM900 Rejection	Worst-case relative to 1.575GHz within (824-915) MHz band, tested at 915 MHz	dBc	67	73.1	–	–	–	–
B3/GSM1700 Rejection	Worst-case relative to 1.575GHz within (1710-1785) MHz band, tested at 1710 MHz	dBc	50	63.5	–	–	–	–
B2/CDMA1900/ GSM1900 Rejection	Worst-case relative to 1.575GHz within (1850-1910) MHz band, tested at 1850 MHz	dBc	58	71.6	–	–	–	–
ISM/WiMax Rejection	Worst-case relative to 1.575GHz within (2400-2570) MHz band, tested at 2400 MHz	dBc	63	73.6	–	–	–	–
$IP1dB_{915MHz}$	Input 1dB gain compression interferer signal level at 915 MHz	dBm	–	-5	–	–	–	–
$IP1dB_{1710MHz}$	Input 1dB gain compression interferer signal level at 1710 MHz	dBm	–	-12	–	–	–	–
$IP1dB_{1850MHz}$	Input 1dB gain compression interferer signal level at 1850 MHz	dBm	–	-8	–	–	–	–
$IP1dB_{2400MHz}$	Input 1dB gain compression interferer signal level at 2400 MHz	dBm	–	3	–	–	–	–
OOB IIP2[4]	Out of Band Input 2nd Order Intercept Point (2-tone at 824.6 MHz and 2400 MHz)	dBm	–	12	–	–	–	–
OOB IIP3[5]	Out of Band Input 3rd Order Intercept Point (2-tone at 1712.7 MHz and 1850 MHz)	dBm	–	23	–	–	–	–
$H2_{788MHz}$[6]	2nd Harmonics of signal at 788 MHz	dBm	–	-34	–	–	–	–

Table 2. Performance at Vdd = Vsd = 1.8 V, Idd = 4 mA (R2 = 2.2 kOhm) nominal operating conditions

Symbol	Parameter and Test Condition	Units	At 1.575GHz (Typ.)
Passband Performance			
G	Gain	dB	15.2
NF[2]	Noise Figure	dB	1.22
IP1dB	Input 1dB Compressed Power	dBm	-11.5
IIP3[3]	Input 3rd Order Intercept Point (2-tone at Fc +/- 2.5 MHz)	dBm	-5
S11	Input Return Loss	dB	-7
S22	Output Return Loss	dB	-8
S12	Reverse Isolation	dB	-31
CMRR	Common mode rejection ratio	dB	31
Idd	Supply DC current at Shutdown (SD) voltage Vsd = 2.7 V	mA	4
Ish	Shutdown Current at Vsd = 0 V	uA	0.5
Out of Band Performance			
B5/CDMA/GSM850/B8/ GSM900 Rejection	Worst-case relative to 1.575 GHz within (824-915) MHz band, tested at 915 MHz	dBc	74
B3/GSM1700 Rejection	Worst-case relative to 1.575 GHz within (1710-1785) MHz band, tested at 1710 MHz	dBc	59
B2/CDMA1900/ GSM1900 Rejection	Worst-case relative to 1.575 GHz within (1850-1910) MHz band, tested at 1850 MHz	dBc	80
ISM / WiMax Rejection	Worst-case relative to 1.575 GHz within (2400-2570) MHz band, tested at 2400 MHz	dBc	82
$IP1dB_{915MHz}$	Input 1dB gain compression interferer signal level at 915 MHz	dBm	-5
$IP1dB_{1710MHz}$	Input 1dB gain compression interferer signal level at 1710 MHz	dBm	-12
$IP1dB_{1850MHz}$	Input 1dB gain compression interferer signal level at 1850 MHz	dBm	-9
$IP1dB_{2400MHz}$	Input 1dB gain compression interferer signal level at 2400 MHz	dBm	2
OOB IIP2[4]	Out of Band Input 2nd Order Intercept Point (2-tone at 824.6 MHz and 2400 MHz)	dBm	7
OOB IIP3[5]	Out of Band Input 3rd Order Intercept Point (2-tone at 1712.7 MHz and 1850 MHz)	dBm	23
$H2_{788MHz}$[6]	2nd Harmonics of signal at 788 MHz	dBm	-31

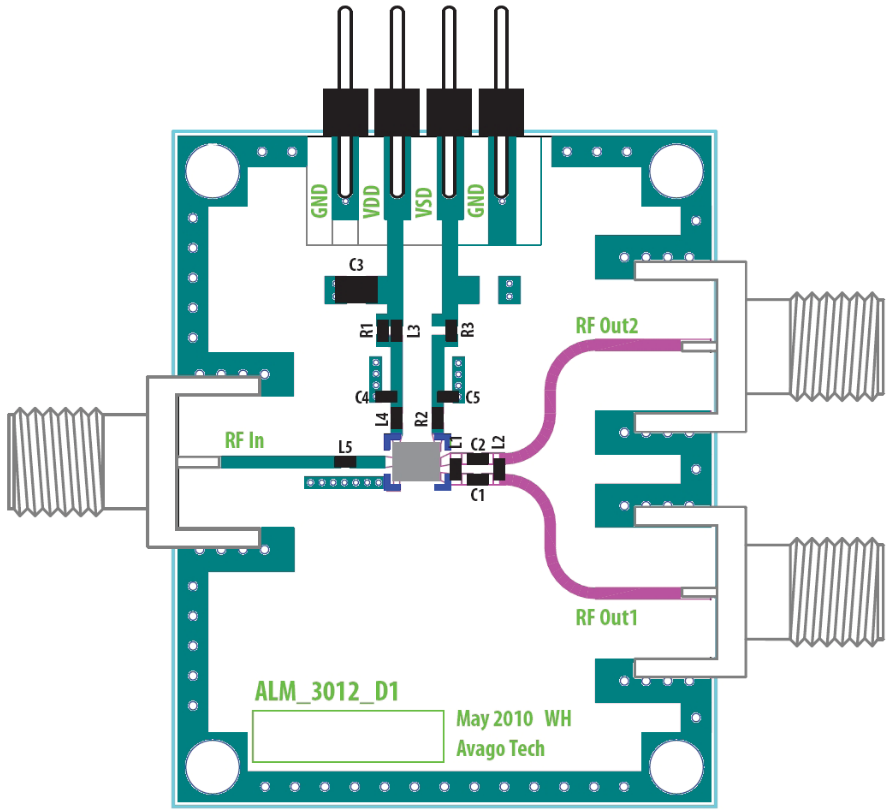
Notes:

1. Measured with differential outputs
2. Losses from demoboard deembeded
3. 1.575 GHz IIP3 test condition: F_{RF1} = 1572.5 MHz, F_{RF2} = 1577.5 MHz with input power of -20 dBm per tone measured at the worst case side band
4. OOB Input IP2 test condition: Input jammer tones: 824.6 MHz at -17 dBm and 2400 MHz at -40 dBm. Output IM2 tone at 1575.4 MHz
5. 1.575 GHz IIP3 test condition: F_{RF1} = 1712.7 MHz, F_{RF2} = 1850 MHz with input power of 10 dBm per tone measured at the worst case side band
6. H2 test condition: Input tone: 788 MHz at -17 dBm



Circuit Symbol	Size	Description
L1	0402	5.6 nH Inductor (Taiyo Yuden HK10055N6S-T)
L2	0402	10 nH Inductor (Taiyo Yuden HK100510NJ-T)
L3	0402	22 nH Inductor (Taiyo Yuden HK100522NJ-T)
L4	0402	2.2 nH Inductor (Taiyo Yuden HK10052N2S-T)
L5	0402	10 nH Inductor (Taiyo Yuden HK100510NJ-T)
C1	0402	1.6 pF Capacitor (Murata GJM1555C1H1R6CB01D)
C2	0402	100 pF Capacitor (Murata GRM1555C1H101JD01E)
C3	0805	0.1 µF Capacitor (Murata GRM21BR71H104KA01L)
C4	0402	33 pF Capacitor (Murata GRM1555C1H330JZ01D)
C5	0402	6.8 pF Capacitor (Murata GJM1555C1H6R8DB01D)
R1	0402	12 Ohm Resistor (Rohm MCR01MZSJ120)
R2	0402	3.3 kOhm (KOA RK73B1ETTP332J)
R3	0402	0 Ohm (Kamaya RMC1/16S-JPTH)

Figure 12. Demoboard and application circuit components table for differential output



Circuit Symbol	Size	Description
L1	0402	Not applicable
L2	0402	Not applicable
L3	0402	22 nH Inductor (Taiyo Yuden HK100522NJ-T)
L4	0402	2.2 nH Inductor (Taiyo Yuden HK10052N2S-T)
L5	0402	10 nH Inductor (Taiyo Yuden HK100510NJ-T)
C1	0402	0 Ohm Resistor (Kamaya RMC1/16S-JPTH)
C2	0402	Not applicable
C3	0805	0.1 µF Capacitor (Murata GRM21BR71H104KA01L)
C4	0402	33 pF Capacitor (Murata GRM1555C1H330JZ01D)
C5	0402	6.8 pF Capacitor (Murata GJM1555C1H6R8DB01D)
R1	0402	12 Ohm Resistor (Rohm MCR01MZSJ120)
R2	0402	3.3 kOhm Resistor (KOA RK73B1ETTP332J)
R3	0402	0 Ohm Resistor (Kamaya RMC1/16S-JPTH)

Figure 13. Demoboard and application circuit components table for single-ended output (for illustration purposes, refer to application notes for data)

