

# ATR0610

## ANTARIS 4 GPS Low Noise Amplifier

### Data Sheet

PRELIMINARY



#### Features

- Low power consumption < 10 mW
- Very small, PLLP6 package (1.6 x 2.0 mm)
- Low noise figure
- High small signal gain
- RoHS compliant (lead-free)



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<b>Title</b>	ATR0610		
<b>Subtitle</b>	ANTARIS 4 GPS Low Noise Amplifier		
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<b>Data Sheet Revisions</b>	<b>Identification of applicable hardware</b>	<b>Comments</b>

	Products marked with this lead-free symbol on the product label comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS).
	This is an Electrostatic Sensitive Device (ESD). Observe precautions for handling.

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# 1 Description

## 1.1 Overview

The ATR0610 is a GPS low-noise amplifier IC designed for GPS applications. The part uses Atmel's SiGe1 SiGe technology and is optimized for high linearity, low-noise figure, low BOM and low power consumption. The part features an integrated  $50\Omega$  output match and is prematched at the input. Due to internal supply blocking, the BOM is minimized. Together with the small footprint of 1.6 mm x 2.0 mm, the LNA allows for a very compact GPS receiver design.

## 1.2 Benefits

- Low power consumption < 10 mW
- Very small, PLLP6 package (1.6 mm x 2.0 mm)
- Few external components

## 1.3 Features

- Low noise figure
- High small signal gain
- Single +2.7V operation
- Power-up control
- $50\Omega$  output
- Unconditionally stable
- Ultra compact PLLP6 package
- RoHS compliant (lead-free)

