# GPS1502L

## SiGe:C low-noise amplifier MMIC for GPS, GLONASS, Galileo and COMPASS

Rev. 5 — 22 March 2019 Product data sheet

## 1 General description

The GPS1502L is a Low-Noise Amplifier (LNA) for GNSS receiver applications and is available in a small plastic 6-pin extremely thin leadless package. The GPS1502L requires only one external matching inductor.

The GPS1502L adapts itself to the changing environment resulting from co-habitation of different radio systems in modern cellular handsets. It has been designed for low power consumption and optimal performance when jamming signals from co-existing cellular transmitters are present. At low jamming power levels, it delivers 17 dB gain at a noise figure of 0.6 dB and a supply current of 4.2 mA. During high jamming power levels, resulting, for example, from a cellular transmit burst, it temporarily increases its bias current to improve sensitivity.

The GPS1502L is optimized for 1164 MHz to 1299 MHz.

## 2 Features and benefits

- Covers full GNSS lower L-band, from 1164 MHz to 1299 MHz
- Noise figure = 0.6 dB
- Gain 17 dB
- High-input 1 dB compression point of -13 dBm
- High in-band $IP3_i$ of -1 dBm
- Supply voltage 1.5 V to 3.1 V
- Optimized performance at a low supply current of 4.2 mA
- Integrated RF supply decoupling capacitor
- Power-down mode current consumption < 1 µA
- Integrated temperature stabilized bias for easy design
- Requires only one input matching inductor
- Integrated DC blocking at both RF input and output
- Integrated matching for the output
- ESD protection on all pins
- Self-shielding package concept
- Low Bill of Materials
- 6-pin leadless package: 1.1 mm × 0.7 mm × 0.37 mm; 0.4 mm pitch
- 180 GHz transit frequency - SiGe:C technology
- Moisture sensitivity level 1

## 3 Applications

- Smart phones
- Feature phones
- Tablets
- Digital still cameras
- Digital video cameras
- RF front-end modules
- Complete GNSS modules
- Personal health applications

# 4 Quick reference data

**Table 1. Quick reference data**

*f = 1176 MHz; $V_{CC}$ = 1.8 V; $V_{I(ENABLE)}$ ≥ 0.8 V; $P_i$ = -45 dBm; $T_{amb}$ = 25 °C; input matched to 50 Ω (see Figure 3 and Table 10). Unless otherwise specified.*

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CC}$ | supply current | | | 2.3 | 4.2 | 6.1 | mA |
| $G_p$ | power gain | | | 15.6 | 17 | 18 | dB |
| NF | noise figure | | [1] | - | 0.6 | 0.8 | dB |
| $P_{i(1dB)}$ | input power at 1 dB gain compression | | | -15 | -13 | - | dBm |
| $IP3_i$ | input third-order intercept point | Δf = 1 MHz | | -6 | -1 | - | dBm |

[1] PCB losses are subtracted.

# 5 Ordering information

**Table 2. Ordering information**

| Type number | Orderable part number | Package | | |
|---|---|---|---|---|
| | | Name | Description | Version |
| GPS1502L | GPS1502LX | XSON6 | plastic extremely thin small outline package; no leads; 6 terminals; body 1.1 mm × 0.7 mm × 0.37 mm | SOT1232 |

