

# DATA SHEET

## **SA1921**

Satellite and cellular dual-band RF  
front-end

Product specification  
Supersedes data of 1998 Sep 11  
IC17 Data Handbook

1999 Mar 02

# Satellite and cellular dual-band RF front-end

# SA1921

## DESCRIPTION

The SA1921 is an integrated dual-band RF front-end that operates at both cellular (AMPS, DAMPS, and GSM) and satellite (1515–1600 MHz) frequencies, and is designed in a 13 GHz  $f_T$  BiCMOS process—QUBiC1. The low-band is a combined low-noise amplifier (LNA) and mixer. The LNA has a 1.7 dB noise figure at 943 MHz with 18.3 dB of gain and an IIP3 of -5 dBm. The wide-dynamic range mixer has a 11 dB noise figure at 943 MHz with 7.2 dB of gain and an IIP3 of +5 dBm.

The high-band contains a receiver front-end, and a high frequency transmit mixer intended for closed loop transmitters. One advantage of the high-band architecture is an image-rejection mixer with over 30 dB of image rejection; thus, eliminating external filter cost while saving board space. The system noise figure is 3.9 dB at 1550 MHz with a power gain of 22.2 dB and an IIP3 of -11.5 dB.

## FEATURES

- Low current consumption
- Outstanding low- and high-band noise figure
- Excellent gain stability versus temperature and supply
- Image reject high-band mixer with over 30 dB of rejection
- Increased low-band LNA gain compression during analog transmission
- LO input and output buffers
- On chip logic for network selection and power down
- Very small outline package

## APPLICATIONS

- 800 to 1000 MHz analog and digital receivers
- 1515 to 1600 MHz digital receivers
- Portable radios
- Digital mobile communications equipment

## PIN CONFIGURATION

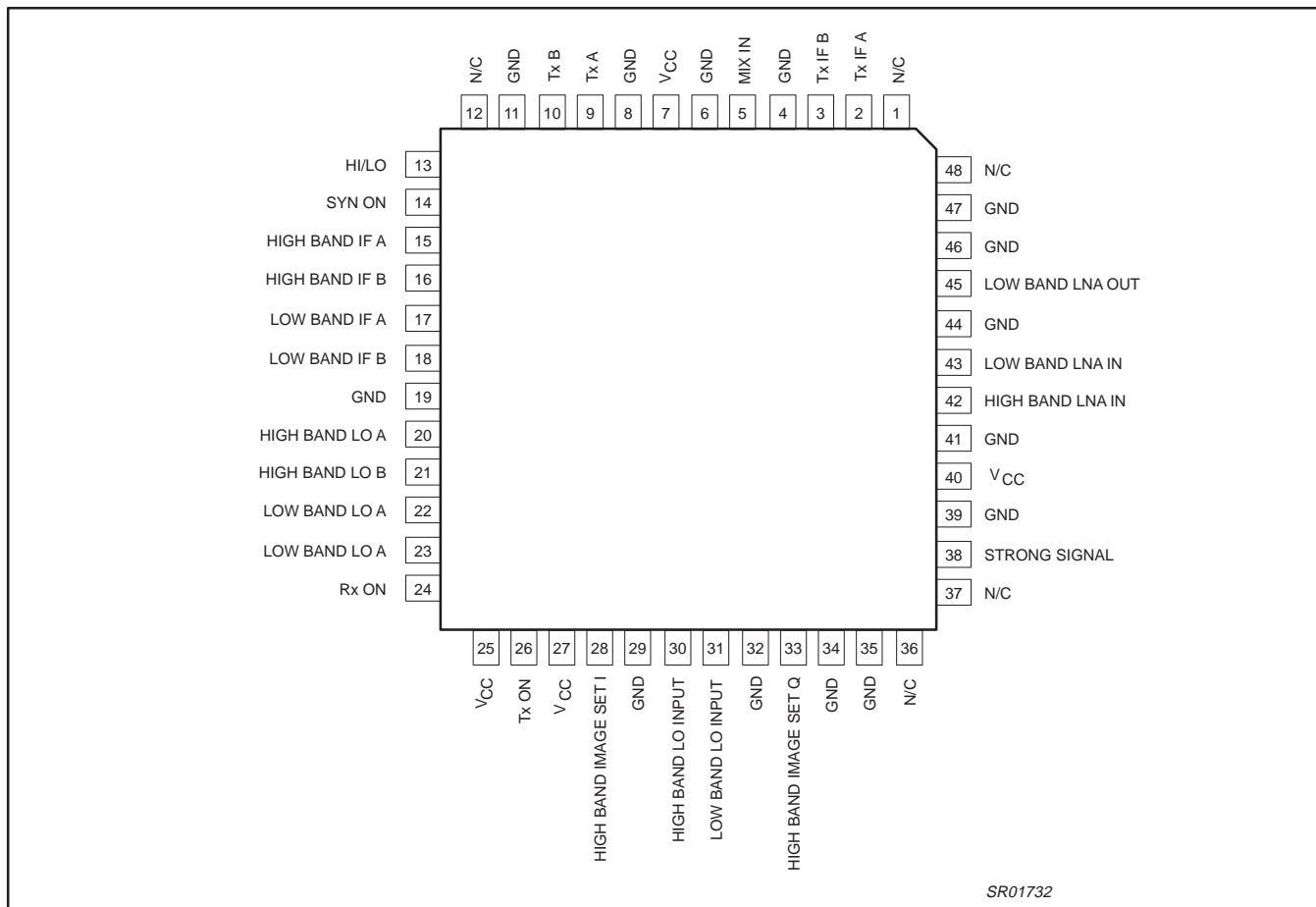


Figure 1. Pin Configuration

## ORDERING INFORMATION

| TYPE NUMBER | PACKAGE |  |          |
|-------------|---------|--|----------|
|             | NAME    | DESCRIPTION  | VERSION  |
| SA1921      | LQFP48  | Plastic low profile quad flat package; 48 leads; body 7x7x1.4 mm | SOT313-2 |

## Satellite and cellular dual-band RF front-end

SA1921

## PIN DESCRIPTIONS

| PIN NO. | PIN NAME              | DESCRIPTION                |
|---------|-----------------------|----------------------------|
| 1       | N/C                   | No Connection              |
| 2       | Tx IF A               | Transmit IF A              |
| 3       | Tx IF B               | Transmit IF B              |
| 4       | GND                   | Ground                     |
| 5       | MIX IN                | Low Band Mixer Input       |
| 6       | GND                   | Ground                     |
| 7       | V <sub>CC</sub>       | V <sub>CC</sub>            |
| 8       | GND                   | Ground                     |
| 9       | Tx A                  | Transmit Signal A          |
| 10      | Tx B                  | Transmit Signal B          |
| 11      | GND                   | Ground                     |
| 12      | N/C                   | No Connection              |
| 13      | HI/LO                 | High Band/Low Band Control |
| 14      | SYN ON                | LO Buffer Power Control    |
| 15      | HIGH BAND IF A        | High Band IF A             |
| 16      | HIGH BAND IF B        | High Band IF B             |
| 17      | LOW BAND IF A         | Low Band IF A              |
| 18      | LOW BAND IF B         | Low Band IF B              |
| 19      | GND                   | Ground                     |
| 20      | HIGH BAND LO A        | High Band LO Output        |
| 21      | HIGH BAND LO B        | High Band LO Output        |
| 22      | LOW BAND LO A         | Low Band LO Output         |
| 23      | LOW BAND LO B         | Low Band LO Output         |
| 24      | Rx ON                 | LNA/Mixer Power Control    |
| 25      | V <sub>CC</sub>       | V <sub>CC</sub>            |
| 26      | Tx ON                 | Tx Mixer/Driver Power      |
| 27      | V <sub>CC</sub>       | V <sub>CC</sub>            |
| 28      | HIGH BAND IMAGE SET I | High Band Image Set I      |
| 29      | GND                   | Ground                     |
| 30      | HIGH BAND LO INPUT    | High Band LO Connection    |
| 31      | LOW BAND LO INPUT     | Low Band LO Connection     |
| 32      | GND                   | Ground                     |
| 33      | HIGH BAND IMAGE SET Q | High Band Image Set Q      |
| 34      | GND                   | Ground                     |
| 35      | GND                   | Ground                     |
| 36      | N/C                   | No Connection              |
| 37      | N/C                   | No Connection              |
| 38      | STRONG SIGNAL         | Strong Signal Detection    |
| 39      | GND                   | Ground                     |
| 40      | V <sub>CC</sub>       | V <sub>CC</sub>            |
| 41      | GND                   | Ground                     |
| 42      | HIGH BAND LNA IN      | High Band LNA Input        |
| 43      | LOW BAND LNA IN       | Low Band LNA Input         |
| 44      | GND                   | Ground                     |
| 45      | LOW BAND LNA OUT      | Low Band LNA Output        |
| 46      | GND                   | Ground                     |
| 47      | GND                   | Ground                     |
| 48      | N/C                   | No Connection              |

# Satellite and cellular dual-band RF front-end

# SA1921

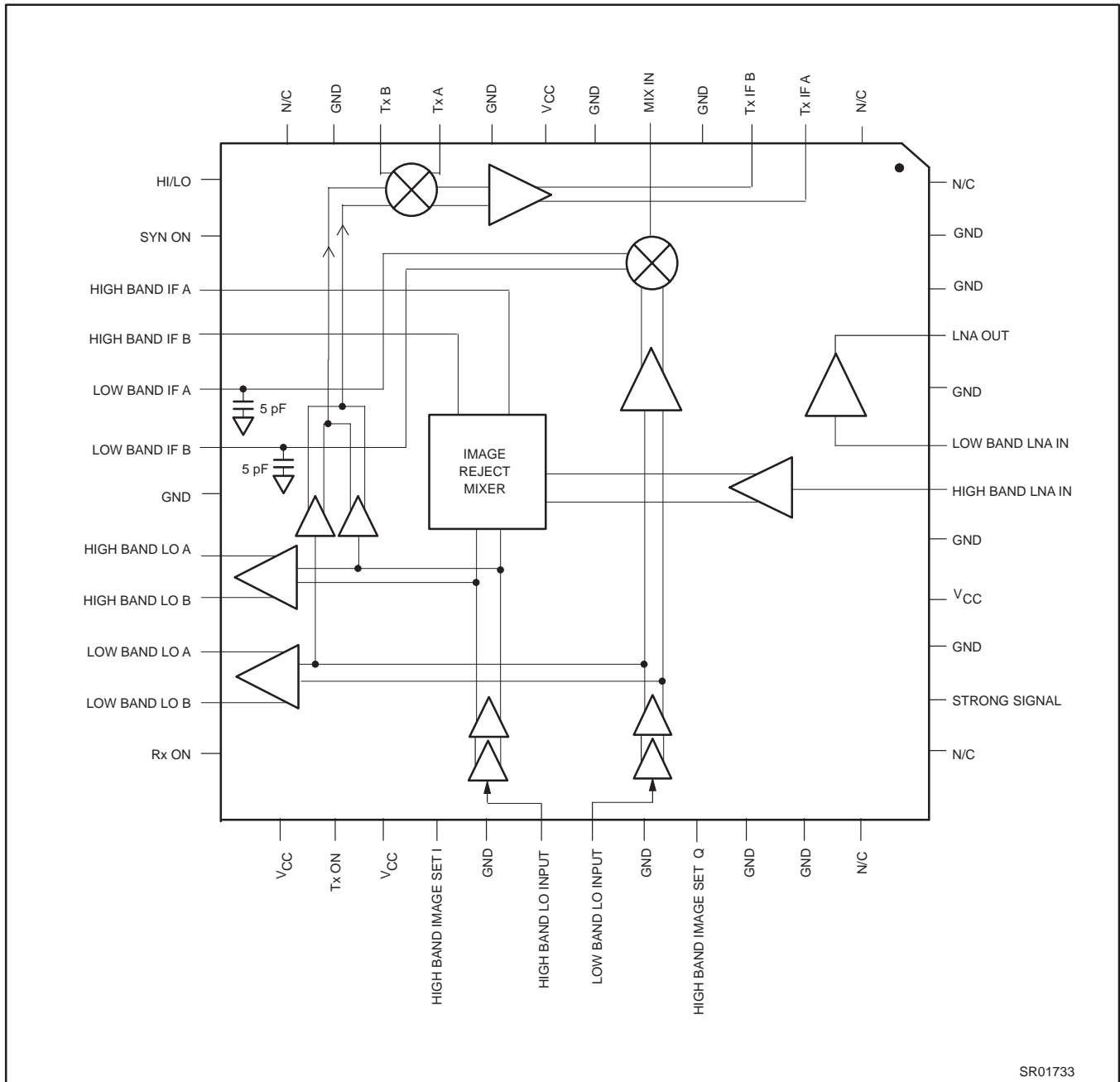


Figure 2. Block Diagram

SR01733

Satellite and cellular dual-band RF front-end

SA1921

**Table 1. POWER DOWN CONTROL**

| Control State<br>(Hi/Lo, Syn On, Rx On, Tx On, Strong Signal) |                                 | LO BUFFER |          | LNA       |                 | MIXER     |          | Tx MIXER DRIVER |          |
|---|---------------------------------|-----------|----------|-----------|-----------------|-----------|----------|-----------------|----------|
|   |                                 | High Band | Low Band | High Band | Low Band        | High Band | Low Band | High Band       | Low Band |
| x000x   | Sleep                           | Off       | Off      | Off       | Off             | Off       | Off      | Off             | Off      |
| 01000   | Low-Band LO Buffer on           | Off       | On       | Off       | Off             | Off       | Off      | Off             | Off      |
| 01100   | Low-Band Receive Normal         | Off       | On       | Off       | On              | Off       | On       | Off             | Off      |
| 01101   | Low-Band receive Strong Signal  | Off       | On       | Off       | Off             | Off       | On       | Off             | Off      |
| 01110   | Low-Band Transmit (Analog only) | Off       | On       | Off       | On<br>High Bias | Off       | On       | Off             | On       |
| 01010   | N/A                             | Off       | On       | Off       | Off             | Off       | Off      | Off             | On       |
| 11000   | High-Band LO Buffer On          | On        | Off      | Off       | Off             | Off       | Off      | Off             | Off      |
| 11100   | High-Band Receive Normal        | On        | Off      | On        | Off             | On        | Off      | Off             | Off      |
| 11101   | High-Band Receive Strong Signal | On        | Off      | Off       | Off             | On        | Off      | Off             | Off      |
| 11010   | N/A                             | On        | Off      | Off       | Off             | Off       | Off      | On              | Off      |

**NOTE:**

1. "0" is low logic state; "1" is high logic state.

# Satellite and cellular dual-band RF front-end

SA1921

## OPERATION

The low-band contains both an LNA and mixer that is designed to operate in the 800 to 1000 MHz frequency range. The high-band contains an LNA and image-rejection mixer that is designed to operate in the 1515 to 1600 MHz frequency range with over 30 dB of rejection over an intermediate frequency (IF) range from 150 to 185 MHz.

Image rejection is achieved in the internal architecture by two RF mixers in quadrature and two all-pass filters in the I and Q IF channels that phase shift the IF by 45° and 135°, respectively. The two phase shifted IFs are recombined and buffered to produce the IF output signal.

The LO section consists of an internal phase shifter to provide quadrature LO signals to the receive mixers. The filters outputs are buffered before being fed to the receive mixers. The transmit mixer section consists of a low-noise amplifier, and a down-convert mixer. In the transmit mode, an internal LO buffer is used to drive the transmit IF down-convert mixer.

### Low-Band Receive Section

The circuit contains a LNA followed by a wide-band mixer. In a typical application circuit, the LNA output uses an external pull-up inductor to  $V_{CC}$  and is AC coupled. The mixer IF outputs are differential. A typical application will load the output buffer with an inductor across the IF outputs, a pull-up inductor to  $V_{CC}$  and an AC coupled capacitor to the matching network.

### Low-Band Receive Section (Analog Transmit Mode)

The bias current of the low-band LNA will increase during analog transmission, which increases its gain compression point and makes the receiver less sensitive to PA leakage power for an AMPS application.

### High-Band Receive Section

The circuit contains an LNA followed by two high dynamic range mixers. These are Gilbert cell mixers; the internal architecture is fully differential. The LO is shifted in phase by 45° and 135° and mixes the amplified RF signal to create I and Q channels. The two I and Q channels are buffered, phase shifted by 45° and 135°, respectively, amplified and recombined internally to realize the image rejection.

The IF output is differential and of the open-collector type. A typical application will load the output buffer with an inductor across the IF outputs, a pull-up inductor to  $V_{CC}$  and an AC coupled capacitor to the matching network.

