

Features

- Low Noise Figure
- High Small Signal Gain
- Single +2.7V Operation
- Power-up Control
- 50Ω Output
- Unconditionally Stable
- Ultra Compact PLLP6 Package
- Pb-free, RoHS Compliant, Green

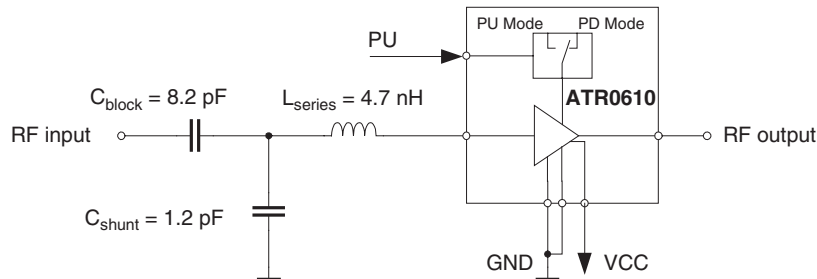
Benefits

- Low Power Consumption < 10 mW
- Very Small, PLLP6 Package (1.6 mm × 2.0 mm)
- Few External Components

1. Description

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 50Ω 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 × 2.0 mm, the LNA allows for a very compact GPS receiver design.

Figure 1-1. Block Diagram



2.7-V GPS Low-noise Amplifier

ATR0610

2. Pin Configuration

Figure 2-1. Pinning PLLP6 (Not Scaled)

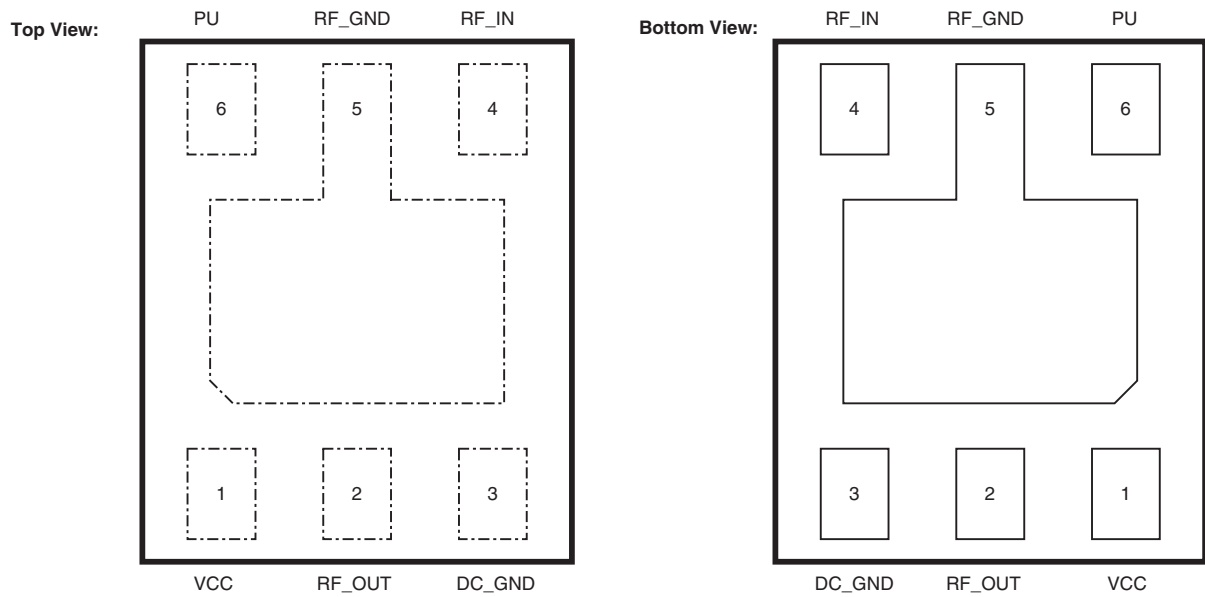


Table 2-1. Pin Description

| 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 |

3. Absolute Maximum Ratings

| 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 |

Electrostatic sensitive device.
Observe precautions for handling.