# 6 Marking

**Table 3. Marking code**

| Type number | Marking code |
|---|---|
| GPS1502L | L |

# 7 Block diagram

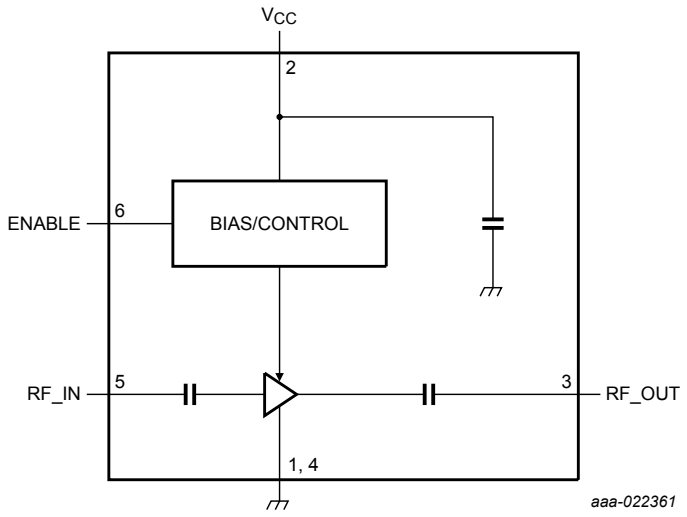



**Figure 1. Block diagram**

# 8 Pinning information

## 8.1 Pinning

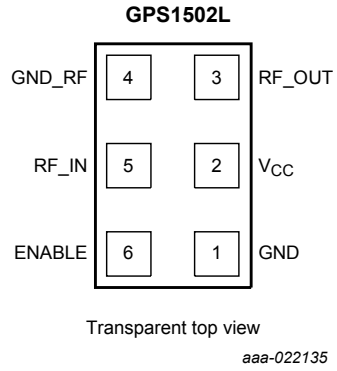



**Figure 2. Pin configuration**

## 8.2 Pin description

**Table 4. Pin description**

| Symbol | Pin | Description |
|---|---|---|
| GND | 1 | ground |
| $V_{CC}$ | 2 | supply voltage |
| RF_OUT | 3 | RF output |
| GND_RF | 4 | ground RF |
| RF_IN | 5 | RF input |
| ENABLE | 6 | enable |

# 9 Limiting values

**Table 5. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | -0.5 | +6.0 | V |
| $V_{I(ENABLE)}$ | input voltage on pin ENABLE | $V_{I(ENABLE)} < V_{CC} + 0.5$ V | -0.5 | +5.0 | V |
| $V_{I(RF\_IN)}$ | input voltage on pin RF_IN | DC [1] | -0.5 | +0.5 | V |
| $V_{I(RF\_OUT)}$ | input voltage on pin RF_OUT | DC; $V_{I(RF\_OUT)} < V_{CC} + 0.5$ V [1] | -0.5 | +5.0 | V |
| $P_i$ | input power | RF; ON state, OFF state | - | 15 | dBm |
| $T_{stg}$ | storage temperature | | -65 | +150 | °C |
| $T_j$ | junction temperature | | - | 150 | °C |
| $V_{ESD}$ | electrostatic discharge voltage | Human Body Model (HBM); according to JEDEC standard JS-001 | - | ±2 | kV |
| | | Charged Device Model (CDM); according to JEDEC standard JS-002 | - | ±1 | kV |

[1] The RF input and RF output are AC coupled through internal DC blocking capacitors.

# 10 Operating conditions

**Table 6. Operating conditions**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | 1.5 | - | 3.1 | V |
| $T_{amb}$ | ambient temperature | | -40 | +25 | +85 | °C |
| $V_{I(ENABLE)}$ | input voltage on pin ENABLE | OFF state | 0.0 | - | 0.3 | V |
| | | ON state | 0.8 | - | $V_{CC}$ | V |

# 11 Thermal characteristics

**Table 7. Thermal characteristics**

| Symbol | Parameter | Conditions | Typ | Unit |
|---|---|---|---|---|
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | 225 | K/W |