### Control Logic Section

Pins HI/LO, SYN ON, Rx On, Tx On, Strong Signal, control the logic functions. The HI/LO mode selects between low-band and high-band operation. The SYN ON mode enables the LO buffers independent of the other circuitry. When SYN ON is high, all internal buffers in the LO path of the circuit are turned on, thus minimizing LO pulling when the remainder of the receive or transmit chain is powered-up.

The Rx ON mode enables the LO buffers when the device is in the low-band receive normal, receive strong signal and transmit modes; the Rx ON mode enables the LO buffers, also, when the device is in the high-band receive normal, and receive strong signal modes.

The Tx ON mode enables the transmit mixer. The strong signal mode, when disabled, allows the low- and high-band LNAs to function normally; and when the strong signal mode is enabled, it turns-off the low- and high-band LNAs. This is needed when the input signal is large and needs to be attenuated.

### Local Oscillator (LO) Section

The LO input directly drives the two internal all-pass networks to provide quadrature LO to the receive mixers. A synthesizer-on (SYN ON) mode is used to power-up all LO input buffers, thus minimizing the pulling effect on the external VCO when entering receive or transmit mode.

### Transmit Mixer Section

The transmit mixer is used for down-conversion to the transmit IF. Its inputs are coupled to the transmit RF which is down-converted to a modulated transmit IF frequency, and phase-locked with the baseband modulation.

The IF outputs are HIGH impedance (open-collector type). A typical application will load the output buffer with an inductor across the IF outputs, a pull-up inductor to  $V_{CC}$  and AC coupled capacitors to the matching network.

## Satellite and cellular dual-band RF front-end

SA1921

**ABSOLUTE MAXIMUM RATINGS**

| SYMBOL          | PARAMETERS                                  | VALUE       | UNIT |
|-----------------|---|-------------|------|
| V <sub>CC</sub> | Input supply voltage at pins: 7, 25, 27, 40 | 4.75        | V    |
| P <sub>D</sub>  | Power dissipation                           | 150         | mW   |
| P <sub>IN</sub> | Input power at all ports                    | +20         | dBm  |
| T <sub>sr</sub> | Storage temperature range                   | -65 to +125 | °C   |

**RECOMMENDED OPERATING CONDITIONS**

| SYMBOL          | PARAMETERS                             | RATING     | UNIT |
|-----------------|--|------------|------|
| V <sub>CC</sub> | DC Supply voltage                      | 3.6 to 3.9 | V    |
| T <sub>O</sub>  | Operating temperature range (pin temp) | -40 to +85 | °C   |

**DC ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, all Input/Output ports are single-ended.

**DC PARAMETERS**

V<sub>CC</sub> = +3.75 V, T<sub>A</sub> = +25°C unless otherwise noted

| SYMBOL          | PARAMETERS                      | CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------------|---------------------------------|-----------|------|------|------|------|
| I <sub>CC</sub> | Current Consumption: Sleep Mode | X000X     |      | 1.0  | 25   | μA   |
| I <sub>CC</sub> | Low Band Receive Normal         | 01100     | 9.8  | 12.2 | 14.7 | mA   |
| I <sub>CC</sub> | Low Band Receive Strong         | 01101     |      | 9.0  |      | mA   |
| I <sub>CC</sub> | Low Band Transmit (Analog)      | 01111     |      | 18.0 |      | mA   |
| I <sub>CC</sub> | Low Band Transmit (GSM)         | 01010     |      | 16.5 |      | mA   |
| I <sub>CC</sub> | High Band Receive Normal        | 11100     | 32.0 | 40.0 | 48.0 | mA   |
| I <sub>CC</sub> | High Band Receive Strong        | 11101     |      | 36.0 |      | mA   |
| I <sub>CC</sub> | High Band Transmit (GSM)        | 11010     |      | 19.4 |      | mA   |
|                 | Logic Low Input                 |           | 0    |      | 0.5  | V    |
|                 | Logic High Input                |           | 1.9  |      | 4.0  | V    |

## Satellite and cellular dual-band RF front-end

SA1921

**AC ELECTRICAL CHARACTERISTICS****Low-Band, Dual Mode of Operation** $V_{CC} = +3.75\text{ V}$ ,  $\text{Freq}_{RF} = 943\text{ MHz}$ ,  $\text{Freq}_{LO} = 1106\text{ MHz}$ ,  $P_{LOin} = -3\text{ dBm}$ ,  $T_A = +25^\circ\text{C}$ ; unless otherwise stated.

| PARAMETERS  | Min  | -3 $\sigma$ | TYP   | +3 $\sigma$ | Max  | UNITS           | NOTES |
|---|------|-------------|-------|-------------|------|-----------------|-------|
| <b>System</b>                                     |      |             |       |             |      |                 |       |
| RF Input Frequency Range                          | 869  |             | 943   |             | 960  | MHz             |       |
| IF Frequency                                      |      |             | 163   |             |      | MHz             |       |
| LO Frequency                                      | 1032 |             | 1106  |             | 1123 | MHz             |       |
| Cascaded Power Gain; includes 3dB filter loss     |      | 21.4        | 22.5  | 23.6        |      | dB              |       |
| Power Gain Reduction (Strong Signal Mode—LNA Off) |      | 30          | 36    | 42          |      | dB              |       |
| Cascaded Noise Figure; includes 3dB filter loss   |      |             | 2.6   |             |      | dB              |       |
| <b>LNA</b>  |      |             |       |             |      |                 |       |
| LNA Gain  |      | 17.6        | 18.3  | 19          |      | dB              |       |
| LNA IIP3 (60 kHz spacing)                         |      | -6.0        | -5.0  | -4.0        |      | dBm             |       |
| LNA IIP3 (200 kHz spacing)                        |      |             | -3.0  |             |      | dBm             |       |
| LNA Noise Figure                                  |      | 1.6         | 1.7   | 1.8         |      | dB              |       |
| LNA 1 dB RF Input Compression Point               |      |             | -21.0 |             |      | dBm             |       |
| <b>Mixer</b>                                      |      |             |       |             |      |                 |       |
| Mixer Gain  |      | 6.9         | 7.2   | 7.5         |      | dB              |       |
| Mixer IIP3 (60 kHz spacing)                       |      | 4.0         | 5.0   | 6.0         |      | dBm             |       |
| Mixer Noise Figure                                |      | 10.4        | 11.0  | 11.6        |      | dB              |       |
| Mixer 1 dB RF Input Compression Point             |      |             | -13.0 |             |      | dBm             |       |
| <b>Other</b>                                      |      |             |       |             |      |                 |       |
| Input Impedance, RF Port                          |      |             | 50    |             |      | $\Omega$        |       |
| Return Loss at LNA Inputs and Output              |      |             |       |             | -10  | dB              | 1     |
| Return Loss at Mixer Input and Outputs            |      |             |       |             | -10  | dB              | 1     |
| LO leakage at RF Port                             |      |             | -42   |             |      | dBm             |       |
| LO Input Power                                    |      | -5          | -3    | -1          |      | dBm             |       |
| Turn ON/OFF Time                                  |      |             | 100   |             |      | $\mu\text{sec}$ |       |

**Low-Band LO Buffer** $V_{CC} = +3.75\text{ V}$ ,  $\text{Freq}_{LO} = 1106\text{ MHz}$ ,  $P_{LOin} = -3\text{ dBm}$ ,  $T_A = +25^\circ\text{C}$ ; unless otherwise stated.

| PARAMETERS                    | Min  | -3 $\sigma$ | TYP. | +3 $\sigma$ | Max  | UNITS           | NOTES |
|-------------------------------|------|-------------|------|-------------|------|-----------------|-------|
| LO Frequency                  | 1032 |             | 1106 |             | 1123 | MHz             |       |
| Differential Output Power     |      |             | -7   |             |      | dBm             |       |
| Differential Output Impedance |      |             | 100  |             |      | $\Omega$        |       |
| Harmonic Content              |      |             | -20  |             |      | dBc             |       |
| Input Power                   |      | -5          | -3   | -1          |      | dBm             |       |
| Input Impedance               |      |             | 50   |             |      | $\Omega$        | 1     |
| Turn On/Off Time              |      |             | 10   |             |      | $\mu\text{sec}$ |       |

**NOTE:**

- External matching network is required.



## Satellite and cellular dual-band RF front-end

SA1921

**AC ELECTRICAL CHARACTERISTICS****High-Band, Single Mode of Operation  
LNA and Image Reject Mixer** $V_{CC} = +3.75$  V,  $Freq_{RF} = 1550$  MHz,  $Freq_{LO} = 1713$  MHz,  $P_{LOin} = -3$  dBm,  $T_A = +25^\circ$ C; unless otherwise stated.

| PARAMETERS  | MIN  | -3 $\sigma$ | TYP.  | +3 $\sigma$ | MAX  | UNITS     | NOTES |
|---|------|-------------|-------|-------------|------|-----------|-------|
| RF Input Frequency Range  | 1515 |             |       |             | 1600 | MHz       |       |
| IF Frequency  | 150  |             | 163   |             | 185  | MHz       |       |
| LO Frequency  | 1665 |             |       |             | 1785 | MHz       |       |
| Power Gain  |      | 21.5        | 22.2  | 22.9        |      | dB        |       |
| Power Gain Reduction (Strong Signal Mode—LNA Off)   |      | 34          | 47    | 60          |      | dB        |       |
| Noise Figure  |      | 3.7         | 3.9   | 4.1         |      | dB        |       |
| Input Impedance, RF Port  |      |             | 50    |             |      | $\Omega$  |       |
| Return Loss at Inputs   |      |             |       |             | -10  | dB        | 1     |
| LO leakage at RF Port   |      |             | -48   |             |      | dBm       |       |
| 1 dB RF Input Compression Point   |      |             | -24   |             |      | dBm       |       |
| IP3 (3 <sup>RD</sup> Order Intermodulation Product)<br>Referred to the RF Input Port  |      | -14         | -11.5 | -9          |      | dBm       |       |
| (2 x LO) – (2 x RF) Spur Performance<br>-50 dBm IN Referred to RF Input Port<br>Measure at LO = 1688 MHz and RF = 1606 MHz    |      |             | -62   |             |      | dBc       |       |
| (3 x LO) – (3 x RF) Spur Performance.<br>-50 dBm IN Referred to RF Input Port.<br>Measure at LO = 1688 MHz and RF = 1634 MHz. |      |             | -102  |             |      | dBc       |       |
| Image rejection, $f_{RX} + 2f_{IF}$<br>Referred to the RF Input Port  |      | 31.5        | 34    | 36.5        |      | dB        |       |
| LO Input Power  |      | -5          | -3    | -1          |      | dBm       |       |
| Turn ON/OFF Time  |      |             | 10    |             |      | $\mu$ sec |       |

**High-Band LO Buffer** $V_{CC} = +3.75$  V,  $Freq_{LO} = 1713$  MHz,  $P_{LOin} = -3$  dBm,  $T_A = +25^\circ$ C; unless otherwise stated.

| PARAMETERS                    | MIN  | -3 $\sigma$ | TYP. | +3 $\sigma$ | MAX  | UNITS     | NOTES |
|-------------------------------|------|-------------|------|-------------|------|-----------|-------|
| LO Frequency Range            | 1665 |             |      |             | 1785 | MHz       |       |
| Differential Output Power     |      |             | -9   |             |      | dBm       |       |
| Differential Output Impedance |      |             | 100  |             |      | $\Omega$  |       |
| Harmonic Content              |      |             | -20  |             |      | dBc       |       |
| Input Power                   |      | -5          | -3   | -1          |      | dBm       |       |
| Input Impedance               |      |             | 50   |             |      | $\Omega$  | 1     |
| Turn On/Off Time              |      |             | 10   |             |      | $\mu$ sec |       |

**NOTE:**

- External matching network is required.

## Satellite and cellular dual-band RF front-end

SA1921

**Transmit Mixer**

$V_{CC} = +3.75$  V,  $Freq_{RF} = 1550$  MHz,  $Freq_{LO} = 1713$  MHz,  $P_{LOin} = -3$  dBm,  $T_A = +25^\circ$  C; unless otherwise stated.

| PARAMETERS   | MIN | -3 $\sigma$ | TYP. | +3 $\sigma$ | MAX  | UNITS    | NOTES |
|--|-----|-------------|------|-------------|------|----------|-------|
| T <sub>X</sub> Mixer Input Frequency                 | 824 |             |      |             | 1661 | MHz      |       |
| T <sub>X</sub> RF Input Impedance, Balanced          |     |             | 200  |             |      | $\Omega$ |       |
| T <sub>X</sub> Mixer Output Frequency                | 70  |             | 163  |             | 200  | MHz      |       |
| T <sub>X</sub> IF Load Impedance                     |     |             | 1000 |             |      | $\Omega$ |       |
| Maximum T <sub>X</sub> IF Load Capacitance           |     |             |      |             | 2    | pF       |       |
| Conversion Power Gain                                |     | 17          | 18   | 19          |      | dB       | 1     |
| 1 dB Input Compression Point                         |     |             | -17  |             |      | dBm      |       |
| IIP2   |     |             | 20   |             |      | dBm      |       |
| IIP3   |     | -9          | -7   | -5          |      | dBm      |       |
| Noise Figure (double sideband)                       |     |             | 8.5  |             |      | dB       |       |
| Reverse Isolation T <sub>XIN</sub> -L <sub>OIN</sub> |     | 40          |      |             |      | dB       |       |
| Isolation L <sub>OIN</sub> -T <sub>XIN</sub>         |     | 40          |      |             |      | dB       |       |

**NOTES:**

1. Input and output ports matched to 50  $\Omega$ .



# Satellite and cellular dual-band RF front-end

# SA1921

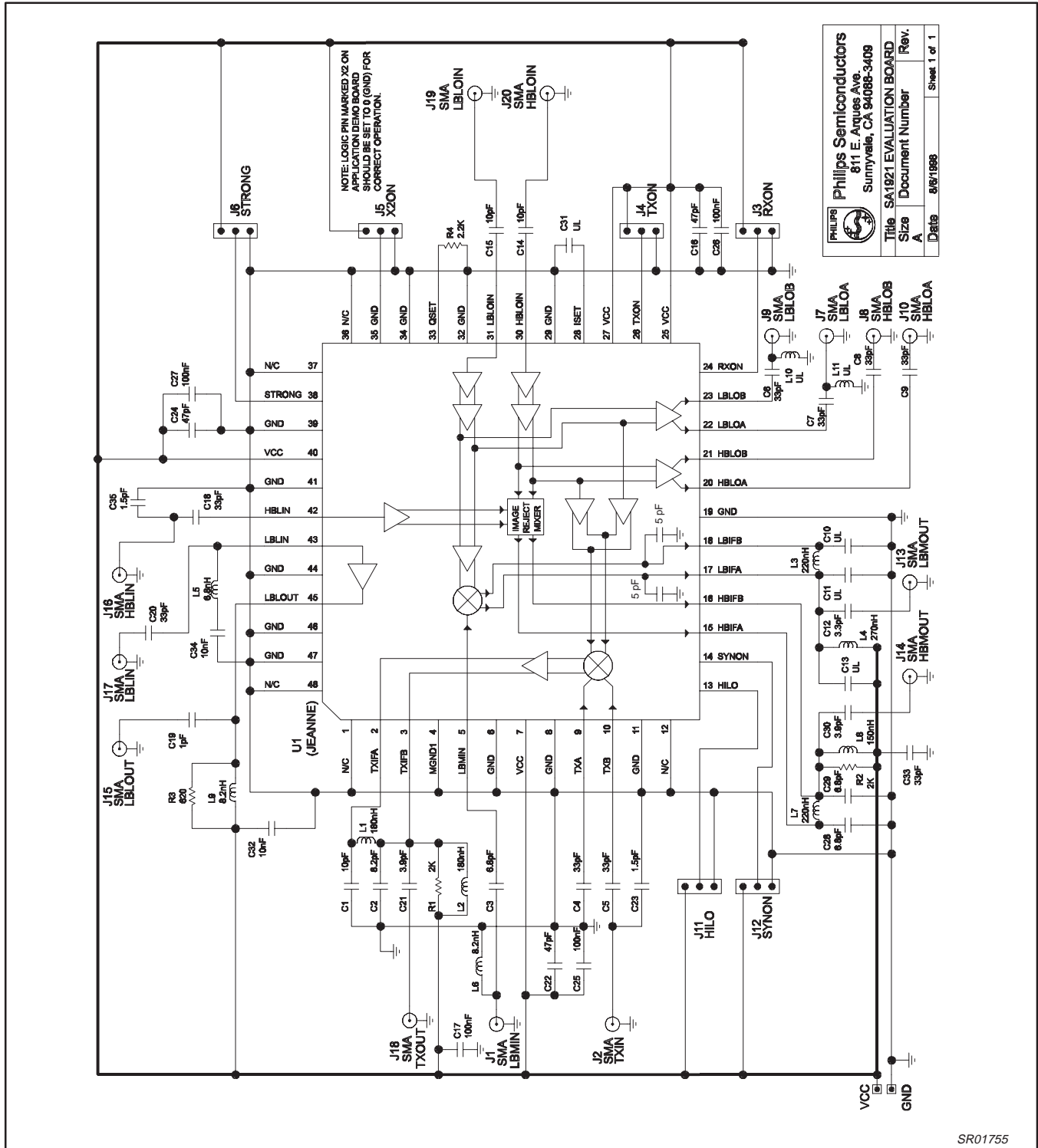


Figure 4. SA1921 Dual-Band Application Circuit

**NOTE:**  
GSM and Satellite frequencies

Satellite and cellular dual-band RF front-end

SA1921

**PERFORMANCE CHARACTERISTICS**

$V_{CC} = +3.75$  V,  $Freq_{RF} = 1550$  MHz,  $Freq_{LO} = 1713$  MHz,  $P_{LOin} = -3$  dBm,  $T_A = +25^\circ\text{C}$ ; unless otherwise stated.