## 1.4 Block Diagram

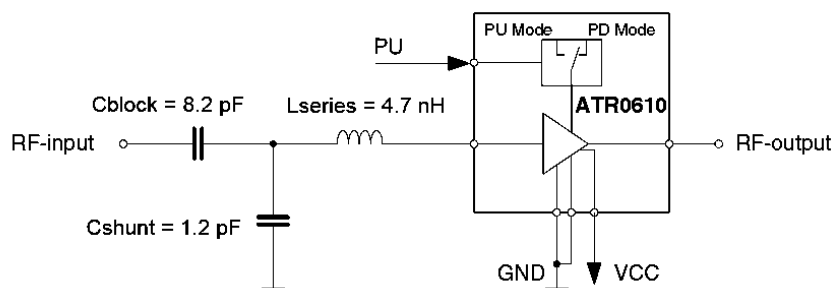


Figure 1-1: Block Diagram

## 2 Mechanical Specification

Package: PLLP 6, 1.6x2.0mm  
Dimensions in mm

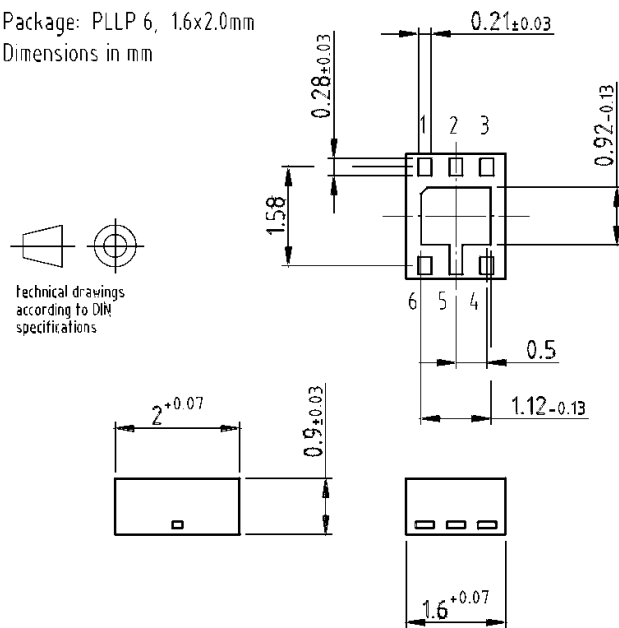


Figure 2-1: Package

## 3 Pin Configuration

### 3.1 Pinout

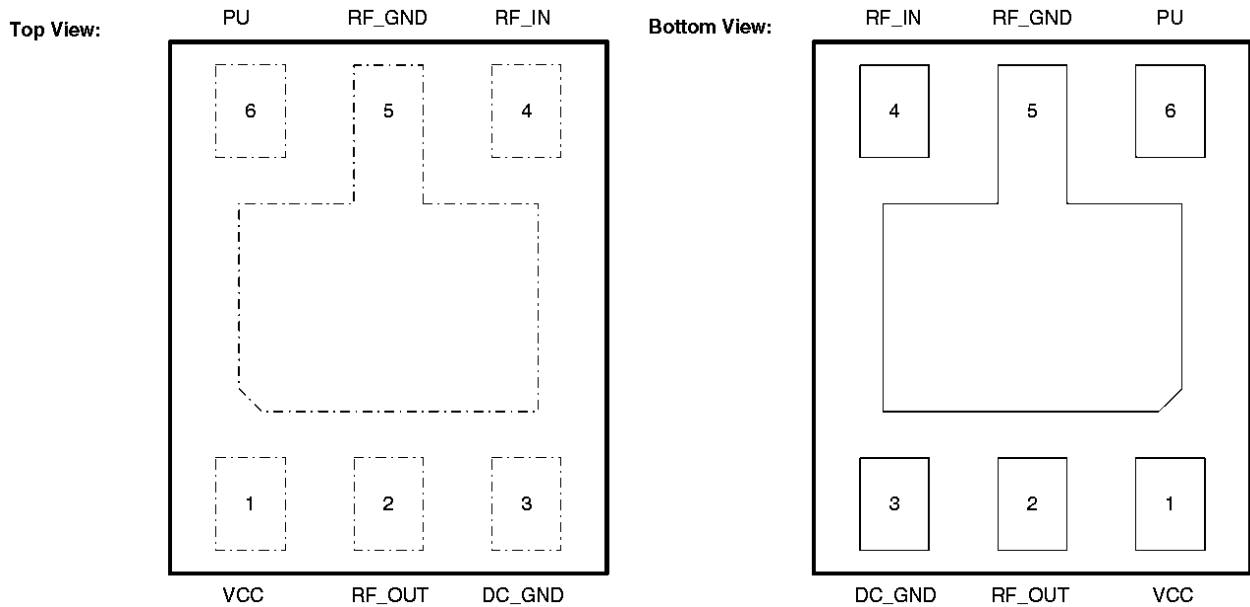


Figure 3-1: Pinning PLLP6 (Not Scaled)

### 3.2 Signal Description

Pin	Symbol	Type	Function
1	VCC	Supply	Supply voltage
2	RF_OUT	Output	Signal output
3	DC_GND	Supply	Ground
4	RF_IN	Input	Input for received signal
5	RF_GND	Supply	Ground for RF stage
6	PU	Input	Power up

Table 3-1: Pin Description

## 4 Electrical Specification

### 4.1 Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameters	Symbol	Value	Unit
Supply voltage	$V_{CC}$	-0.3 to +3.7	V
Power-up voltage	$V_{PU}$	-0.3 to +3.7	V
Input power	$P_{in}$	-5	dBm
Operating temperature	$T_{op}$	-40 to +85	°C
Storage temperature	$T_{stg}$	-55 to +125	°C

Table 4-1: Absolute Maximum Ratings

### 4.2 Operating Conditions

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
1	Operating frequency		RF_IN	f		1575.42		MHz	D
2	Supply voltage		VCC	$V_{CC}$	2.7	3	3.3	V	C
3	Operating current	RF ON ( $V_{PU} = 1.8$ V)	VCC	I		3.3		mA	A
4	Power-down current	RF ON ( $V_{PU} = 0$ V)		$I_{PD}$		0.2	1	μA	A
5	Small-signal gain	See <sup>1</sup>		G		16		dB	A
6	Minimum noise figure			$NF_{min}$		1.5		dB	C
7	Noise figure	See <sup>1</sup>		NF		1.6		dB	C
8	Input referred 1 dB compression point	Caused by a DCS blocker at 1710 MHz		Icp1		-9		dBm	C
9	Input 3rd order intercept point	f1 = 1750 MHz f2 = 1925 MHz, see <sup>1</sup>		IIP3		-1		dBm	C
10	Input 3rd order intercept point (in-band)	f1 = 1750 MHz f2 = 1577 MHz, see <sup>1</sup>		IIP3 <sub>inb</sub>		-3		dBm	C
11	Input return loss	See <sup>1</sup>		$RL_{in}$	10			dB	C
12	Output return loss	See <sup>1</sup>		$RL_{out}$	10			dB	C
13	Reverse isolation	See <sup>1</sup>		$1/IS_{12}^2$		30		dB	C
14	Control voltage	Power-up mode	PU	$V_{PU,high}$	1.2	1.8	3.3	V	C
15	Control current	Power-up mode	PU	$I_{PU,high}$	0	10	50	μA	C
16	Control voltage	Power-down mode	PU	$V_{PU,low}$	0	0.2	0.4	V	C
17	Control current	Power-down mode	PU	$I_{PU,low}$			0.7	μA	C