# 12 Characteristics

**Table 8. Characteristics at $V_{CC}$ = 1.8 V**

*f = 1176 MHz; $V_{CC}$ = 1.8 V; $V_{I(ENABLE)}$ ≥ 0.8 V; $P_i$ < -40 dBm; $T_{amb}$ = 25 °C. Input matched to 50 Ω (see Figure 3 and Table 10). Unless otherwise specified.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}$ | supply current | $V_{I(ENABLE)}$ ≥ 0.8 V | | | | |
| | | $P_i$ < -40 dBm | 2.3 | 4.2 | 6.1 | mA |
| | | $P_i$ = -20 dBm | - | 4.9 | - | mA |
| | | $V_{I(ENABLE)}$ ≤ 0.3 V | - | - | 1 | µA |
| $G_p$ | power gain | no jammer | 15.6 | 17 | 18 | dB |
| | | $P_{jam}$ = -21 dBm; $f_{jam}$ = 915 MHz | - | 17 | - | dB |
| | | $P_{jam}$ = -21 dBm; $f_{jam}$ = 1427 MHz | - | 17 | - | dB |
| $RL_{in}$ | input return loss | | 8 | 11 | - | dB |
| $RL_{out}$ | output return loss | | 7 | 10 | - | dB |
| ISL | isolation | | 25 | 27 | - | dB |
| K | Rollett stability factor | | 1 | - | - | |
| NF | noise figure | no jammer [1] | - | 0.60 | 0.80 | dB |
| | | $P_{jam}$ = -22 dBm; $f_{jam}$ = 915 MHz [1] | - | 0.80 | - | dB |
| | | $P_{jam}$ = -22 dBm; $f_{jam}$ = 1427 MHz [1] | - | 0.90 | - | dB |
| $P_{i(1dB)}$ | input power at 1 dB gain compression | | -15 | -13 | - | dBm |
| $IP3_i$ | input third-order intercept point | Δf = 1 MHz | -6 | -1 | - | dBm |
| $t_{on}$ | turn-on time | time from $V_{I(ENABLE)}$ ON to 90 % of the gain | - | - | 2 | µs |
| $t_{off}$ | turn-off time | time from $V_{I(ENABLE)}$ OFF to 10 % of the gain | - | - | 1 | µs |

[1] PCB losses are subtracted.

### Table 9. Characteristics at $V_{CC}$ = 2.8 V

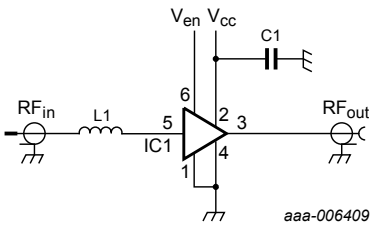
*f = 1176 MHz; $V_{CC}$ = 2.8 V; $V_{I(ENABLE)}$ ≥ 0.8 V; $P_i$ < -40 dBm; $T_{amb}$ = 25 °C. Input matched to 50 Ω (see Figure 3 and Table 10. Unless otherwise specified.*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}$ | supply current | $V_{I(ENABLE)}$ ≥ 0.8 V | | | | |
| | | $P_i$ < -40 dBm | 2.4 | 4.4 | 6.4 | mA |
| | | $P_i$ = -20 dBm | - | 5.1 | - | mA |
| | | $V_{I(ENABLE)}$ ≤ 0.3 V | - | - | 1 | µA |
| $G_p$ | power gain | no jammer | 15.6 | 17 | 18 | dB |
| | | $P_{jam}$ = -21 dBm; $f_{jam}$ = 915 MHz | - | 17 | - | dB |
| | | $P_{jam}$ = -21 dBm; $f_{jam}$ = 1427 MHz | - | 17 | - | dB |
| $RL_{in}$ | input return loss | | 9 | 12 | - | dB |
| $RL_{out}$ | output return loss | | 7 | 10 | - | dB |
| ISL | isolation | | 25 | 27 | - | dB |
| K | Rollett stability factor | | 1 | - | - | |
| NF | noise figure | no jammer [1] | - | 0.65 | 0.85 | dB |
| | | $P_{jam}$ = -22 dBm; $f_{jam}$ = 915 MHz [1] | - | 0.85 | - | dB |
| | | $P_{jam}$ = -22 dBm; $f_{jam}$ = 1427 MHz [1] | - | 0.95 | - | dB |
| $P_{i(1dB)}$ | input power at 1 dB gain compression | | -11 | -9 | - | dBm |
| $IP3_i$ | input third-order intercept point | Δf = 1 MHz | -6 | 0 | - | dBm |
| $t_{on}$ | turn-on time | time from $V_{I(ENABLE)}$ ON to 90 % of the gain | - | - | 2 | µs |
| $t_{off}$ | turn-off time | time from $V_{I(ENABLE)}$ OFF to 10 % of the gain | - | - | 1 | µs |

[1] PCB losses are subtracted.