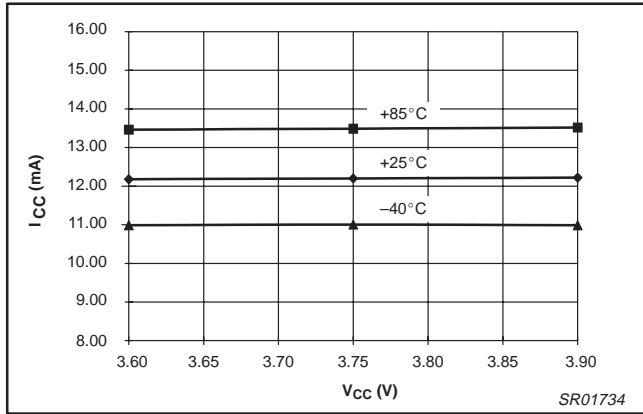


Figure 5. Low Band Receive Normal ICC

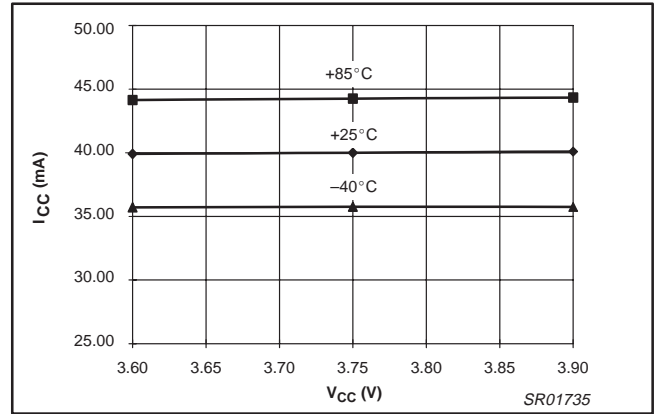


Figure 6. High Band Receive Normal ICC

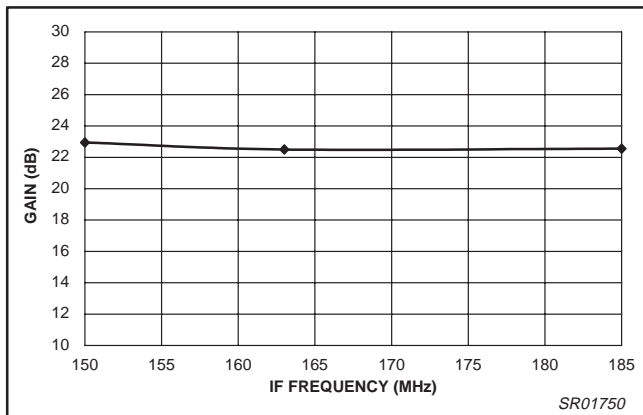


Figure 7. High Band Gain vs. IF Frequency

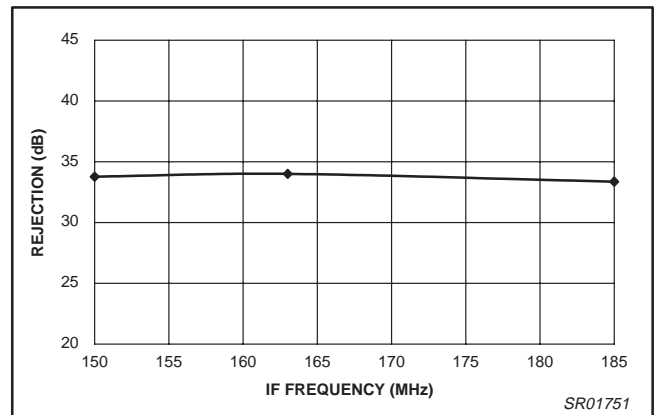


Figure 8. High Band Image Rejection vs. IF Frequency

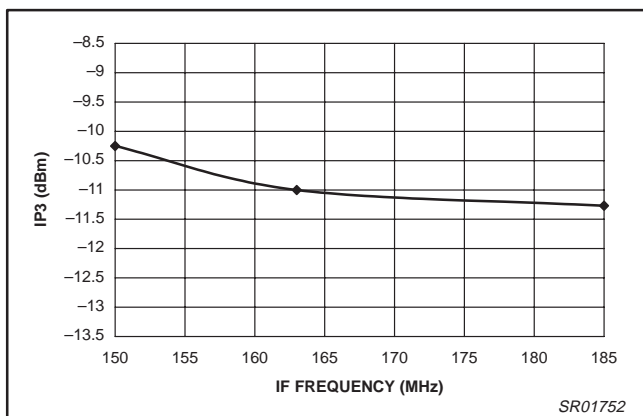


Figure 9. High Band IP3 vs. IF Frequency

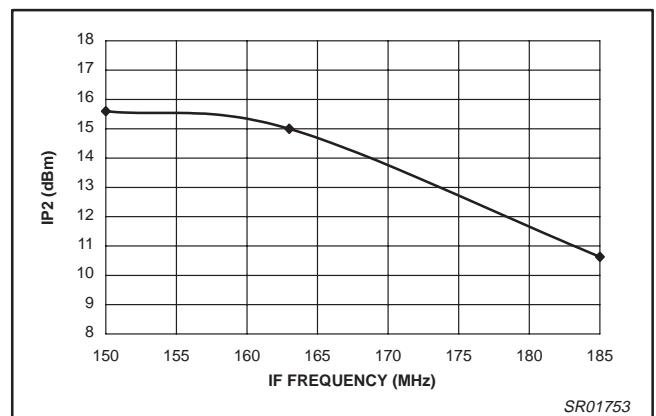


Figure 10. High Band IP2 vs. IF Frequency

Satellite and cellular dual-band RF front-end

SA1921

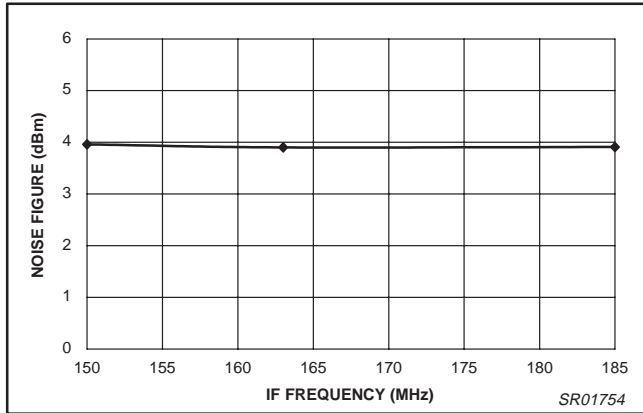


Figure 11. High Band NF vs. IF Frequency

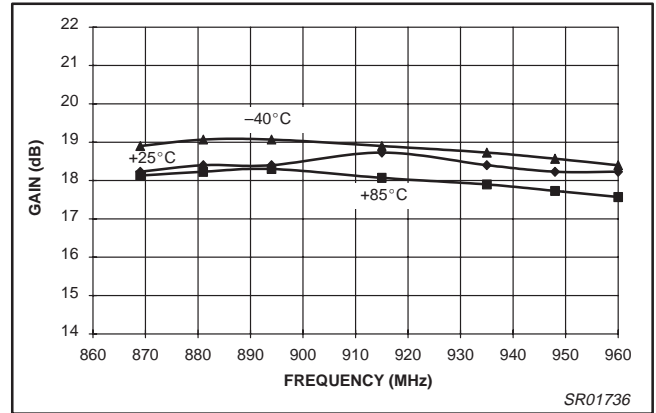


Figure 12. LB LNA Gain vs. Frequency

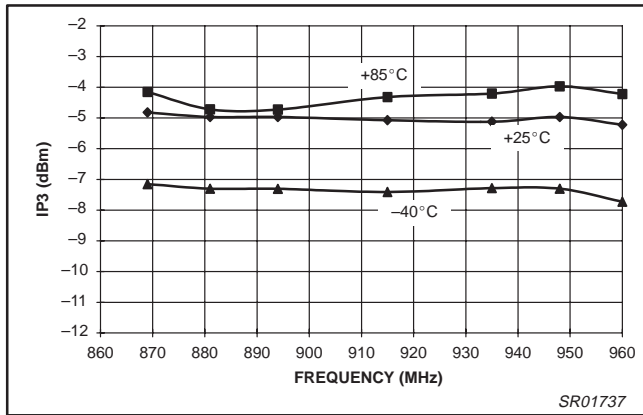


Figure 13. LB LNA IP3 vs. Frequency

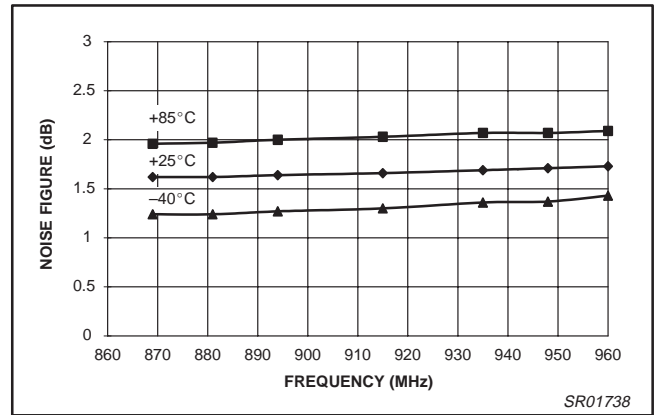


Figure 14. LB LNA Noise Figure vs. Frequency

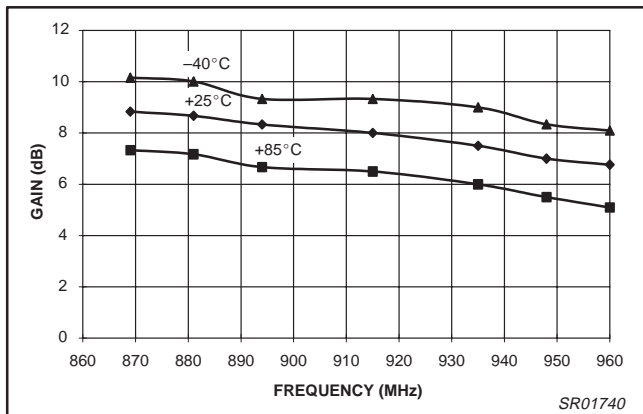


Figure 15. LB Mixer Gain vs. Frequency

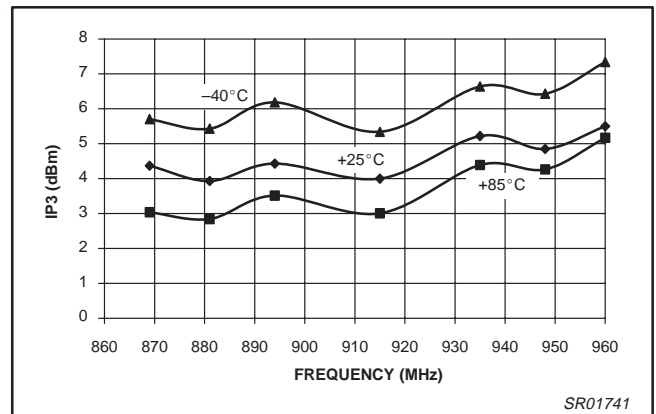


Figure 16. LB Mixer IP3 vs. Frequency

Satellite and cellular dual-band RF front-end

SA1921

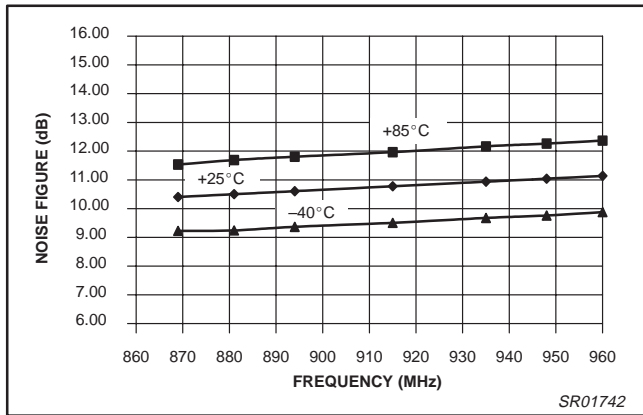


Figure 17. LB Mixer Noise Figure vs. Frequency

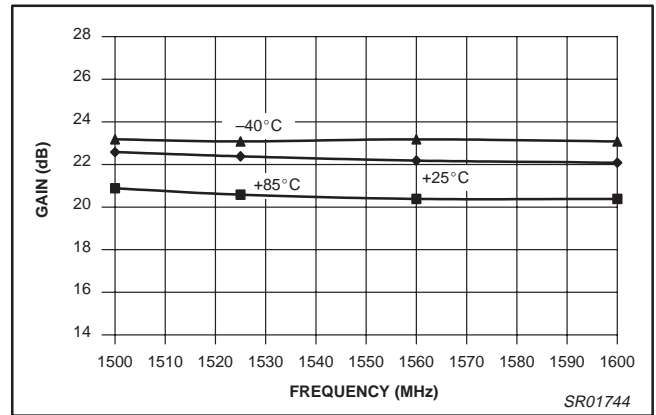


Figure 18. HB Gain vs. Frequency

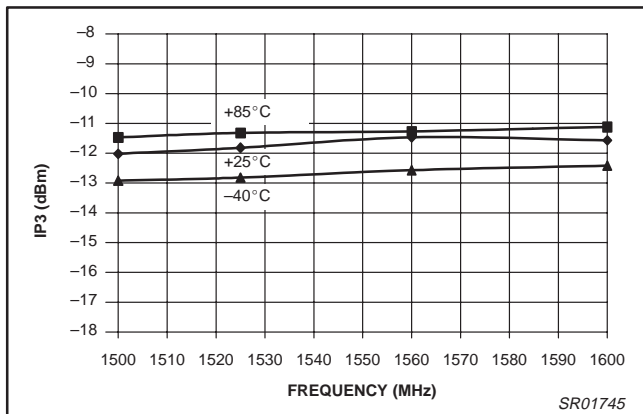