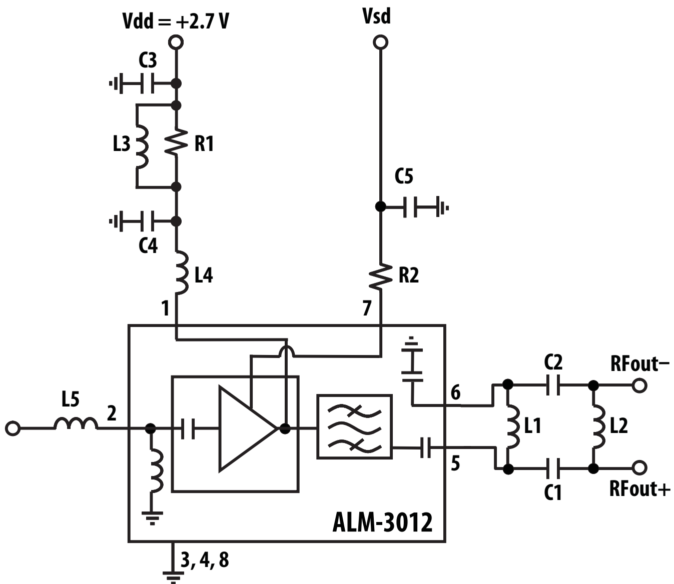


Figure 14a. Application Circuit – Differential outputs

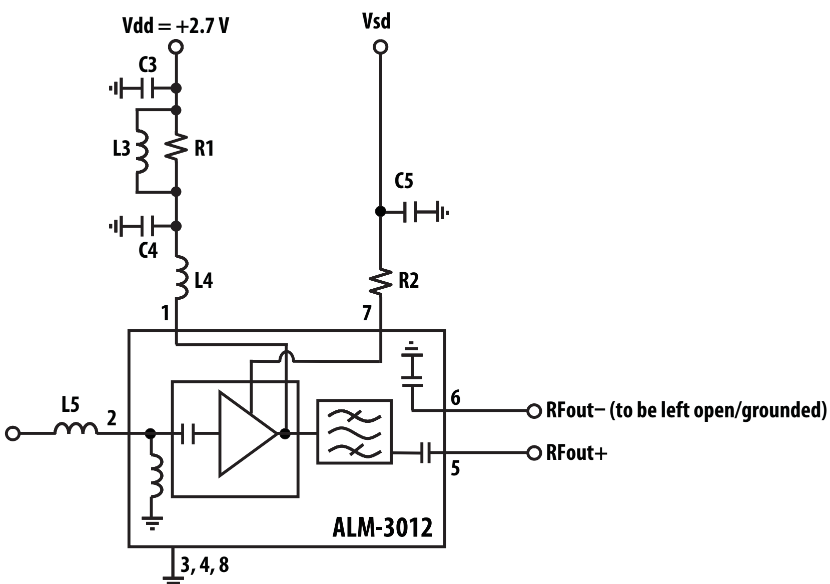


Figure 14b. Application Circuit – Single-ended output

Notes:

- The ALM-3012 can be operated with supply voltage (Vdd) from 1.8 V to 3.6 V. Vsd can operate from 1 V to Vdd.
- RF input match is achieved by a single series inductor, L5. It is used to match the module for best NF and S11.
- The differential outputs of the module are already pre-matched. Suggested matching components are shown as L1, L2, C1 and C2 for 100 ohm differential load impedance. In practice, they may be tuned to match the RF GPS System on Chip (SoC) with a different input impedance, or an SoC that is located a significant distance away from the module such that the phase shift of the transmission lines connecting the module and SoC are not negligible.
- Best noise performance is obtained using high-Q wirewound inductors. This circuit demonstrates that low noise figures are obtainable with standard 0402 chip inductors.
- C3 and C4 are bypass capacitors for RF and low frequency stability and linearity .
- Bias control is achieved by either varying the Vsd voltage with/ without R2, or fixing the Vsd voltage to Vdd and adjusting R2 for the desired current.
- L3 and R1 isolates the demoboard from external disturbances during measurement. They are not needed in actual application. Likewise, C5 mitigate the effect of external noise pickup on the Vsd line. This component is not required in actual operation.

ALM-3012 Typical Performance Curves

Unless otherwise stated, all measurements are made with circuit of Figure 14a using demoboard of Figure 12 with Vdd = 2.7 V, Idd = 6.2 mA (R2 = 3.3 kOhm, Vsd = 2.7 V) at 25° C.