4. Thermal Resistance

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

5. Electrical Characteristics

$V_{CC} = 2.7V$, $V_{PU} = 1.8V$, $f = 1575\text{ MHz}$, $T_{amb} = 25^\circ\text{C}$, $Z_{load} = 50\Omega$

Minimum/maximum limits are at +25°C ambient temperature, unless otherwise specified.

| 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 ($V_{PU} = 1.8V$) | VCC | I | | 3.3 | | mA | A |
| 4 | Power-down current | RF OFF ($V_{PU} = 0V$) | VCC | I_{PD} | | 0.2 | 1 | μA | A |
| 5 | Small signal gain | (1) | | G | | 16 | | dB | A |
| 6 | Minimum noise figure | | | NF_{min} | | 1.5 | | dB | C |
| 7 | Noise figure | (1) | | NF | | 1.6 | | dB | C |
| 8 | Input referred 1 dB compression point | Caused by a DCS blocker at 1710 MHz(1) | | Icp1 | | -9 | | dBm | C |
| 9 | Input 3 rd -order intercept point | f1 = 1750 MHz f2 = 1925 MHz(1) | | IIP3 | | -1 | | dBm | C |
| 10 | Input 3 rd -order intercept point (inband) | f1 = 1575 MHz f2 = 1577 MHz(1) | | $IIP3_{inb}$ | | -3 | | dBm | C |
| 11 | Input return loss | (1) | | RL_{in} | 10 | | | dB | C |
| 12 | Output return loss | (1) | | RL_{out} | 10 | | | dB | C |
| 13 | Reverse isolation | (1) | | $1/ S_{12} ^2$ | | 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: 1. Using the proposed input matching (see Figure 1-1 on page 1) and the PCB layout shown in Figure 7-1 on page 11.

