ALM-1712
GPS Filter-LNA-Filter Front-End Module

Data Sheet

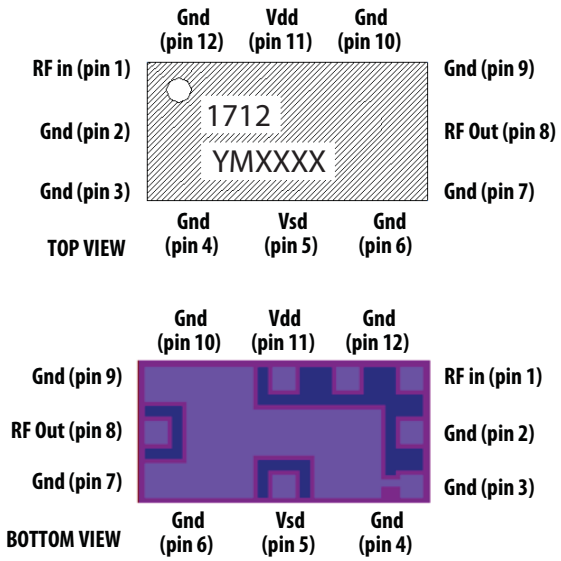
Description

Avago Technologies' ALM-1712 is a GPS front-end module that combines a low-noise amplifier (LNA) with GPS FBAR filters. 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 Cell/PCS-Band frequencies.

The low noise figure and high gain, coupled with low current consumption make it suitable for use in critical low-power GPS applications or during low-battery situations.

Component Image

Surface Mount 4.5 x 2.2 x 1 mm^3 12-lead MCOB



Note:
Package marking provides orientation and identification
"1712" = Product Code
"Y" = Year of manufacture
"M" = Month of manufacture
"XXXX" = Last 4 digit of lot number

Features

- Very Low Noise Figure : 1.65 dB typ
- Exceptional Cell/PCS-Band rejection
- Advanced GaAs E-pHEMT & FBAR Technology
- Low external component count
- Shutdown current : < 1 uA
- CMOS compatible shutdown pin (SD)
- ESD : > 3kV at RFin pin
- 1mm typical thickness
- Adjustable bias current via single external resistor/ voltage
- Useable down to 1.0V supply voltage
- Small package dimension: 4.5(L)x2.2(W)x1(H) mm^3
- Meets MSL3, Lead-free and halogen free

Specifications (Typical performance @ 25°C)

At 1.575GHz, Vdd = 2.7V, Idd = 8.0mA

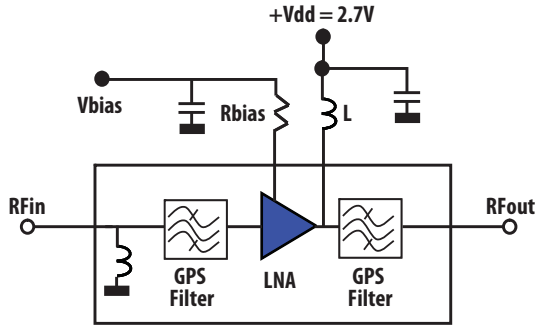
- Gain = 12.8 dB
- NF = 1.65 dB
- IIP3 = +7 dBm, IP1dB = +3 dBm
- S11 = -9 dB, S22 =-10 dB
- Cell-Band Rejection: > 95dBc
- PCS-Band Rejection: > 90dBc

Application

- GPS Front-end Module

Attention: Observe precautions for handling electrostatic sensitive devices.
For RF_IN (Pin 1): ESD Human Body Model = 3 kV
All other pins: ESD Machine Model = 40 V
ESD Human Body Model = 250 V
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Application Circuit



Absolute Maximum Rating[1] T_A = 25°C

Symbol	Parameter	Units	Absolute Max.
Vdd	Device Drain to Source Voltage[2]	V	3.6
Idd	Drain Current[2]	mA	20
$P_{in,max}$	CW RF Input Power (Vdd = 2.7V, Idd = 6mA)	dBm	15
P_{diss}	Total Power Dissipation[4]	mW	72
T_j	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to 150

Thermal Resistance[3] (Vdd = 2.7 V, Idd = 8mA), θ_{jc} = 92.2 °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 TB is 25°C. Derate 10.9 mW/°C for Tb > 143°C.

Electrical Specifications

T_A = 25°C, Freq=1.575GHz, measured on demo board[1] unless otherwise specified – Typical Performance[1]

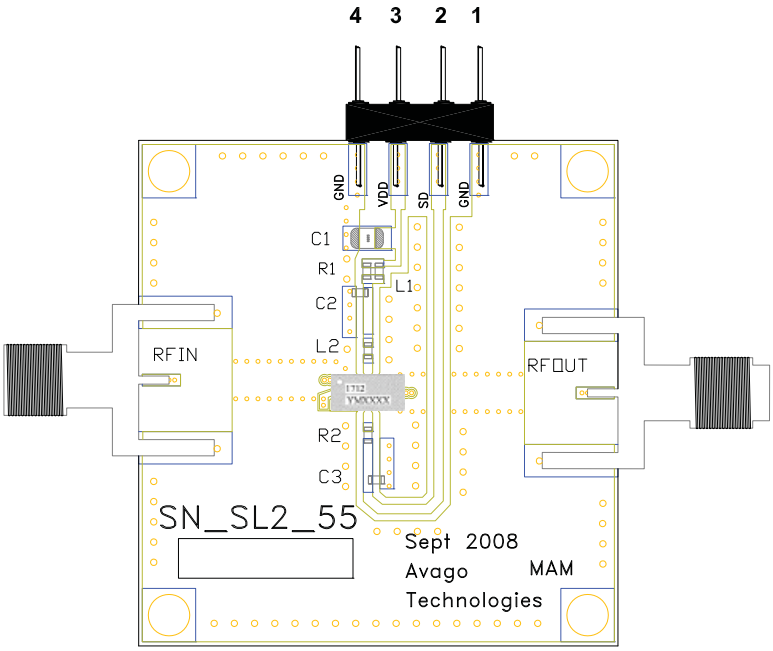
Table 1. Performance at Vdd = Vsd = 2.7V, Idd = 8mA (Rbias = 8.2k Ohm) nominal operating conditions

Symbol	Parameter and Test Condition	Units	Min.	Typ	Max.
G	Gain	dB	11	12.8	-
NF	Noise Figure	dB	-	1.65	2.1
IP1dB	Input 1dB Compressed Power	dBm	-	+3	-
IIP3[2]	Input 3rd Order Intercept Point (2-tone @ Fc +/- 2.5MHz)	dBm	-	+7	-
S11	Input Return Loss	dB	-	-9	-
S22	Output Return Loss	dB	-	-10	-
S12	Reverse Isolation	dB	-	-22	-
Cell Band Rejection	Relative to 1.575GHz @ 827.5MHz	dBc	81	104	-
PCS Band Rejection	Relative to 1.575GHz @ 1885MHz	dBc	81	92.6	-
$IP1dB_{1885MHz}$	Input 1dB gain compression interferer signal level at 1885MHz	dBm		30	
$IP1dB_{890MHz}$	Input 1dB gain compression interferer signal level at 890MHz	dBm		30	
Idd	Supply DC current at Shutdown (SD) voltage Vsd=2.7V	mA	-	8	15
Ish	Shutdown Current @ VSD = 0V	uA	-	0.5	-

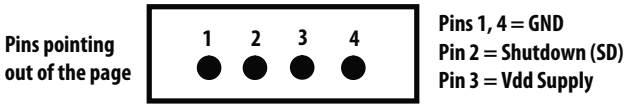
Table 2. Performance at Vdd = 1.8V, Vsd = 1.8V, Idd = 4mA (Rbias = 4.7kOhm) nominal operating conditions

Symbol	Parameter and Test Condition	Units	Typ
G	Gain	dB	11.8
NF	Noise Figure	dB	1.8
IP1dB	Input 1dB Compressed Power	dBm	2.5
IIP3[2]	Input 3rd Order Intercept Point (2-tone @ Fc +/- 2.5MHz)	dBm	6
S11	Input Return Loss	dB	-9
S22	Output Return Loss	dB	-8.5
S12	Reverse Isolation	dB	-20
Cell Band Rejection	Relative to 1.575GHz @ 827.5MHz	dBc	100
PCS Band Rejection	Relative to 1.575GHz @ 1885MHz	dBc	90
Idd	Supply DC current at Shutdown (SD) voltage Vsd=1.8V	mA	4
Ish	Shutdown Current @ VSD = 0V	uA	0.5