Figure 19. HB IP3 vs. Frequency

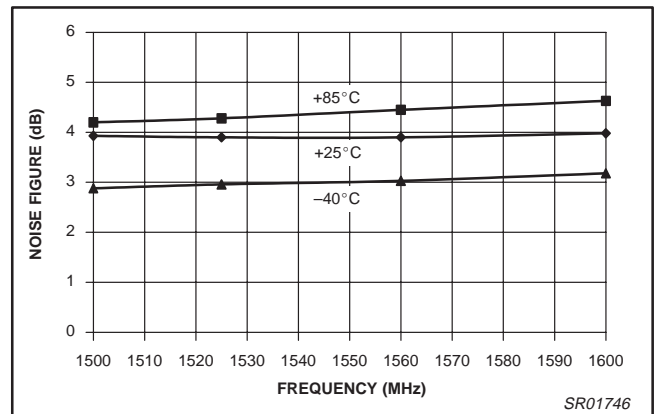


Figure 20. HB Noise Figure vs. Frequency

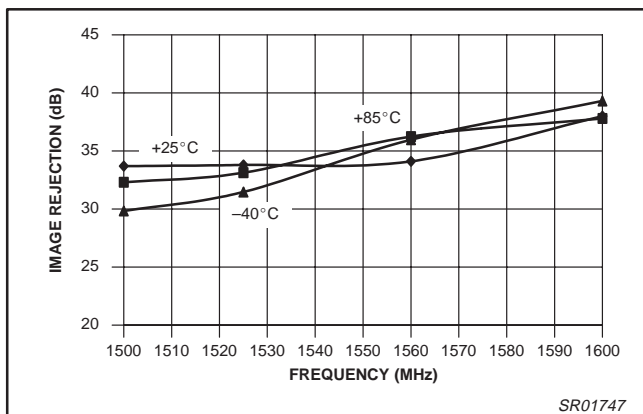


Figure 21. HB Image Rejection vs. Frequency

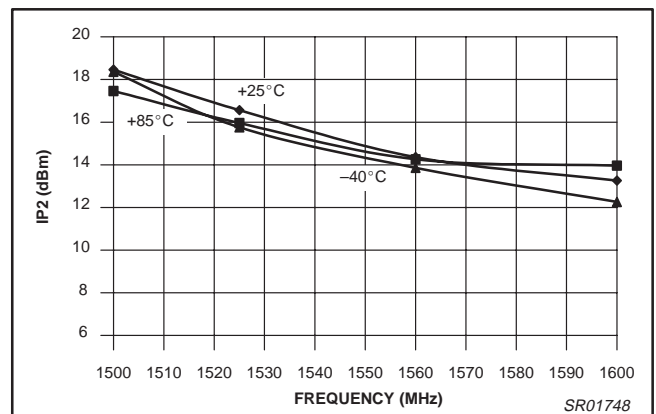


Figure 22. HB IP2 vs. Frequency

Satellite and cellular dual-band RF front-end

SA1921

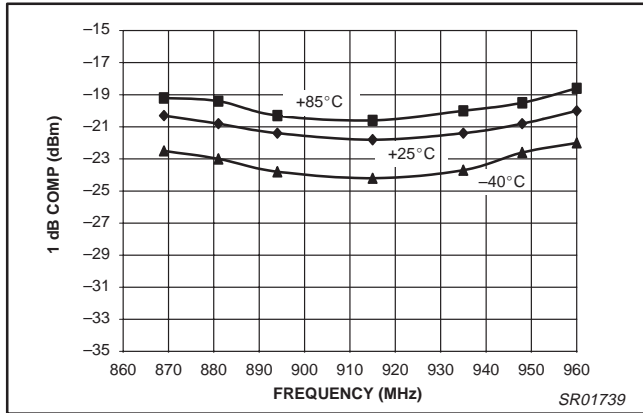


Figure 23. LB LNA 1 dB Compression vs. Frequency

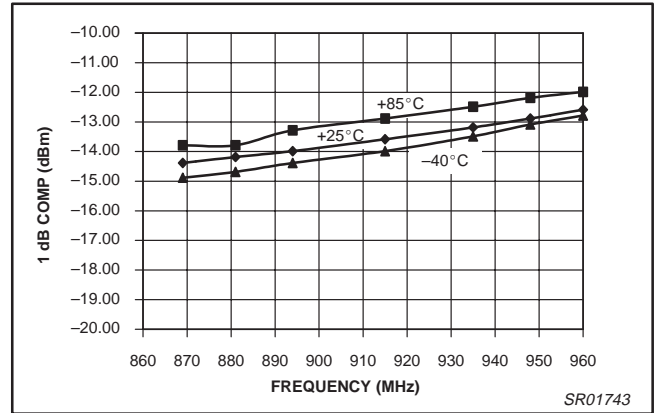


Figure 24. LB Mixer 1 dB Compression vs. Frequency

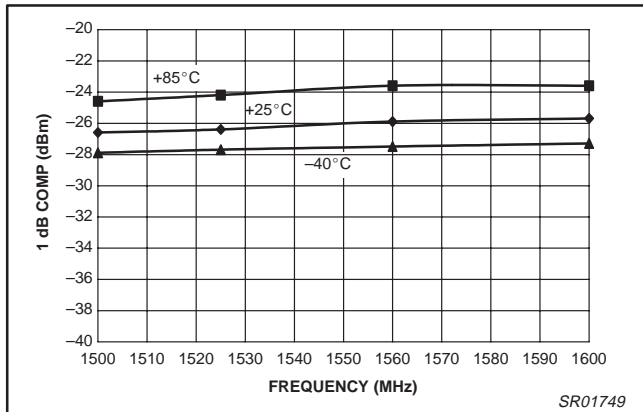


Figure 25. HB 1 dB Compression vs. Frequency



# Satellite and cellular dual-band RF front-end

# SA1921

## S-PARAMETERS

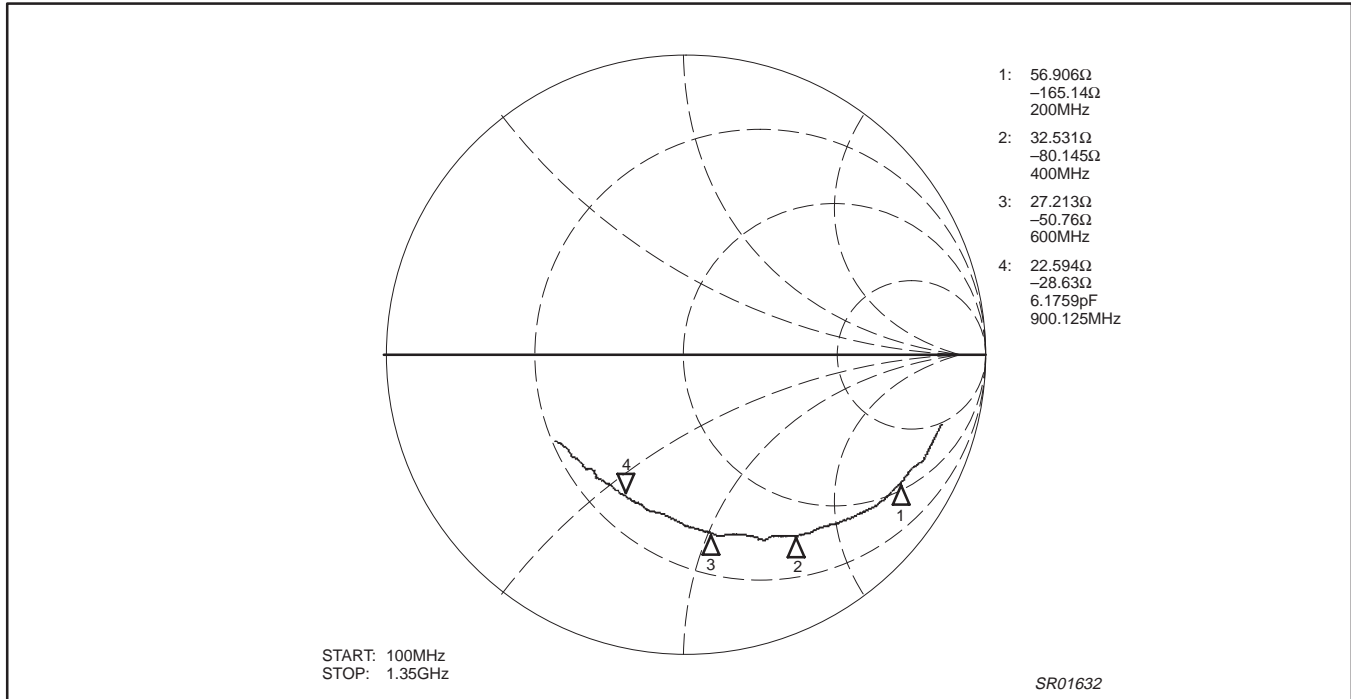


Figure 26. Typical  $S_{11}$  of the Low Band LNA at 3.75 V for the Low Band Receive Normal Mode

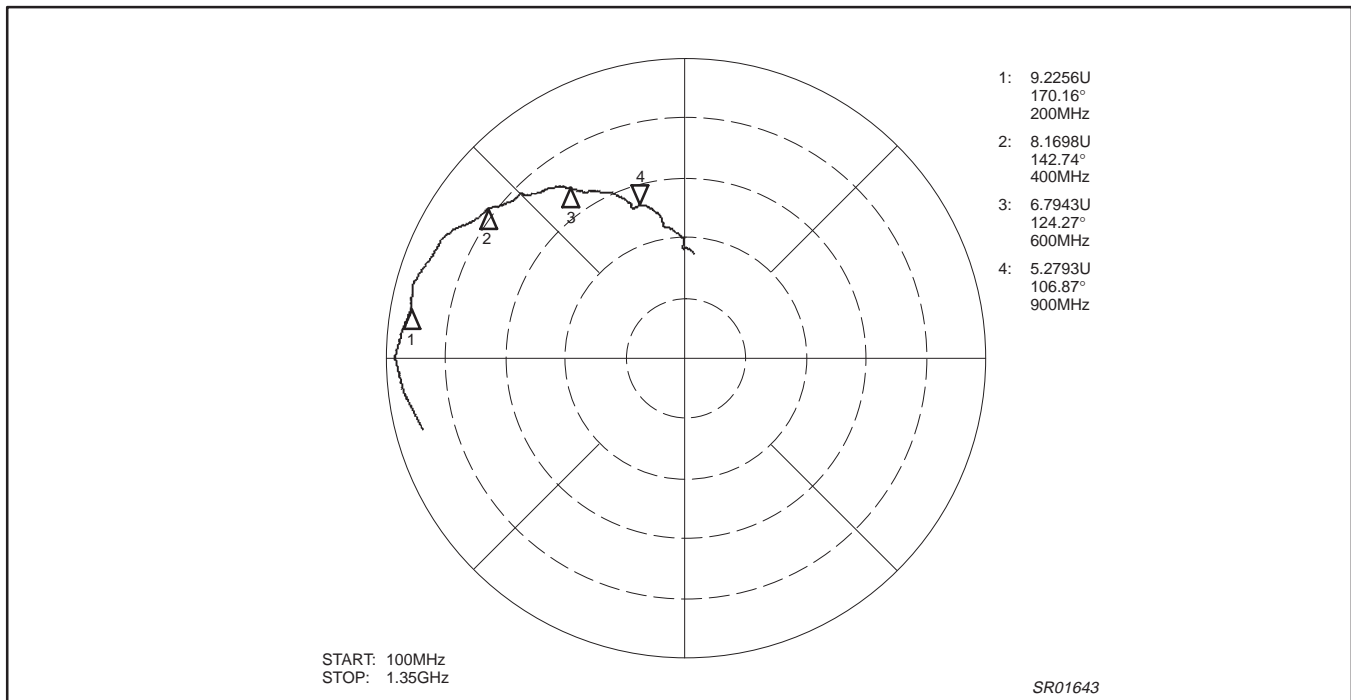


Figure 27. Typical  $S_{21}$  of the Low Band LNA @ 3.75V for the Low Band Receive Normal Mode

Satellite and cellular dual-band RF front-end

SA1921

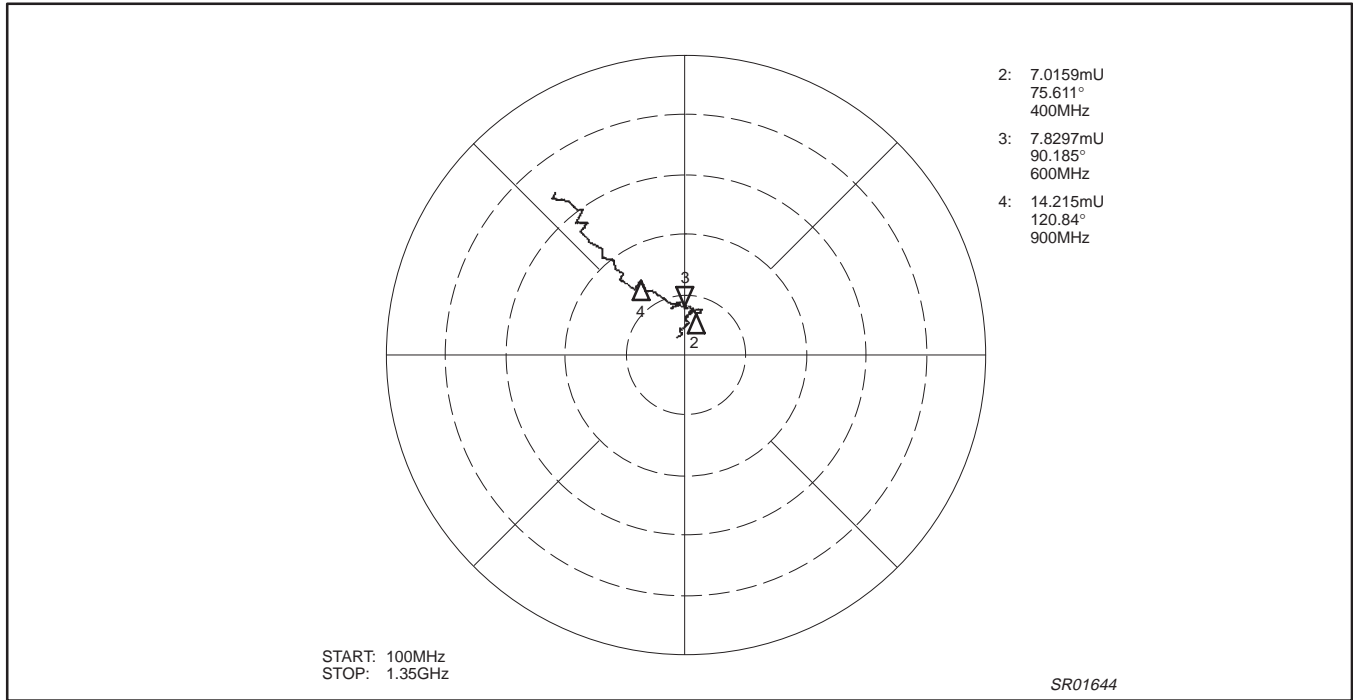


Figure 28. Typical  $S_{12}$  of the Low Band LNA @ 3.75V for the Low Band Receive Normal Mode

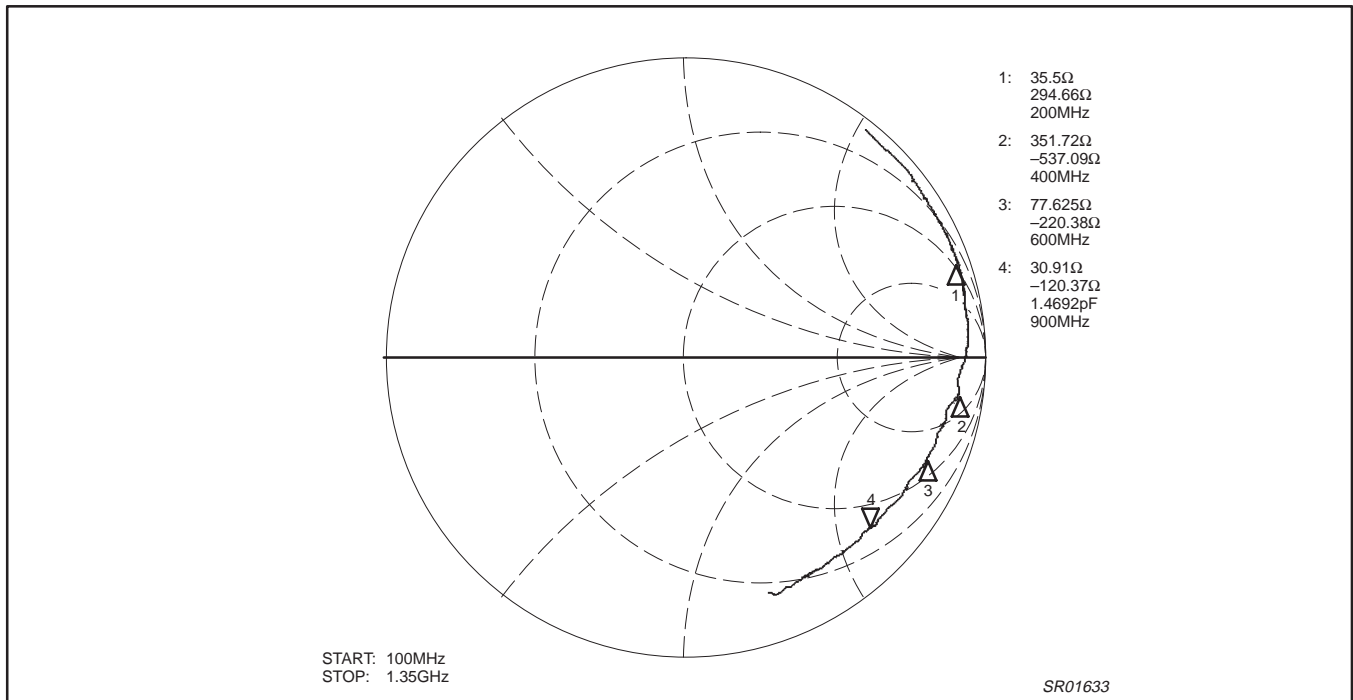


Figure 29. Typical  $S_{22}$  of the Low Band LNA @ 3.75V for the Low Band Receive Normal Mode