6. Measurement Results of Typical Samples

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

6.1 Matched Device (see [Figure 1-1 on page 1](#))

Figure 6-1. Gain and Maximum Available Gain

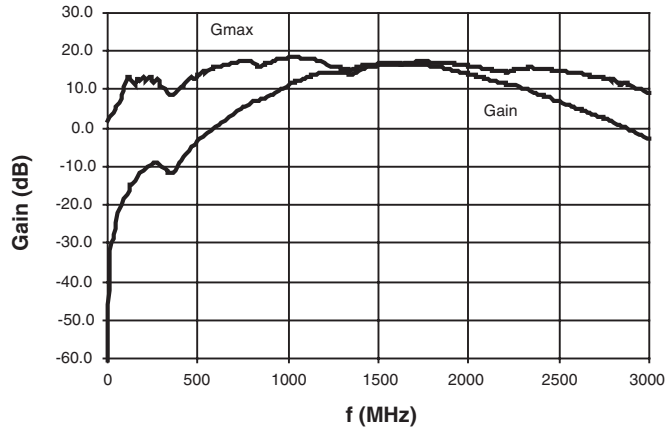


Figure 6-2. Input and Output Return Loss

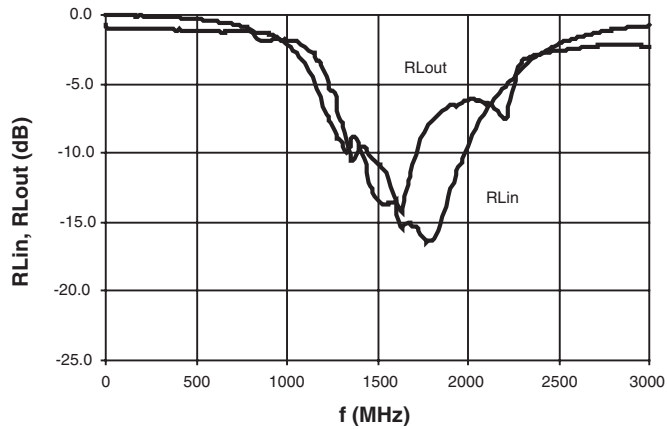


Figure 6-3. Reverse Transfer Function

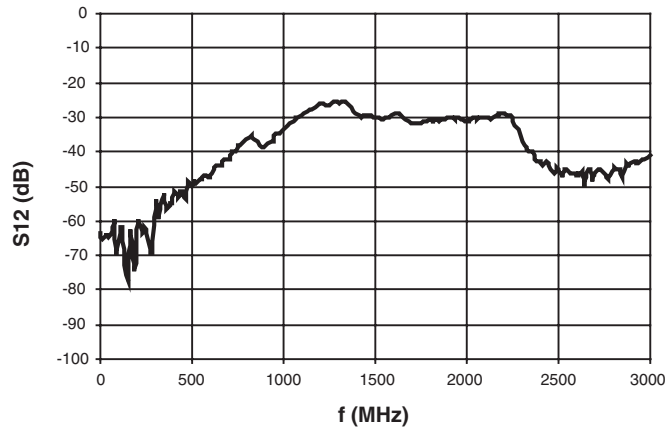


Figure 6-4. K Factor (→ Unconditional Stability)

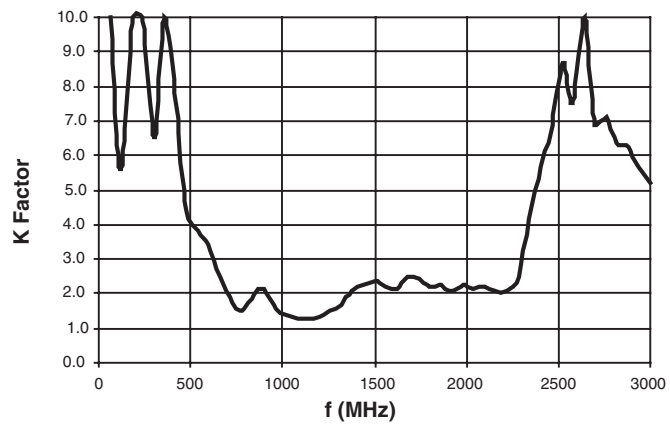


Table 6-1. Measured Scattering Parameters of Matched Device (Given as Linear Magnitude and Phase in Degree)

| f/MHz | S ₁₁ | ∠(S ₁₁) | S ₂₁ | ∠(S ₂₁) | S ₁₂ | ∠(S ₁₂) | S ₂₂ | ∠(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 |

Table 6-1. Measured Scattering Parameters of Matched Device (Given as Linear Magnitude and Phase in Degree)

| f/MHz | S ₁₁ | ∠(S ₁₁) | S ₂₁ | ∠(S ₂₁) | S ₁₂ | ∠(S ₁₂) | S ₂₂ | ∠(S ₂₂) | K Factor |
|-------|-----------------|---------------------|-----------------|---------------------|-----------------|---------------------|-----------------|---------------------|----------|
| 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 |

Figure 6-5. Gain versus Blocker at 1710 MHz (Compression)

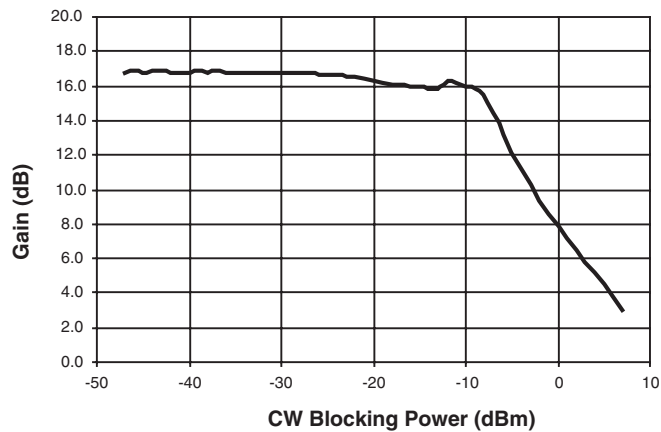


Figure 6-6. Out of Band Intermodulation Product 3rd Order (IP3)