Notes:
1. Measurements at 1.575GHz obtained using demo board described in Figures 6 and 7
2. 1.575GHz IIP3 test condition: F_{RF1} = 1572.5 MHz, F_{RF2} = 1577.5 MHz with input power of -20dBm per tone measured at the worst case side band



DC Pin Conguration of 4-pin connector



Circuit Symbol	Size	Description
L1	0402	22 nH Inductor (Taiyo Yuden HK100522NJ-T)
L2	0402	6.8 nH Inductor (Taiyo Yuden HK10056N8J-T)
C1	0805	0.1 uF Capacitor (Murata GRM188R71C104KA01D)
C2	0402	15 pF Capacitor (Kyocera CM05CH150AHF)
C3	0402	6.8 pF Capacitor (Kyocera CM05CH6R8C50AHF)
R1	0402	12 Ohm (KOA RK73B1ETTP120J)
R2	0402	8.2 kOhm (KOA RK73B1ETTP822J)

Figure 1. Demoboard and application circuit components table

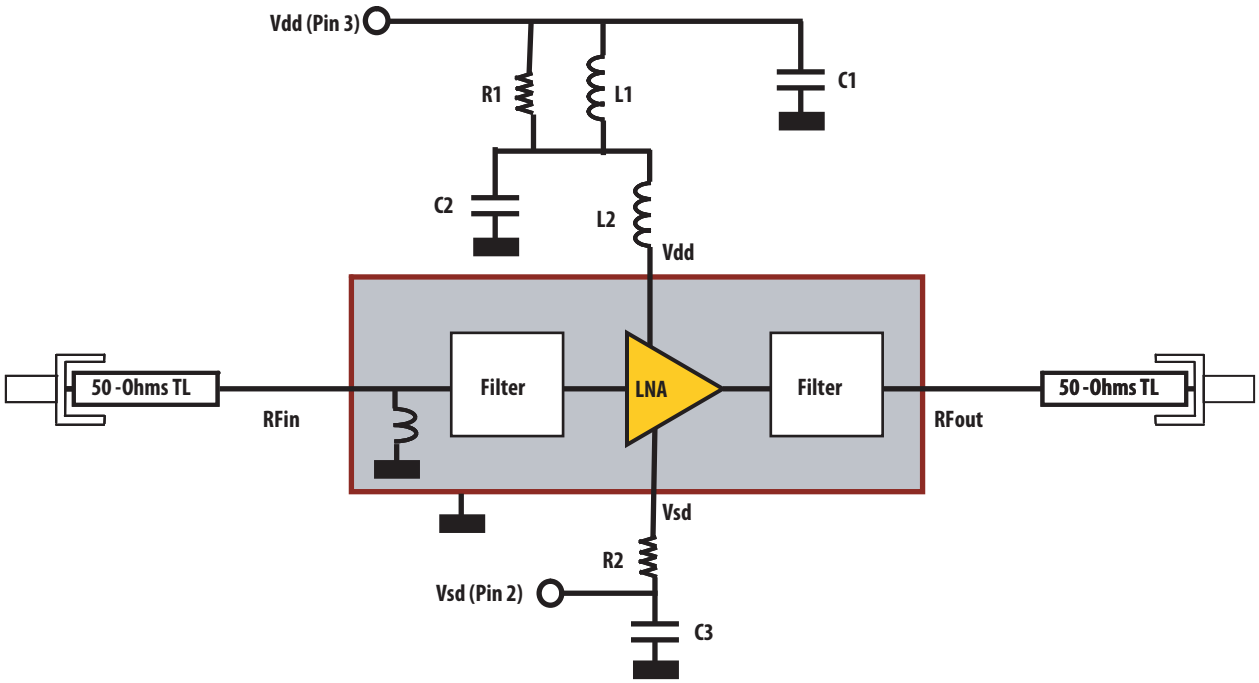


Figure 2. Demoboard and application schematic diagram

Notes

- The module is fully matched at the input and output RF pins. The RFinput pin, pin1, is directly connected to a shunt inductor that is grounded. The RF output filter blocks DC. Best noise performance is obtained using high-Q wirewound inductors. This circuit demonstrates that low noise figures are obtainable with standard 0402 chip inductors.
- C2 and L2 form a matching network that affects the frequency response and linearity of the LNA, these can be tuned to optimize gain and return loss.
- L1 and R1 isolates the demoboard from external disturbances during measurement. It is not needed in actual application. Likewise, C1 and C3 mitigate the effect of external noise pickup on the Vdd and Vsd lines respectively. These components are not required in actual operation.
- 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.

ALM-1712 Typical Performance Curves at 25°C

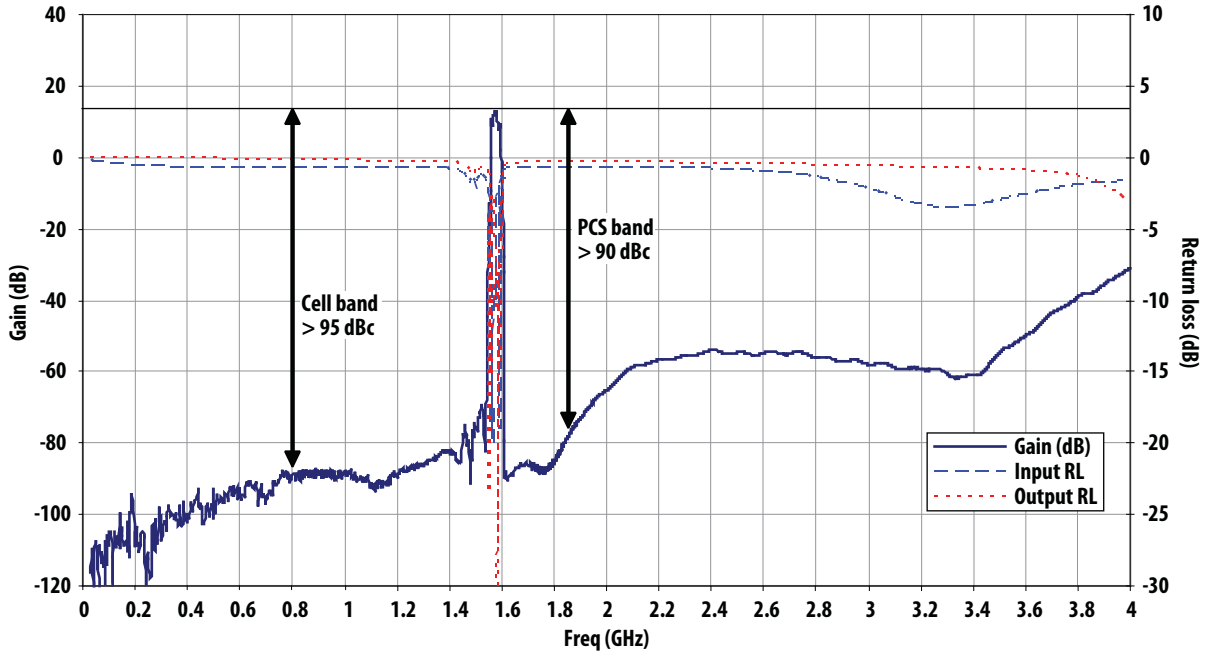


Figure 3a. Typical S-Parameter Plot @ Vdd = 2.7V, Idd = 8mA.

