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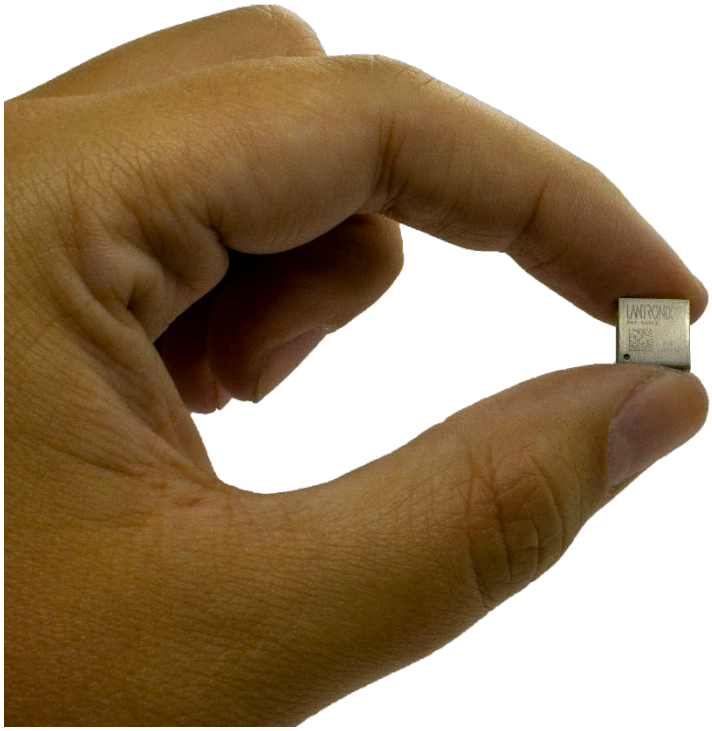

PNT-SG3FS GNSS Module
Hardware User Guide

Part Number PMD-00144
Revision A October 2022

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Revision History

Date	Rev.	Comments
October 2022	A	Initial release.

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1. Introduction

Overview

This document is relevant to PNT-SG3FS, a Global Navigation Satellite System (GNSS) standalone module with an integrated Teseo III receiver from ST Microelectronics. The multi-constellation receiver can track up to 32 satellite signals in view across GPS L1C/A, BeiDou B1, Galileo E1B/C, GLONASS L1OF, SBAS L1C/A (WAAS, EGNOS, MSAS, GAGAN), and QZSS L1C/A bands. The module supports Differential GPS (DGPS) data according to RTCM 10402.3. Assisted GNSS algorithms support extended ephemeris data using local autonomous or server-assisted based solutions for fast Time to First Fix (TTFF) operation.

The module can output measurement data (carrier phase) supporting RTK/PPP client algorithms for precise positioning applications.

The module supports 1.8V or 3.3V power supply domains and an embedded 16Mb flash memory that enables support for many features including data logging, geofencing, odometer, 5 day autonomous assisted GNSS, and firmware updates. The PNT-SG3FS module further integrates a temperature compensated crystal oscillator (TXCO) for navigation performance and stability, and a real-time clock (RTC) oscillator with a clock-trimming feature to compensate for the accuracy of the 32.768 kHz crystal in timing applications.

Figure 1 shows the pin out of the module.

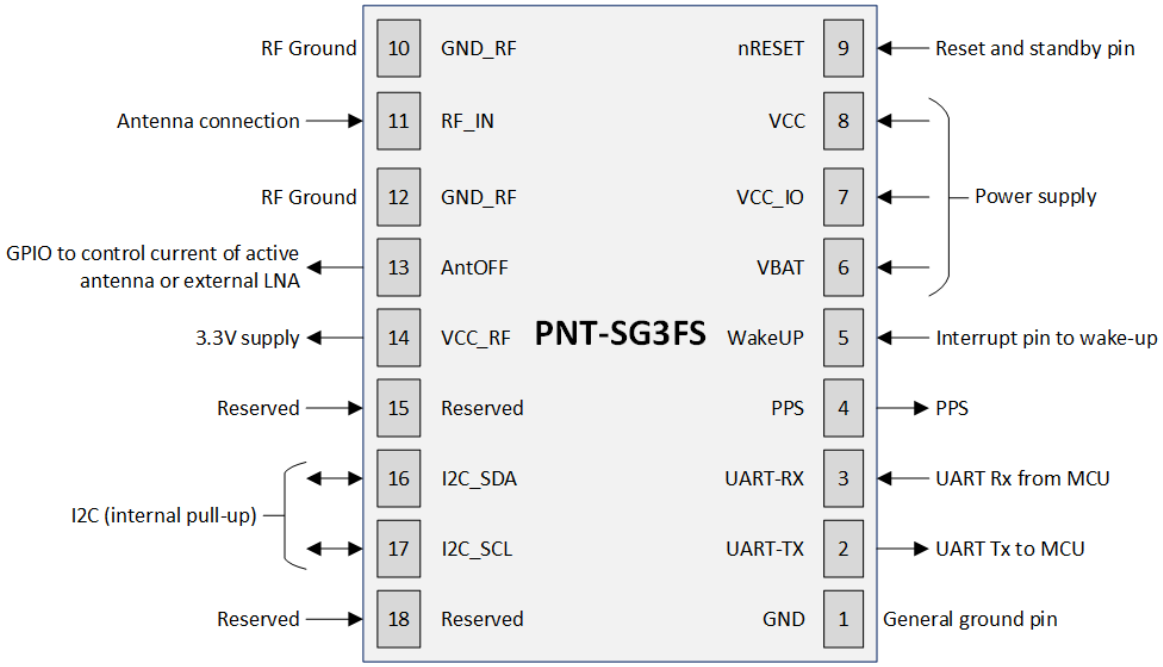

Figure 1: PNT-SG3FS Pin Out

2. Power

The PNT-SG3FS is supplied with 3 power pins: VCC (pin 8), VCC_IO (pin 7), and VBAT (pin 6).