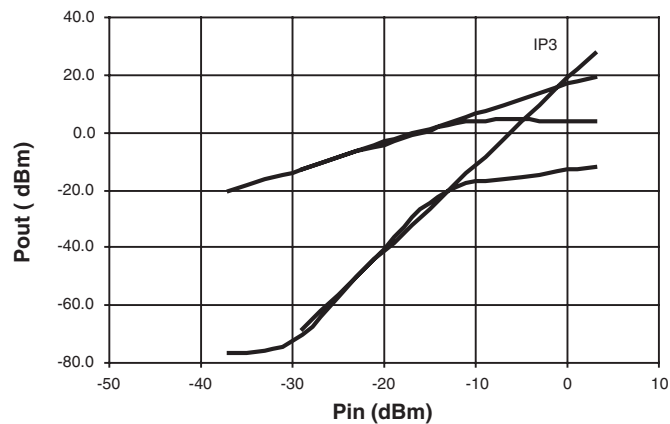


Figure 6-7. Inband Intermodulation Product 3rd Order (Inband IP3)

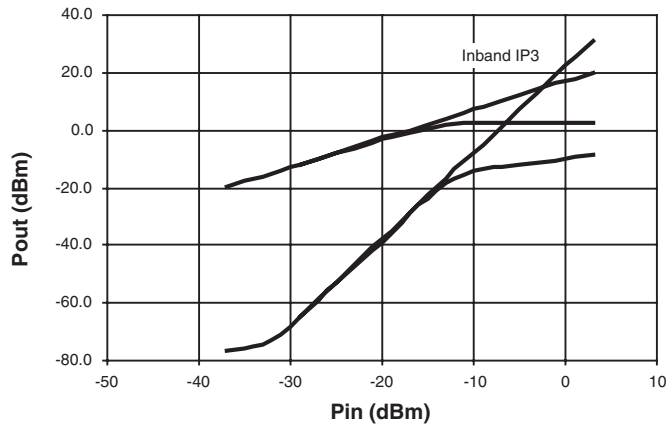


Figure 6-8. Noise Figure without any De-embedding

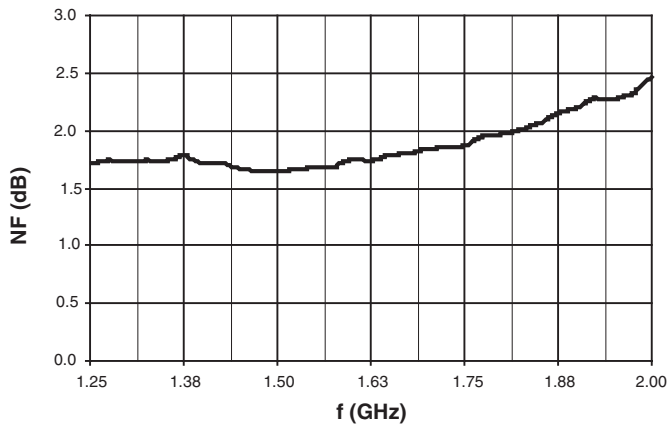
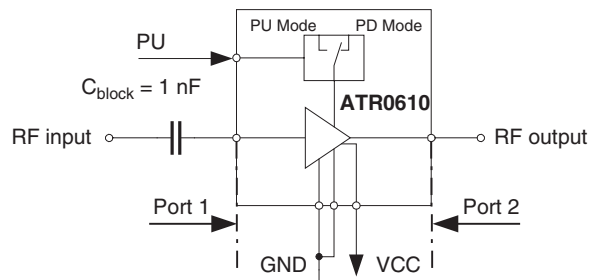


Figure 6-9. Reference Planes of Unmatched Device



6.2 Unmatched Device (see Figure 6-9 on page 8)

Table 6-2. Measured Scattering Parameters of Unmatched Device (De-embedded)
(Given as Linear Magnitude and Phase in Degree)

| f/MHz | S11 | φ(S11) | S21 | φ(S21) | S12 | φ(S12) | S22 | φ(S22) |
|-------|-------|--------|------|--------|-------|--------|-------|--------|
| 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 |