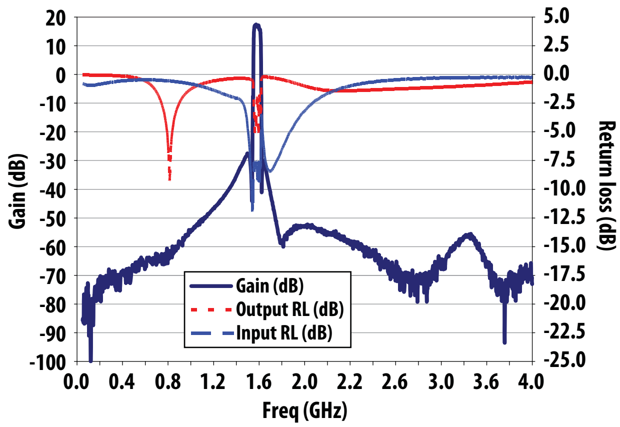


Figure 15a. Typical S-Parameter Plot

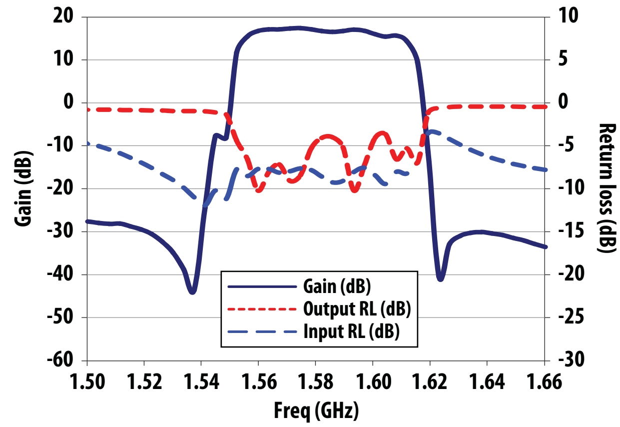


Figure 15b. Passband response of typical S-Parameter Plot

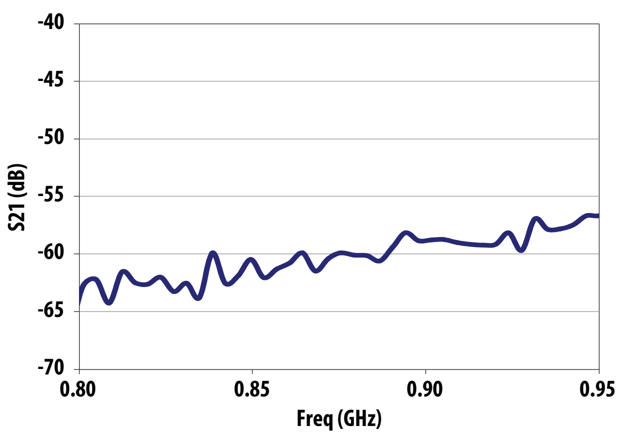


Figure 15c. Rejection plot for (800 – 950) MHz

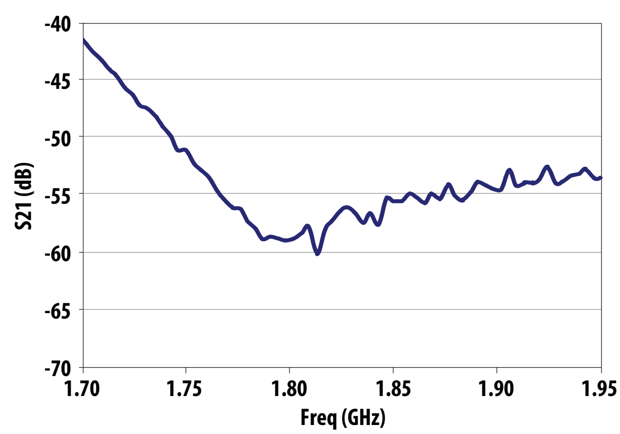


Figure 15d. Rejection plot for (1700 – 1950) MHz

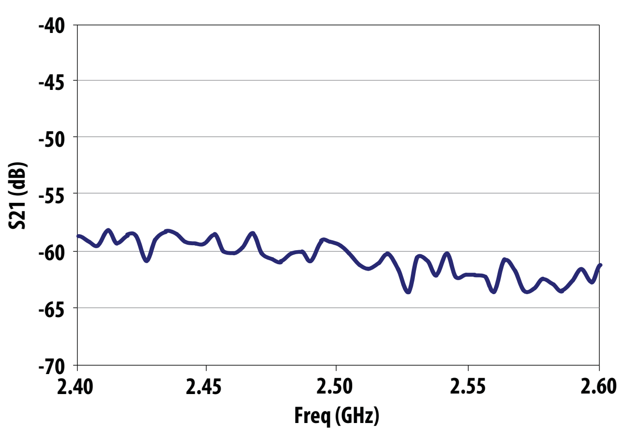


Figure 15e. Rejection plot for (2400 – 2600) MHz

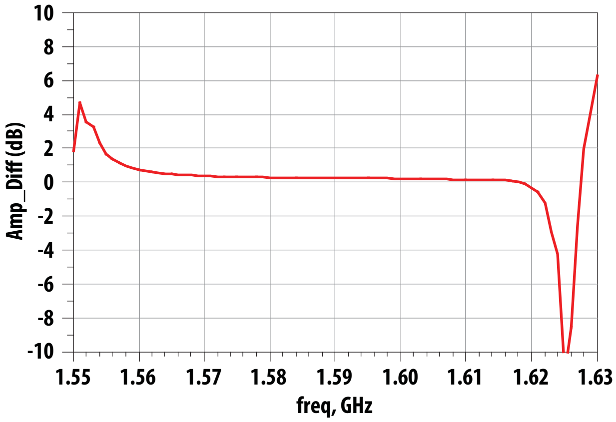


Figure 16. Amplitude difference between RFout+ and RFout- ports

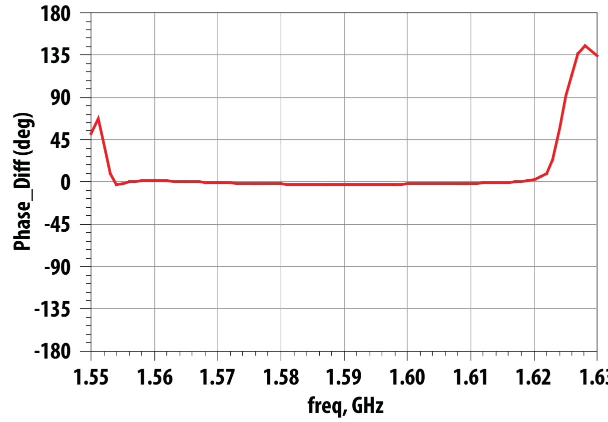


Figure 17. Phase difference between RFout+ and RFout- ports

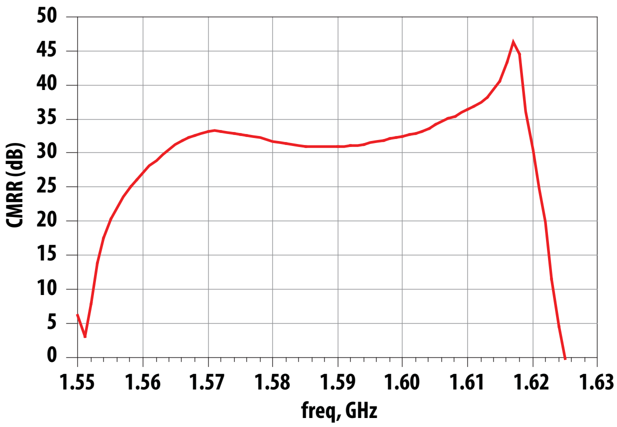


Figure 18. Common-mode rejection ratio

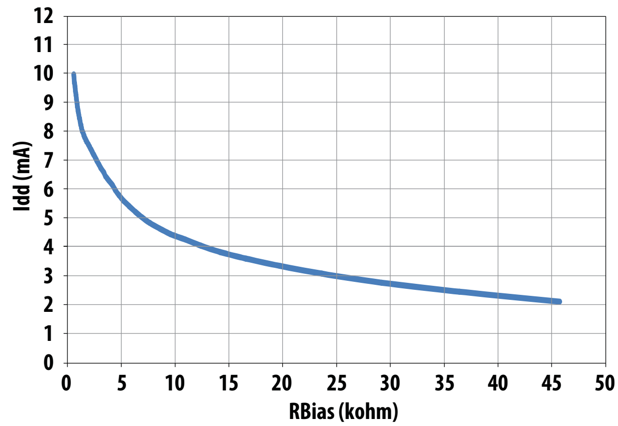


Figure 19. Idd vs R2

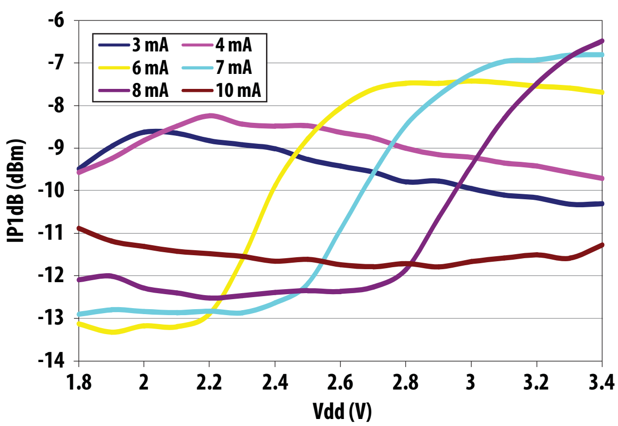


Figure 20. IP1dB vs. Vdd. Measurements made with RFout- port terminated with 50 ohm load to ground

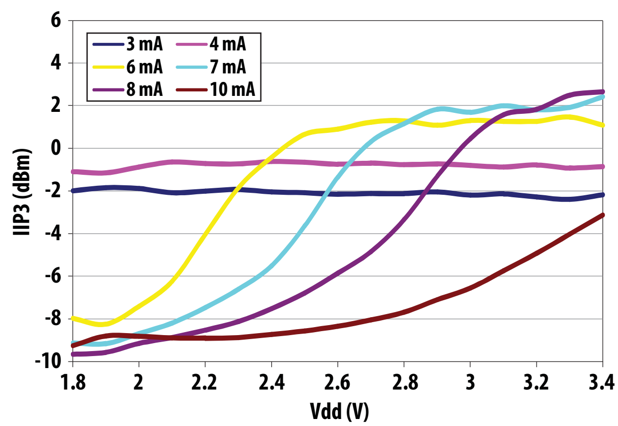