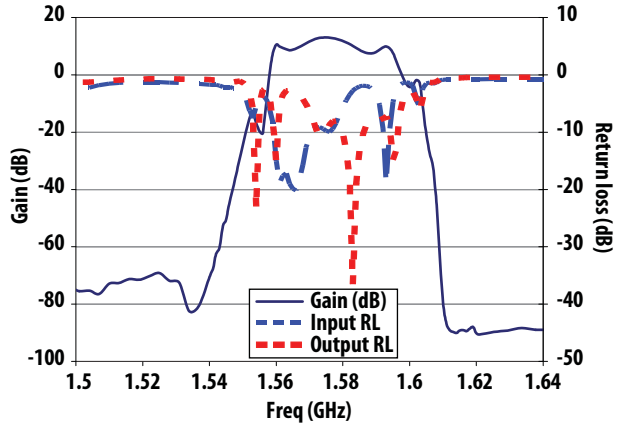


Figure 3b. Passband response of typical S-Parameter Plot @ Vdd = 2.7V, Idd = 8mA

ALM-1712 Typical Performance Curves at 25°C

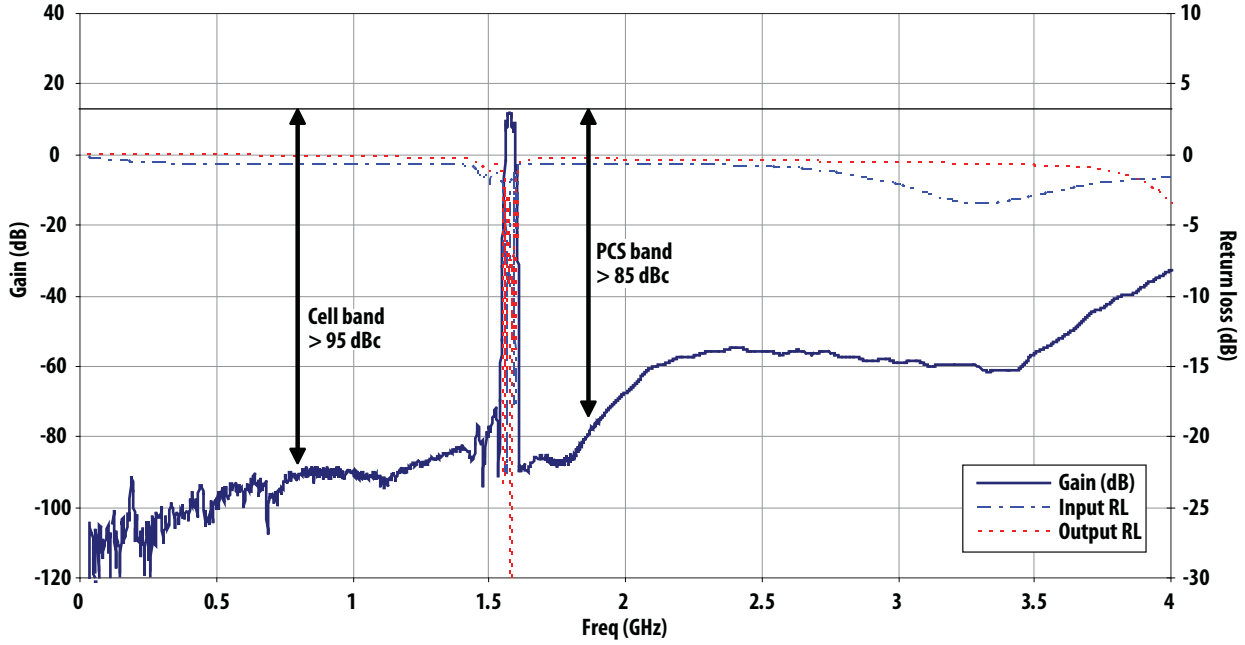


Figure 4a. Typical S-Parameter Plot @ Vdd = 1.8V, Idd = 4mA.