Figure 6-10. Minimum Noise Figure NF_{min} (De-embedded)

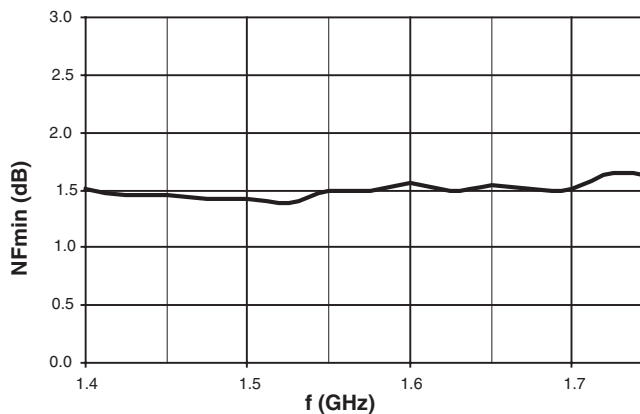
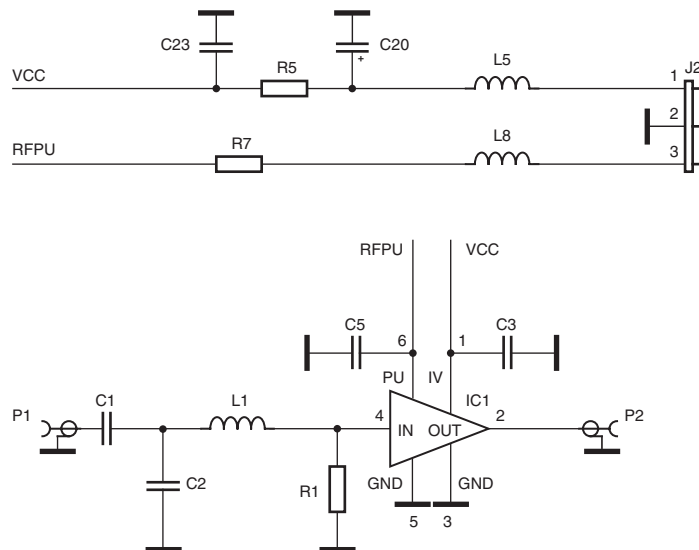


Table 6-3. Raw Noise Data of Unmatched Device (De-embedded)

| f/GHz | NFmin/dB | $ \Gamma_{opt} $ | $\phi(\Gamma_{opt})$ | Rn/ Ω |
|-------|----------|------------------|----------------------|--------------|
| 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 |

