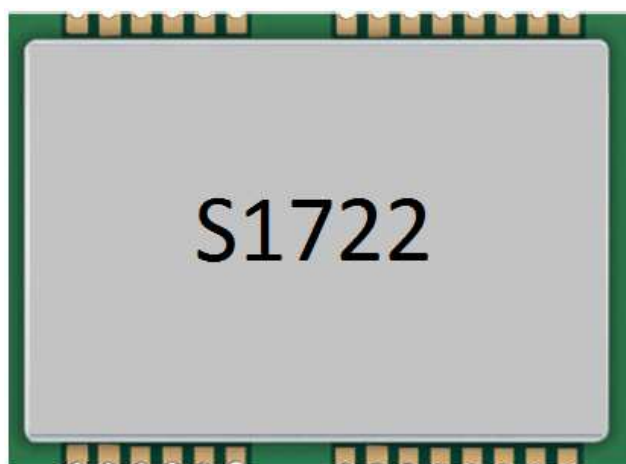# S1722 Family GNSS Module Data Sheet



17mmx 22.4mm

GPS : S1722R8 / S1722F8 / S1722F8-RAW

GPS/Beidou : S1722F8-BD / S1722F8-BD12 / S1722F8-BD-RAW

GPS/GLONASS : S1722F8-GL / S1722F8-GL12

# S1722

## Features

- 167 Acquisition/Tracking Channels
- Support QZSS, WAAS, MSAS, EGNOS, GAGAN
- 16 million time-frequency hypothesis testing per sec
- -148dBm cold start sensitivity
- -165dBm tracking sensitivity
- 29 second cold start TTFF
- 3.5 second TTFF with AGPS
- 1 second hot start
- 2.5m CEP accuracy
- Multipath detection and suppression
- Jamming detection and mitigation
- 7-day extended ephemeris AGPS
- Contains LNA, SAW Filter, TCXO, RTC Xtal, Regulator
- Works with active and passive antenna
- On board active antenna short protection
- On board active antenna detection
- Complete receiver in 17mm x 22.4mm size
- Operating temperature -40 ~ +85ºC
- Pb-free RoHS compliant

## Applications

- Navigation and asset tracking
- Timing reference
- Survey market

## High-Performance Low-Cost 167 Channel SMD Global Positioning Receiver Module

The S1722 family is state-of-the-art global navigation satellite system receivers capable of using GPS, GPS/Beidou, or GPS/GLONASS signal under the same footprint. User can upgrade from GPS navigation system to GPS/Beidou or GPS/GLONASS dual-satellite navigation systems by choosing appropriate model type without hardware redesign.

The -BD12 and -GL12 entry level models offer dual-satellite navigation capability, tracking up to 12 GPS/Beidou or 12 GPS/GLONASS signals combined respectively. Its NMEA output is the same format as GPS receivers, thus users can effortlessly upgrade GPS product to GPS/Beidou or GPS/GLONASS product without needing modification on the application software.

The -BD and -GL standard models tracks up to 24 GPS/Beidou or 24 GPS/GLONASS satellite signals combined respectively.

Dual-satellite navigation receiver module receives greater number of satellites than available for GPS-only receivers. The increased satellite number offers superior performance in challenging urban canyon and multipath environments.

-Raw stands for raw measurement which output satellite carrier phase data for post processing by default.

The S1722 module contains SkyTraq Venus 8 positioning engine inside, featuring high sensitivity for indoor fix, low power consumption, and fast TTFF. The superior -148dBm cold start sensitivity allows it to acquire, track, and get position fix autonomously in difficult weak signal environment. The receiver's -165dBm tracking sensitivity allows continuous position coverage in nearly all application environments. The high performance signal parameter search engine is capable of testing 16 million time-frequency hypotheses per second, offering industry-leading signal acquisition and TTFF speed.