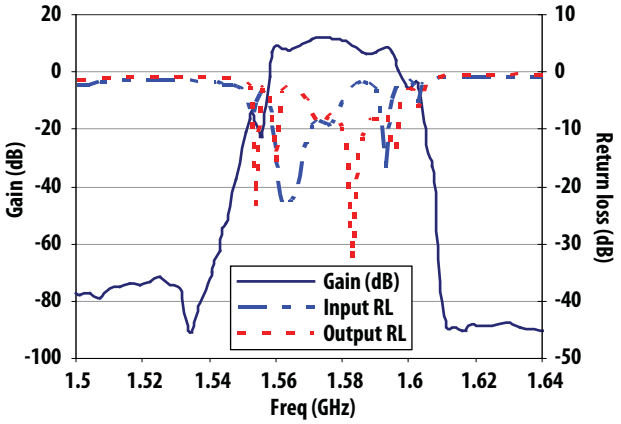


Figure 4b. Passband response of typical S-Parameter Plot @ Vdd = 1.8V, Idd = 4mA

ALM-1712 Typical Performance Curves at 25°C, R2 = 8.2k Ohm

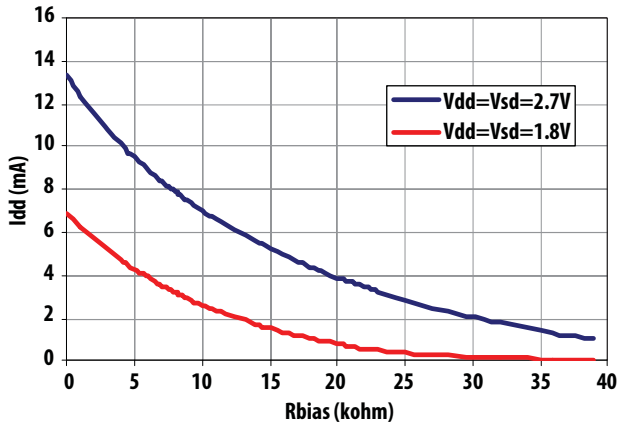


Figure 5. Idd vs Rbias at 25°C

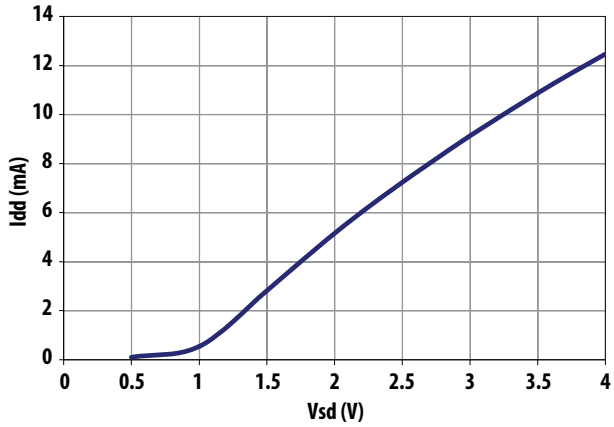


Figure 6. Idd vs Vsd for Vdd = 2.7V, Rbias = 8.2k Ohm

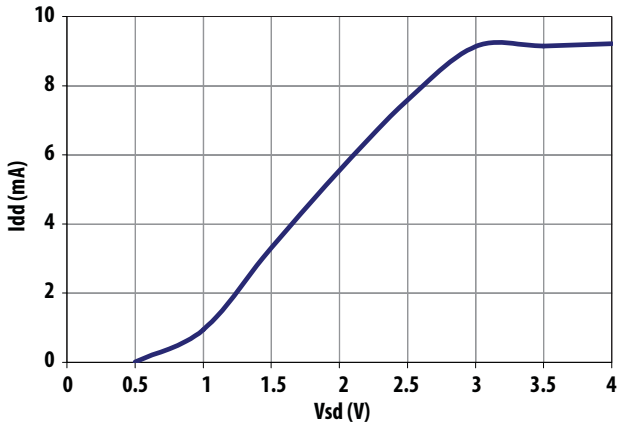


Figure 7. Idd vs Vsd for Vdd = 1.8V, Rbias = 4.7k Ohm

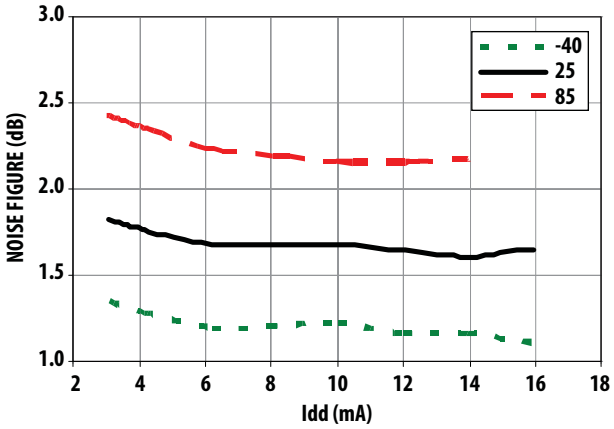


Figure 8. NF vs. Idd at Vdd = 2.7V

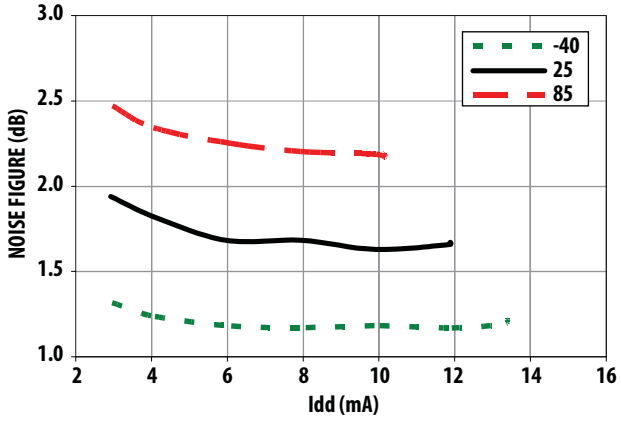


Figure 9. NF vs Idd at Vdd = 1.8V

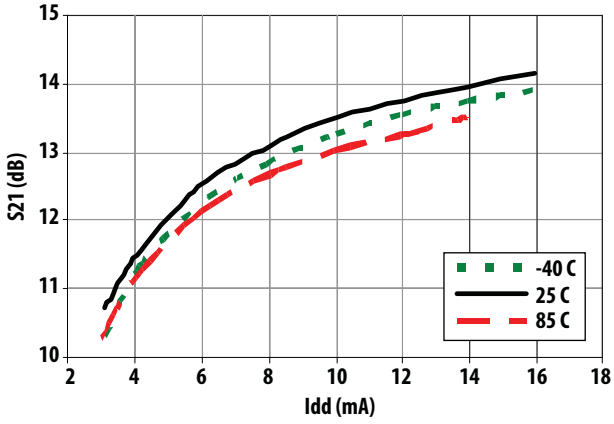


Figure 10. Gain vs. Idd at Vdd = 2.7V

ALM-1712 Typical Performance Curves at 25°C, R2 = 8.2k Ohm

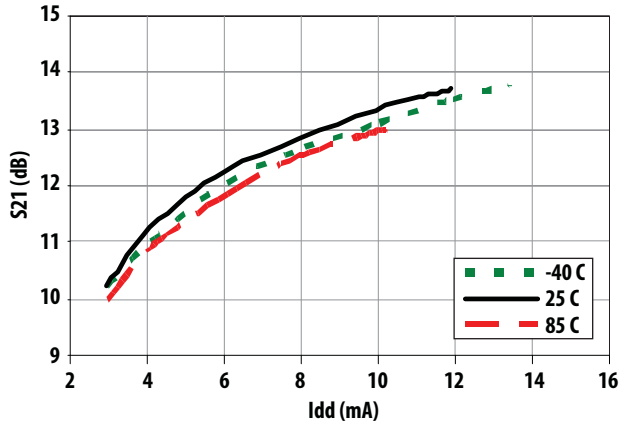


Figure 11. Gain vs. Idd at Vdd = 1.8V

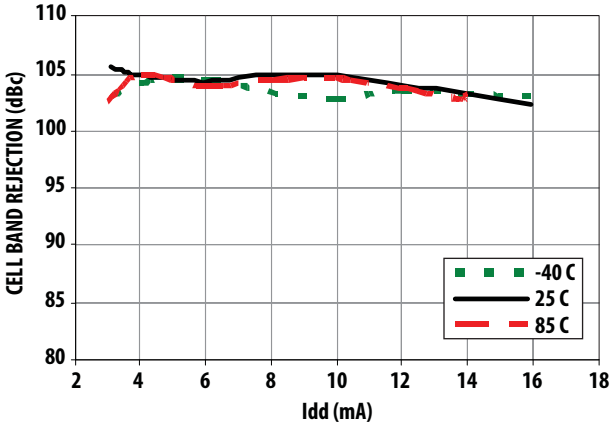


Figure 12. Cell band rejection vs. Idd at Vdd = 2.7V

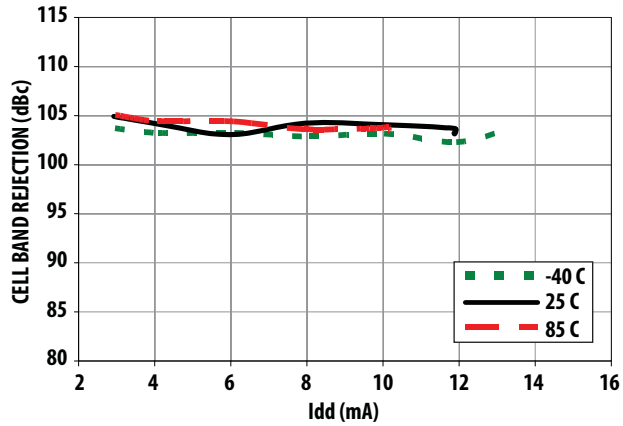


Figure 13. Cell band rejection vs. Idd at Vdd = 1.8V

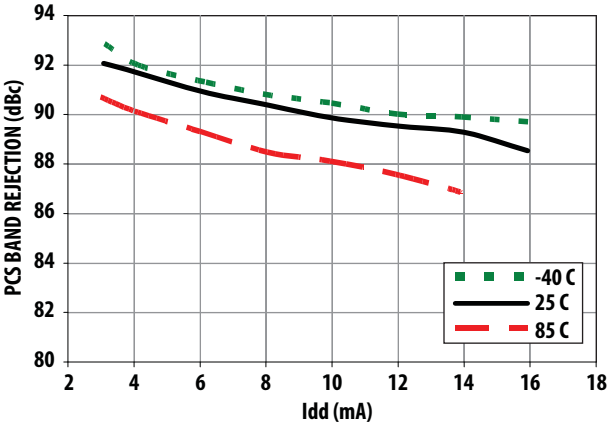


Figure 14. PCS band rejection vs. Idd at Vdd = 2.7V

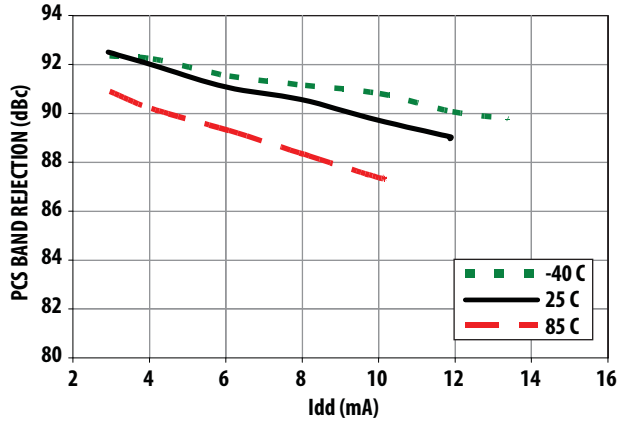