Figure 21. IIP3 vs. Vdd. Measurements made with RFout- port terminated with 50 ohm load to ground

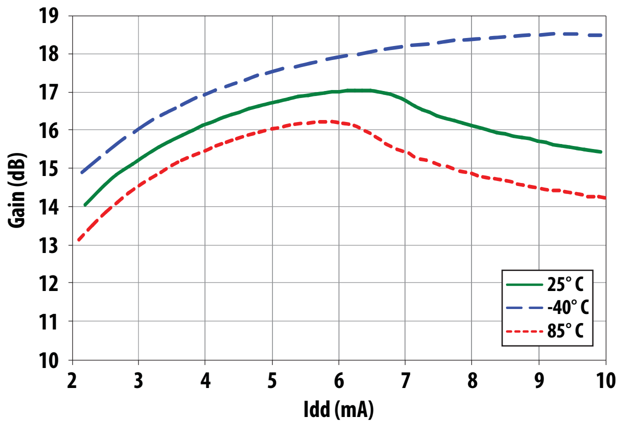


Figure 22. Gain vs. Idd at 1.575 GHz

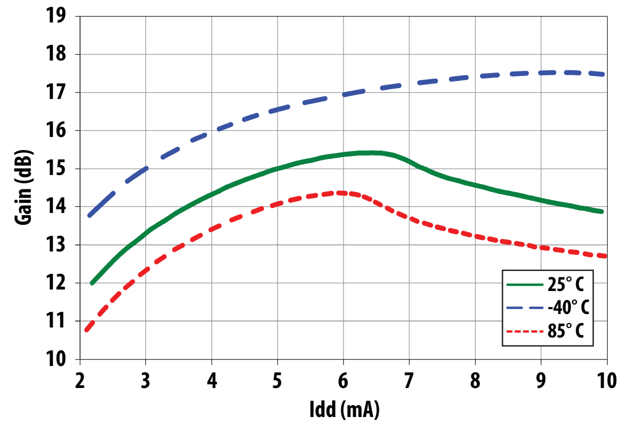


Figure 23. Gain vs. Idd at 1.6017 GHz

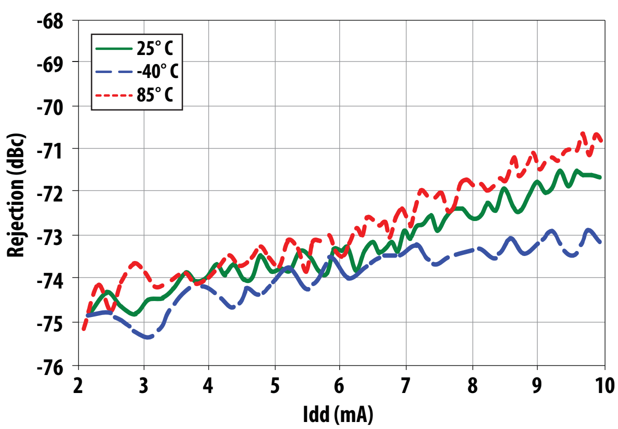


Figure 24. Rejection at 915 MHz relative to 1.575 GHz vs. Idd

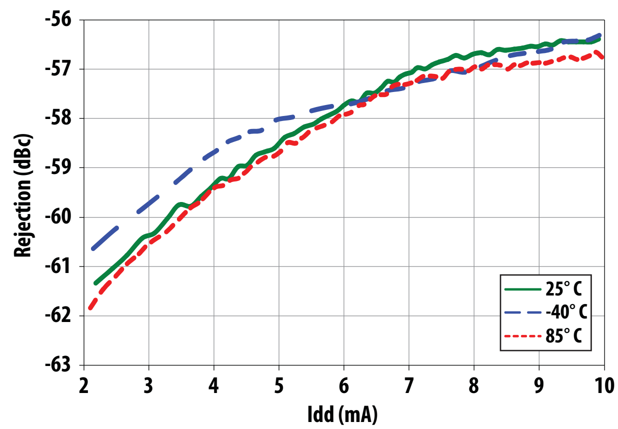


Figure 25. Rejection at 1710 MHz relative to 1.575 GHz vs. Idd

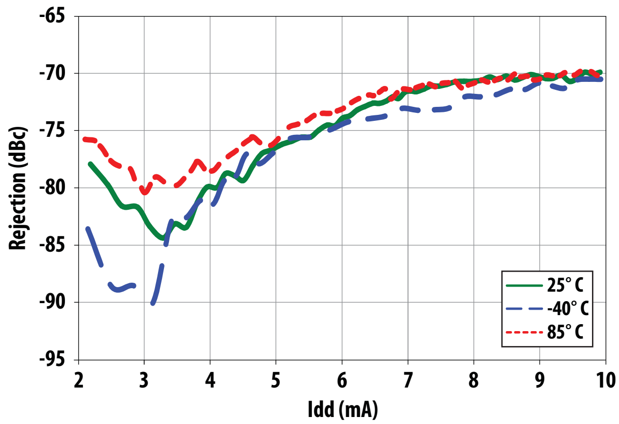


Figure 26. Rejection at 1850 MHz relative to 1.575 GHz vs. Idd

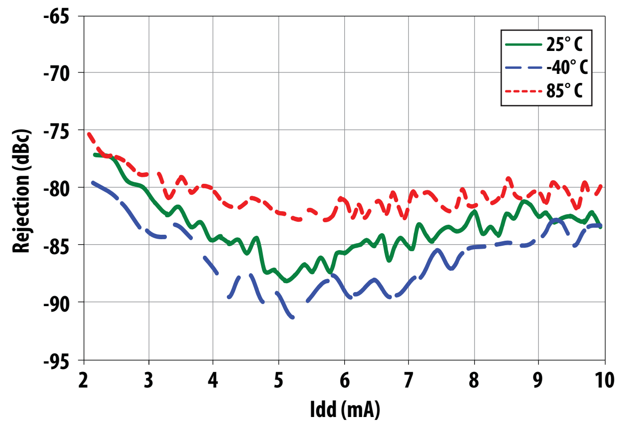


Figure 27. Rejection at 2400 MHz relative to 1.575 GHz vs. Idd

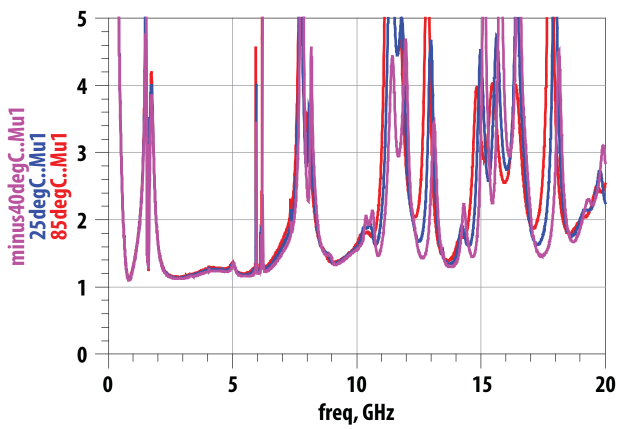


Figure 28. Edwards-Sinsky Output Stability Factor (Mu)

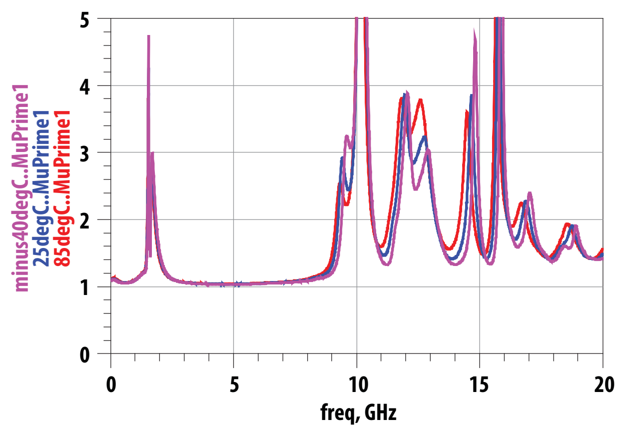


Figure 29. Edwards-Sinsky Input Stability Factor (Mu')

ALM-3012 Typical Performance Curves

Unless otherwise stated, all measurements are made with circuit of Figure 14a using demoboard of Figure 12 with Vdd = 1.8 V, Idd = 4 mA (R2 = 2.2 kOhm, Vsd = 1.8 V) at 25° C.