Satellite and cellular dual-band RF front-end

SA1921

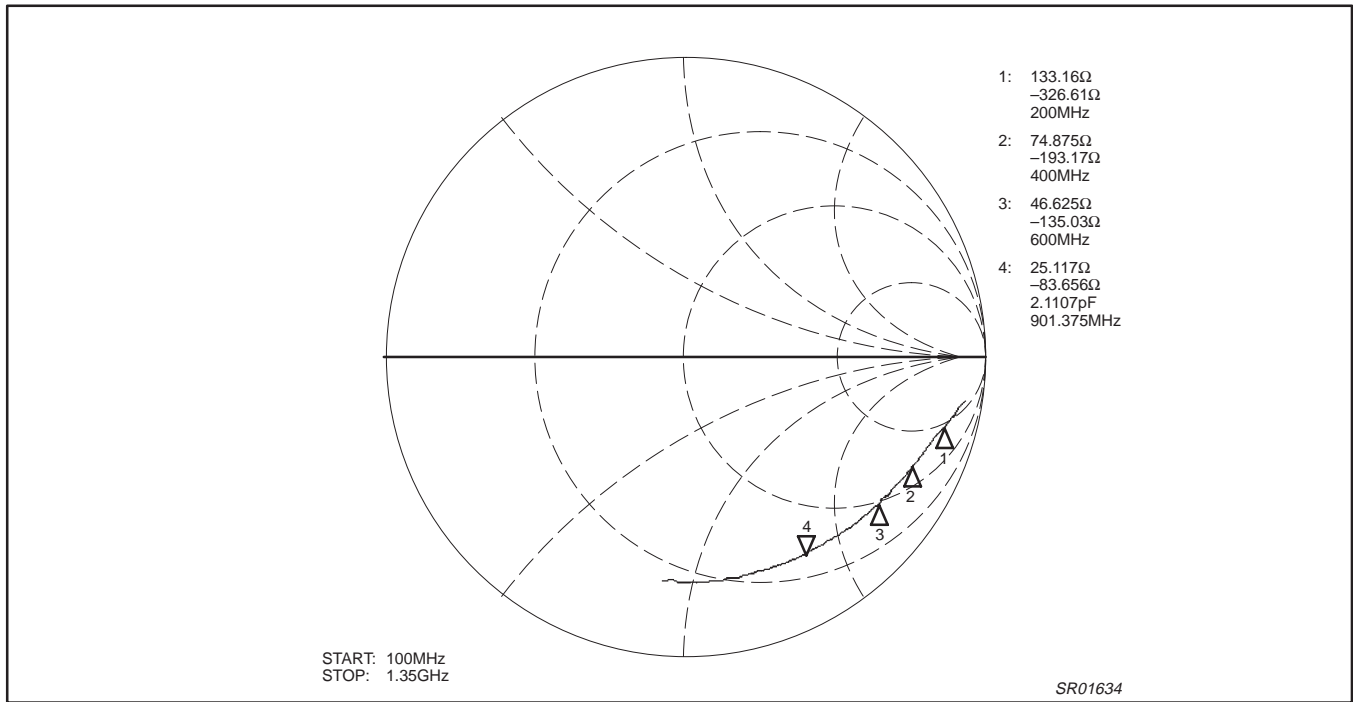


Figure 30. Typical  $S_{11}$  of Low Band LNA @ 3.75V for Receive Strong Signal Mode

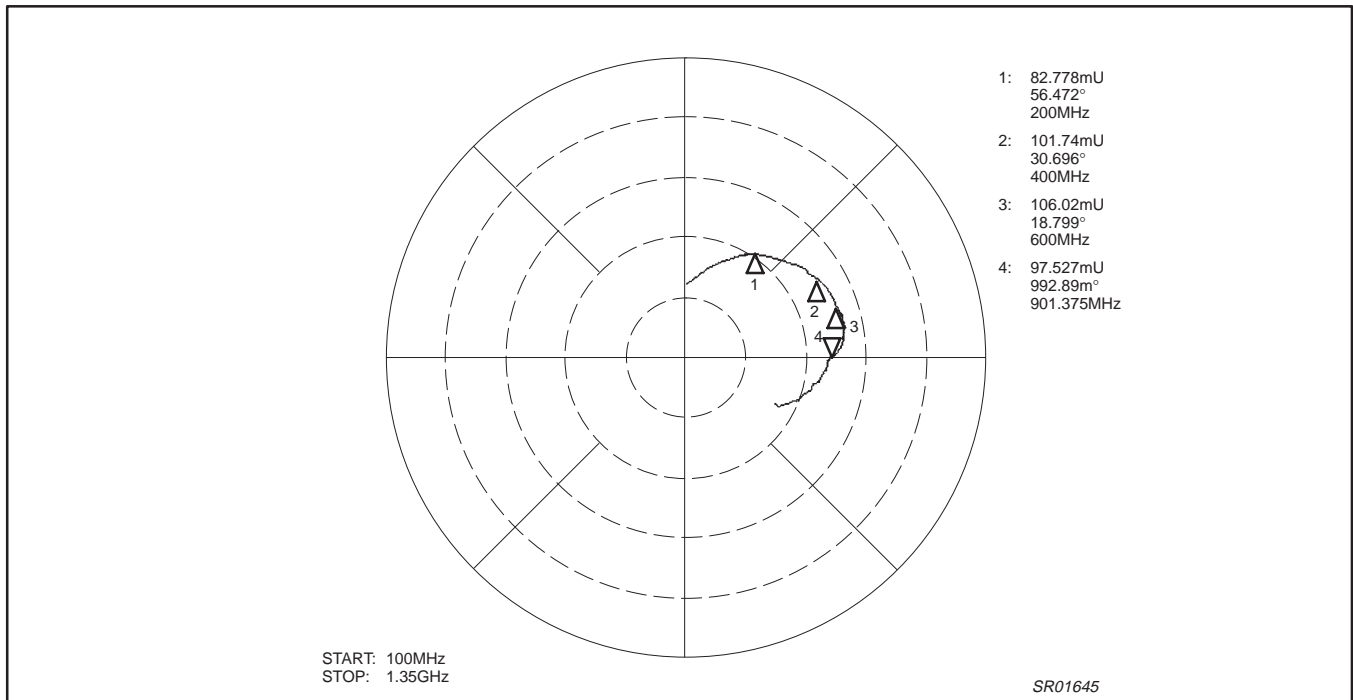


Figure 31. Typical  $S_{21}$  of the Low Band LNA @ 3.75V for Receive Strong Signal Mode

Satellite and cellular dual-band RF front-end

SA1921

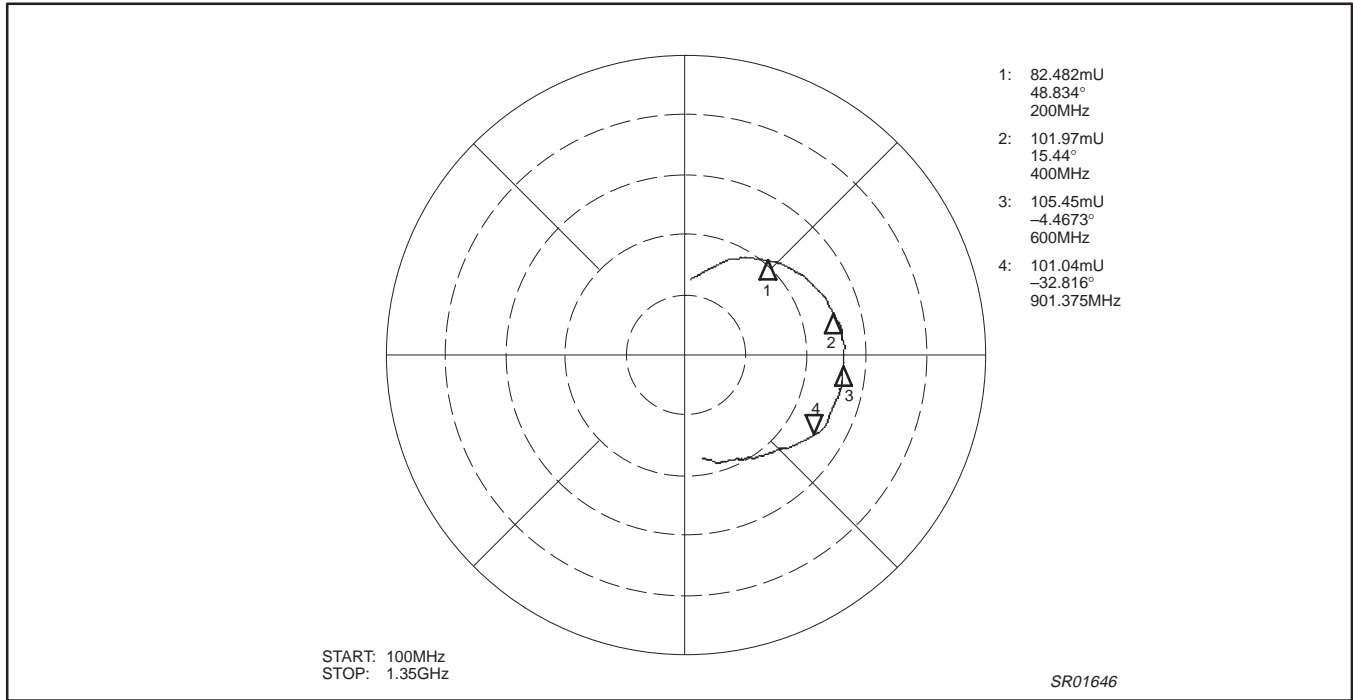


Figure 32. Typical  $S_{12}$  for the Low Band LNA @ 3.75V for the Receive Strong Signal Mode

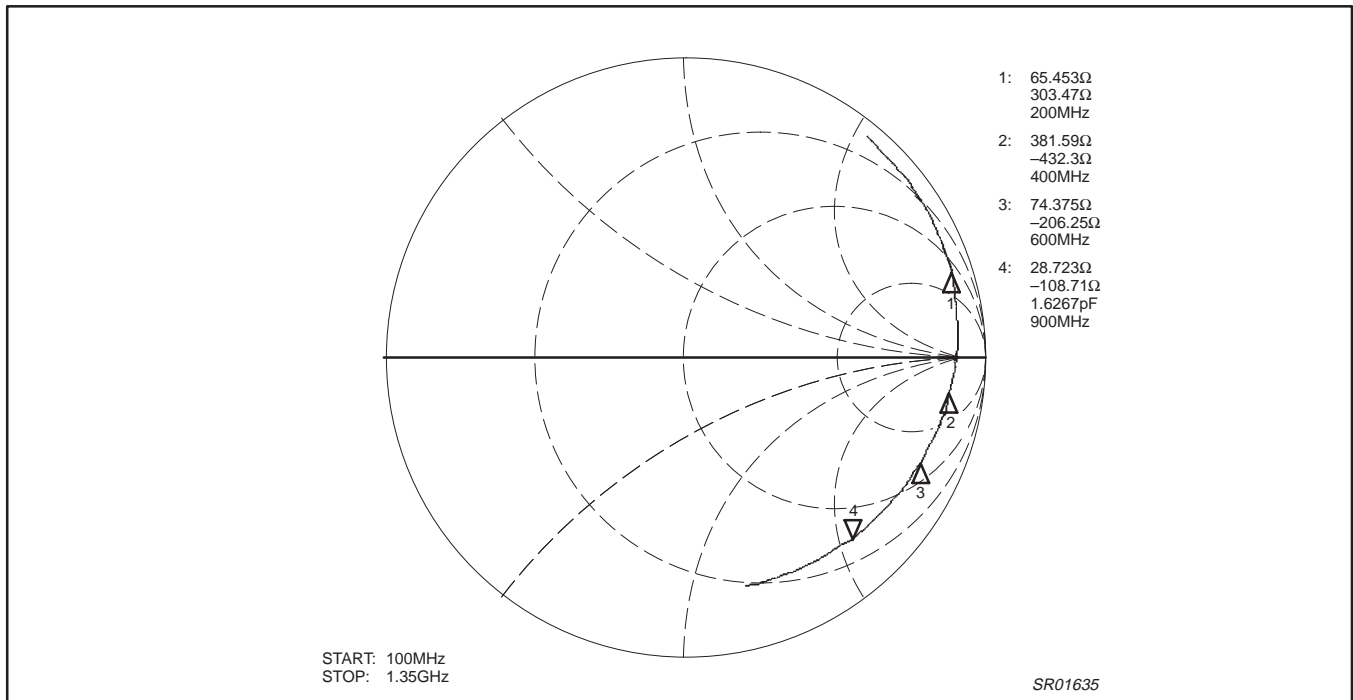


Figure 33. Typical  $S_{22}$  for the Low Band LNA @ 3.75V for the Strong Receive Signal Mode

Satellite and cellular dual-band RF front-end

SA1921

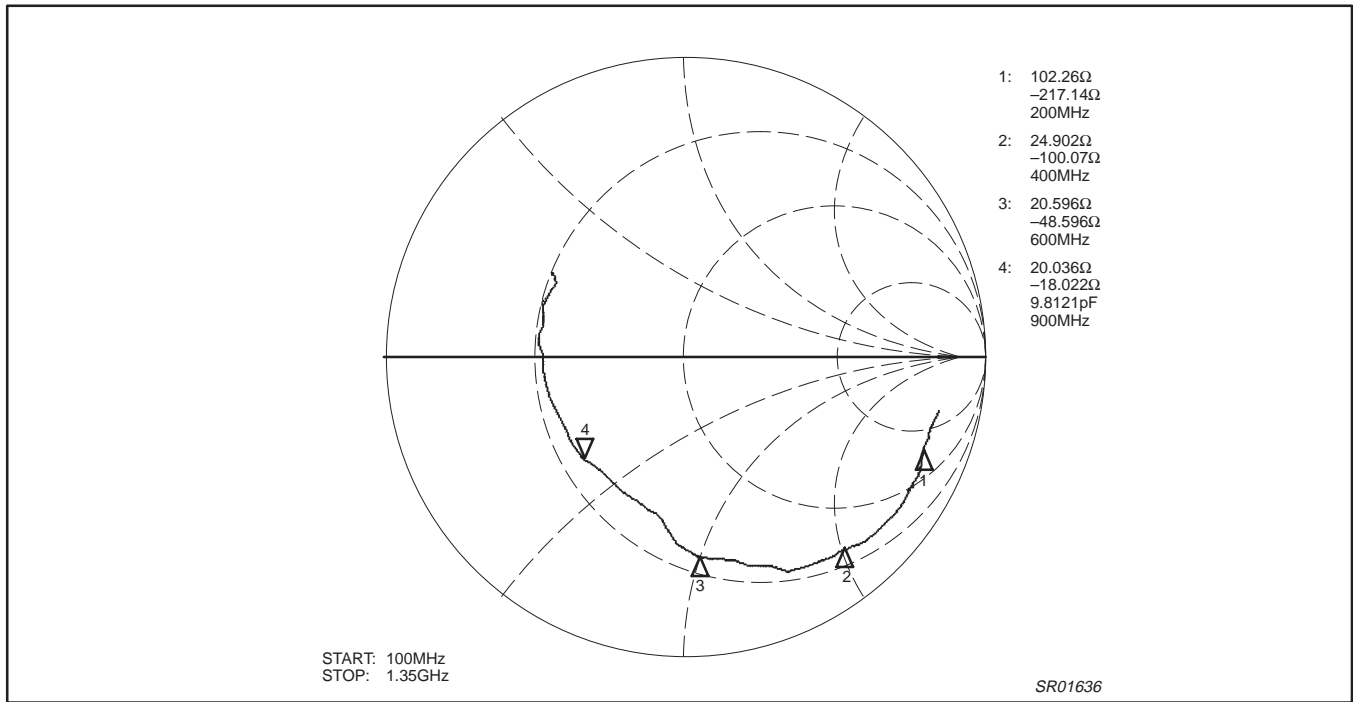


Figure 34. Typical  $S_{11}$  for the Low Band Mixer @ 3.75V for the Receive Normal Mode