\*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

Note: <sup>1</sup> Using the proposed input matching (Figure 1-1)

Table 4-2: Operating Conditions

### 4.3 Thermal Resistance

Parameters	Symbol	Value	Unit
Thermal resistance	$R_{th}$	100	K/W

Table 4-3: Thermal Resistance

## 5 Measured Results of Typical Samples

$V_{CC} = 2.7V$ ,  $V_{PU} = 1.8V$ ,  $T_{amb} = 25^{\circ}C$ ,  $Z_{LOAD} = 50\Omega$

### 5.1 Matched Device

Related schema: See Figure 1-1.

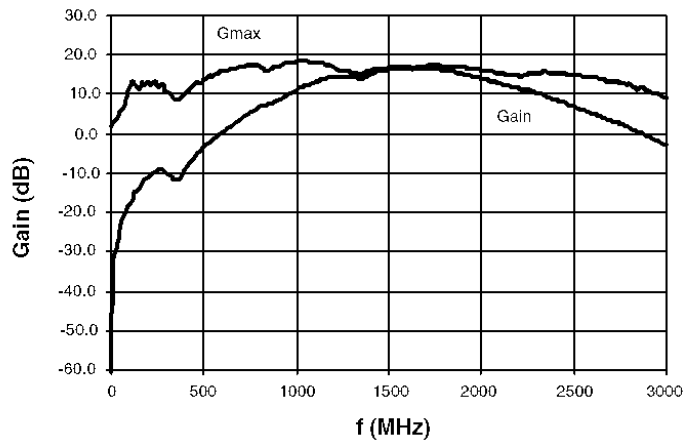


Figure 5-1: Gain and Maximum Available Gain

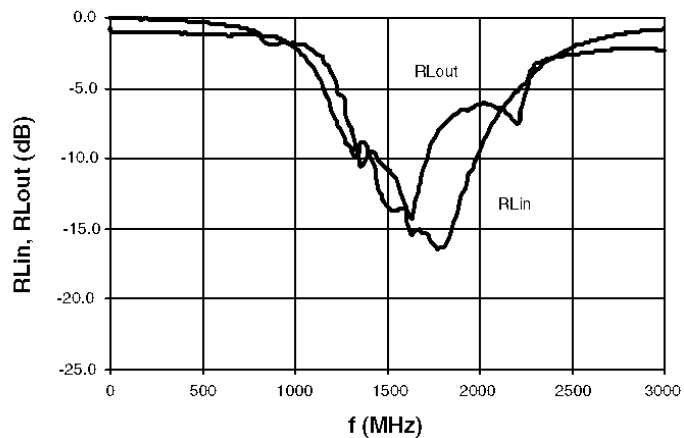


Figure 5-2: Input and Output Return Loss



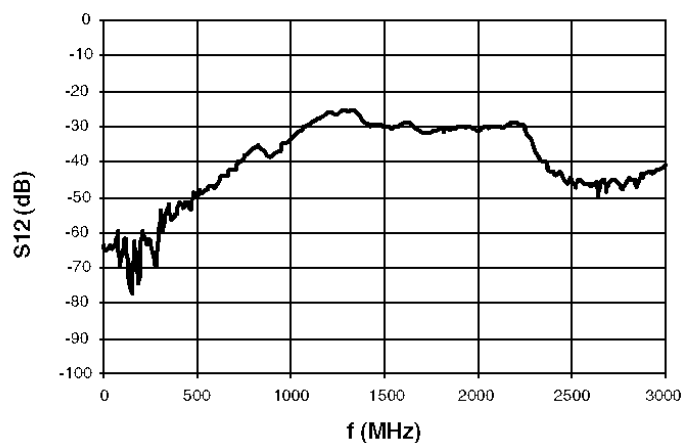


Figure 5-3: Reverse Transfer Function

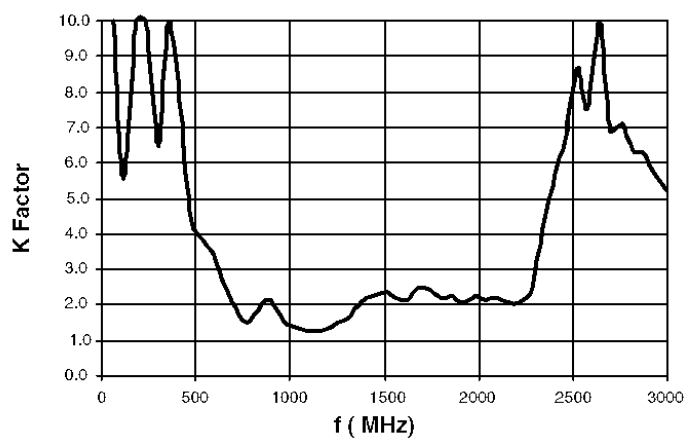


Figure 5-4: K Factor (→ Unconditional Stability)

f/MHz	$ S_{11} $	$\varphi(S_{11})$	$ S_{21} $	$\varphi(S_{21})$	$ S_{12} $	$\varphi(S_{12})$	$ S_{22} $	$\varphi(S_{22})$	K Factor
60	0.897	-9.9	0.06	-96.1702	0.0006	19.5	0.998	-6.6	13.5
120	0.891	-25.6	0.17	-98.98544	0.0008	84.2	0.996	-17.4	5.5
180	0.886	-37.4	0.26	-113.4846	0.0002	173.8	0.991	-26.1	43.3
240	0.891	-49.4	0.34	-128.3148	0.0008	-86.0	0.987	-34.4	10.1
300	0.894	-61.9	0.32	-145.6032	0.0021	-137.8	0.981	-42.8	6.5
360	0.890	-74.3	0.26	-128.5304	0.0014	153.2	0.979	-51.4	12.3
420	0.879	-86.0	0.41	-113.438	0.0022	149.7	0.973	-60.1	7.4
480	0.876	-97.1	0.62	-117.7927	0.0037	147.3	0.965	-69.3	4.4
540	0.872	-108.2	0.83	-125.7797	0.0039	143.4	0.958	-78.0	3.8
600	0.869	-118.8	1.07	-135.3626	0.0043	142.5	0.948	-87.1	3.4
660	0.872	-129.8	1.34	-144.9783	0.0063	130.7	0.935	-96.9	2.5
720	0.874	-140.7	1.66	-155.2931	0.0101	127.3	0.920	-106.6	1.7
780	0.878	-153.0	2.04	-168.018	0.0144	108.8	0.893	-116.9	1.5
840	0.813	-165.3	2.30	177.8467	0.0152	73.6	0.863	-126.3	2.0
900	0.806	-172.6	2.64	169.357	0.0126	71.9	0.853	-137.2	2.1
960	0.813	176.5	3.17	157.1773	0.0185	79.4	0.817	-149.8	1.6
1020	0.809	164.4	3.78	143.6133	0.0237	67.9	0.767	-163.0	1.4