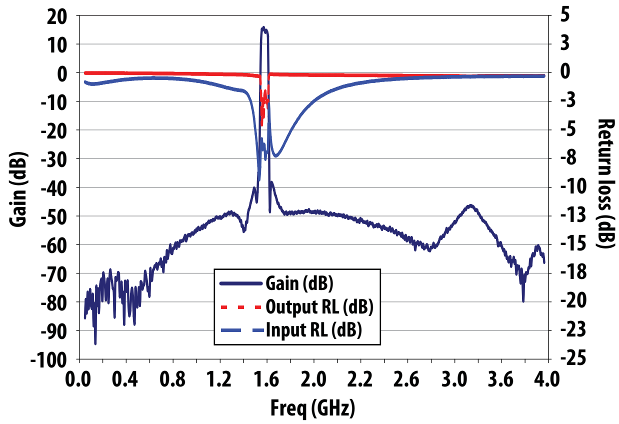


Figure 30a. Typical S-Parameter Plot

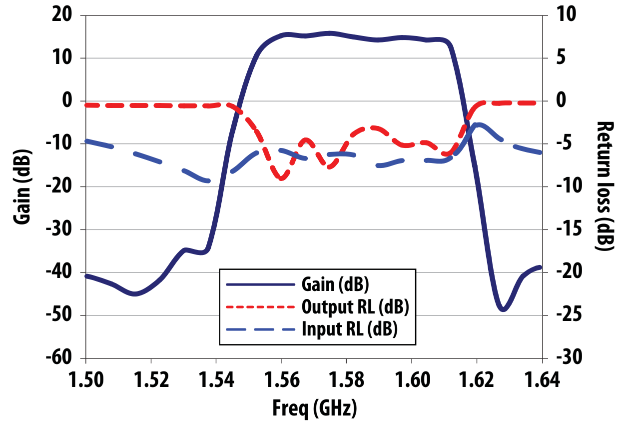


Figure 30b. Passband response of typical S-Parameter Plot

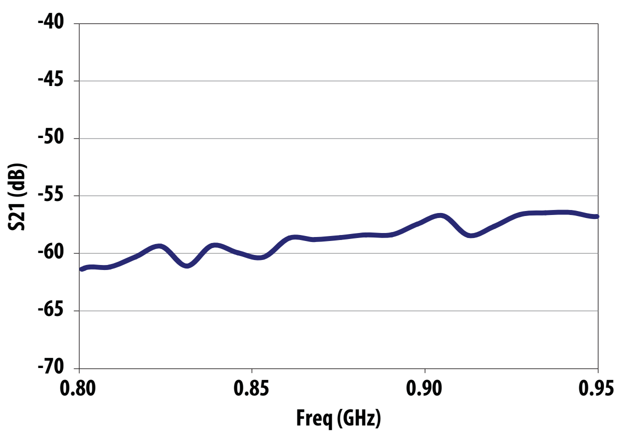


Figure 30c. Rejection plot for (800 – 950) MHz

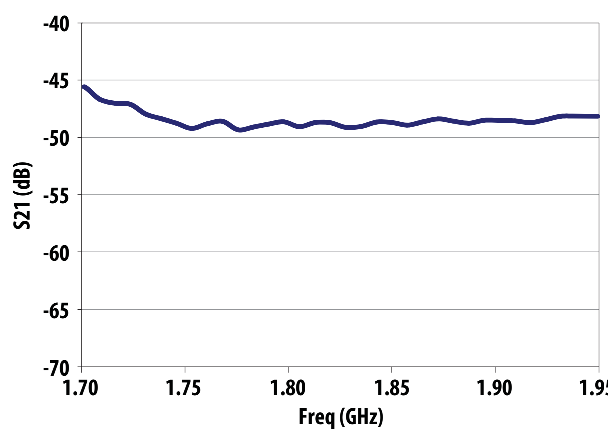


Figure 30d. Rejection plot for (1700 – 1950) MHz

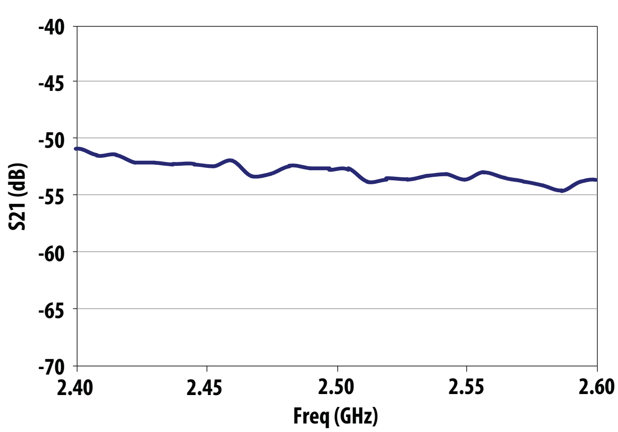


Figure 30e. Rejection plot for (2400 – 2600) MHz

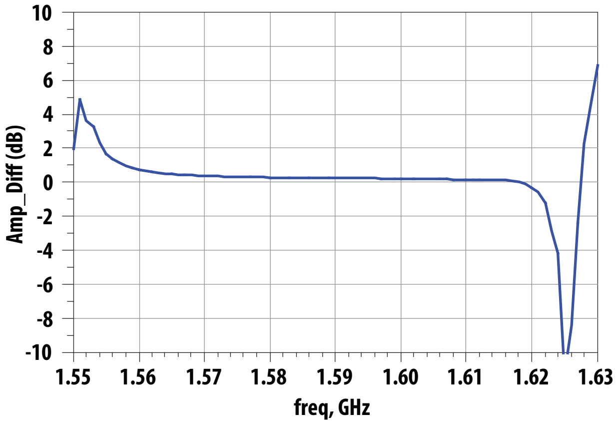


Figure 31. Amplitude difference between RFout+ and RFout- ports

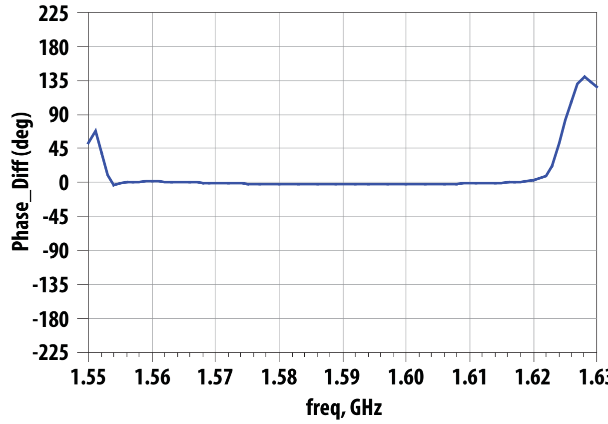


Figure 32. Phase difference between RFout+ and RFout- ports

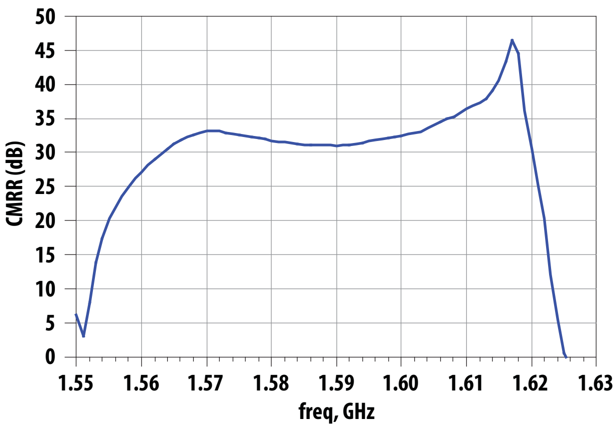


Figure 33. Common-mode rejection ratio

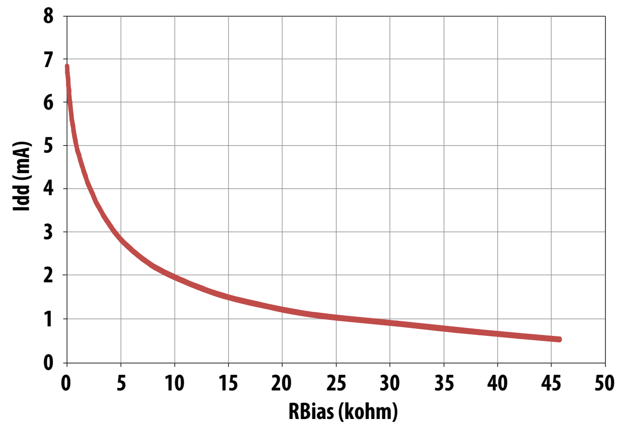


Figure 34. Idd vs R2

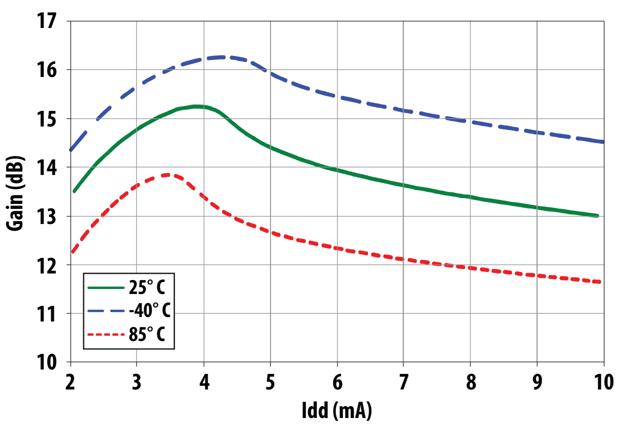


Figure 35. Gain vs. Idd at Vdd = 1.8 V at 1.575 GHz

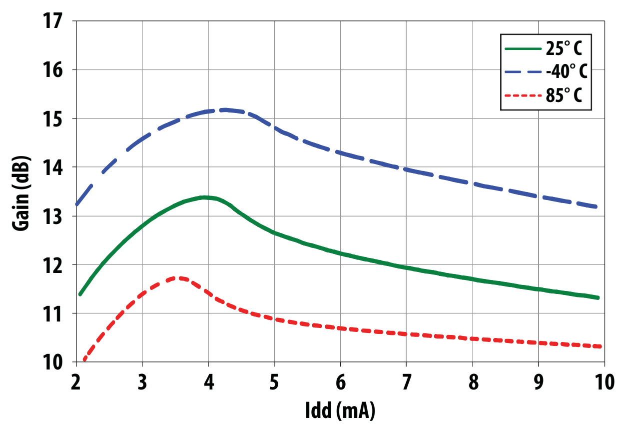


Figure 36. Gain vs. Idd at Vdd = 1.8 V at 1.6017 GHz

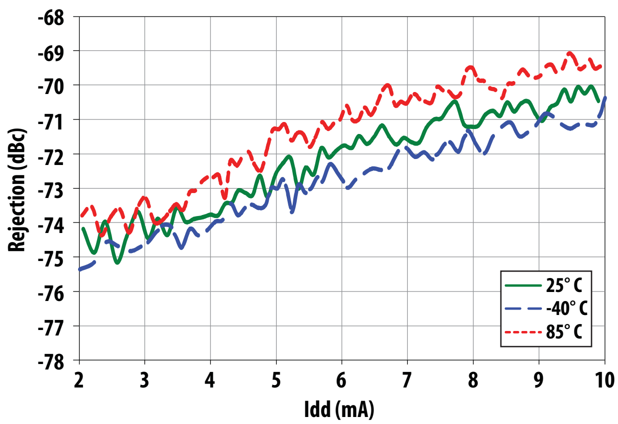


Figure 37. Rejection at 915 MHz relative to 1.575 GHz vs. Idd

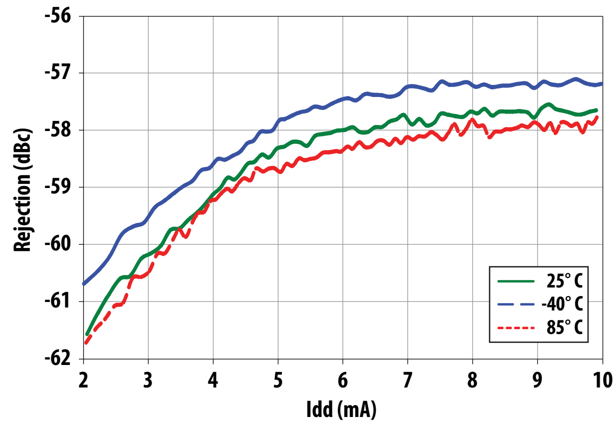


Figure 38. Rejection at 1710 MHz relative to 1.575 GHz vs. Idd

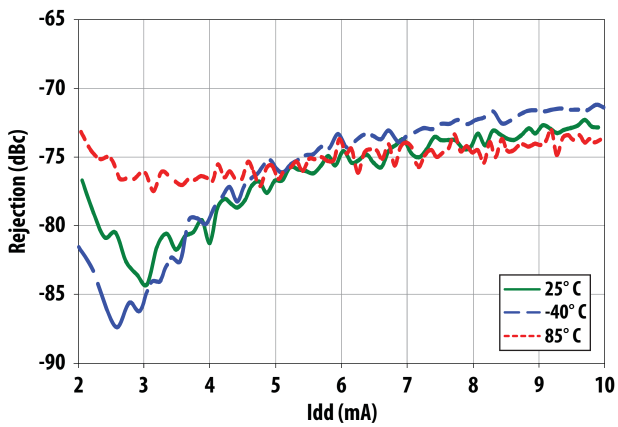


Figure 39. Rejection at 1850 MHz relative to 1.575 GHz vs. Idd

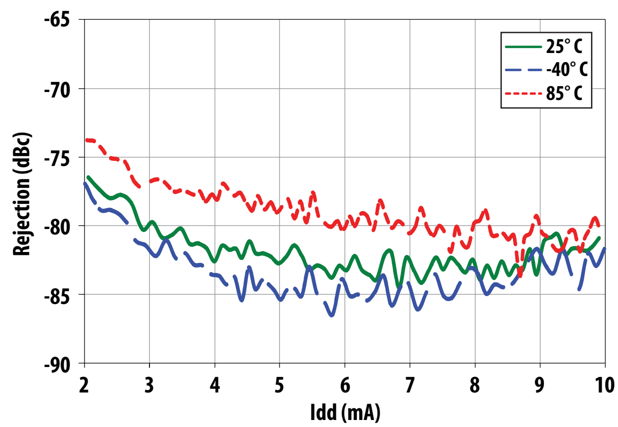


Figure 40. Rejection at 2400 MHz relative to 1.575 GHz vs. Idd

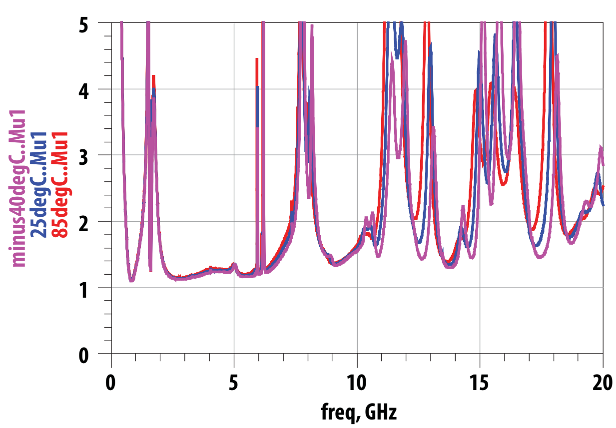


Figure 41. Edwards-Sinsky Output Stability Factor (Mu)

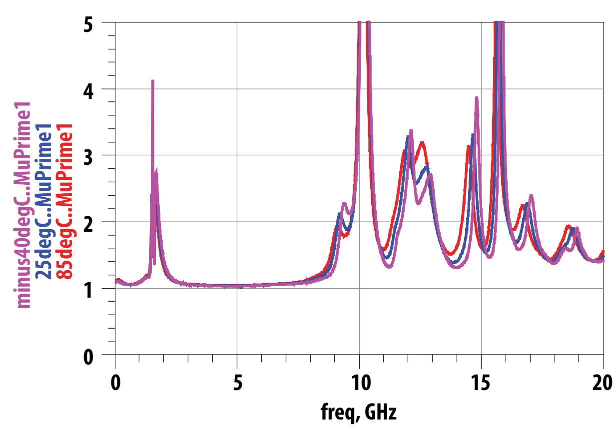


Figure 42. Edwards-Sinsky Input Stability Factor (Mu')

ALM-3012 Scattering Parameter and Measurement Reference Planes

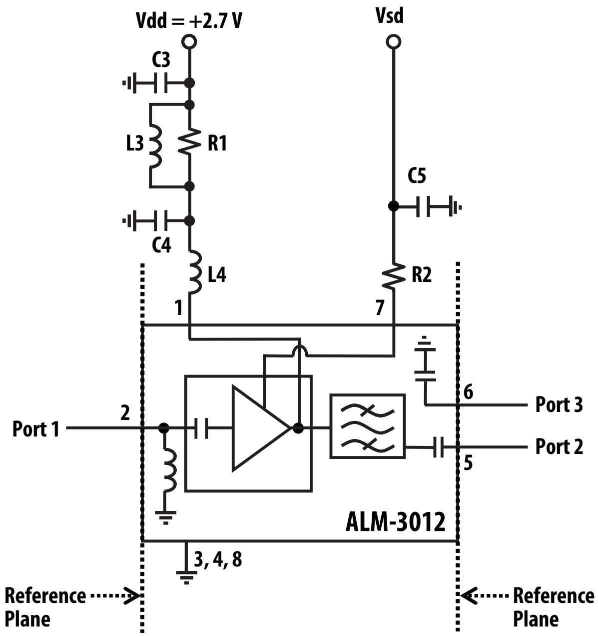


Figure 43. Scattering parameter measurement reference planes. Component values are as shown in Fig 12.

ALM-3012 Typical Scattering Parameters at 25° C, Vdd = 2.7 V, Idd = 6.2 mA

The S- and Noise Parameters are measured using a coplanar waveguide PCB with 10 mils Rogers® RO4350. Figure 42 shows the input and output reference planes. The circuit values are as indicated in Figure 12.