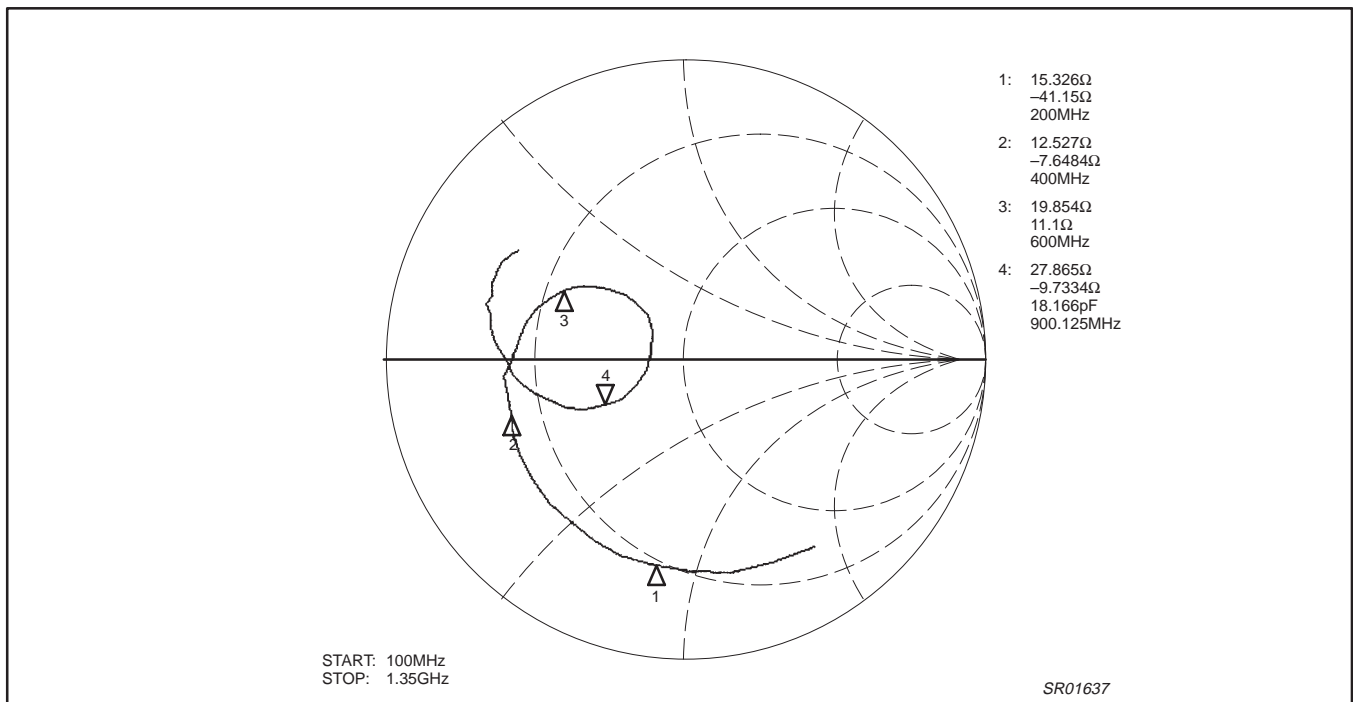


Figure 35. Typical  $S_{11}$  for the Low Band LO @ 3.75V for the Low Band Receive Normal Mode

Satellite and cellular dual-band RF front-end

SA1921

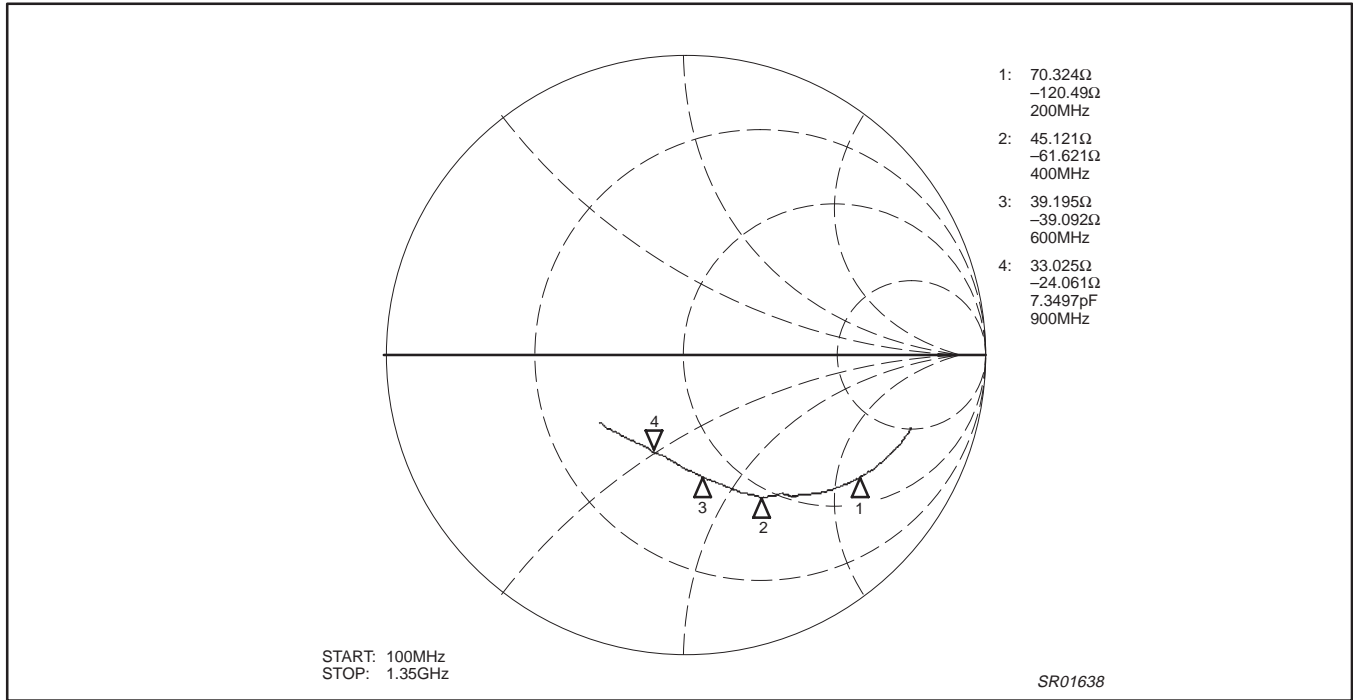


Figure 36. Typical  $S_{11}$  for the Low Band LNA @ 3.75V for the Low Band Transmit (Analog) Mode

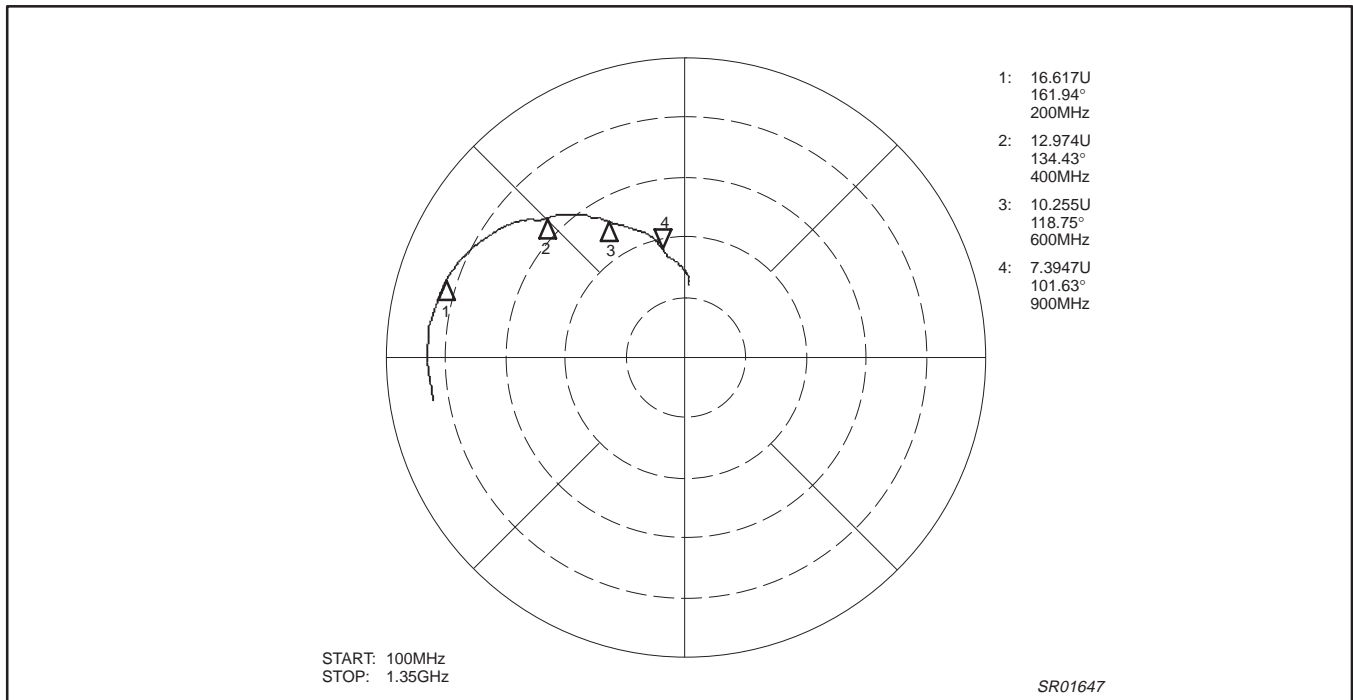


Figure 37. Typical  $S_{21}$  of the Low Band LNA @ 3.75V for the Low Band Transmit (Analog) Mode

Satellite and cellular dual-band RF front-end

SA1921

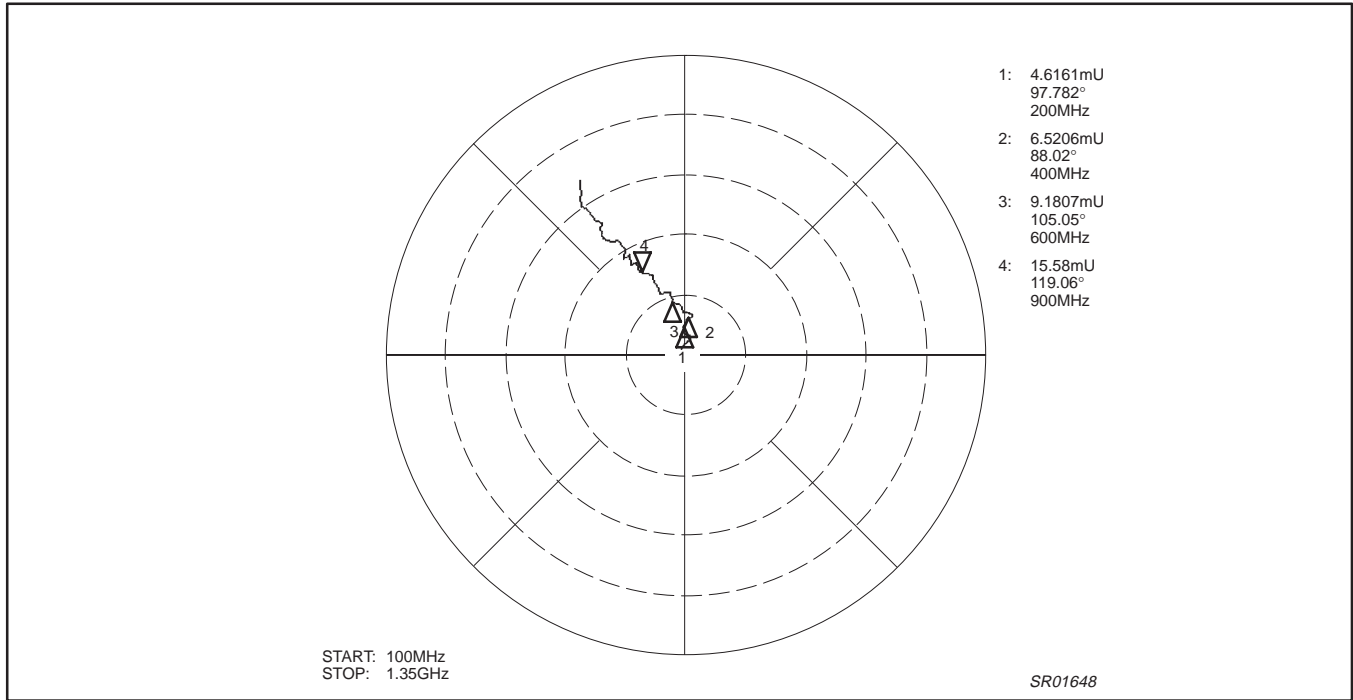


Figure 38. Typical  $S_{12}$  for the Low Band LNA @ 3.75V for the Low Band Transmit (Analog) Mode

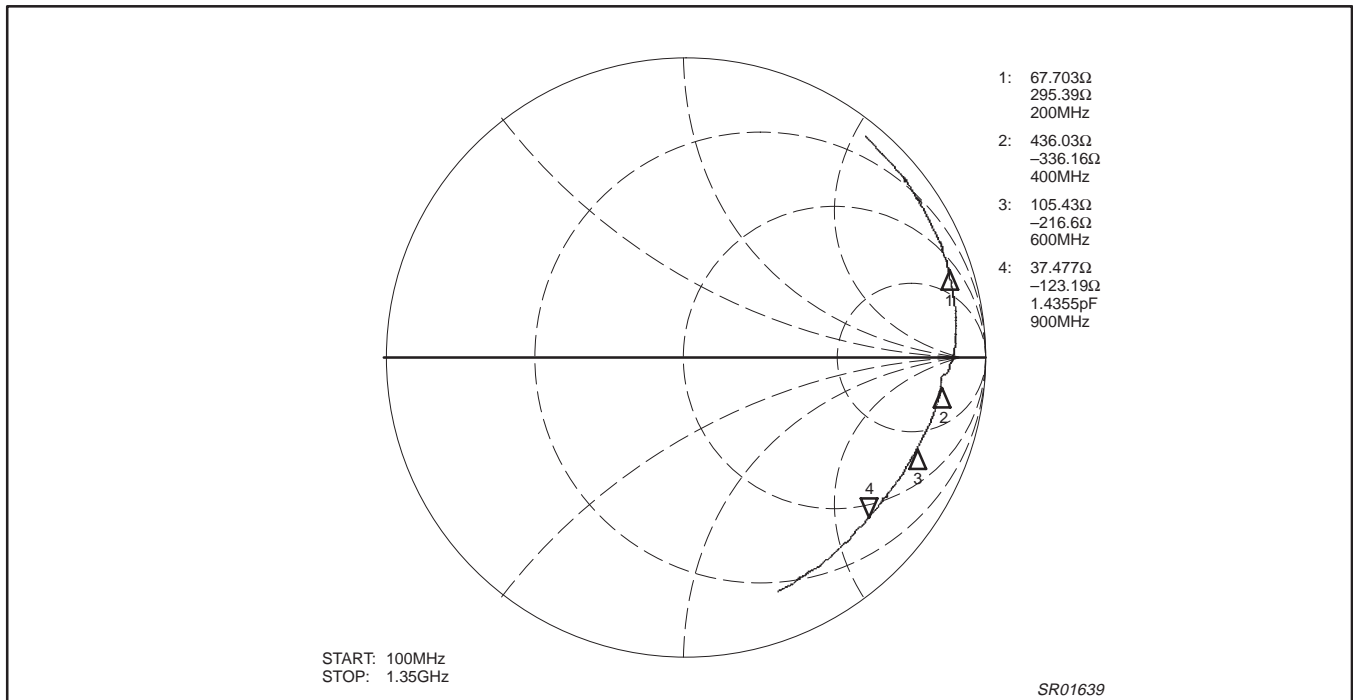


Figure 39. Typical  $S_{22}$  for the Low Band LNA @ 3.75V for the Low Band Transmit (Analog) Mode

Satellite and cellular dual-band RF front-end

SA1921

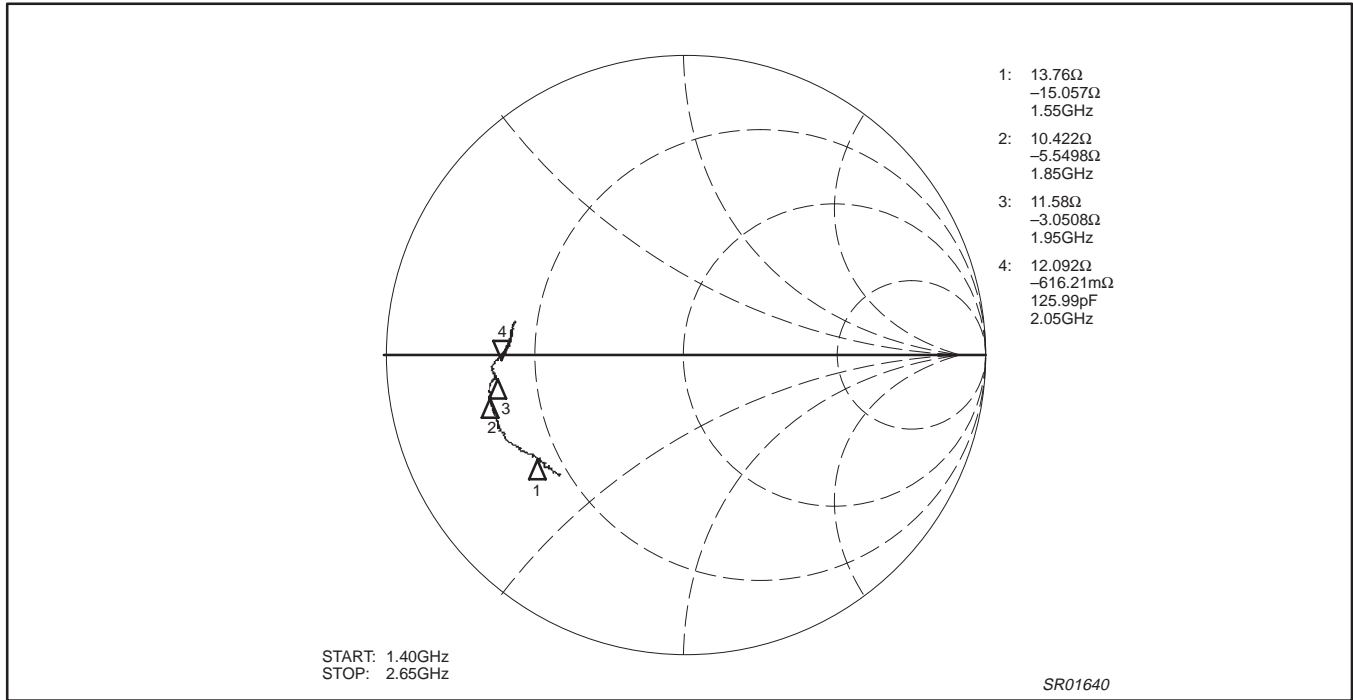


Figure 40. Typical  $S_{11}$  for the High Band LNA @ 3.75V for the High Band Receive Normal Mode