VCC

VCC (pin 8) is the main supply. The VCC voltage range differs depending on the voltage of VCC_IO, as shown in Table 1 below.

Table 1. VCC Voltage Characteristics Against VCC_IO

Symbol	Parameter	VCC_IO	Min	Typ	Max	Unit
VCC	Digital supply voltage	1.8	1.755	1.8	4.2	V
VCC	Digital supply voltage	3.3	3.0	3.3	4.2	V

During startup or low power application, current can change suddenly. It is important that supply IC can provide this current variability.

VBAT

VBAT (pin 6) is the supply for the low-power domain backup: backup RAM and RTC.

VBAT can be either connected to VCC, or it can be connected to a dedicated always-on power supply. Supplying power to VBAT during low-power mode enables fast recovery of GNSS fix.

VBAT prevents current flow when VBAT is lower than VCC. This is important when VBAT is supplied with a small battery, especially if the battery is not rechargeable.

The VBAT voltage range differs depending on the voltage of VCC_IO, as shown in Table 2 below.

Table 2. VBAT Voltage Characteristics Against VCC_IO

Symbol	Parameter	VCC_IO	Min	Typ	Max	Unit
VBAT	Backup input supply voltage	1.8	1.755	1.8	4.2	V
VBAT	Backup input supply voltage	3.3	3.0	3.3	4.2	V

VCC_IO

The VCC_IO (pin 7) voltage range is shown in Table 3 below.

Table 3. VCC_IO Supported Voltage Range

Symbol	Parameter	Min	Typ	Max	Unit
VCC_IO	IO supply voltage	1.755	1.8	1.98	V
VCC_IO	IO supply voltage	3.0	3.3	3.6	V

Note: *VCC_IO must be equal to or lower than VCC and VBAT. Refer to Table 14-1 and Table 14-2 in PNT-SG3FS datasheet for associated limits.*

Figure 2 below shows the minimum functional connections needed for the PNT-SG3FS.

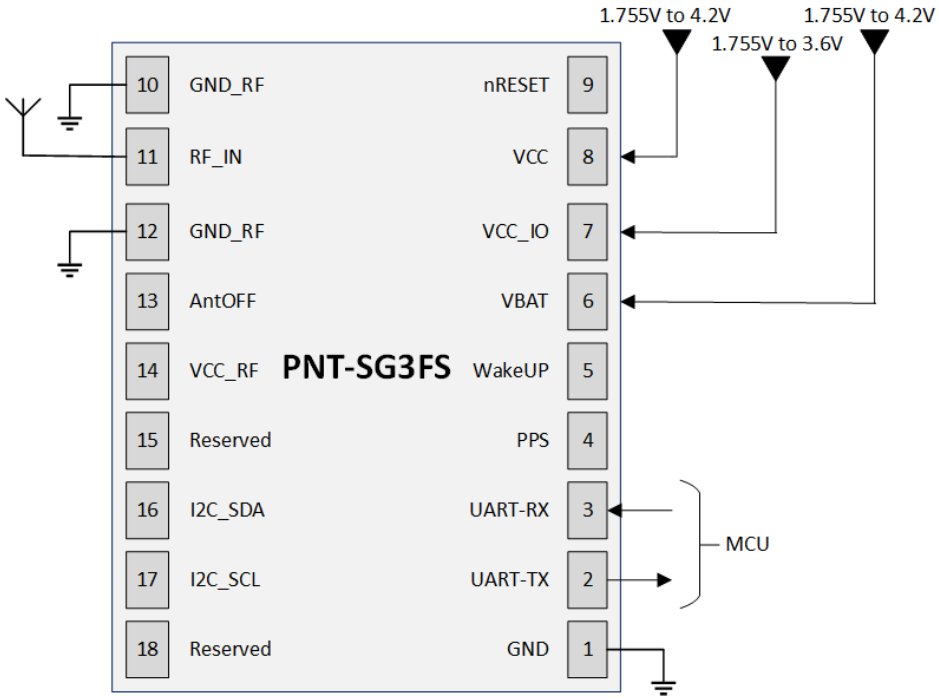

Figure 2: PNT-SG3FS Minimum Functional Connections

VCC_RF

VCC_RF (pin 14) is an output image of VCC with filtering for LNA or active antenna supply as shown in Figure 3 below.

It can be filtered to remove high-frequency noise. This filtering can be planned and not mounted.

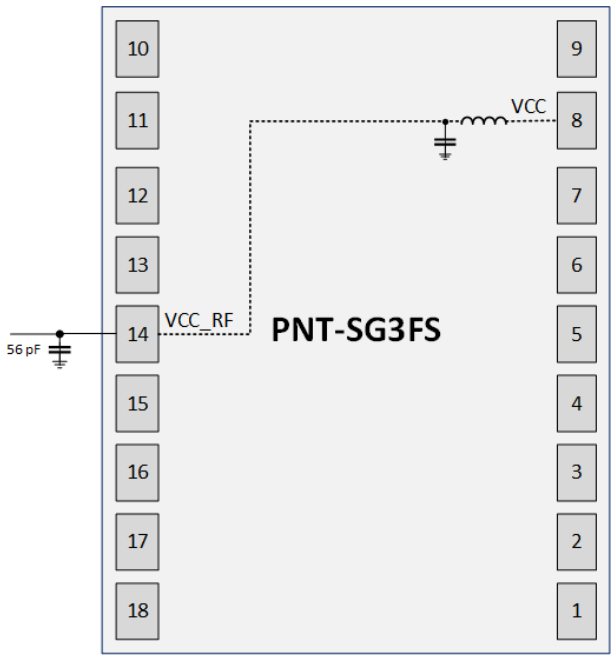

Figure 3: VCC_RF Output Supply Filtering

Power Supply Design Reference

If power supply is undisturbed, no filtering is required. Nevertheless, it could be planned for a first PCB wave to have soldering pads as shown in Figure 4 below for filtering. A 27nH inductor can be 0 ohms and replace by a line for a second PCB.