	S11	S11	S12	S12	S13	S13	S21	S21	S22	S22	S23	S23	S31	S31	S32	S32	S33	S33
Freq (GHz)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)
0.05	-0.68	155.80	-88.61	-158.04	-86.05	-102.63	-87.99	66.92	-0.01	-3.16	-68.15	82.72	-86.39	-82.86	-66.85	85.97	0.00	-5.07
0.1	-0.86	134.67	-92.61	171.13	-85.46	147.59	-84.20	45.83	-0.02	-6.35	-61.40	85.20	-88.73	-143.69	-61.57	82.71	-0.01	-10.31
0.2	-0.86	101.74	-81.88	104.37	-84.25	40.25	-68.80	-17.09	-0.03	-12.42	-56.09	73.40	-78.71	-136.22	-56.23	72.91	-0.02	-20.16
0.3	-0.63	76.76	-76.62	91.94	-75.49	108.25	-64.46	-53.51	-0.09	-19.26	-53.90	64.15	-75.88	152.83	-53.87	64.37	-0.11	-30.80
0.4	-0.56	57.99	-74.41	97.36	-73.58	81.12	-64.58	-66.78	-0.11	-25.25	-52.90	57.96	-73.55	109.21	-52.93	54.77	-0.14	-39.97
0.5	-0.53	42.69	-74.45	104.60	-73.34	102.38	-63.43	-38.53	-0.14	-31.56	-53.61	48.86	-69.12	72.29	-53.94	47.81	-0.17	-49.29
0.6	-0.52	31.15	-71.97	102.53	-71.99	81.42	-58.52	-30.59	-0.16	-37.48	-56.65	45.26	-68.05	50.98	-56.74	40.35	-0.19	-57.68
0.7	-0.52	21.03	-73.16	83.31	-70.48	89.04	-53.78	-31.00	-0.19	-43.70	-67.44	47.23	-63.49	39.08	-65.93	46.82	-0.20	-66.03
0.8	-0.55	12.96	-69.99	73.83	-70.87	69.06	-50.45	-42.49	-0.21	-49.54	-61.05	-156.01	-64.64	21.40	-60.40	-155.26	-0.22	-73.53
0.824	-0.56	11.21	-74.12	85.92	-69.88	66.03	-49.60	-42.92	-0.21	-50.91	-57.32	-159.96	-64.94	18.04	-57.73	-159.76	-0.22	-75.20
0.9	-0.58	5.91	-74.18	117.24	-69.87	63.63	-47.85	-50.55	-0.25	-55.37	-51.23	-162.97	-64.87	8.10	-51.24	-163.17	-0.23	-80.51
0.915	-0.59	4.75	-73.52	74.00	-71.87	69.38	-47.45	-51.19	-0.23	-56.46	-49.79	-162.34	-64.70	6.45	-49.76	-163.17	-0.23	-81.74
1.0	-0.58	-0.68	-80.13	68.34	-71.91	43.34	-45.61	-59.95	-0.27	-59.49	-45.98	-165.38	-64.05	6.06	-45.85	-166.45	-0.27	-84.82
1.1	-0.61	-6.07	-76.05	61.29	-79.76	48.26	-43.36	-69.39	-0.30	-65.76	-42.30	-171.26	-64.80	4.23	-42.26	-171.40	-0.27	-91.26
1.2	-0.62	-11.40	-92.81	41.65	-77.80	94.27	-41.17	-80.42	-0.33	-72.88	-39.14	-178.46	-62.71	18.47	-39.14	-178.41	-0.28	-97.70
1.3	-0.59	-16.23	-82.36	-170.04	-78.79	158.91	-39.04	-93.39	-0.37	-80.54	-36.57	175.37	-59.92	33.30	-36.63	175.37	-0.28	-103.41
1.4	-0.47	-21.86	-71.20	-165.25	-74.54	170.84	-36.63	-114.53	-0.45	-91.37	-34.10	166.84	-56.25	32.78	-34.06	166.86	-0.29	-109.14
1.5	-0.48	-30.66	-66.96	-172.36	-70.59	-174.86	-34.12	-170.70	-0.79	-112.07	-31.21	153.76	-61.83	153.74	-31.24	153.67	-0.29	-114.27
1.575	-1.00	-32.06	-36.42	-135.60	-64.51	-170.66	12.89	-119.70	-18.41	-52.67	-37.65	95.38	-24.45	-148.75	-38.22	93.40	-0.29	-117.92
1.6	-1.13	-33.36	-36.47	19.35	-69.35	-125.99	12.49	29.91	-22.39	1.71	-34.05	126.69	-20.45	-36.57	-33.73	125.09	-0.29	-119.15
1.7	-2.11	-39.23	-67.81	-154.77	-67.10	175.62	-44.00	158.29	-0.33	-69.22	-34.45	170.95	-39.10	-67.35	-34.42	170.79	-0.29	-123.92
1.71	-2.13	-39.07	-66.65	-152.69	-66.51	173.46	-43.81	154.26	-0.34	-70.74	-34.17	170.15	-39.37	-69.00	-34.14	170.19	-0.29	-124.18
1.785	-2.27	-38.49	-65.25	-175.48	-64.41	179.51	-46.91	135.71	-0.39	-83.43	-31.81	162.33	-42.12	-85.47	-31.83	162.19	-0.29	-127.44
1.8	-2.27	-38.64	-63.50	-168.83	-63.45	-171.96	-48.53	133.44	-0.40	-85.42	-31.47	160.97	-42.36	-88.37	-31.44	160.89	-0.29	-128.14
1.850	-2.28	-39.37	-65.41	-168.58	-62.18	173.69	-52.80	141.01	-0.42	-90.50	-30.54	157.58	-43.50	-95.20	-30.57	157.47	-0.29	-130.27
1.9	-2.29	-40.22	-62.61	-165.97	-61.54	179.25	-57.39	167.77	-0.44	-94.29	-29.90	154.71	-44.40	-98.76	-29.90	154.87	-0.30	-132.15
1.910	-2.30	-40.47	-62.36	-172.68	-61.73	175.77	-57.05	171.63	-0.45	-95.15	-29.73	154.13	-44.62	-99.58	-29.71	154.21	-0.29	-132.54
2.0	-2.32	-42.61	-60.41	-164.87	-59.39	172.04	-53.88	-129.83	-0.46	-101.44	-28.61	149.36	-46.00	-106.30	-28.58	149.39	-0.29	-136.06
2.1	-2.37	-45.06	-58.82	-171.16	-58.40	170.41	-49.25	-118.49	-0.47	-107.34	-27.59	144.74	-46.01	-110.67	-27.58	144.73	-0.28	-139.61
2.2	-2.44	-47.73	-57.39	-178.02	-57.18	168.34	-46.78	-122.18	-0.49	-113.13	-26.64	140.30	-46.94	-116.90	-26.64	140.23	-0.28	-143.16
2.3	-2.51	-50.21	-55.52	177.15	-56.46	164.89	-45.29	-124.39	-0.50	-118.23	-25.84	136.21	-47.55	-120.54	-25.83	136.17	-0.28	-146.34
2.4	-2.60	-52.77	-54.37	175.90	-55.27	163.97	-44.15	-128.37	-0.51	-123.39	-25.06	132.06	-48.35	-121.49	-25.07	132.09	-0.27	-149.52
2.5	-2.68	-55.19	-53.74	173.90	-54.00	162.38	-43.69	-130.85	-0.52	-128.03	-24.40	128.45	-48.81	-120.39	-24.39	128.36	-0.27	-152.39
2.570	-2.73	-56.87	-53.00	173.26	-53.18	162.85	-43.27	-132.08	-0.53	-131.25	-23.97	125.78	-49.27	-117.96	-23.94	125.73	-0.26	-154.37
3.0	-3.07	-66.91	-48.97	159.56	-49.68	152.10	-42.98	-110.79	-0.58	-149.50	-21.56	110.88	-46.81	-70.88	-21.57	110.88	-0.26	-165.32
3.5	-3.32	-78.45	-48.50	134.42	-48.26	134.43	-30.44	-179.23	-0.58	-167.27	-20.66	96.49	-35.85	-171.83	-20.66	96.56	-0.24	-175.41
4.0	-3.42	-89.39	-45.12	132.08	-45.07	130.87	-38.04	177.37	-0.59	175.59	-18.68	85.04	-44.67	-148.67	-18.68	84.98	-0.22	175.73
4.5	-3.30	-99.37	-41.67	120.37	-41.95	122.01	-33.74	-108.47	-0.66	160.36	-17.25	73.25	-35.77	-97.42	-17.26	73.15	-0.23	168.40
5.0	-2.51	-106.78	-32.07	61.64	-35.00	78.40	-12.61	-142.51	-1.54	145.42	-15.41	46.87	-17.21	-135.65	-15.44	46.55	-0.48	161.99
5.5	-2.87	-116.94	-47.20	-87.40	-47.16	107.01	-19.30	98.54	-0.73	136.18	-17.20	55.22	-24.86	111.96	-17.20	55.33	-0.23	157.39
6.0	-2.68	-122.47	-50.36	-125.63	-45.83	99.14	-23.07	82.60	-0.89	125.91	-15.81	47.17	-26.98	100.67	-15.80	47.19	-0.27	150.99
6.5	-2.49	-127.93	-45.54	-146.41	-39.88	103.61	-25.91	68.64	-1.06	110.73	-14.76	36.30	-29.83	97.07	-14.72	36.58	-0.32	143.89
7.0	-2.26	-135.28	-37.39	-147.30	-37.38	93.20	-29.73	58.80	-1.91	86.87	-13.95	19.41	-30.20	95.46	-13.97	19.65	-0.36	136.67
7.5	-1.90	-145.22	-30.31	-160.89	-35.17	85.00	-22.30	105.47	-10.17	48.00	-14.77	-14.81	-27.15	98.56	-14.84	-14.44	-0.42	129.74
8.0	-1.65	-161.71	-20.07	170.54	-32.62	76.64	-15.61	-10.40	-4.28	119.61	-21.71	5.98	-26.67	60.15	-21.21	7.84	-0.25	122.51
8.5	-3.02	-172.58	-17.91	77.04	-30.30	46.36	-22.22	170.55	-2.26	110.91	-19.39	16.15	-26.83	63.09	-19.31	13.77	-0.23	115.43