Figure 15. PCS band rejection vs. Idd at Vdd = 1.8V

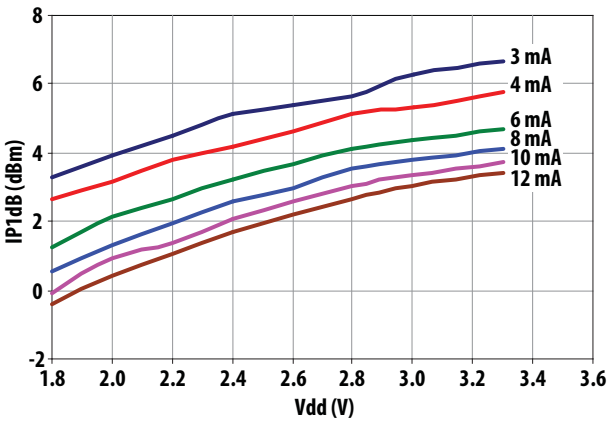


Figure 16. IP1dB vs. Vdd at 25°C

ALM-1712 Typical Performance Curves at 25°C, R2 = 8.2k Ohm

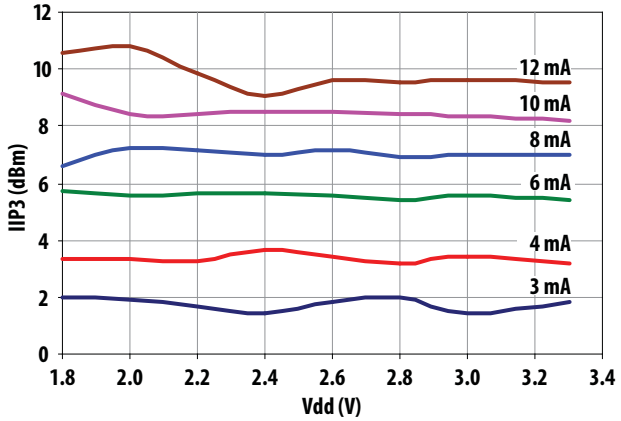


Figure 17. IIP3 vs. Vdd at 25°C

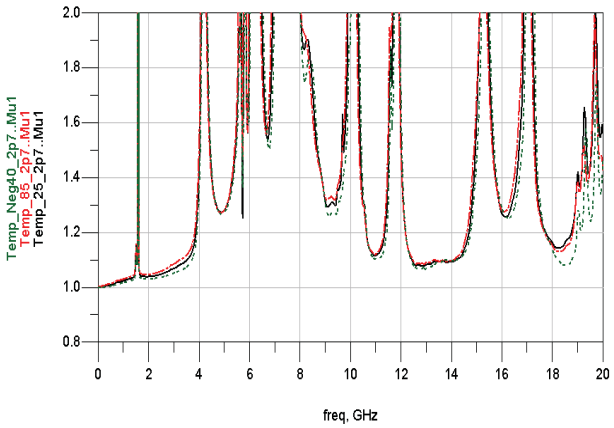


Figure 18. Edwards-Sinsky Output Stability Factor (Mu) at Vdd = 2.7V

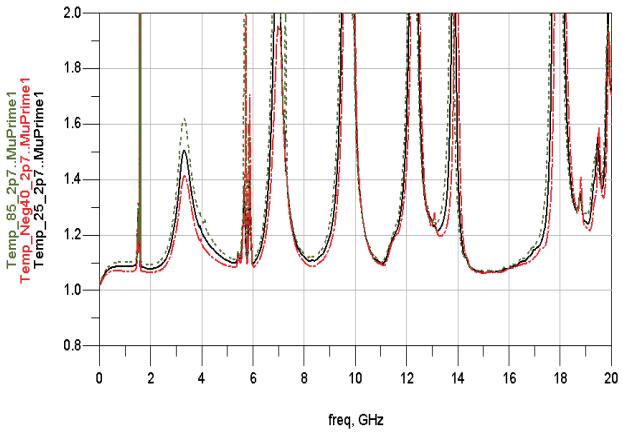


Figure 19. Edwards-Sinsky Input Stability Factor (Mu) at Vdd = 2.7V

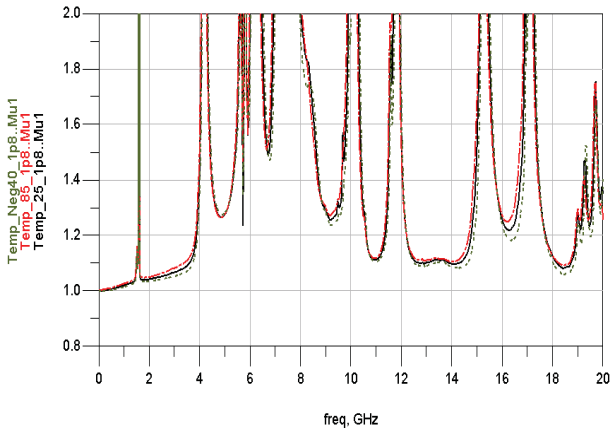


Figure 20. Edwards-Sinsky Output Stability Factor (Mu) at Vdd = 1.8V

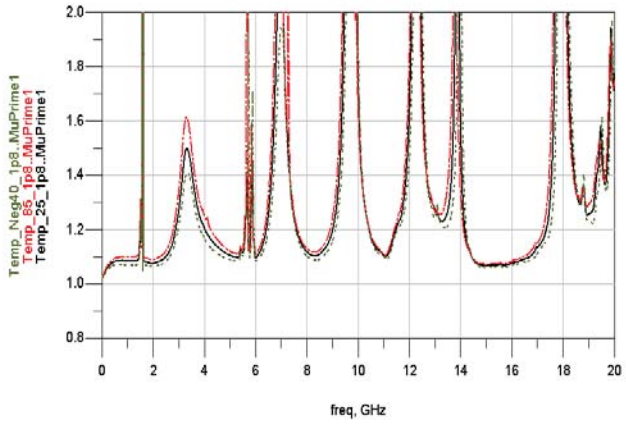


Figure 21. Edwards-Sinsky Input Stability Factor (Mu) at Vdd = 1.8V

ALM-1712 Scattering Parameter and Measurement Reference Planes

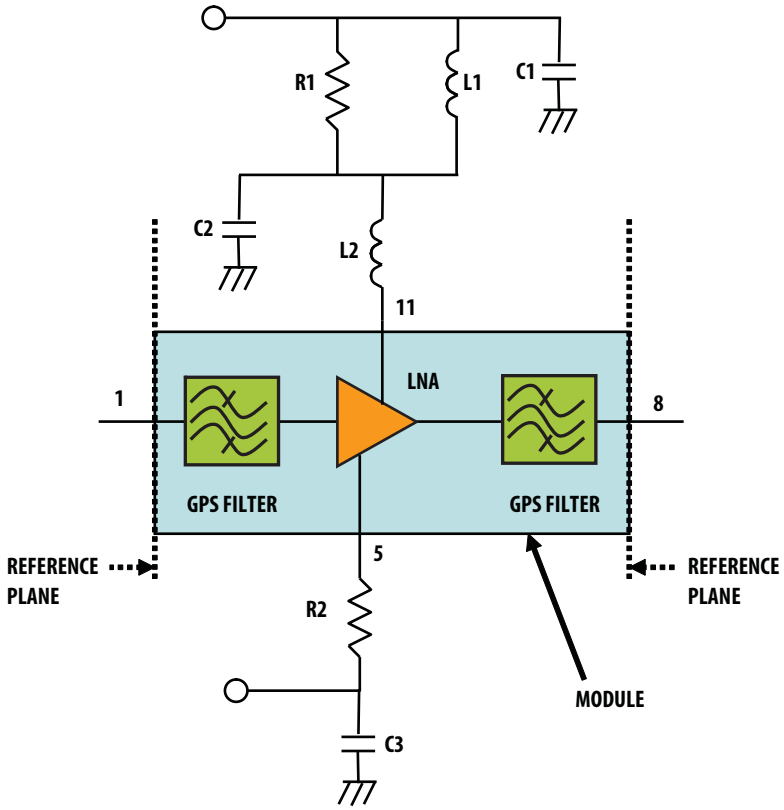


Figure 22. Scattering parameter measurement reference planes

ALM-1712 Typical Scattering Parameters at 25°C, Vdd = 2.7V, Idd = 8mA

The S- and Noise Parameters are measured using a microstrip PCB with 10 mils Rogers® RO4350. Figure 27 shows the input and output reference planes. The circuit values, with the exception of L3, are as indicated in Figure 6.