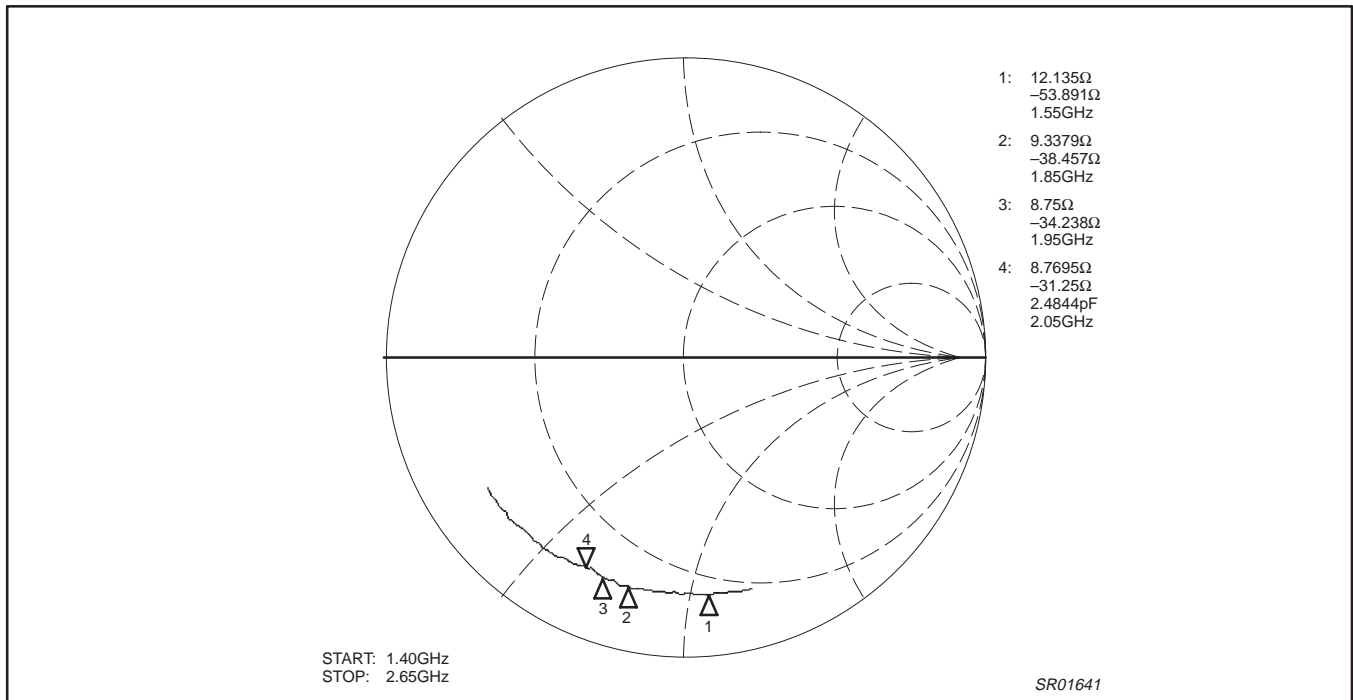


Figure 41. Typical  $S_{11}$  for the High Band LNA @ 3.75V for the High Band Receive Strong Signal Mode



Satellite and cellular dual-band RF front-end

SA1921

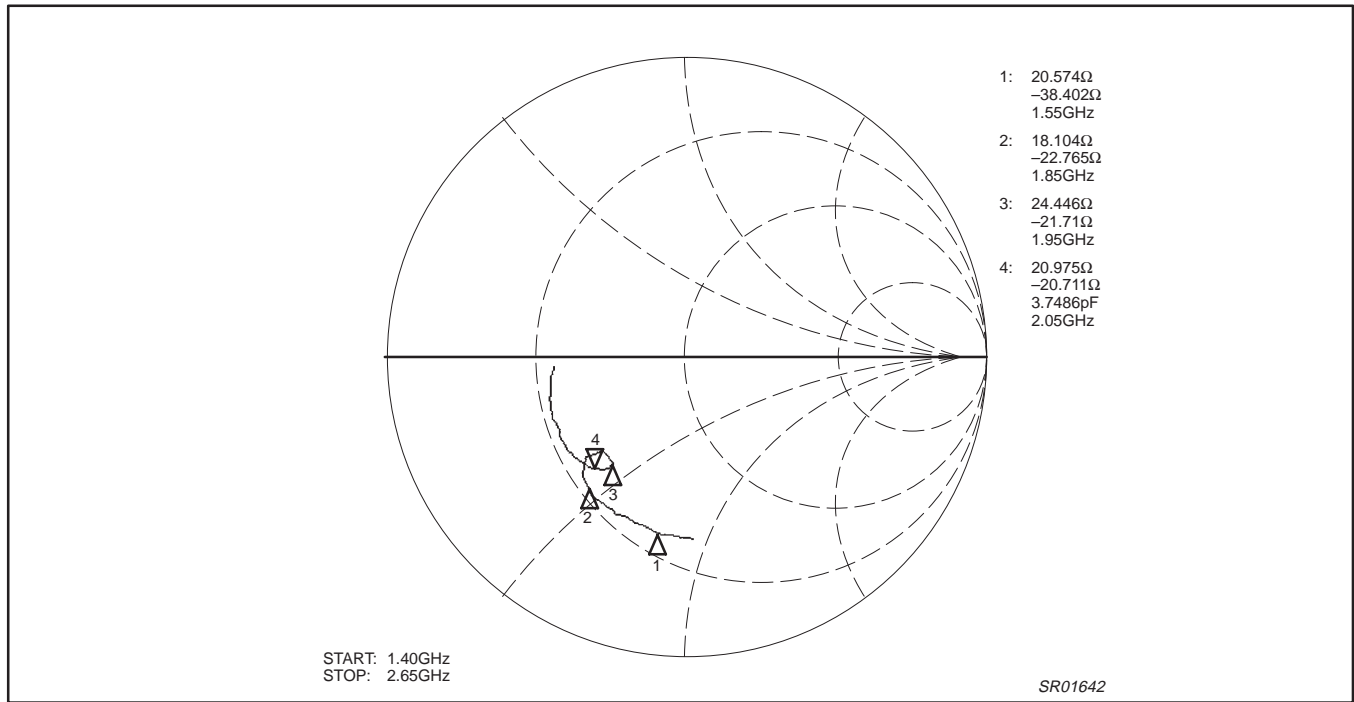


Figure 42. Typical  $S_{11}$  of the High Band LO @ 3.75V for the High Band Receive Normal Mode

## Satellite and cellular dual-band RF front-end

## SA1921

Table 2. Typical S-Parameters of Low Band LNA at  $V_{CC} = +3.75V$ , LB Receive Normal Mode

| FREQ (MHz) | S11  (U) | <S11 (DEG) | S21  (U) | <S21 (DEG) | S12  (U) | <S12 (DEG) | S22  (U) | <S22 (DEG) |
|------------|----------|------------|----------|------------|----------|------------|----------|------------|
| 100        | 0.89     | -15.49     | 8.70     | -165.43    | 0.0027   | 108.66     | 0.97     | 51.38      |
| 150        | 0.87     | -22.76     | 8.71     | -179.74    | 0.0038   | 93.41      | 0.96     | 31.54      |
| 200        | 0.85     | -29.87     | 8.53     | 170.16     | 0.0049   | 92.10      | 0.96     | 19.54      |
| 250        | 0.82     | -37.01     | 8.33     | 161.71     | 0.0065   | 86.08      | 0.95     | 11.08      |
| 300        | 0.79     | -43.99     | 8.12     | 154.61     | 0.0071   | 82.95      | 0.94     | 4.19       |
| 350        | 0.75     | -50.47     | 7.75     | 148.41     | 0.0078   | 69.24      | 0.93     | -1.56      |
| 400        | 0.73     | -56.72     | 7.49     | 144.24     | 0.0072   | 71.73      | 0.91     | -5.69      |
| 450        | 0.70     | -63.14     | 7.24     | 139.14     | 0.0078   | 76.99      | 0.91     | -10.06     |
| 500        | 0.67     | -69.13     | 6.97     | 134.34     | 0.0071   | 82.72      | 0.90     | -13.94     |
| 550        | 0.63     | -75.14     | 6.71     | 130.13     | 0.0078   | 84.15      | 0.89     | -17.69     |
| 600        | 0.61     | -81.15     | 6.45     | 126.62     | 0.0074   | 87.69      | 0.88     | -21.14     |
| 650        | 0.59     | -86.84     | 6.23     | 122.98     | 0.0079   | 91.07      | 0.88     | -24.77     |
| 700        | 0.57     | -92.30     | 6.03     | 119.16     | 0.0085   | 103.71     | 0.87     | -28.09     |
| 750        | 0.55     | -97.73     | 5.80     | 115.55     | 0.0098   | 103.73     | 0.87     | -31.38     |
| 800        | 0.54     | -102.99    | 5.56     | 111.56     | 0.0107   | 113.57     | 0.86     | -34.82     |
| 850        | 0.53     | -108.21    | 5.24     | 107.93     | 0.0121   | 115.45     | 0.86     | -38.18     |
| 900        | 0.52     | -113.27    | 4.97     | 105.40     | 0.0134   | 124.98     | 0.86     | -41.51     |
| 950        | 0.51     | -118.12    | 4.75     | 104.08     | 0.0155   | 127.67     | 0.86     | -44.72     |
| 1000       | 0.51     | -122.43    | 4.62     | 102.52     | 0.0175   | 128.87     | 0.86     | -47.96     |
| 1050       | 0.51     | -126.73    | 4.52     | 99.54      | 0.0193   | 128.89     | 0.86     | -51.12     |
| 1100       | 0.50     | -130.83    | 4.34     | 96.33      | 0.0217   | 129.85     | 0.86     | -54.20     |
| 1150       | 0.51     | -134.58    | 4.13     | 93.78      | 0.0238   | 128.74     | 0.86     | -57.23     |
| 1200       | 0.51     | -138.20    | 3.94     | 91.13      | 0.0269   | 131.20     | 0.86     | -60.03     |
| 1250       | 0.51     | -141.69    | 3.72     | 88.49      | 0.0297   | 130.22     | 0.87     | -62.72     |
| 1300       | 0.51     | -145.12    | 3.46     | 86.84      | 0.032    | 128.07     | 0.87     | -65.57     |
| 1350       | 0.52     | -148.25    | 3.25     | 86.69      | 0.033    | 127.73     | 0.87     | -68.10     |

## Satellite and cellular dual-band RF front-end

SA1921

**Table 3. Typical S-Parameters of Low Band LNA at  $V_{CC} = +3.75V$ , LB Strong Signal Mode**

| FREQ (MHz) | S11  (U) | <S11 (DEG) | S21  (U) | <S21 (DEG) | S12  (U) | <S12 (DEG) | S22  (U) | <S22 (DEG) |
|------------|----------|------------|----------|------------|----------|------------|----------|------------|
| 100        | 0.94     | -8.77      | 0.05     | 88.15      | 0.049    | 84.08      | 0.96     | 50.15      |
| 150        | 0.92     | -12.15     | 0.07     | 68.32      | 0.069    | 63.51      | 0.95     | 30.01      |
| 200        | 0.90     | -15.01     | 0.08     | 55.23      | 0.082    | 47.79      | 0.93     | 17.79      |
| 250        | 0.88     | -17.75     | 0.09     | 46.14      | 0.090    | 37.04      | 0.92     | 9.22       |
| 300        | 0.87     | -20.37     | 0.09     | 39.25      | 0.094    | 28.09      | 0.91     | 2.68       |
| 350        | 0.85     | -23.15     | 0.10     | 33.96      | 0.099    | 21.40      | 0.90     | -2.68      |
| 400        | 0.85     | -25.85     | 0.10     | 29.86      | 0.100    | 14.70      | 0.89     | -7.56      |
| 450        | 0.84     | -28.73     | 0.10     | 26.35      | 0.102    | 9.32       | 0.88     | -12.06     |
| 500        | 0.83     | -31.65     | 0.10     | 23.06      | 0.103    | 4.37       | 0.88     | -16.23     |
| 550        | 0.82     | -34.56     | 0.10     | 20.07      | 0.103    | -0.41      | 0.87     | -20.35     |
| 600        | 0.81     | -38.02     | 0.10     | 17.87      | 0.103    | -5.17      | 0.86     | -24.23     |
| 650        | 0.80     | -41.41     | 0.10     | 15.28      | 0.104    | -9.07      | 0.85     | -28.29     |
| 700        | 0.80     | -44.70     | 0.10     | 12.27      | 0.104    | -13.29     | 0.85     | -32.11     |
| 750        | 0.79     | -48.40     | 0.10     | 9.05       | 0.103    | -18.00     | 0.84     | -35.85     |
| 800        | 0.78     | -52.30     | 0.10     | 5.24       | 0.103    | -23.07     | 0.83     | -39.74     |
| 850        | 0.78     | -56.58     | 0.10     | 2.20       | 0.102    | -28.68     | 0.83     | -43.59     |
| 900        | 0.77     | -60.63     | 0.09     | -0.26      | 0.099    | -33.94     | 0.82     | -47.19     |
| 950        | 0.77     | -64.88     | 0.09     | -2.21      | 0.094    | -39.65     | 0.82     | -50.95     |
| 1000       | 0.76     | -69.05     | 0.09     | -4.19      | 0.090    | -44.01     | 0.81     | -54.29     |
| 1050       | 0.76     | -73.21     | 0.09     | -7.58      | 0.086    | -47.95     | 0.81     | -57.67     |
| 1100       | 0.76     | -77.26     | 0.09     | -11.56     | 0.084    | -52.34     | 0.81     | -60.86     |
| 1150       | 0.76     | -81.34     | 0.08     | -16.05     | 0.080    | -58.43     | 0.80     | -64.05     |
| 1200       | 0.76     | -85.37     | 0.08     | -19.50     | 0.076    | -62.90     | 0.80     | -66.96     |
| 1250       | 0.76     | -89.33     | 0.07     | -23.71     | 0.074    | -68.35     | 0.80     | -69.89     |
| 1300       | 0.76     | -93.28     | 0.07     | -27.20     | 0.072    | -75.17     | 0.79     | -72.64     |
| 1350       | 0.75     | -97.37     | 0.06     | -31.20     | 0.068    | -82.58     | 0.79     | -75.21     |