If one wave is planned, use only capacitor footprint and not the inductor.

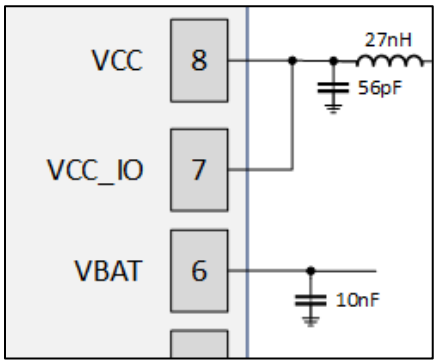

Figure 4: Power Supply Filtering

Current Consumption Optimization

Use of an SMPS at 1.8V to supply VCC is recommended to optimize current consumption.

Figure 5 is an application example with an external switching voltage regulator in order to achieve an efficiency around 85%.

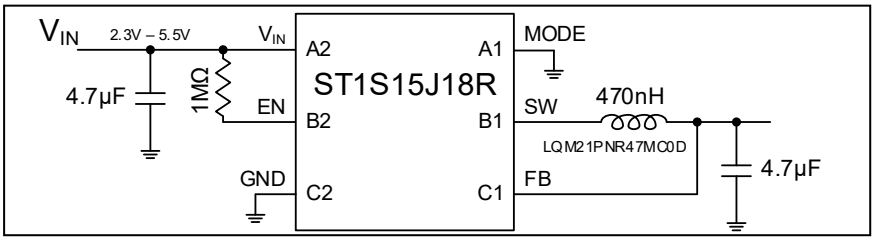

Figure 5: Example of SMPS to Improve Current Consumption

If VCC_IO is also supplied via an SMPS, this will enable the lowest current consumption.

3. Interfaces

I2C

I2C (pins 16, 17) is in slave only.

Internal pull-up resistors on VCC_IO are present. It is important to avoid having other pull-ups for current leakage in low-power mode.

UART

The UARTs (Universal Asynchronous Receiver/Transmitter) (pins 2, 3) support many of the same functions as the industry-standard 16C650 UART.

The PNT-SG3FS UARTs vary from the 16C650 on some minor points:

- Receive FIFO trigger levels
- Internal register map address space, and bit function of each register
- Deltas of modem status signals are not available
- 1.5 stop bits are not supported
- Independent receive clock feature is not supported

4. I/O Pins

PPS

PPS (pin 4) is the time pulse every one second. It can be configured with different conditions of pulses.

WakeUP

WakeUP (pin 5) is an external interrupt used to wake up the PNT-SG3FS for asynchronous wake-up during standby.

If not used, leave it floating.

Internal circuitry, shown in Figure 6 below, is done with resistor bridge to ensure 1V ± 0.25V level. Take care to not change the resistor bridge value to be outside of this 0.75V - 1.25V range.

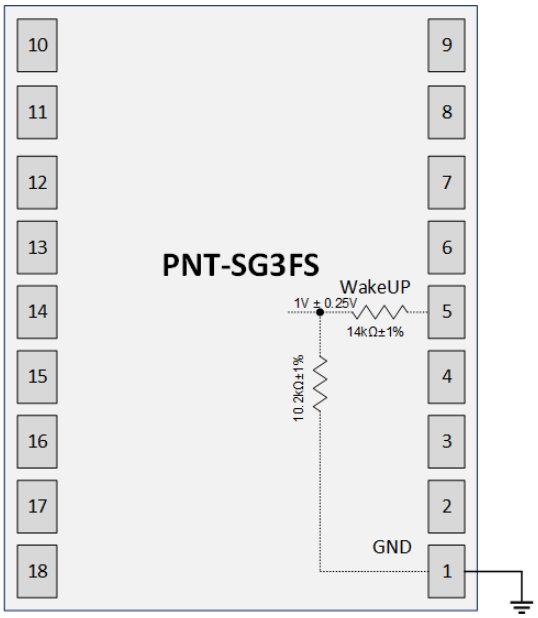

Figure 6: WakeUP Internal Circuitry

nRESET

nRESET (pin 9) can force a PNT-SG3FS under reset.

Reset signal is active low.

The host processor must have full control of this pin to support firmware upgrades.

RF_IN

RF_IN (pin 11) is the RF input.

No DC is present in the RF input. Decoupling capacitor inside.

AntOFF

AntOFF (pin 13) is a GPIO used to switch OFF external LNA or switch OFF current for the active antenna.

A 10kOhm pull down is necessary to ensure a low level during standby period.

Reserved

Pins 15 and 18 are reserved, and both must be left floating.

5. Standby Modes

Standby mode is the mode where only low power backup domain is running. It means VBAT must be always maintain. It allows to have very low current consumption and fast GNSS reacquisition at the end of the standby time due to RTC.

The PNT-SG3FS offers three different standby modes:

- Hardware OFF standby
- Hardware standby
- Software standby

As IO buffers are not supplied during standby mode, it is important to keep all IO without external voltage to avoid any current leakage. UART-RX is an exception that can be left high.