ALM-3012 Typical Scattering Parameters at 25° C, Vdd = 1.8 V, Idd = 4 mA

	S11	S11	S12	S12	S13	S13	S21	S21	S22	S22	S23	S23	S31	S31	S32	S32	S33	S33
Freq (GHz)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)	Mag. (dB)	Ang. (deg)
0.05	-0.68	155.78	-84.63	31.19	-92.06	-89.65	-93.35	-170.48	-0.01	-3.15	-66.38	85.39	-89.69	98.85	-67.95	79.94	0.00	-5.07
0.1	-0.86	134.68	-81.82	137.91	-84.26	91.20	-85.78	45.85	-0.02	-6.36	-61.82	87.69	-98.33	132.92	-61.29	80.38	-0.01	-10.33
0.2	-0.87	101.79	-85.15	130.87	-87.03	102.85	-71.43	-13.76	-0.03	-12.42	-56.31	72.24	-86.05	106.02	-56.21	72.32	-0.02	-20.16
0.3	-0.64	76.84	-81.49	148.78	-77.55	121.26	-66.94	-53.84	-0.09	-19.25	-53.90	63.42	-81.42	114.83	-53.79	62.72	-0.11	-30.79
0.4	-0.56	58.09	-76.63	121.37	-74.87	137.11	-69.62	-55.29	-0.11	-25.25	-53.17	55.94	-72.92	104.02	-53.13	56.15	-0.14	-39.97
0.5	-0.51	42.76	-74.30	85.33	-69.99	85.60	-67.65	-36.01	-0.14	-31.55	-53.91	50.21	-70.28	81.37	-53.69	49.27	-0.17	-49.28
0.6	-0.49	31.18	-71.28	83.41	-70.33	77.04	-61.70	-18.74	-0.16	-37.46	-56.31	40.20	-67.74	54.33	-56.80	41.03	-0.19	-57.66
0.7	-0.48	21.01	-70.40	75.56	-70.76	81.10	-56.98	-26.76	-0.19	-43.69	-67.32	37.02	-66.02	60.04	-67.91	48.38	-0.20	-66.02
0.8	-0.49	12.84	-69.71	75.51	-73.09	85.77	-53.50	-33.27	-0.21	-49.53	-59.76	-160.71	-65.40	31.78	-60.45	-158.90	-0.22	-73.50
0.824	-0.49	11.06	-69.57	77.73	-74.18	56.99	-53.01	-35.59	-0.21	-50.90	-57.74	-161.32	-64.36	33.16	-57.67	-159.77	-0.22	-75.19
0.9	-0.51	5.70	-72.71	61.22	-73.53	69.02	-50.65	-43.15	-0.25	-55.35	-51.04	-163.20	-64.15	16.86	-51.17	-162.44	-0.23	-80.50
0.915	-0.51	4.52	-77.92	63.78	-74.22	66.43	-50.25	-45.94	-0.23	-56.45	-50.32	-163.01	-65.45	19.04	-50.01	-163.86	-0.23	-81.72
1.0	-0.50	-1.01	-76.54	69.98	-73.59	69.01	-48.24	-51.95	-0.27	-59.49	-45.94	-166.78	-64.30	22.48	-45.99	-165.68	-0.27	-84.80
1.1	-0.52	-6.53	-75.84	59.59	-75.08	60.70	-46.00	-63.07	-0.30	-65.74	-42.30	-171.63	-64.71	24.16	-42.16	-171.56	-0.27	-91.23
1.2	-0.53	-11.96	-85.09	145.21	-79.05	92.63	-43.72	-74.38	-0.33	-72.86	-39.11	-177.88	-62.42	29.00	-39.10	-178.11	-0.28	-97.69
1.3	-0.50	-16.87	-77.18	-139.84	-84.16	138.35	-41.21	-86.89	-0.36	-80.50	-36.61	175.19	-58.74	41.35	-36.58	175.31	-0.28	-103.37
1.4	-0.38	-22.56	-69.40	-154.16	-77.76	-176.50	-38.27	-109.33	-0.44	-91.34	-34.07	167.32	-54.67	38.33	-34.06	167.13	-0.28	-109.12
1.5	-0.51	-31.64	-66.00	-175.53	-71.66	174.74	-35.72	-175.94	-0.78	-112.05	-31.21	153.64	-62.67	34.73	-31.24	153.71	-0.29	-114.23
1.575	-0.90	-32.45	-35.61	-146.11	-64.52	173.76	10.88	-121.34	-27.49	-135.32	-36.78	97.05	-26.57	-149.82	-37.33	95.58	-0.29	-117.90
1.6	-1.03	-33.60	-36.00	7.91	-69.33	-136.23	10.36	27.08	-16.84	55.03	-34.22	119.20	-22.51	-39.26	-33.86	117.76	-0.29	-119.13
1.7	-1.76	-37.86	-67.47	-154.95	-65.42	-177.85	-48.15	153.84	-0.33	-69.20	-34.46	170.80	-41.24	-71.74	-34.44	170.73	-0.29	-123.88
1.71	-1.77	-37.82	-67.08	-159.96	-65.11	176.79	-48.06	151.04	-0.34	-70.71	-34.16	170.14	-41.53	-73.29	-34.16	170.40	-0.29	-124.16
1.785	-1.80	-38.76	-66.02	-166.60	-63.27	175.27	-51.34	137.09	-0.39	-83.40	-31.82	162.28	-43.97	-85.84	-31.82	162.18	-0.29	-127.39
1.8	-1.80	-39.14	-64.15	-162.47	-62.93	-178.82	-52.64	138.83	-0.40	-85.39	-31.45	161.05	-44.33	-87.77	-31.47	161.06	-0.29	-128.11
1.850	-1.82	-40.47	-62.22	-165.59	-62.80	176.55	-57.47	151.76	-0.42	-90.47	-30.52	157.45	-45.50	-92.38	-30.55	157.51	-0.29	-130.25
1.9	-1.84	-41.71	-63.55	-166.70	-61.75	179.24	-60.96	-164.89	-0.44	-94.26	-29.87	154.78	-46.11	-96.36	-29.89	154.87	-0.29	-132.11
1.910	-1.85	-42.04	-61.21	-176.16	-61.75	168.66	-60.20	-162.58	-0.44	-95.11	-29.72	154.21	-46.12	-96.60	-29.75	154.18	-0.29	-132.52
2.0	-1.90	-44.74	-60.33	-172.04	-59.11	173.63	-54.78	-114.94	-0.45	-101.39	-28.61	149.24	-47.23	-101.55	-28.60	149.50	-0.28	-136.04
2.1	-1.97	-47.63	-57.71	-178.33	-58.76	171.36	-50.75	-113.10	-0.47	-107.29	-27.56	144.84	-47.27	-107.45	-27.58	144.86	-0.28	-139.58
2.2	-2.06	-50.70	-57.12	-177.77	-57.55	169.07	-48.29	-115.81	-0.48	-113.09	-26.64	140.30	-48.11	-110.04	-26.63	140.27	-0.28	-143.11
2.3	-2.15	-53.54	-55.89	177.88	-56.06	163.90	-46.69	-119.13	-0.49	-118.20	-25.84	136.16	-48.12	-112.86	-25.84	136.21	-0.28	-146.30
2.4	-2.26	-56.44	-55.05	176.61	-55.22	162.33	-45.64	-123.27	-0.51	-123.34	-25.08	132.15	-48.44	-115.75	-25.07	132.14	-0.27	-149.47
2.5	-2.36	-59.18	-53.44	171.30	-54.38	157.16	-45.05	-126.63	-0.52	-127.99	-24.40	128.49	-48.72	-115.89	-24.40	128.34	-0.26	-152.34
2.570	-2.43	-61.09	-53.43	168.47	-53.55	158.47	-44.58	-127.69	-0.52	-131.23	-23.96	125.87	-49.00	-114.96	-23.95	125.84	-0.26	-154.33
3.0	-2.89	-72.33	-49.42	157.01	-50.13	148.32	-43.46	-111.88	-0.57	-149.46	-21.57	110.95	-46.98	-85.29	-21.56	110.89	-0.25	-165.28
3.5	-3.32	-84.82	-48.64	135.67	-48.28	130.34	-32.17	-178.69	-0.57	-167.23	-20.66	96.58	-37.14	-170.46	-20.66	96.63	-0.24	-175.36
4.0	-3.59	-96.20	-45.68	129.79	-45.49	127.48	-38.59	-179.51	-0.59	175.62	-18.67	85.04	-43.48	-151.54	-18.68	85.04	-0.21	175.77
4.5	-3.64	-106.17	-42.50	118.00	-42.66	119.02	-34.66	-118.97	-0.66	160.40	-17.24	73.21	-36.68	-110.69	-17.26	73.15	-0.22	168.46
5.0	-3.10	-113.58	-33.37	59.30	-36.12	76.97	-14.08	-153.03	-1.58	145.88	-15.55	45.72	-18.52	-146.62	-15.58	45.37	-0.50	162.19
5.5	-3.46	-122.19	-49.19	-88.55	-46.98	106.42	-21.22	93.08	-0.73	136.14	-17.17	55.21	-26.43	109.22	-17.17	55.36	-0.22	157.45
6.0	-3.36	-127.24	-50.25	-133.73	-45.91	98.60	-24.94	76.23	-0.89	125.91	-15.79	47.20	-28.36	96.94	-15.79	47.23	-0.27	151.07
6.5	-3.21	-132.55	-44.61	-148.01	-40.25	103.61	-28.00	60.59	-1.06	110.76	-14.76	36.46	-30.58	97.89	-14.72	36.64	-0.31	143.97
7.0	-3.03	-140.33	-36.93	-150.85	-37.51	93.13	-32.33	47.42	-1.91	86.89	-13.96	19.53	-30.12	95.91	-13.97	19.74	-0.36	136.77
7.5	-2.83	-152.43	-29.49	-154.73	-35.97	79.04	-25.15	70.39	-10.09	48.77	-14.82	-14.86	-26.92	86.36	-14.89	-14.33	-0.41	129.85
8.0	-4.02	-169.61	-18.40	149.05	-33.22	77.26	-19.51	-100.30	-4.98	123.79	-21.65	6.47	-29.29	61.25	-21.12	5.80	-0.24	122.62
8.5	-4.51	-172.65	-18.55	70.34	-31.14	45.73	-18.50	119.41	-2.04	109.26	-19.17	15.15	-26.62	57.96	-19.19	13.40	-0.22	115.54

ALM-3012 Typical Noise Parameters at 25° C, Freq = 1.575 GHz, Vdd = 2.7 V, Idd = 6.2 mA

Freq (GHz)	Fmin (dB)	GAMMA OPT		Rn/50
		Mag	Ang	
1.565	0.82	0.669	27.0	0.4380
1.575	0.86	0.600	30.9	0.4514
1.585	0.84	0.662	28.2	0.4356
1.598	0.83	0.670	26.1	0.4456
1.602	0.81	0.689	25.8	0.4492
1.606	0.82	0.675	26.5	0.4434

ALM-3012 Typical Noise Parameters at 25° C, Freq = 1.575 GHz, Vdd = 1.8 V, Idd = 4 mA

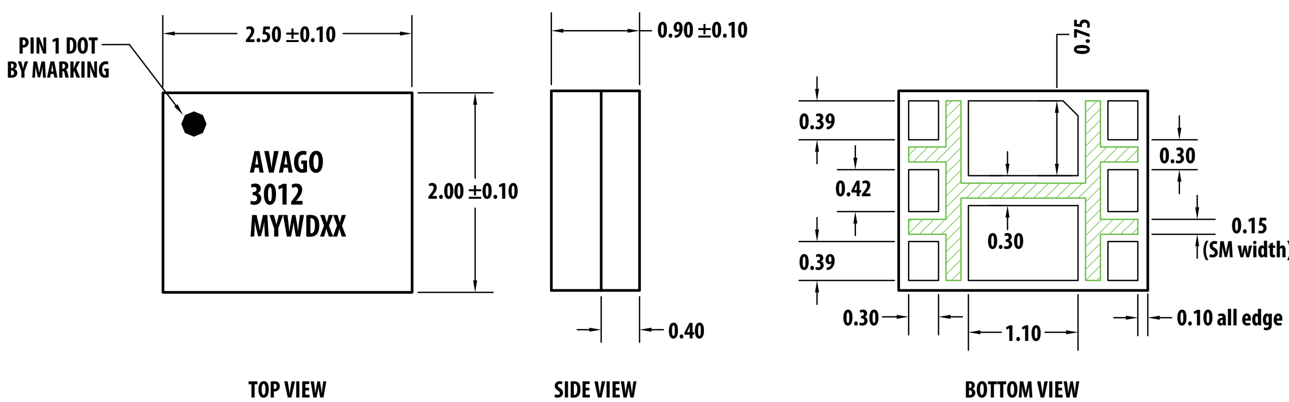
Freq (GHz)	Fmin (dB)	GAMMA OPT		Rn/50
		Mag	Ang	
1.565	0.95	0.708	25.4	0.5946
1.575	0.95	0.709	25.7	0.6028
1.585	0.99	0.708	26.6	0.5820
1.598	0.98	0.707	26.6	0.6020
1.602	0.92	0.723	26.5	0.6082
1.606	0.95	0.718	26.4	0.6070

Note:
- The exceptional noise figure performance of the ALM-3012 is due to its highly optimized design. In this regard, the Fmin of the ALM-3012 shown above is locked down by the internal input pre-match. This allows the use of relatively inexpensive chip inductors for external matching.