The S1722 module contains LNA for easy integration with passive antenna and a SAW filter for increased jamming immunity. It works with both passive and active antenna; the self-contained antenna detection and short circuit protection feature enables lowest integration cost for system integrators using active antenna.

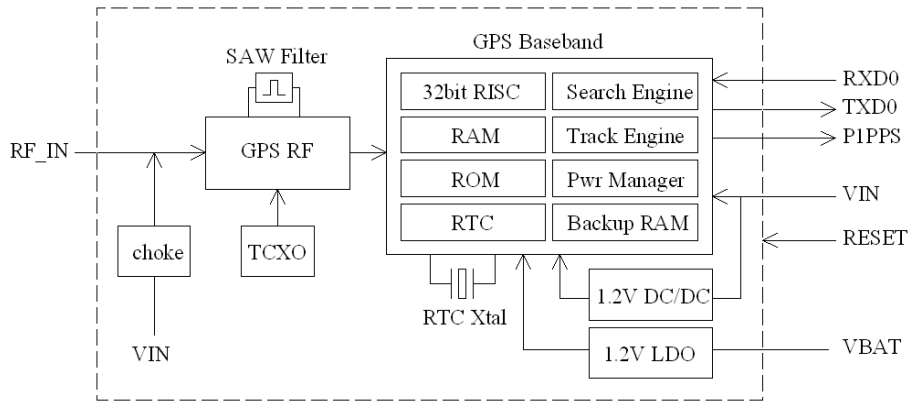| Product Series | Product Description |
|---|---|
| S1722R8 | ROM version GPS receiver module, Venus 8 chipset |
| S1722F8 | Flash version GPS receiver module, Venus 8 chipset |
| S1722F8-RAW | Flash version GPS receiver module, Venus 8 chipset, output carrier phase raw data |
| S1722F8-BD | Flash version GPS/Beidou receiver module, Venus 8 chipset |
| S1722F8-BD12 | Flash version GPS/Beidou receiver module, Venus 8 chipset |
| S1722F8-BD-RAW | Flash version GPS/Beidou receiver module, Venus 8 chipset, output carrier phase raw data |
| S1722F8-GL | Flash version GPS/GLONASS receiver module, Venus 8 chipset |
| S1722F8-GL12 | Flash version GPS/GLONASS receiver module, Venus 8 chipset |

| Model Number | Satellite | Max Tracked Signals | Antenna Detection | Antenna Short Protection | 7-day server-based AGPS | Self-Aided Ephemeris Estimation | ROM | Flash (Program Upgradeable) | Max Update Rate | UART | I2C | Support GPS-only mode | Support Beidou-only mode | Support GLONASS-only mode | Support GPS/Beidou mode | Support GPS/GLONASS mode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1722R8 | GPS + QZSS + SBAS | 14 | | | V | | V | | 40 | 1 | | V | | | | |
| S1722F8 | GPS + QZSS + SBAS | 14 | V | V | V | V | | V | 50 | 2 | 1 | V | | | | |
| S1722F8-RAW | GPS + QZSS + SBAS | 14 | V | V | V | V | | V | 20 | 2 | 1 | V | | | | |
| S1722F8-BD | GPS + QZSS + SBAS + Beidou | 28 | V | V | V | V | | V | 20 | 2 | 1 | V | V | | V | |
| S1722F8-BD12 | GPS + QZSS + SBAS + Beidou | 14 | V | V | V | V | | V | 20 | 2 | 1 | | | | V | |
| S1722F8-BD-RAW | GPS + QZSS + SBAS + Beidou | 28 | V | V | V | V | | V | 20 | 2 | 1 | V | V | | V | |
| S1722F8-GL | GPS + QZSS + SBAS + GLONASS | 28 | V | V | V | V | | V | 20 | 2 | 1 | V | | V | | V |
| S1722F8-GL12 | GPS + QZSS + SBAS + GLONASS | 14 | V | V | V | V | | V | 20 | 2 | 1 | | | | | V |