Please refer to the PNT-SG3FS datasheet and software user guide for more information on these standby modes.

6. Front End Management

RF input impedance is 50 ohms.

Passive Antenna

A passive antenna, as shown in Figure 7 below, can be directly connected to the PNT-SG3FS.

Take care that the antenna is close to the module. In addition, an impedance-matching component might be necessary to match the antenna.

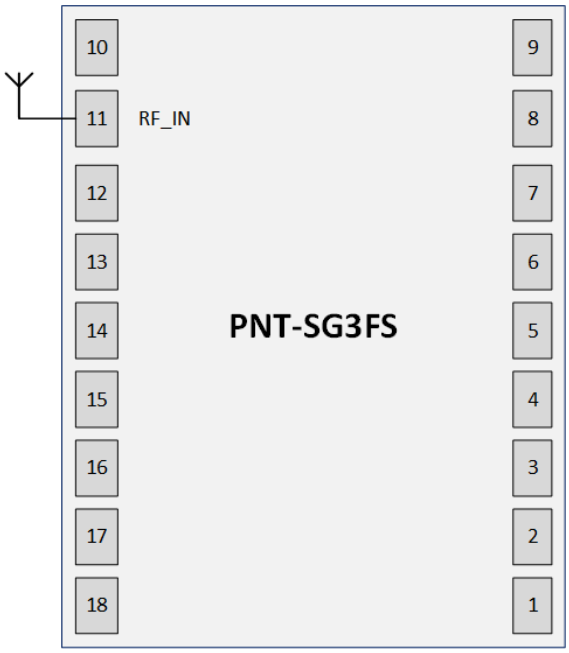

Figure 7: PNT-SG3FS Passive Antenna Connection

External LNA

External LNA means a passive antenna used with an LNA on the same PCB as the PNT-SG3FS module. To optimize power consumption during low-power mode if needed, the LNA should have an enable pin compatible with VCC_IO to be switched OFF/ON.

Figure 8 below shows a block diagram of the LNA connection.

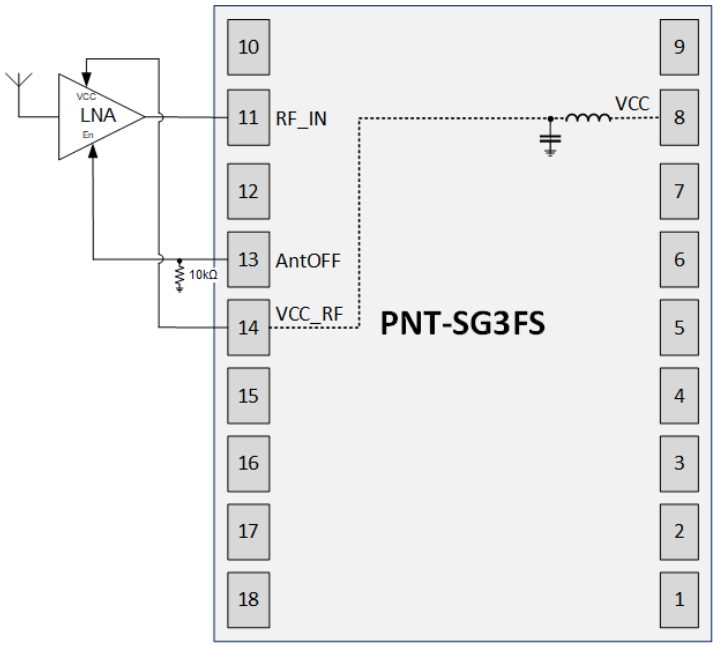

Figure 8: External LNA Connection

Active Antenna

PNT-SG3FS Module Without Current-Sensing

To optimize current during low-power operating mode, the active antenna can be used with a switch to cut the current flow as shown in Figure 9 below.

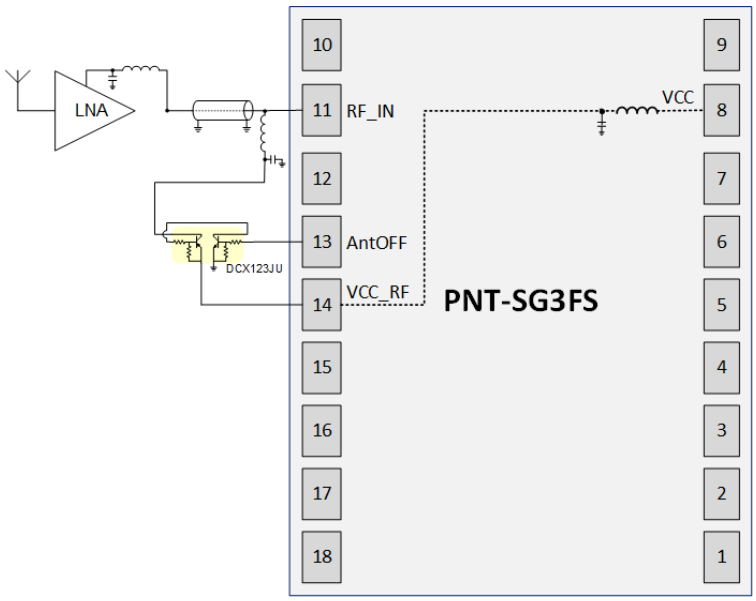

Figure 9: Active Antenna with Current Switch Control

To improve the functionality, a current limiter like that shown in Figure 10 below can be used.