## Satellite and cellular dual-band RF front-end

SA1921

Table 4. Typical S-Parameters of Low Band LNA at  $V_{CC} = +3.75V$ , LB Transmit On (Analog) Mode

| FREQ (MHz) | S11  (U) | <S11 (DEG) | S21  (U) | <S21 (DEG) | S12  (U) | <S12 (DEG) | S22  (U) | <S22 (DEG) |
|------------|----------|------------|----------|------------|----------|------------|----------|------------|
| 100        | 0.80     | -18.49     | 16.98    | -170.30    | 0.003    | 121.40     | 0.95     | 50.55      |
| 150        | 0.76     | -27.25     | 17.07    | 173.61     | 0.004    | 100.49     | 0.94     | 30.44      |
| 200        | 0.72     | -35.34     | 16.62    | 161.95     | 0.005    | 87.01      | 0.93     | 18.29      |
| 250        | 0.67     | -43.14     | 15.82    | 152.47     | 0.005    | 88.74      | 0.92     | 9.80       |
| 300        | 0.62     | -50.04     | 14.89    | 144.65     | 0.007    | 80.87      | 0.91     | 2.68       |
| 350        | 0.57     | -55.41     | 13.73    | 138.33     | 0.007    | 64.95      | 0.89     | -2.99      |
| 400        | 0.55     | -61.58     | 12.97    | 134.43     | 0.007    | 90.16      | 0.87     | -6.38      |
| 450        | 0.51     | -67.13     | 12.27    | 129.49     | 0.007    | 90.97      | 0.86     | -10.66     |
| 500        | 0.47     | -72.08     | 11.53    | 125.20     | 0.008    | 89.19      | 0.85     | -14.35     |
| 550        | 0.44     | -76.94     | 10.83    | 121.58     | 0.009    | 96.23      | 0.84     | -17.92     |
| 600        | 0.42     | -81.92     | 10.24    | 118.69     | 0.009    | 98.83      | 0.84     | -21.27     |
| 650        | 0.40     | -86.62     | 9.78     | 115.74     | 0.009    | 102.03     | 0.83     | -24.85     |
| 700        | 0.38     | -91.05     | 9.32     | 112.66     | 0.010    | 107.95     | 0.83     | -28.04     |
| 750        | 0.37     | -95.76     | 8.89     | 109.66     | 0.012    | 108.58     | 0.83     | -31.27     |
| 800        | 0.36     | -100.37    | 8.46     | 106.44     | 0.012    | 114.73     | 0.82     | -34.68     |
| 850        | 0.35     | -105.06    | 7.92     | 103.48     | 0.014    | 115.62     | 0.82     | -38.05     |
| 900        | 0.34     | -109.12    | 7.39     | 101.58     | 0.015    | 116.40     | 0.82     | -41.29     |
| 950        | 0.34     | -113.76    | 7.02     | 100.76     | 0.017    | 116.04     | 0.82     | -44.70     |
| 1000       | 0.34     | -117.50    | 6.81     | 99.95      | 0.019    | 122.13     | 0.82     | -47.58     |
| 1050       | 0.34     | -121.31    | 6.64     | 97.57      | 0.021    | 122.61     | 0.83     | -50.73     |
| 1100       | 0.34     | -124.67    | 6.36     | 94.92      | 0.023    | 121.36     | 0.83     | -53.76     |
| 1150       | 0.35     | -127.76    | 6.09     | 92.79      | 0.025    | 123.58     | 0.83     | -56.81     |
| 1200       | 0.35     | -130.93    | 5.80     | 90.59      | 0.026    | 125.25     | 0.83     | -59.62     |
| 1250       | 0.36     | -133.78    | 5.48     | 88.25      | 0.030    | 123.53     | 0.84     | -62.32     |
| 1300       | 0.36     | -136.90998 | 5.10     | 87.00      | 0.03     | 122.37     | 0.84     | -65.27     |
| 1350       | 0.37     | -140.02216 | 4.82     | 87.05      | 0.03     | 122.64     | 0.85     | -68.06     |

## Satellite and cellular dual-band RF front-end

SA1921

Table 5. Typical S-Parameters of Low Band Mixer Input at  $V_{CC} = +3.75V$ , LB Receive Normal Mode

| FREQ (MHz) | S11  (U) | <S11 (DEG) |
|------------|----------|------------|
| 100        | 0.85     | -13.10     |
| 150        | 0.84     | -17.65     |
| 200        | 0.85     | -23.74     |
| 250        | 0.85     | -29.63     |
| 300        | 0.85     | -37.49     |
| 350        | 0.85     | -45.23     |
| 400        | 0.85     | -54.50     |
| 450        | 0.80     | -64.14     |
| 500        | 0.75     | -73.90     |
| 550        | 0.70     | -82.34     |
| 600        | 0.67     | -91.47     |
| 650        | 0.57     | -100.54    |
| 700        | 0.53     | -106.44    |
| 750        | 0.51     | -114.37    |
| 800        | 0.49     | -123.87    |
| 850        | 0.48     | -132.17    |
| 900        | 0.49     | -141.42    |
| 950        | 0.47     | -150.07    |
| 1000       | 0.47     | -160.64    |
| 1050       | 0.47     | -169.49    |
| 1100       | 0.47     | -179.79    |
| 1150       | 0.48     | 171.14     |
| 1200       | 0.48     | 162.01     |
| 1250       | 0.49     | 154.08     |
| 1300       | 0.50     | 144.55     |
| 1350       | 0.51     | 136.11     |

## Satellite and cellular dual-band RF front-end

SA1921

Table 6. Typical S-Parameters of Low Band LO Input at  $V_{CC} = +3.75V$ , LB Receive Normal Mode

| FREQ (MHz) | S11  (U) | <S11 (DEG) |
|------------|----------|------------|
| 100        | 0.76     | -55.83     |
| 150        | 0.73     | -78.35     |
| 200        | 0.70     | -98.64     |
| 250        | 0.68     | -116.73    |
| 300        | 0.66     | -133.17    |
| 350        | 0.64     | -147.82    |
| 400        | 0.61     | -161.51    |
| 450        | 0.59     | -173.68    |
| 500        | 0.55     | 173.99     |
| 550        | 0.51     | 162.15     |
| 600        | 0.46     | 150.30     |
| 650        | 0.38     | 140.69     |
| 700        | 0.29     | 132.76     |
| 750        | 0.18     | 131.71     |
| 800        | 0.10     | 171.44     |
| 850        | 0.18     | -150.19    |
| 900        | 0.31     | -149.41    |
| 950        | 0.42     | -157.78    |
| 1000       | 0.50     | -166.73    |
| 1050       | 0.57     | -175.14    |
| 1100       | 0.61     | 177.49     |
| 1150       | 0.64     | 170.74     |
| 1200       | 0.66     | 164.22     |
| 1250       | 0.68     | 157.61     |
| 1300       | 0.68     | 150.89     |
| 1350       | 0.65     | 144.80     |

## Satellite and cellular dual-band RF front-end

SA1921

Table 7. Typical S-Parameters of HB LNA Input at  $V_{CC} = +3.75V$ , HB Receive Normal Mode

| FREQ (MHz) | S11  (U) | <S11 (DEG) |
|------------|----------|------------|
| 1400       | 0.58     | -135.43    |
| 1450       | 0.59     | -138.48    |
| 1500       | 0.59     | -141.42    |
| 1550       | 0.60     | -144.44    |
| 1600       | 0.62     | -146.93    |
| 1650       | 0.63     | -149.85    |
| 1700       | 0.65     | -154.08    |
| 1750       | 0.66     | -158.38    |
| 1800       | 0.66     | -162.67    |
| 1850       | 0.66     | -167.09    |
| 1900       | 0.65     | -170.72    |
| 1950       | 0.63     | -172.76    |
| 2000       | 0.64     | -175.38    |
| 2050       | 0.61     | -178.44    |
| 2100       | 0.60     | -179.38    |
| 2150       | 0.59     | 179.32     |
| 2200       | 0.58     | 178.44     |
| 2250       | 0.58     | 177.61     |
| 2300       | 0.57     | 176.29     |
| 2350       | 0.57     | 175.39     |
| 2400       | 0.57     | 174.35     |
| 2450       | 0.56     | 173.01     |
| 2500       | 0.57     | 172.12     |
| 2550       | 0.57     | 170.91     |
| 2600       | 0.56     | 169.89     |
| 2650       | 0.56     | 168.41     |

## Satellite and cellular dual-band RF front-end

SA1921

Table 8. Typical S-Parameters of HB LNA Input at  $V_{CC} = +3.75V$ , HB Strong Signal Mode

| FREQ (MHz) | S11  (U) | <S11 (DEG) |
|------------|----------|------------|
| 1400       | 0.81     | -73.99     |
| 1450       | 0.81     | -77.23     |
| 1500       | 0.81     | -80.62     |
| 1550       | 0.80     | -84.00     |
| 1600       | 0.80     | -87.02     |
| 1650       | 0.80     | -90.35     |
| 1700       | 0.79     | -93.54     |
| 1750       | 0.79     | -96.48     |
| 1800       | 0.79     | -100.32    |
| 1850       | 0.79     | -103.54    |
| 1900       | 0.79     | -107.23    |
| 1950       | 0.79     | -110.05    |
| 2000       | 0.77     | -113.75    |
| 2050       | 0.78     | -114.79    |
| 2100       | 0.79     | -117.61    |
| 2150       | 0.79     | -120.50    |
| 2200       | 0.80     | -122.65    |
| 2250       | 0.79     | -125.91    |
| 2300       | 0.80     | -128.17    |
| 2350       | 0.79     | -130.64    |
| 2400       | 0.79     | -133.19    |
| 2450       | 0.79     | -135.66    |
| 2500       | 0.79     | -138.22    |
| 2550       | 0.79     | -140.56    |
| 2600       | 0.79     | -143.22    |
| 2650       | 0.79     | -145.47    |



## Satellite and cellular dual-band RF front-end

SA1921

Table 9. Typical S-Parameters of HB LO Input at  $V_{CC} = +3.75V$ , HB Receive Normal Mode

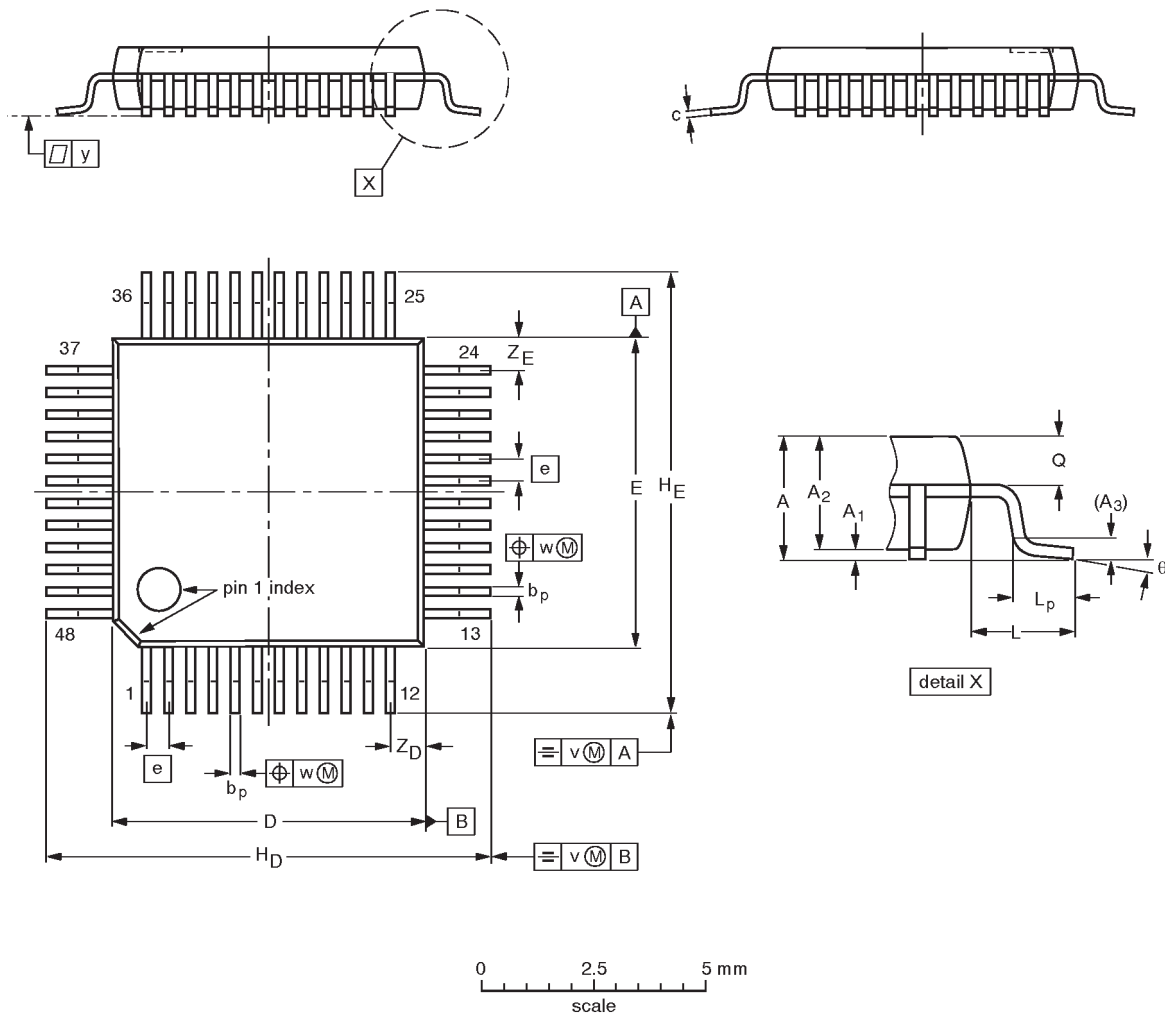
| FREQ (MHz) | S11  (U) | <S11 (DEG) |
|------------|----------|------------|
| 1400       | 0.62     | -87.50     |
| 1450       | 0.61     | -90.87     |
| 1500       | 0.60     | -94.44     |
| 1550       | 0.60     | -98.86     |
| 1600       | 0.59     | -102.10    |
| 1650       | 0.59     | -106.34    |
| 1700       | 0.58     | -110.67    |
| 1750       | 0.57     | -114.48    |
| 1800       | 0.57     | -119.86    |
| 1850       | 0.55     | -126.14    |
| 1900       | 0.48     | -134.66    |
| 1950       | 0.43     | -123.95    |
| 2000       | 0.47     | -126.26    |
| 2050       | 0.48     | -128.33    |
| 2100       | 0.50     | -131.34    |
| 2150       | 0.50     | -135.52    |
| 2200       | 0.50     | -138.76    |
| 2250       | 0.50     | -142.68    |
| 2300       | 0.50     | -146.60    |
| 2350       | 0.49     | -150.21    |
| 2400       | 0.49     | -154.30    |
| 2450       | 0.48     | -157.62    |
| 2500       | 0.47     | -161.79    |
| 2550       | 0.46     | -166.32    |
| 2600       | 0.45     | -170.41    |
| 2650       | 0.43     | -174.86    |

Satellite and cellular dual-band RF front-end

SA1921

LQFP48: plastic low profile quad flat package; 48 leads; body 7 x 7 x 1.4 mm

SOT313-2



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c            | D <sup>(1)</sup> | E <sup>(1)</sup> | e   | H <sub>D</sub> | H <sub>E</sub> | L   | L <sub>p</sub> | Q            | v   | w    | y   | Z <sub>D</sub> <sup>(1)</sup> | Z <sub>E</sub> <sup>(1)</sup> | θ        |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|-----|----------------|----------------|-----|----------------|--------------|-----|------|-----|-------------------------------|-------------------------------|----------|
| mm   | 1.60   | 0.20<br>0.05   | 1.45<br>1.35   | 0.25           | 0.27<br>0.17   | 0.18<br>0.12 | 7.1<br>6.9       | 7.1<br>6.9       | 0.5 | 9.15<br>8.85   | 9.15<br>8.85   | 1.0 | 0.75<br>0.45   | 0.69<br>0.59 | 0.2 | 0.12 | 0.1 | 0.95<br>0.55                  | 0.95<br>0.55                  | 7°<br>0° |

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES |       |      |  | EUROPEAN PROJECTION | ISSUE DATE            |
|-----------------|------------|-------|------|--|---------------------|-----------------------|
|                 | IEC        | JEDEC | EIAJ |  |                     |                       |
| SOT313-2        |            |       |      |  |                     | 93-06-15-<br>94-12-19 |

---

Satellite and cellular dual-band RF front-end

SA1921

---

**NOTES**

## Satellite and cellular dual-band RF front-end

SA1921

**Data sheet status**

| Data sheet status         | Product status | Definition [1]   |
|---------------------------|----------------|--|
| Objective specification   | Development    | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.  |
| Preliminary specification | Qualification  | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Product specification     | Production     | This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.   |

[1] Please consult the most recently issued datasheet before initiating or completing a design.

**Definitions**

**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

**Application information** — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

**Disclaimers**

**Life support** — These products are not designed for use in life support appliances, devices or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips Semiconductors customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

**Right to make changes** — Philips Semiconductors reserves the right to make changes, without notice, in the products, including circuits, standard cells, and/or software, described or contained herein in order to improve design and/or performance. Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

Philips Semiconductors  
811 East Arques Avenue  
P.O. Box 3409  
Sunnyvale, California 94088-3409  
Telephone 800-234-7381

© Copyright Philips Electronics North America Corporation 1999  
All rights reserved. Printed in U.S.A.

Date of release: 03-99

Document order number:

9397 750 05353

*Let's make things better.*