# 13 Application information

## 13.1 GNSS application




For a list of components, see Table 10.

**Figure 3. Schematics GNSS evaluation board**

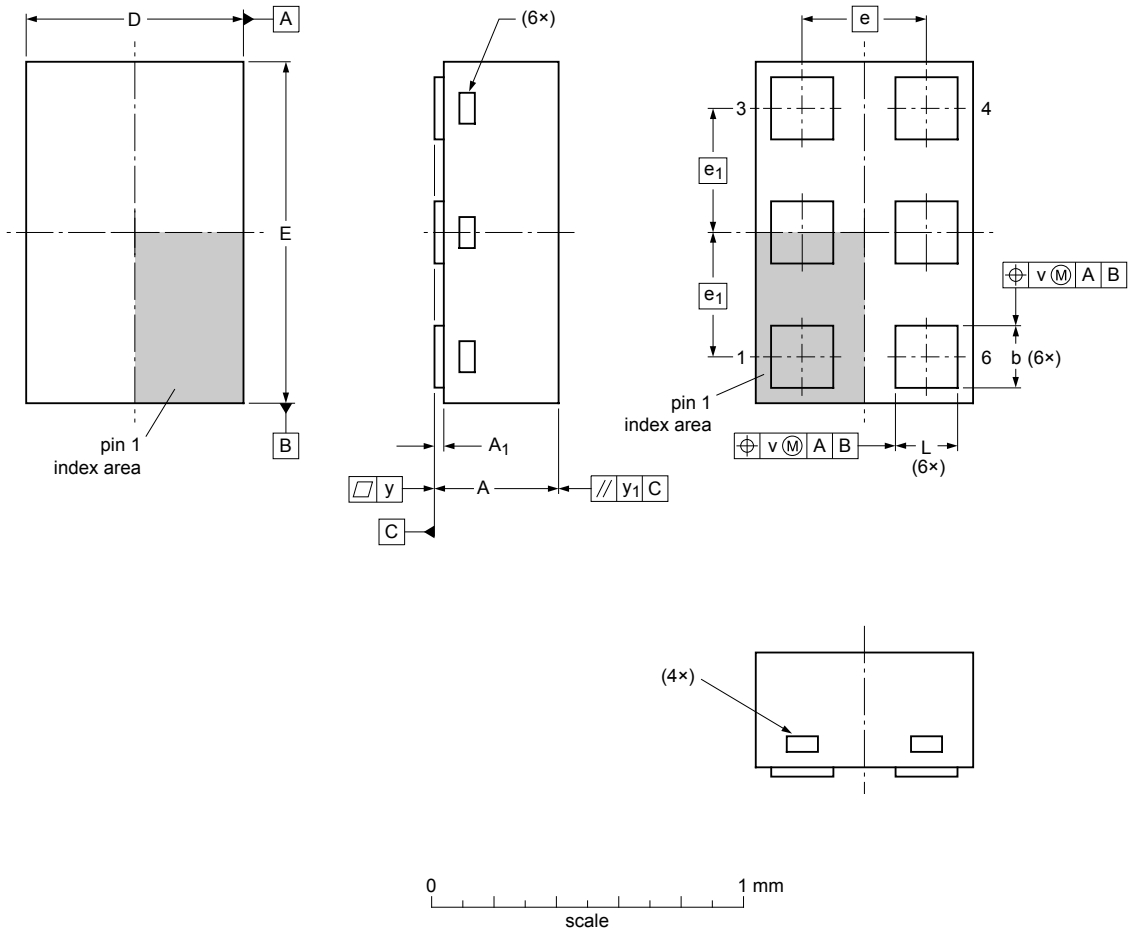
**Table 10. List of components**

*For schematics, see Figure 3.*

| Component | Description | Value | Remarks |
|---|---|---|---|
| C1 | decoupling capacitor | 1 µF | The total capacitance on the $V_{CC}$ node must be at least 1 µF. It must be positioned at a short distance from the $V_{CC}$ pin (preferably within 15 mm). Typically, such capacitance is already present at the output of the $V_{CC}$ voltage regulator. |
| IC1 | GPS1502L | - | NXP Semiconductors |
| L1 | high-quality matching inductor | 11 nH | Murata LQW15A |

## 14 Package outline

**XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1.1 x 0.7 x 0.37 mm** **SOT1232**




Dimensions (mm are the original dimensions)

| Unit | | A | $A_1$ | D | E | $e_1$ | e | b | L | V | Y | $Y_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | min | 0.34 | | 0.65 | 1.05 | | | 0.17 | 0.17 | | | |
| | nom | 0.37 | | 0.70 | 1.10 | 0.4 | 0.4 | 0.20 | 0.20 | 0.1 | 0.05 | 0.1 |
| | max | 0.40 | 0.04 | 0.75 | 1.15 | | | 0.25 | 0.25 | | | |

Note
1. Dimension A is including plating thickness.

*sot1232_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT1232 | | | | | | ~~13-04-12~~ 13-11-08 |

**Figure 4. Package outline SOT1232 (XSON6)**

## 15 Handling information

**CAUTION**

This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices.
Such precautions are described in the *ANSI/ESD S20.20, IEC/ST 61340-5, JESD625-A* or equivalent standards.

## 16 Abbreviations

**Table 11. Abbreviations**

| Acronym | Description |
|---|---|
| ESD | electrostatic discharge |
| GLONASS | global navigation satellite system |
| GNSS | global navigation satellite system |
| GPS | global positioning system |