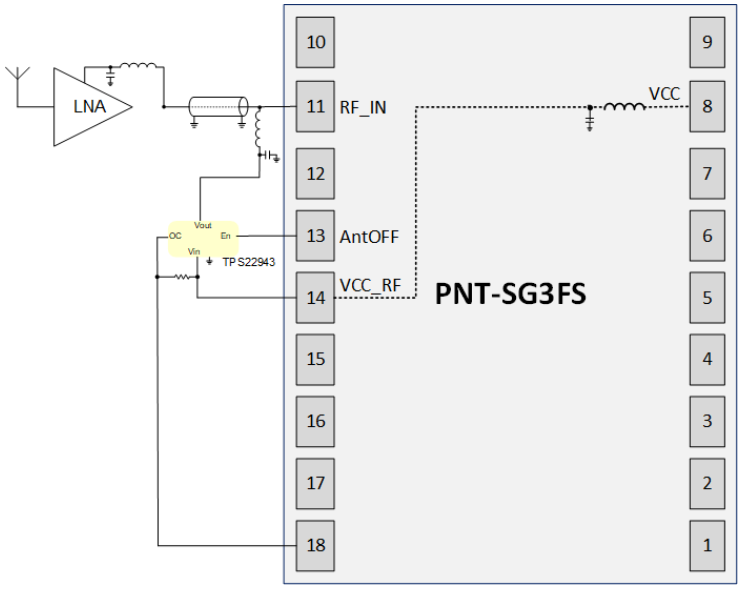

Figure 10: Active Antenna Current Sense Without On-Module Antenna Sensing

To prevent a short circuit on the antenna, use the antenna detect configuration script:

```
# GPIO High/Low status
206 -> ffffffeff
207 -> 00000000
# Activate and configure antenna sensing
226 -> 3483F01F
# Antenna status message
228 -> 00020010
# Configure GPIO
242 -> 18140008
243 -> 01030001
244 -> 00000101
# GPIO alternate function
253 -> FFF7C3F0
254 -> 00100000
```