Figure 6-11. Schematic of Application Board

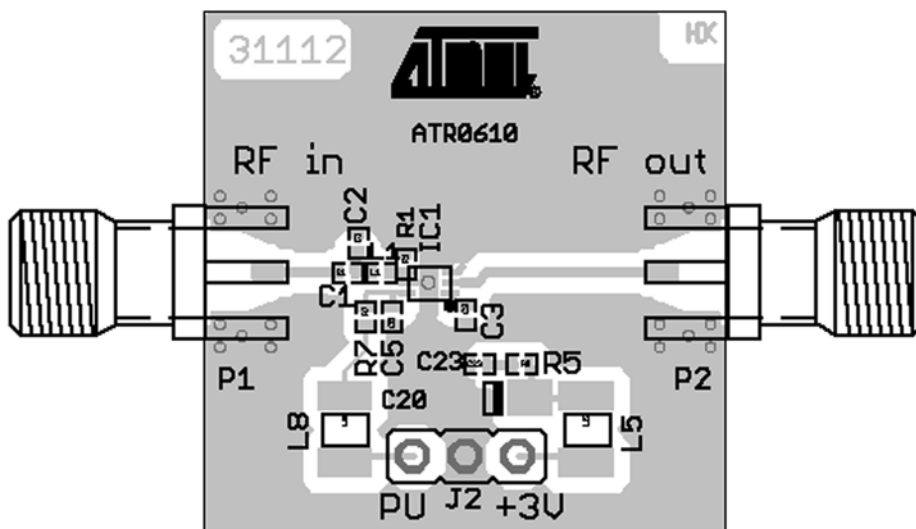


7. Bill of Materials of Application Board

| Component | Qty. | Value | Tolerance | Voltage | Material | Manufacturer | Manufacturer Order Code | Distributor | Distributor Order Code |
|-------------------|------|--------------------|-----------|---------|----------|------------------------|-------------------------|------------------|------------------------|
| R5 | 1 | 1 | 5% | | | Vishay® | CRCW04021R0J | | |
| R7 | 1 | 1 | 5% | | | Vishay | CRCW04021R0J | | |
| C2 ⁽¹⁾ | 1 | 1p2 ⁽²⁾ | 0.25 pF | 25V | C0G | Murata® | GRM1555C1H1R2BZ01D | | |
| L1 ⁽¹⁾ | 1 | 4n7 ⁽²⁾ | 5% | | | Würth® Elektronik | 744784047 | | |
| C1 ⁽¹⁾ | 1 | 8p2 ⁽²⁾ | ±0.1 pF | 25V | C0G | Vishay | VJ0402A8R2CXX | | |
| C20 | 1 | 10μ | 10% | | | Vishay | 293D106X56R3A2. | | |
| C23 | 1 | 100n | 20% | 16V | Y5V | Vishay | VJ0402V104MXJ | | |
| P1, P2 | 2 | 142-0711-821 | | | | Johnson Components™ | 742-0711-821 | RS Components | 363-4729 |
| IC1 | 1 | ATR0610 | | | | Atmel® | ATR0610 | | |
| J2 | 1 | JP2E | | | | Molex® | 90120-0762 | RS Components | 360-6241 |
| L5, L8 | 2 | WE74476401 | 10% | | | Würth Elektronik | 74476401 | | |
| C3, C5 | 2 | NC | | | | | | | |
| R1 | 1 | NC | | | | | | | |

- Notes:
1. L1, C1 and C2 are the only devices which are needed for final application. All other components are only used for the application board shown in [Figure 7-1](#).
 2. Depending on the layout of the final application board other values are possible.