Freq	S11	S11	S21	S21	S12	S12	S22	S22
(GHz)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
0.05	-12.2813	-169.1045	-78.5985	-118.6197	-75.3162	-70.6236	-0.0139	-6.4262
0.1	-7.8838	-169.8366	-80.2105	-44.2872	-77.8347	78.6666	-0.0129	-12.9064
0.2	-4.4390	160.9400	-88.3611	-26.8997	-84.9811	-52.5101	-0.0239	-25.7921
0.3	-2.7484	128.4677	-93.1890	146.9933	-95.7323	-93.8166	-0.0408	-38.6637
0.4	-1.6958	98.0830	-82.4311	72.1450	-91.4153	134.8656	-0.0586	-51.7707
0.5	-1.2250	71.1871	-87.5317	74.8441	-86.2042	89.1550	-0.0839	-64.7003
0.6	-0.9647	47.1599	-83.9345	2.4539	-83.9655	44.4489	-0.1176	-77.6721
0.7	-0.7769	24.9663	-87.1777	16.8436	-89.7125	89.2787	-0.1593	-90.7009
0.8	-0.6840	4.1937	-89.0754	23.6186	-84.0169	68.3845	-0.2033	-103.7875
0.8275	-0.6688	-1.4933	-82.6808	29.4261	-85.4435	23.3297	-0.2156	-107.4985
0.9	-0.6429	-15.6400	-86.2170	50.1742	-80.1019	16.7844	-0.2536	-116.9904
1.0	-0.6433	-35.2987	-89.8955	16.3515	-83.4658	76.0517	-0.3143	-130.5097
1.1	-0.6889	-54.3642	-89.7764	26.3778	-87.8452	42.6101	-0.3792	-144.0879
1.2	-0.7700	-73.5017	-88.3877	24.5619	-91.1393	-18.3166	-0.4492	-158.0046
1.3	-0.8962	-93.7356	-81.6680	4.3236	-82.3674	24.6131	-0.5281	-172.6828
1.4	-1.0825	-117.7479	-84.2247	13.1278	-83.7201	36.3685	-0.6427	170.2750
1.5	-3.1884	-158.1944	-64.3997	-6.0480	-74.5813	25.8761	-1.8420	143.5935
1.575	-12.6822	59.1532	13.0368	39.9257	-22.7494	-20.8073	-7.6981	-102.4255
1.6	-1.3605	-90.7517	-4.2007	162.6715	-39.5066	99.8606	-2.6483	-132.1157
1.7	-1.0557	-148.0250	-84.1315	-38.0764	-79.5091	-43.7184	-0.6849	152.6995
1.8	-1.2168	-173.8421	-74.9280	-18.6142	-82.0203	-17.8936	-0.7547	133.6041
1.885	-1.3285	166.9986	-67.1664	-37.5682	-82.1472	12.8835	-0.8054	120.2958
1.9	-1.3484	163.5944	-65.8559	-42.9223	-94.0070	92.3834	-0.8153	117.9458
2.0	-1.4237	141.8114	-59.7454	-82.9734	-77.0829	17.4269	-0.8530	103.1774
2.1	-1.4757	120.1555	-56.5598	-131.5103	-74.7928	15.8149	-0.8846	88.6500
2.2	-1.4906	98.4440	-55.2044	-177.4959	-69.4497	6.1486	-0.9029	74.3008
2.3	-1.4821	76.1674	-54.6914	142.1389	-68.9444	-12.2943	-0.9211	59.7357
2.4	-1.4762	53.9309	-54.9054	108.1967	-65.9196	-26.5157	-0.9298	45.4343
2.5	-1.4613	31.2193	-55.3077	76.3233	-64.5282	-46.5423	-0.9280	31.1024
3.0	-2.3453	-101.0651	-63.0882	-86.2040	-62.8334	-140.6771	-0.8851	-40.5730
3.5	-3.2714	60.4967	-51.5009	148.0650	-63.6359	-114.2158	-0.9030	-113.2549
4.0	-1.9145	-81.3355	-29.4520	-14.9763	-56.2757	-76.7681	-4.2973	155.3328
4.5	-1.7221	-174.7204	-28.4613	164.0139	-43.4760	124.3518	-4.4604	156.2470
5.0	-1.7326	104.6016	-33.0583	60.3322	-42.6988	33.9350	-3.6100	78.8373
6.0	-1.9468	-20.5010	-36.1546	73.7877	-42.6681	-101.4024	-5.4108	-54.4746
7.0	-3.4235	157.0821	-17.6803	-144.9459	-37.6409	-148.9499	-25.4307	-14.4329
8.0	-3.1077	-13.4313	-18.7523	71.4275	-34.2191	68.9708	-3.7923	97.8638
9.0	-6.0381	162.2739	-10.5877	-140.2798	-22.0530	-131.2648	-4.4324	-11.8532
10.0	-4.1903	-8.8509	-18.5914	54.4355	-25.6713	41.2167	-2.0463	-140.4388
11.0	-5.5904	-176.1339	-16.7598	-36.7858	-34.4157	-172.5656	-3.1203	75.2660
12.0	-6.1883	-2.1359	-14.7206	173.3796	-29.5172	-135.0231	-4.8972	-51.2525
13.0	-6.7365	-177.1317	-7.8168	0.7304	-18.9525	37.0810	-7.2551	167.0920
14.0	-5.5082	16.2145	-8.9757	163.5030	-17.7173	-162.2647	-8.4444	85.3310
15.0	-2.7069	-147.9203	-17.3830	-16.1334	-23.7804	19.0535	-7.3686	-69.8251
16.0	-2.7125	66.9269	-28.7486	-70.5093	-33.2607	-64.9003	-5.4797	99.0454
17.0	-3.1761	-74.6931	-20.3747	163.3262	-26.1787	-172.7465	-4.1225	-52.0353
18.0	-4.8204	142.3282	-16.4452	5.6130	-20.9566	34.3559	-4.5326	160.9072
19.0	-6.6201	35.6719	-16.8197	-140.3818	-21.0562	-109.9069	-6.1153	10.1069
20.0	-4.2513	-82.2759	-16.6962	7.7630	-19.6242	40.3753	-3.9544	-48.0473

ALM-1712 Typical Scattering Parameters at 25°C, Vdd = 1.8V, Idd = 4mA

Freq	S11	S11	S21	S21	S12	S12	S22	S22
(GHz)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
0.05	-11.7162	-170.7106	-81.6489	-23.9651	-79.9989	166.0013	-0.0126	-6.4575
0.1	-7.7018	-171.4037	-90.7921	41.4586	-89.7263	12.5338	-0.0118	-12.8900
0.2	-4.2936	160.2101	-87.5836	129.6997	-82.2771	4.1346	-0.0230	-25.7784
0.3	-2.6502	128.1445	-87.6370	69.2383	-84.0300	156.2300	-0.0388	-38.6553
0.4	-1.6292	97.8663	-84.9802	68.7977	-92.0657	120.1065	-0.0585	-51.7725
0.5	-1.1819	71.0839	-89.4916	91.3343	-83.3124	74.6750	-0.0829	-64.6993
0.6	-0.9370	47.0797	-83.7495	34.3433	-88.9090	55.9706	-0.1161	-77.6595
0.7	-0.7687	24.9542	-91.9936	32.7459	-84.5974	61.4150	-0.1561	-90.6813
0.8	-0.6818	4.2036	-88.8808	13.4125	-82.3807	61.8048	-0.1997	-103.7763
0.8275	-0.6681	-1.4945	-87.1387	30.0060	-85.8761	56.5107	-0.2133	-107.4801
0.9	-0.6419	-15.6543	-87.4630	20.0434	-80.3162	35.6866	-0.2493	-116.9728
1.0	-0.6391	-35.3217	-87.3744	0.7020	-86.5401	34.8313	-0.3091	-130.4893
1.1	-0.6706	-54.4991	-88.9095	31.5028	-81.4517	24.3737	-0.3754	-144.0612
1.2	-0.7317	-73.9540	-83.6750	4.8216	-97.0178	-9.7918	-0.4438	-157.9779
1.3	-0.8422	-94.3547	-82.8541	2.5784	-87.6032	45.8691	-0.5225	-172.6498
1.4	-1.0218	-117.7708	-81.3320	19.6979	-82.0519	38.3422	-0.6345	170.6171
1.5	-3.1178	-158.6405	-66.2178	0.2042	-75.6859	17.9411	-1.8370	143.6288
1.575	-14.6222	102.7963	11.1602	46.9620	-19.8837	-24.0104	-6.5680	-93.3582
1.6	-1.2793	-90.3379	-5.8793	165.1758	-36.3706	93.3756	-2.9708	-132.5178
1.7	-1.0178	-148.2247	-83.8168	-43.9663	-82.2421	-36.3426	-0.6790	152.7334
1.8	-1.1860	-174.0191	-75.9294	-18.0396	-85.5619	4.6318	-0.7492	133.6285
1.885	-1.3016	166.8680	-70.1464	-29.1946	-81.8251	-8.5338	-0.8019	120.3211
1.9	-1.3205	163.4637	-70.5762	-38.8621	-81.5867	17.4759	-0.8092	117.9725
2.0	-1.4019	141.6880	-63.2144	-73.4820	-75.6511	33.8800	-0.8490	103.1937
2.1	-1.4597	119.9921	-59.1414	-118.9450	-74.2689	17.1435	-0.8795	88.6655
2.2	-1.4900	98.3343	-56.7200	-167.3326	-70.3523	8.8174	-0.9004	74.3125
2.3	-1.4861	76.1362	-56.0579	144.3719	-67.5578	-0.0975	-0.9188	59.7354
2.4	-1.4760	53.9349	-56.2543	101.6464	-65.8084	-23.7959	-0.9264	45.4328
2.5	-1.4724	31.2536	-57.0216	67.1937	-64.7406	-40.7992	-0.9254	31.1044
3.0	-2.4114	-100.7647	-63.8220	-105.0724	-63.6113	-140.8477	-0.8813	-40.5859
3.5	-3.3164	60.2853	-55.5163	156.2360	-64.0937	-112.6474	-0.8934	-113.2368
4.0	-2.0182	-81.3162	-32.5908	-13.8150	-55.4589	-86.6975	-4.3320	153.6624
4.5	-2.0857	-175.5834	-31.5732	161.9374	-43.8706	118.0248	-3.9425	155.8739
5.0	-2.0953	103.1925	-35.7693	60.2045	-43.4300	32.4125	-3.3736	76.4837
6.0	-1.9438	-20.2189	-39.8779	82.5946	-43.4078	-98.0588	-5.5361	-59.2868
7.0	-3.2605	168.5654	-19.7146	-135.9872	-38.5736	-152.9212	-19.3950	-47.0087
8.0	-3.1021	-14.6426	-19.9574	76.9500	-34.7821	72.9994	-3.7442	98.7381
9.0	-5.6083	159.6227	-11.4095	-135.0280	-22.3814	-125.4177	-4.2361	-13.1301
10.0	-4.7026	-11.4639	-19.0763	56.3564	-26.1326	44.5143	-1.9891	-140.5650
11.0	-6.2228	-177.4774	-17.0007	-37.7901	-41.0067	156.6205	-3.1124	75.5748
12.0	-6.8973	-3.4399	-14.8051	170.6036	-26.5812	-137.3411	-4.9162	-50.7293
13.0	-7.8639	-173.4644	-7.9918	-9.5177	-16.9112	30.0451	-7.5108	172.8073
14.0	-5.3591	18.5501	-10.5670	151.8408	-17.3432	-170.1950	-6.7888	82.0130
15.0	-2.6722	-148.4887	-19.7885	-21.5803	-24.1183	19.1445	-6.8135	-76.3488
16.0	-2.7273	66.4705	-28.4288	-71.7468	-30.7434	-72.7299	-5.3249	97.7321
17.0	-3.1547	-75.2469	-21.7596	159.6029	-26.4143	-177.2816	-4.0002	-51.4573
18.0	-4.8167	139.8221	-17.5940	5.2128	-20.4594	32.8663	-4.4196	161.0736
19.0	-6.4763	38.1618	-18.1592	-142.5790	-20.5410	-115.4139	-6.1810	10.7320
20.0	-4.0478	-82.6401	-18.1698	9.8842	-19.4516	35.7041	-3.8017	-49.8195