7. Reference Schematic and BOM

Schematic

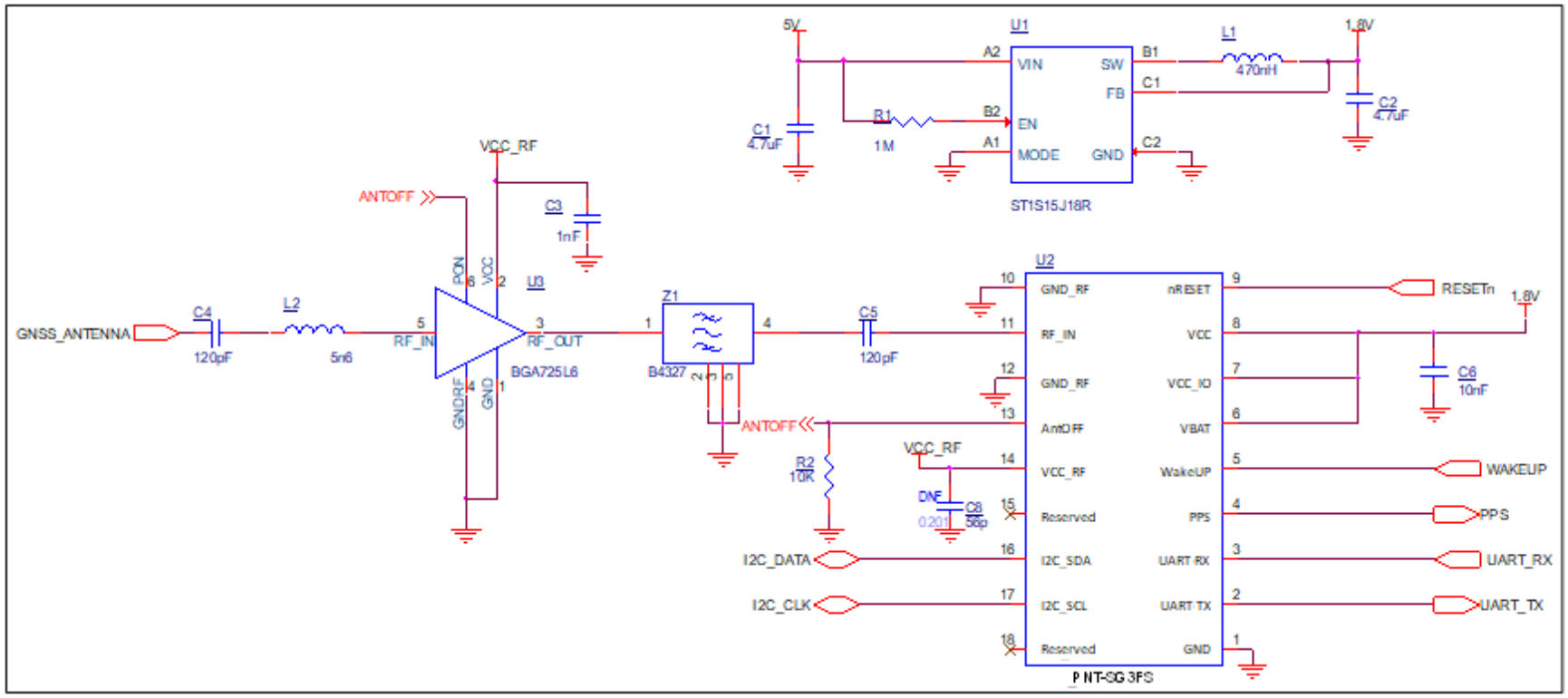

Figure 11: General Schematic

Bill of Materials

Table 4. PNT-SG3FS Carrier BOM

Refs	Value	Description	Manufacturer 1		Manufacturer 2	
			Name	Part Number	Name	Part Number
C1	4.7uF	Surface mount 0402 capacitor ceramic 4.7uF, 20% 6.3V X5R	Murata	GRM155R60J475ME87		
C2	4.7uF	Surface mount 0402 capacitor ceramic 4.7uF, 20% 4V X5R	Murata	GRM155R60G475ME87		
C3	1nF	Automotive Grade Surface mount 0402 capacitor ceramic 1nF, 10% 50V X7R 1nF; 50; X7R	Murata	GCM155R71H102KA37	TDK	CGA2B2X7R1H102K050BA
C7	10nF	Multilayer Ceramic Capacitors MLCC - SMD/SMT SOFT 0402 50V 0.01uF X7R 10% T: 0.5mm	TDK	CGA2B3X7R1H103K050BE	Murata	GCM155R71H103JA55D
C4,C5	120pF	Automotive Grade Surface mount 0402 capacitor ceramic 120pF, 5% 50V C0G 120pF; C0G	Murata	GCM1555C1H121JA16	TDK	CGA2B2C0G1H121J050BA
L1	470nH	Surface mount 0805 Multilayer type Inductor 470nF, 20%, 1.1A	Murata	LQM21PNR47MC0D		
L2	5n6H	Surface mount wire wound inductor. 5n6H; 3%; 0.76A	Coilcraft	0402CS-5N6XJLU	Murata	LQW15AN5N6G80D+00-21
L3	27nH	Unshielded Multilayer Inductor, 27nH, 350mA, 460 mOhm Max, 0402 (1005 Metric)	Murata	LQG15HS27NJ02	TDK	MLG1005S27NJT000
C6,C8,C9, C10,C11	NM	56pF surface mount, general purpose multilayer ceramic chip capacitor, COG, 0201, 50V, +/-2%	Murata	GRM0335C1H560GA01	TDK	CGA1A2C0G1H560J030BA
R1	1M	Surface mount chip resistor 1M; 5%; 1/16W	Yageo	RC0402JR-071ML		
R2	68K	Surface mount chip resistor 68K; 1%; 1/16W	Yageo	AC0402FR-0768KL		
R3	15K	Surface mount chip resistor 15K; 1%; 1/16W	Yageo	RC0402FR-1315KL		
R4	10k	Surface mount chip resistor 10K; 5%; 1/16W	Yageo	RC0402JR-0710KP		
U1	ST1S12GR	Synchronous rectification adjustable step-down switching regulator ST1S12GR; 0.7; 1.7	ST	ST1S12GR TSOT23-5L		
U2	PNT-SG3FS	GNSS Receiver - Low power Teseo III flash-based GPS Galileo GLONASS BeiDou QZSS Receiver	Lantronix	PNT-SG3FS		
U3	BGA725L6	Low Noise Amplifier for GPS, GLONASS, Galileo and Compass BGA725L6	Infineon	BGA725L6		
Z1	B4327	Automotive SAW RF filter for GPS+COMPASS+GLONASS	Epcos	B39162B4327P810		

8. Layout Recommendations

Figure 12 below shows a recommended PCB layout example to ensure best performance of the PNT-SG3FS.

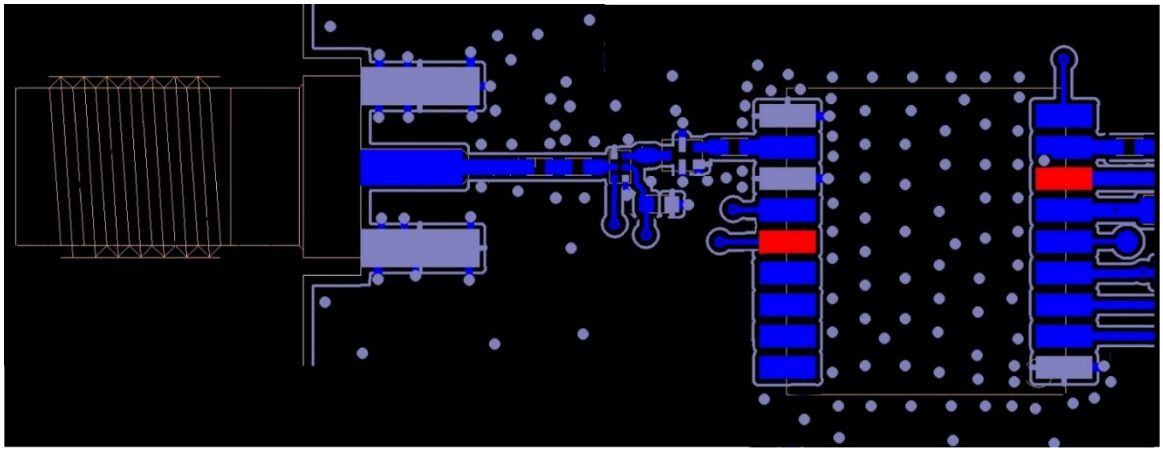

Figure 12: PNT-SG3FS PCB layout example

It is important to have a whole ground plane below the PNT-SG3FS module.

For RF-passive components, use of 0402 (1 x 0.5mm) components is recommended. Please choose the RF ground layer to be able to get 50ohms RF line width as close as possible to the component pads.

On 50ohms RF line it is important to avoid all possible stubs:

- For parallel components, place one pad on the RF line

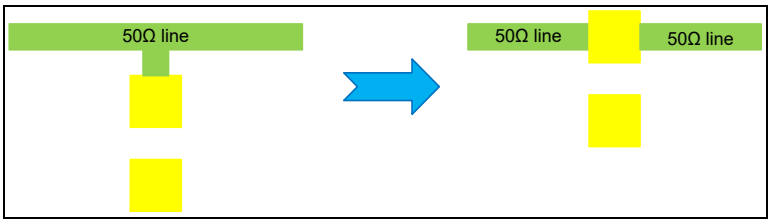

Figure 13: Parallel Component Pads Position

- If a bypass is needed, superimpose the two pads in one as shown in Figure 14 below.