| HBM | human body model |
| LNA | low-noise amplifier |
| MMIC | monolithic microwave-integrated circuit |
| PCB | printed-circuit board |
| SiGe:C | silicon germanium carbon |

# 17 Revision history

**Table 12. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| GPS1502L v.5 | 20190322 | Product data sheet | - | GPS1502L v.4.2 |
| Modification | • Changed the status of the data sheet from company confidential to public | | | |
| GPS1502L v.4.2 | 20181207 | Product data sheet | - | GPS1502L v.4.1 |
| Modification | • adapted the Ordering information table | | | |
| GPS1502L v.4.1 | 20181130 | Product data sheet | - | GPS1502L v.4 |
| Modification | • adapted the orderable partnumber to GPS1502LX | | | |
| GPS1502L v.4 | 20181026 | Product data sheet | - | GPS1502L v.3 |
| Modification | • Status cahanged to Product data sheet | | | |
| GPS1502L v.3 | 20180831 | Preliminary data sheet | - | GPS1502L v.2.1 |
| Modification | • updated min max values for various conditions | | | |
| GPS1502L v.2.1 | 20180730 | Preliminary data sheet | - | GPS1502L v.2 |
| Modification | • data sheet changed to Preliminary<br>• Characteristics value on 1.8 V changed for input and output return loss | | | |
| GPS1502L v.2 | 04192018 | Objective data sheet | - | GPS1502L v.1.1 |
| Modification | • Changed max values for VCC and $P_i$ on limiting values | | | |
| GPS1502L v.1.1 | 03302018 | Objective data sheet | - | - |
| Modification | • revision update<br>revision update | | | |
| GPS1502L v.1 | 03292018 | Objective data sheet | - | - |

# 18 Legal information

## 18.1 Data sheet status

| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
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[2] The term 'short data sheet' is explained in section "Definitions".
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