1080	0.785	150.1	4.34	128.2928	0.0318	51.1	0.693	-176.6	1.3
1140	0.732	135.5	4.93	111.4632	0.0399	35.3	0.598	168.3	1.3
1200	0.637	118.7	5.30	92.48291	0.0491	11.0	0.466	155.8	1.3
1260	0.522	107.6	5.32	76.71066	0.0494	-10.0	0.381	147.9	1.5
1320	0.378	98.0	5.24	63.20023	0.0517	-36.7	0.325	141.9	1.7
1380	0.311	108.3	5.33	56.22391	0.0385	-63.8	0.358	125.1	2.1
1440	0.325	97.5	6.14	41.04218	0.0326	-62.8	0.270	88.5	2.3
1500	0.287	88.9	6.51	25.58716	0.0307	-74.9	0.212	52.2	2.4
1560	0.257	73.3	6.77	8.313904	0.0320	-76.5	0.207	-1.0	2.2
1620	0.180	59.1	6.58	-8.583069	0.0355	-93.7	0.202	-46.0	2.1
1680	0.175	46.3	6.79	-22.98477	0.0281	-107.7	0.268	-62.3	2.5
1740	0.160	3.9	6.78	-40.46539	0.0263	-103.6	0.358	-81.5	2.4
1800	0.152	-43.9	6.33	-57.3143	0.0297	-112.5	0.411	-101.3	2.2
1860	0.187	-77.9	5.95	-73.04535	0.0288	-121.8	0.453	-116.8	2.2
1920	0.249	-104.8	5.58	-87.41135	0.0310	-132.7	0.471	-129.8	2.1
1980	0.314	-122.7	5.15	-100.7899	0.0285	-142.7	0.487	-139.2	2.3
2040	0.389	-137.6	4.71	-114.63	0.0307	-154.3	0.492	-150.3	2.1
2100	0.450	-151.0	4.33	-127.6309	0.0305	-171.1	0.476	-156.8	2.2
2160	0.514	-162.2	3.99	-138.8933	0.0328	175.1	0.452	-162.0	2.1
2220	0.564	-172.4	3.71	-151.1952	0.0333	148.3	0.443	-152.8	2.1
2280	0.621	179.3	3.45	-166.5967	0.0205	110.4	0.645	-158.2	2.5
2340	0.678	169.7	3.08	-178.6954	0.0100	118.3	0.708	-173.7	4.1
2400	0.722	160.6	2.66	170.4748	0.0071	129.9	0.722	175.9	5.7
2460	0.762	152.2	2.39	158.4146	0.0056	136.8	0.738	167.1	6.7
2520	0.793	144.0	2.14	148.5269	0.0042	129.5	0.742	158.8	8.7
2580	0.821	136.5	1.87	139.0457	0.0047	134.1	0.750	151.3	7.5
2640	0.839	129.4	1.65	127.6694	0.0032	158.1	0.762	143.8	11.3
2700	0.857	122.3	1.50	118.4024	0.0048	168.3	0.768	136.4	6.9
2760	0.876	115.8	1.30	109.0173	0.0047	173.3	0.774	129.3	7.1
2820	0.886	109.5	1.13	98.04062	0.0056	-171.8	0.775	121.4	6.3
2880	0.900	103.2	0.99	88.75305	0.0058	-173.3	0.775	113.9	6.2
2940	0.908	97.4	0.84	80.06287	0.0069	175.4	0.775	106.6	5.6
3000	0.914	91.3	0.71	69.79065	0.0086	167.6	0.761	98.8	5.2