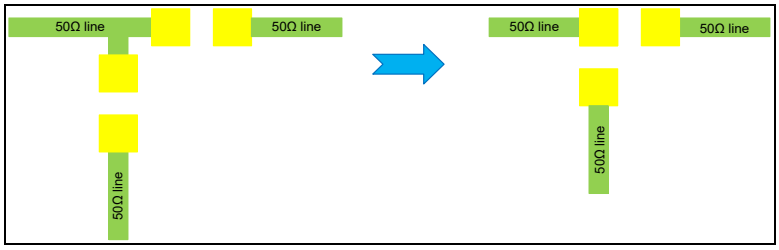

Figure 14: Bypass Component Pads Position

9. Antenna Recommendations

Patch Antenna

Patch antennas have different sizes – 25×25mm, 18×18mm and 12×12mm.

They have the advantage to be cheap, with good efficiency and highly directive. They can be used when mounted on horizontal support.

Larger antennas provide better performance.

Patch Antenna on the Opposite Side of the PNT-SG3FS

Patch antennas can be pin soldered on the opposite side of the PCB as the PNT-SG3FS and other RF components, as shown in Figure 15 below.

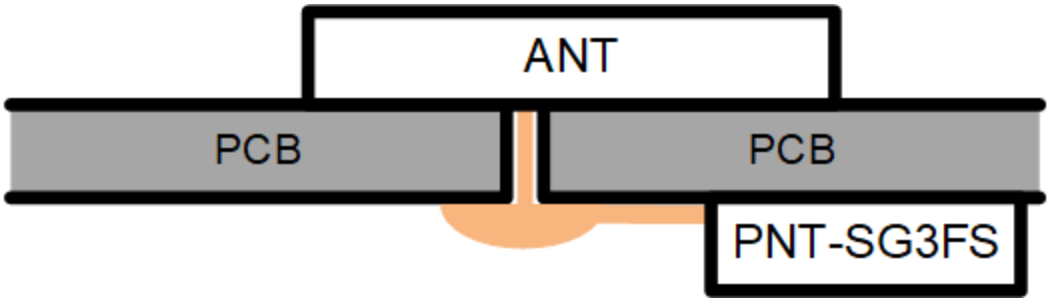

Figure 15: Antenna and PNT-SG3FS - Opposite Placement

Table 5 below provides information on compatible patch antennas (opposite side mount).

Manufacturer	Part Number	Constellation	Size
Taoglas	CGGBP.25.4.A.02	GPS+Glonass+Beidou	25×25mm
Taoglas	CGGBP.25.2.A.02	GPS+Glonass+Beidou	25×25mm
Taoglas	CGGP.18.4.C.02	GPS+Glonass	18×18mm
Yageo	ANT2525B00DT1516S	GPS+Glonass	18×18mm
Yageo	ANT1818B00CT1575S	GPS+Glonass	25×25mm

Table 5. PNT-SG3FS Compatible Patch Antennas (Opposite Side Mount)

Figure 16 below shows an example layout with the antenna mounted on the opposite side of the components.

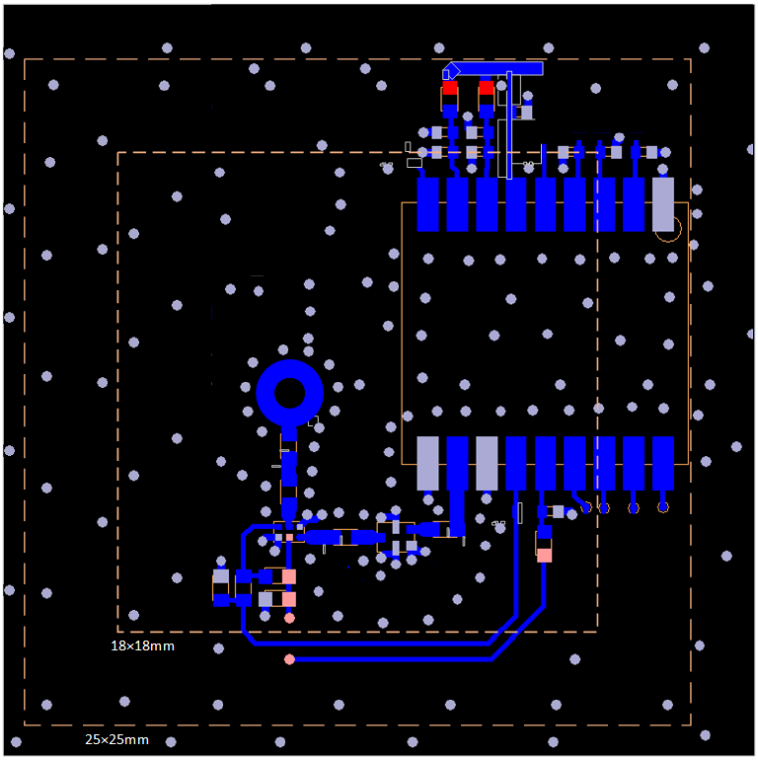

Figure 16: Patch Antenna and PNT-SG3FS, Opposite Side Placement Example

On the antenna side, there is only a ground pad as large as the antenna with one big via for the antenna pin. Antenna performance will improve if the ground plane is larger than the antenna size.

Patch Antenna on the Same Side as the PNT-SG3FS

Table 6 and Figure 17 below provide information on GPS + GLONASS compatible patch antennas and a layout example with the antenna and components mounted on the same side.