ALM-1712 Typical Noise Parameters at 25°C,

Freq = 1.575 GHz, Vdd = 2.7V, Idd = 8mA

Freq	Fmin	GAMMA OPT		
(GHz)	(dB)	Mag	Ang	Rn/50
1.575	1.42	0.21	-103	0.18

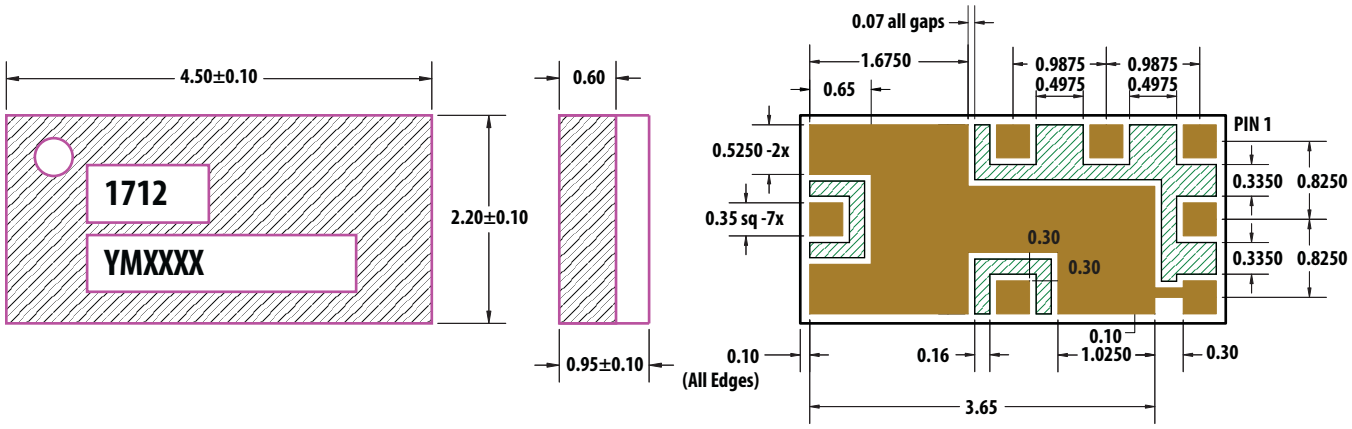
ALM-1712 Typical Noise Parameters at 25°C,

Freq = 1.575 GHz, Vdd = 1.8V, Idd = 4mA

Freq	Fmin	GAMMA OPT		
(GHz)	(dB)	Mag	Ang	Rn/50
1.575	1.71	0.14	-85	0.20

Notes:
The exceptional noise figure performance of the ALM-1712 is due to its highly optimized design. In this regard, the Fmin of the ALM-1712 shown above is locked down by the internal input pre-match. This allows the use of relatively inexpensive chip inductors for external matching.

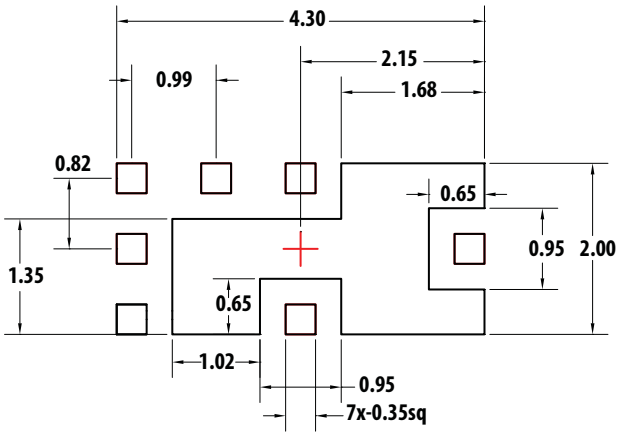
Package Dimensions



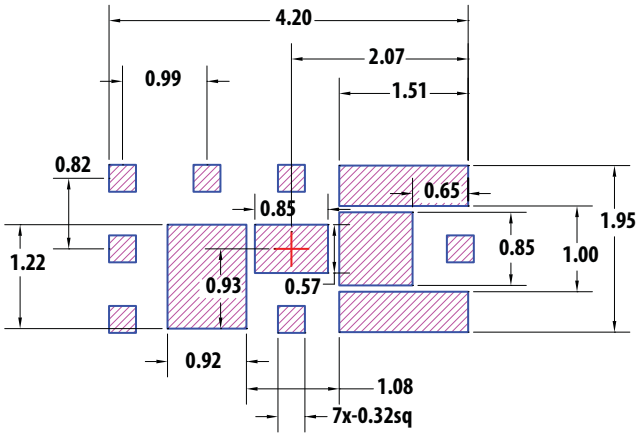
TOP VIEW SIDE VIEW BOTTOM VIEW

Notes:
1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold flash and metal burr.
4. Y refer to year, M refer to month & XXXX refer to last 4 digit of lot number.