Values are given as linear magnitude and phase in degree

**Table 5-1: Measured Scattering Parameters of Matched Device**

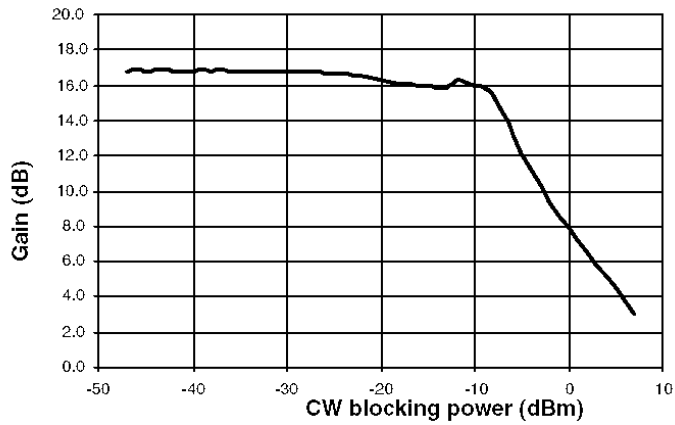


Figure 5-5: Gain versus Blocker at 1710 MHz (Compression)

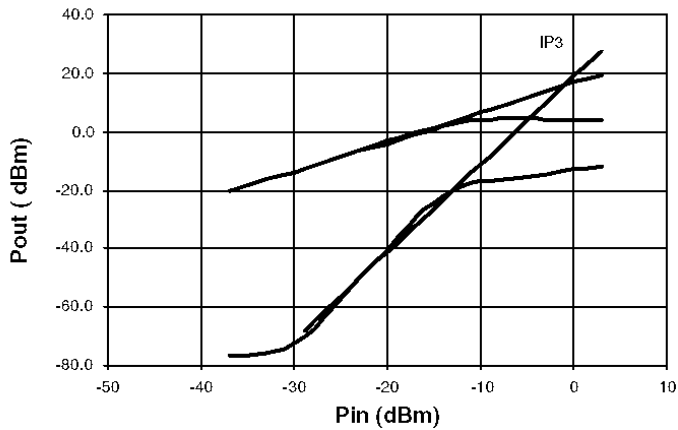


Figure 5-6: Out of Band Intermodulation Product 3rd Order (IP3)