Figure 7-1. Layout of Application Board

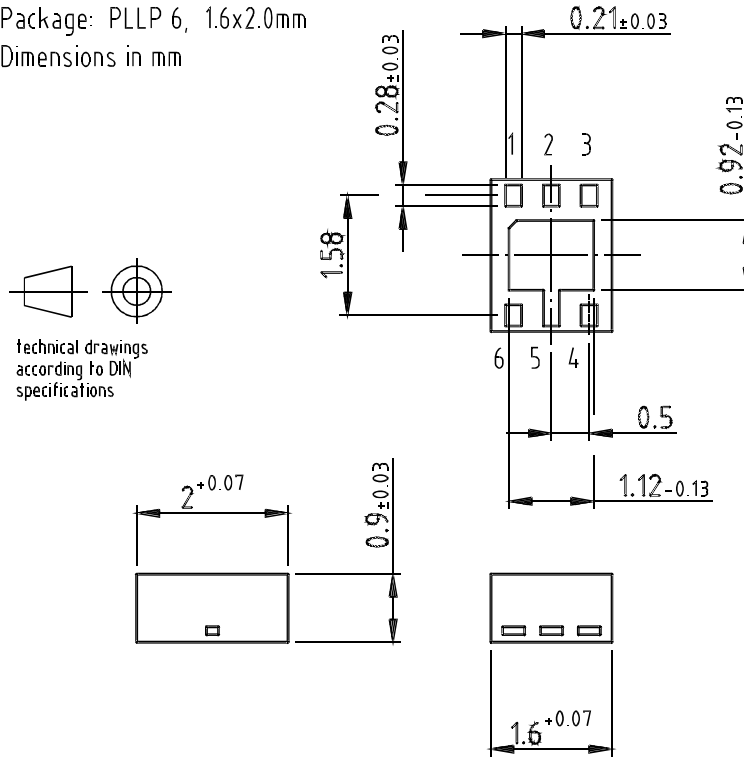


8. Ordering Information

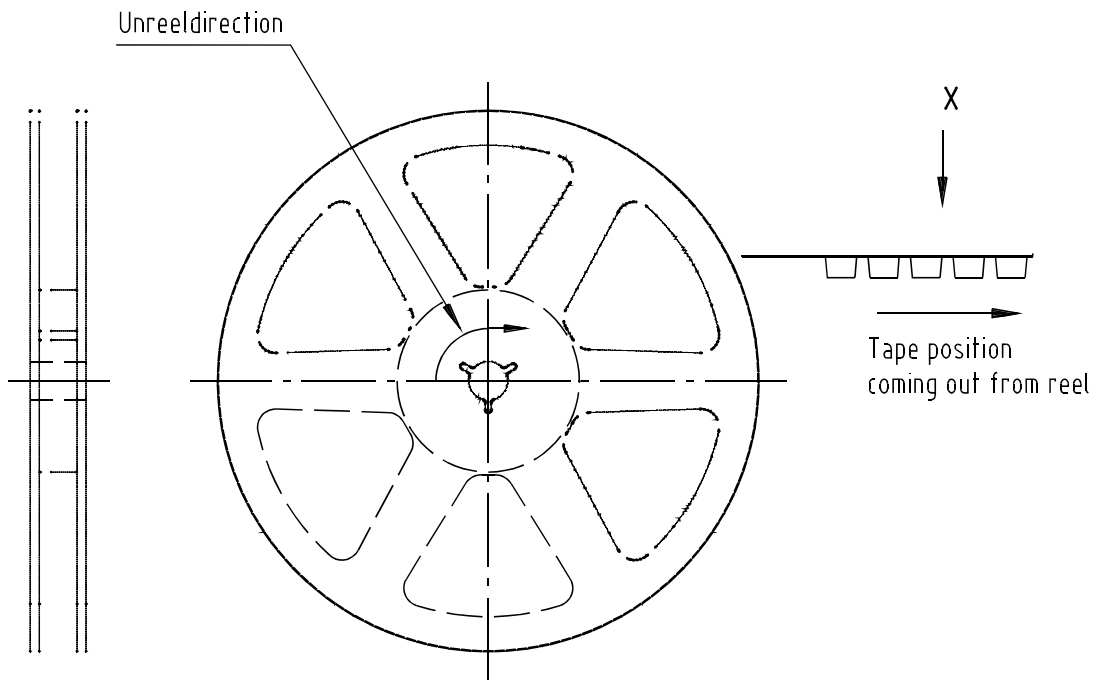
| Extended Type Number | Package | Remarks |
|----------------------|---------|--|
| ATR0610-PQQ | PLL6 | Area 1.6 mm × 2.0 mm, 0.5 mm pitch, PB-free, RoHS compliant, green |

9. Package Information

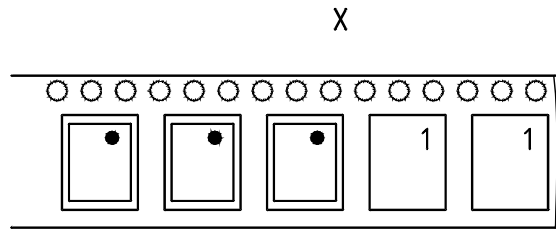
Package: PLL6, 1.6x2.0mm
Dimensions in mm



Drawing-No.: 6.549-5033.01-4
Issue: 1; 25.07.02



technical drawings according to DIN specifications



Drawing-No.: 9.800-5081.01-4.01-4
 Issue: 1; 24.10.02

10. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

| Revision No. | History |
|-----------------|--|
| 4573H-GPS-11/06 | <ul style="list-style-type: none">• Features on page 1 changed• Section 8 "Ordering Information" on page 12 changed |
| 4573G-GPS-10/06 | <ul style="list-style-type: none">• Put datasheet in a new template• ESD logo moved from page 1 to page 3• Section 7 "Bill of Materials of Application Board" on page 11 changed |



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