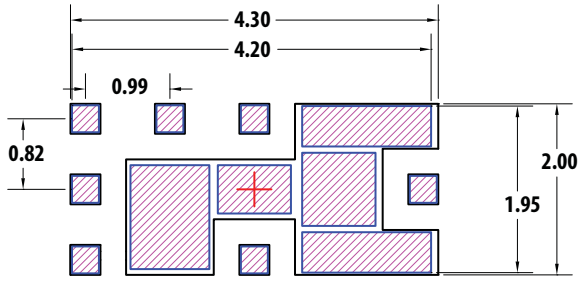
Super Nemo Land Pattern & Stencil Design



LAND PATTERN



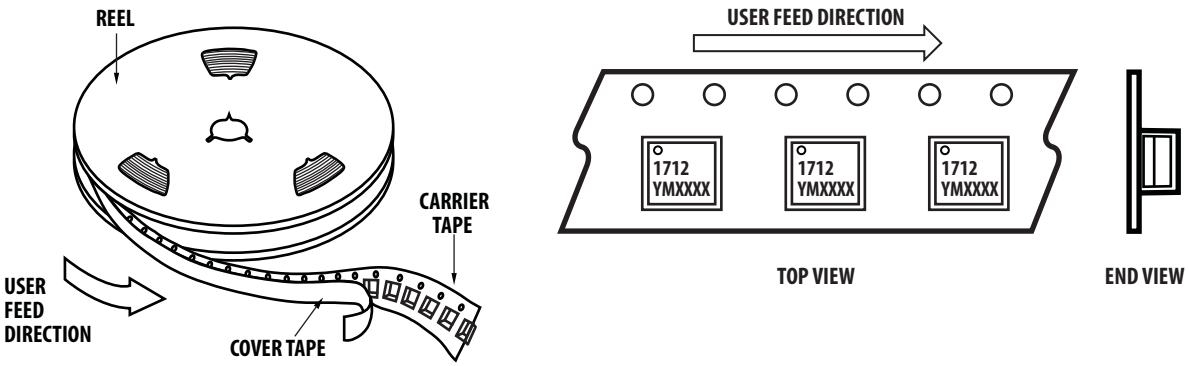
STENCIL OPENING



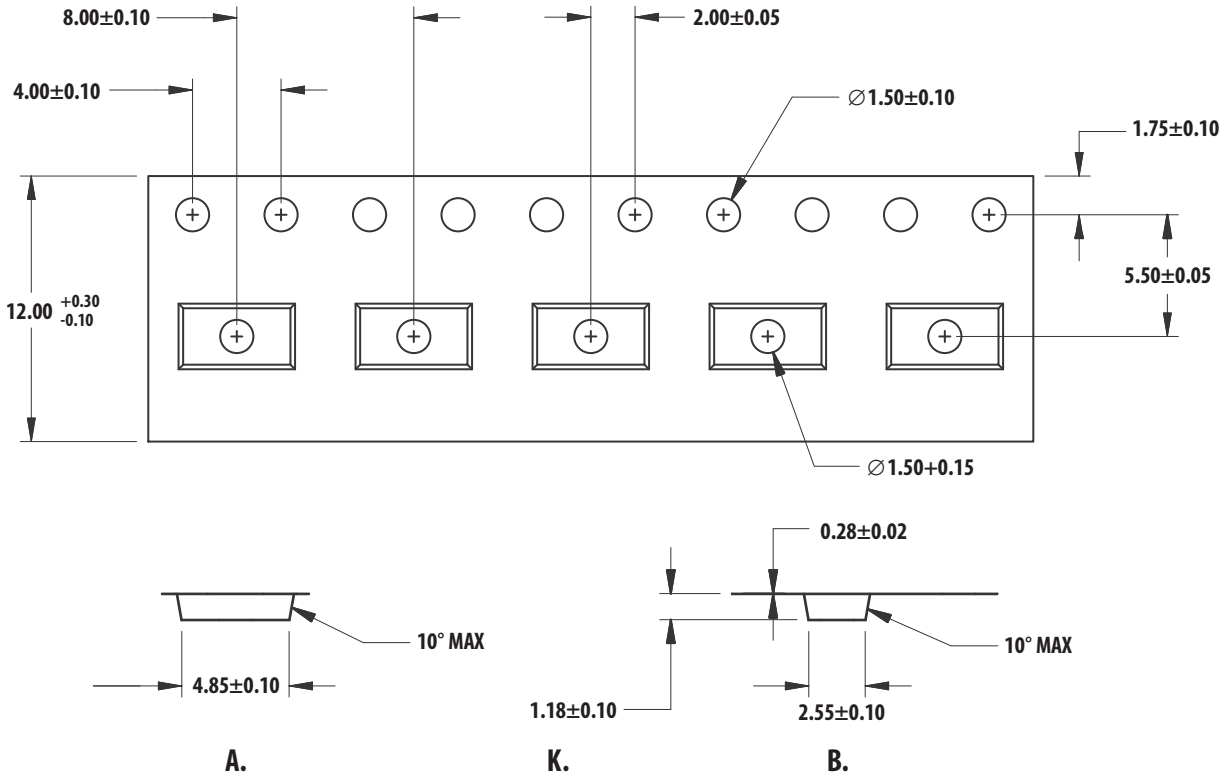
COMBINED LAND PATTERN
AND STENCIL OPENING

All dimensions are in millimeters.

Device Orientation



Tape Dimensions

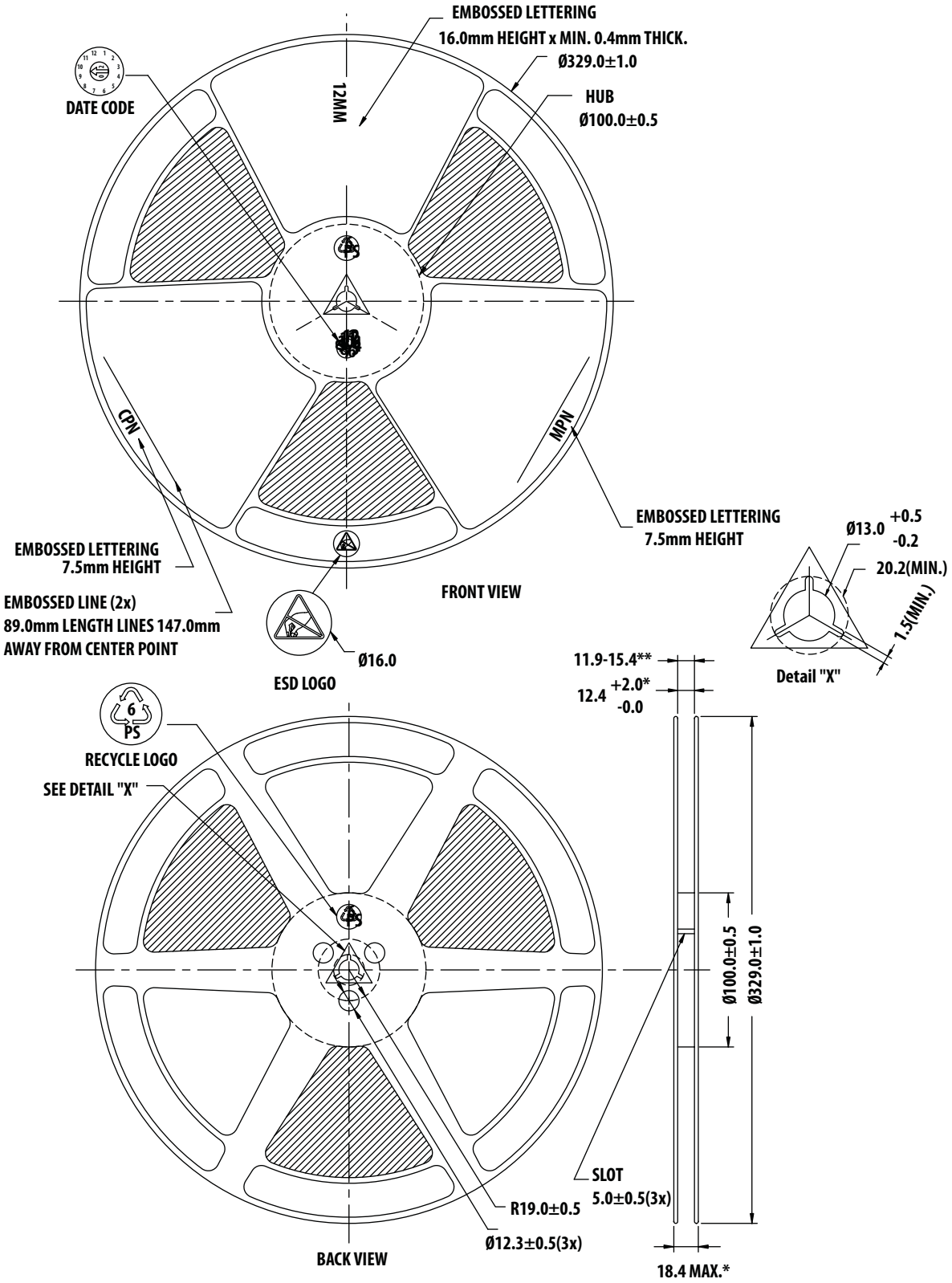


All dimensions are in millimeters.

Part Number Ordering Information

Part Number	Qty	Container
ALM-1712-BLKG	100	Antistatic bag
ALM-1712-TR1G	3000	13" Reel

Reel Dimensions (13″ reel)



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

AV02-1639EN - March 2, 2012