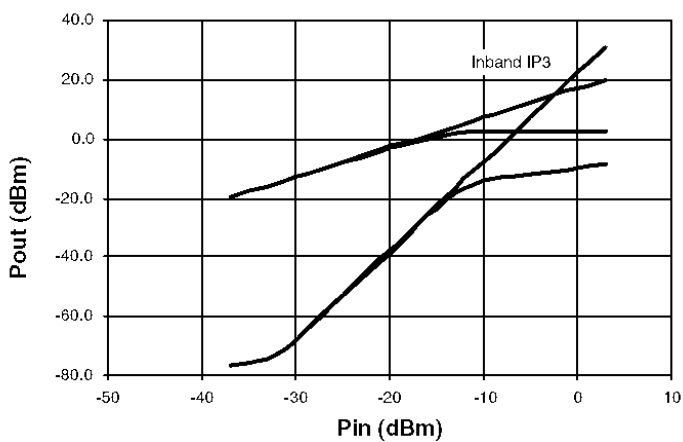
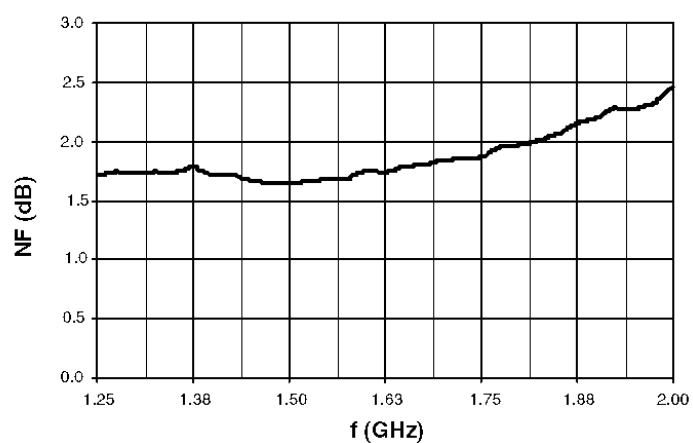


Figure 5-7: Inband Intermodulation Product 3rd Order (Inband IP3)



**Figure 5-8: Noise Figure without De-embedding**

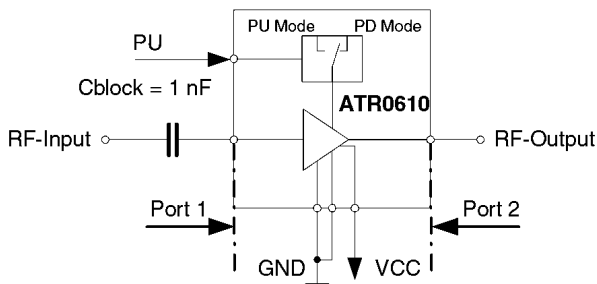
## 5.2 Unmatched Device

Related schema: See Figure 5-9.