Part Number Ordering Information

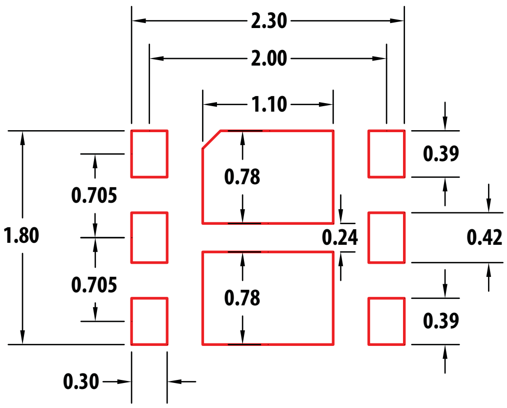
Part Number	Qty	Container
ALM-3012-BLK	100	Antistatic bag
ALM-3012-TR1	3000	7" Reel

Package Dimensions

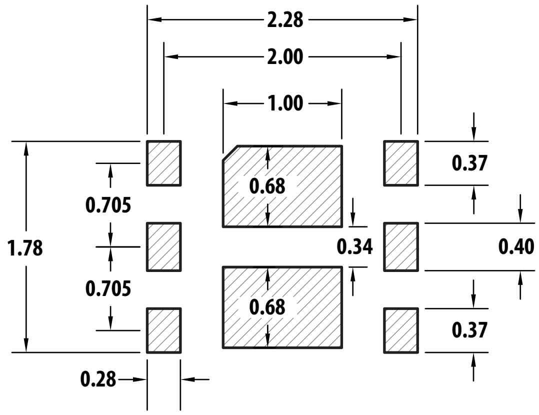


Notes:
1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold flash and metal burr.
4. 3012 = device code, M = manufacturing location (M = Malaysia), Y = Year of Manufacture, W = Work Week, D = Date Code, XX = Last 4 Digit of Lot Number.

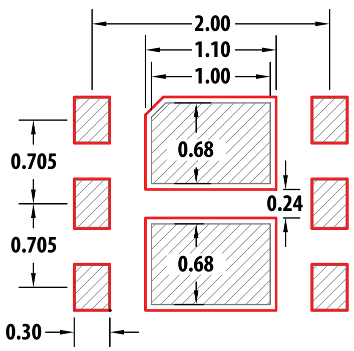
PCB Land Patterns and Stencil Design



LAND PATTERN



STENCIL OPENING

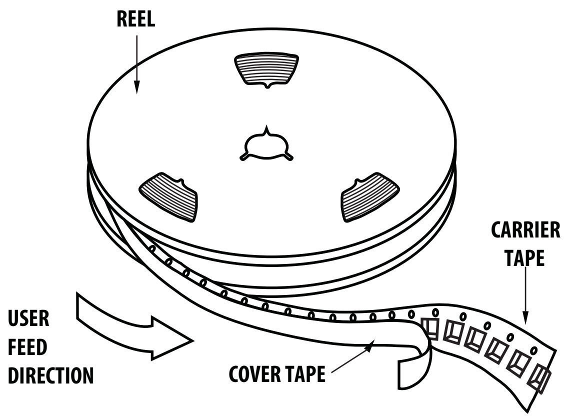


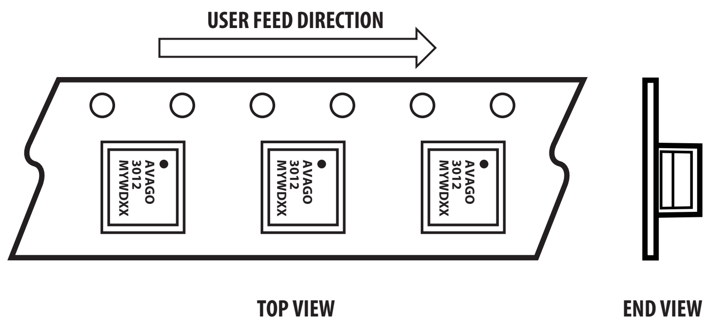
COMBINATION OF LAND PATTERN & STENCIL OPENING

Notes:

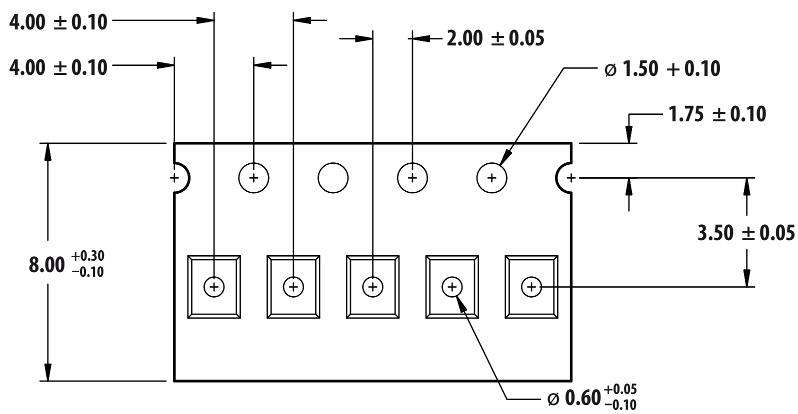
1. All dimensions are in millimeters.
2. Recommended 4 mil stencil thickness.

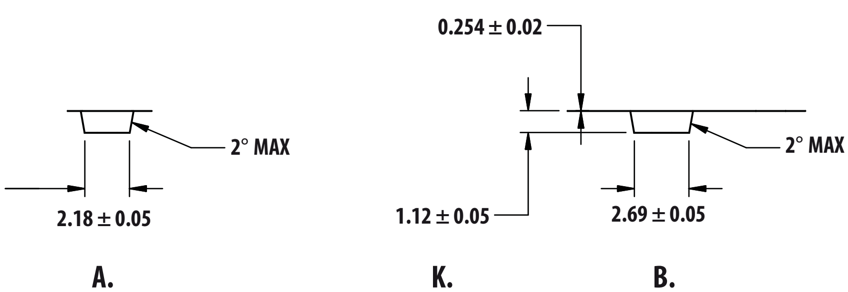
Device Orientation

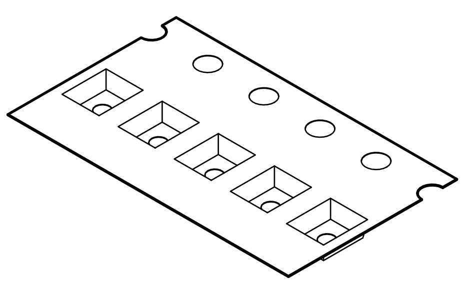




Tape Dimensions

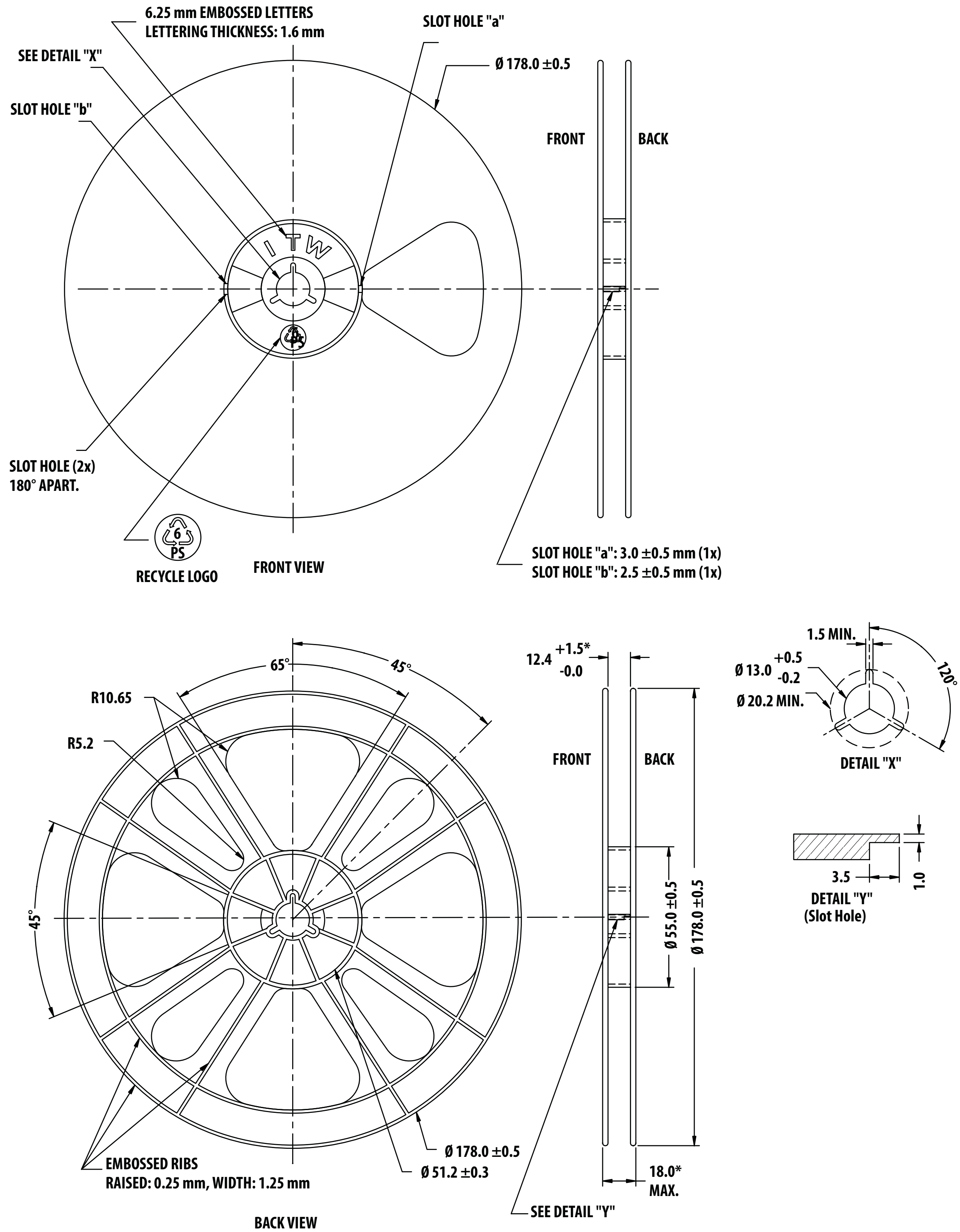






All dimensions are in millimeters

Reel Dimensions (7″ reel)



For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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