Table 6. PNT-SG3FS Compatible Patch Antennas (Same Side Mount)

Manufacturer	Part Number	Constellation	Size
Taoglas	SGGP.25.4.A.02	GPS+GLONASS	25×25mm
Taoglas	SGGP.18.4.A.02	GPS+GLONASS	18×18mm
Yageo	ANT1818B00BT1516S	GPS+GLONASS	18×18mm
Yageo	ANT2525B00BT1516S	GPS+GLONASS	25×25mm

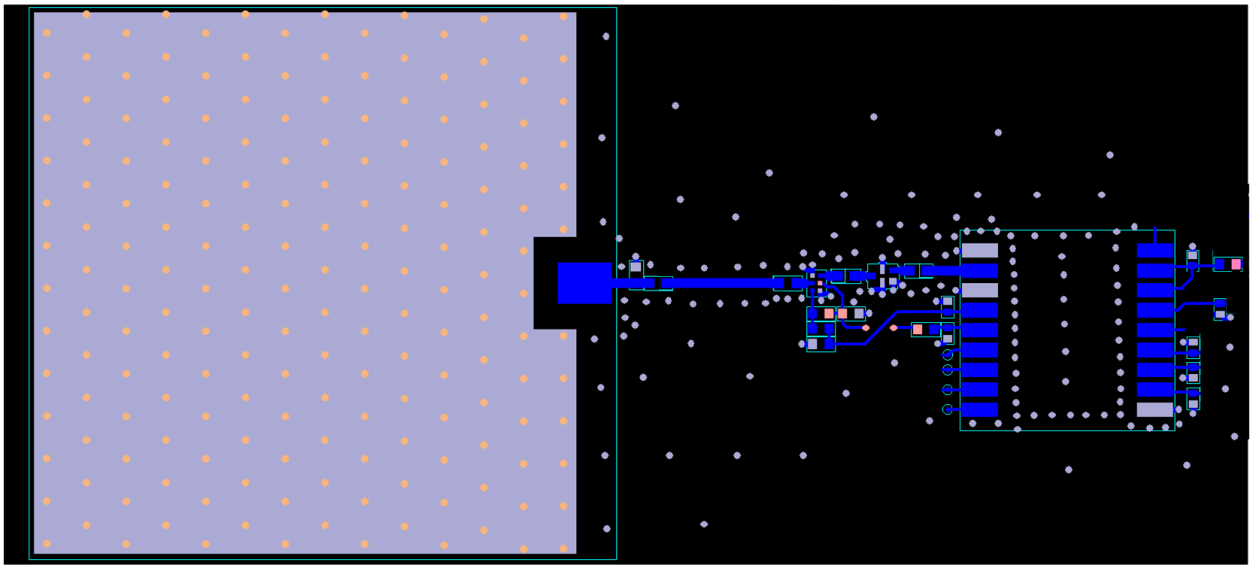

Figure 17: 25×25mm SMD Antenna and PNT-SG3FS, Same Side Placement Example

Chip Antenna

Chip antennas have the advantage of being smaller than patch antennas. They are less directive than patch antennas, with spherical radiation. Most of the time the PCB must be empty of copper below the antenna position with certain apertures.

Figure 18 below shows a layout example of a chip antenna (Taoglas GGBLA.01.A - GPS+Glonass+Beidou) mounted on the edge of the PCB:

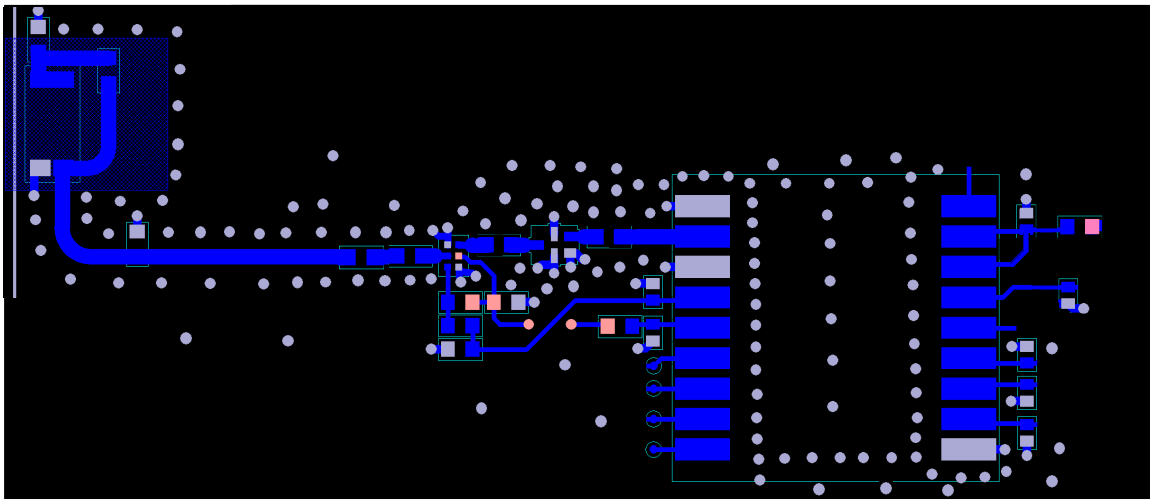

Figure 18: Chip Antenna and PNT-SG3FS, Same Side Layout Example

Follow the Layout Recommendationsin Chapter 8 for better performance.

Remote Antenna

A remote antenna installation means the antenna is connected to the PNT-SG3FS via an RF connector.

If using an active antenna, there is no need to mount LNA on the PCB.

If using a passive remote antenna, it is recommended to mount the external LNA + SAW filter in front of the PNT-SG3FS, and to use a short coaxial cable. Each dB lost in the cable will in turn result in lost sensitivity capability.