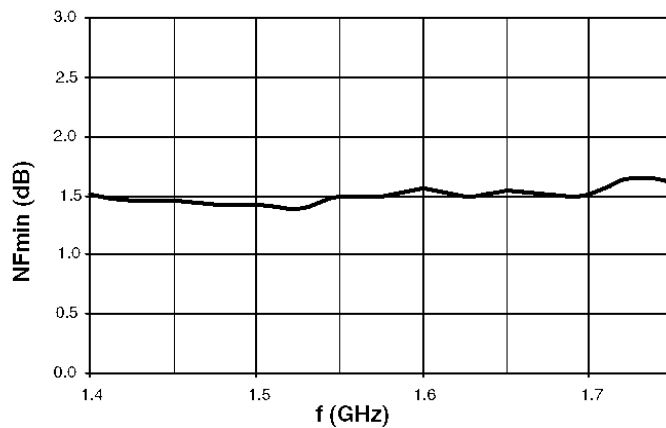
f/MHz	$ S_{11} $	$\varphi(S_{11})$	$ S_{21} $	$\varphi(S_{21})$	$ S_{12} $	$\varphi(S_{12})$	$ S_{22} $	$\varphi(S_{22})$
1.400	0.725	-116.0	6.04	132.8	0.028	63.1	0.400	104.5
1.425	0.712	-117.7	6.12	127.7	0.030	58.2	0.366	94.5
1.450	0.698	-119.3	6.17	122.6	0.031	53.0	0.332	83.6
1.475	0.682	-120.6	6.19	117.6	0.032	47.7	0.303	72.2
1.500	0.666	-122.0	6.18	112.7	0.033	42.0	0.278	60.2
1.525	0.647	-123.1	6.16	108.1	0.033	35.9	0.258	47.4
1.550	0.630	-123.9	6.10	103.8	0.034	29.5	0.244	35.0
1.575	0.610	-124.4	6.05	99.6	0.034	22.5	0.240	22.5
1.600	0.592	-124.6	5.98	95.8	0.034	15.9	0.240	10.8
1.625	0.573	-124.2	5.93	92.4	0.034	7.8	0.249	1.5
1.650	0.558	-123.3	5.92	89.4	0.032	-1.0	0.276	-7.1
1.675	0.552	-121.7	5.99	86.0	0.029	-9.0	0.315	-16.6
1.700	0.556	-120.5	6.05	82.0	0.026	-15.3	0.360	-27.3
1.725	0.565	-120.0	6.10	77.5	0.022	-18.7	0.404	-38.2
1.750	0.573	-120.1	6.10	72.9	0.020	-20.0	0.443	-48.6

Values are given as linear magnitude and phase in degree

**Table 5-2: Measured Scattering Parameters of Unmatched Device (De-embedded)**



**Figure 5-9: Reference Planes of Unmatched Device**



**Figure 5-10: Minimum Noise Figure  $NF_{min}$  (De-embedded)**

f/GHz	NFmin/dB	$ \Gamma_{opt} $	$\phi(\Gamma_{opt})$	$R_n/\Omega$
1.400	1.51	0.31	98.07	8.89
1.425	1.46	0.31	98.55	8.71
1.450	1.45	0.31	100.00	9.30
1.475	1.43	0.31	100.16	9.13
1.500	1.43	0.31	101.78	8.70
1.525	1.38	0.32	103.08	9.15
1.550	1.49	0.31	104.16	9.41
1.575	1.49	0.31	106.49	8.78
1.600	1.57	0.28	109.84	9.05
1.625	1.50	0.30	110.74	8.22
1.650	1.54	0.31	112.12	8.41
1.675	1.52	0.31	113.20	8.61
1.700	1.52	0.31	113.33	8.40
1.725	1.65	0.28	116.76	8.61
1.700	1.52	0.31	113.33	8.40
1.725	1.65	0.28	116.76	8.61
1.750	1.62	0.31	115.03	8.24

Table 5-3: Raw Noise Data of Unmatched Device (De-embedded)

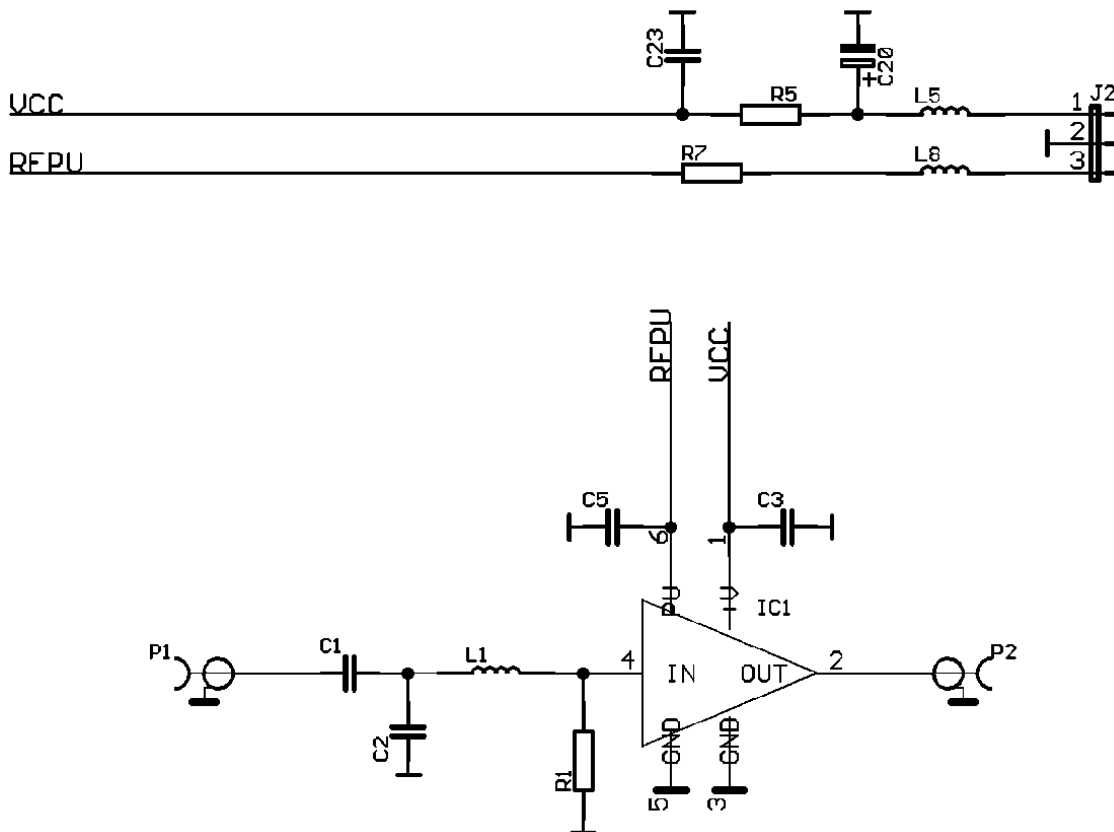


Figure 5-11: Schematic of Application Board

## 6 Tape and Reel

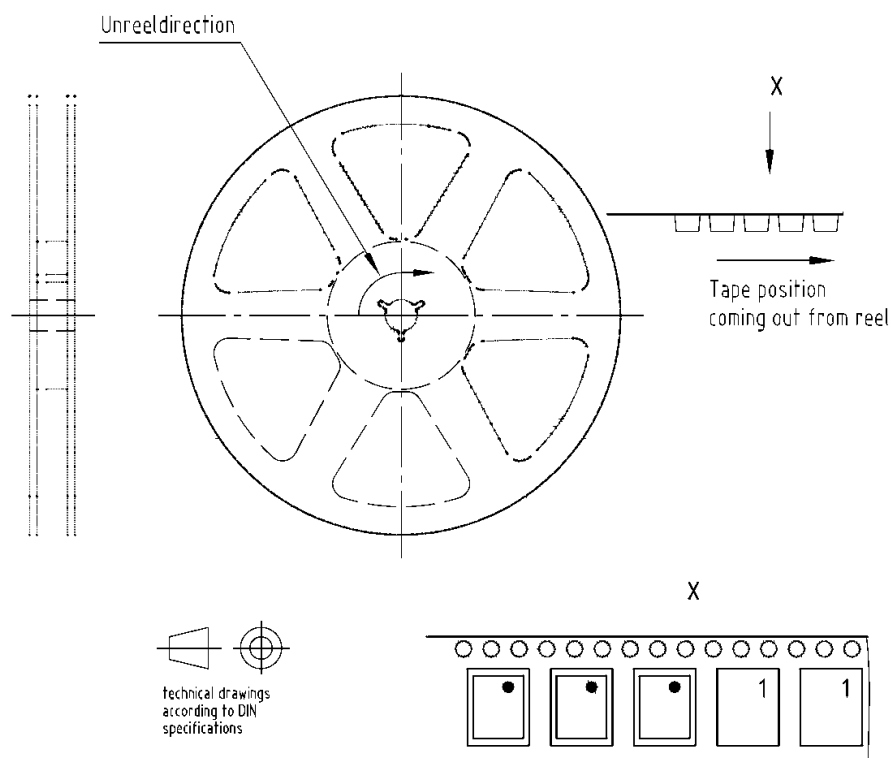


Figure 6-1: Tape and Reel

## 7 Ordering Information

Ordering No.	Product
ATR0610-PQQ	ANTARIS 4 GPS Low Noise Amplifier
	<u>Delivery Packing:</u> Taped and reeled

Table 7-1: Ordering Information

Parts of this product are patent protected.

## Related Documents

[1] ANTARIS 4 GPS Chipset / ANTARIS 4 Receiver Description, Docu No. GPS.G5-DK-06004

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