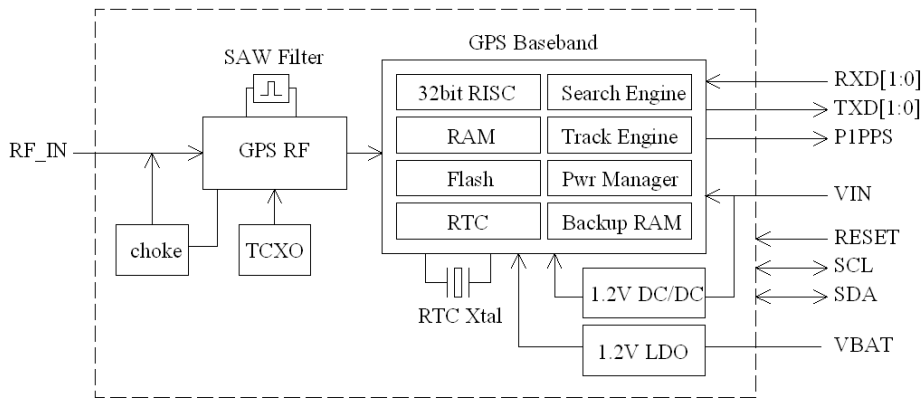## TECHNICAL SPECIFICATIONS

| | |
|---|---|
| Receiver Type | L1 C/A code, 167-channel Venus 8 engine |
| Receiver Modes | GPS or GPS/Beidou or GPS/GLONASS, depending on model selection |
| Augmentation System | QZSS, WAAS, EGNOS, MSAS, GAGAN |

Accuracy

| | |
|---|---|
| Position | 2.5m CEP |
| Velocity | 0.1m/sec |
| Time | 10ns |

| | |
|---|---|
| Startup Time | 1 / 28 / 29 second hot / warm / cold start under open sky average |
| Reacquisition | 1s |

Sensitivity

-148dBm cold-start
-160dBm re-acquisition
-165dBm tracking

| | |
|---|---|
| Multi-path Mitigation | Advanced multi-path detection and suppression |

A-GPS

7-day server-based AGPS (ROM and Flash type)
Self-aided ephemeris estimation (Flash type)

Update Rate

1 / 2 / 4 / 5 / 8 / 10 / 20 / 25 / 40 Hz for ROM GPS (default 1Hz)
1 / 2 / 4 / 5 / 8 / 10 / 20 / 25 / 40 / 50 Hz for Flash GPS (default 1Hz)
1 / 2 / 4 / 5 / 8 / 10 / 20 Hz update rate for Flash GPS raw data output
1 / 2 / 4 / 5 / 8 / 10 / 20 Hz for GPS/Beidou or GPS/GLONASS (default 1Hz)

| | |
|---|---|
| Dynamics | 4G ($39.2 \text{m/sec}^2$) |
| Operational Limits | Altitude < 18,000m or velocity < 515m/s, not exceeding both |
| Serial Interface | 3.3V LVTTL level |
| Protocol | NMEA-0183 V3.01, SkyTraq binary, 9600 baud, 8, N, 1 |
| Datum | Default WGS-84, User definable |
| Input Voltage | 3.3V DC +/-10% |

Current Consumption

| Model Number | S1722R8 | S1722F8 | S1722F8-BD | S1722F8-BD12 | S1722F8-GL | S1722F8-GL12 |
|---|---|---|---|---|---|---|
| Acquisition Current (mA) | 33 | 38 | 45 | 45 | 45 | 45 |
| Tracking Current (mA) | 25 | 30 | 40 | 40 | 40 | 40 |

| | |
|---|---|
| Dimension | 17mm L x 22.4mm W |
| Weight: | 2g |
| Operating Temperature | -40$^o$C ~ +85$^o$C |
| Storage Temperature | -55 ~ +100$^o$C |
| Humidity | 5% ~ 95% |

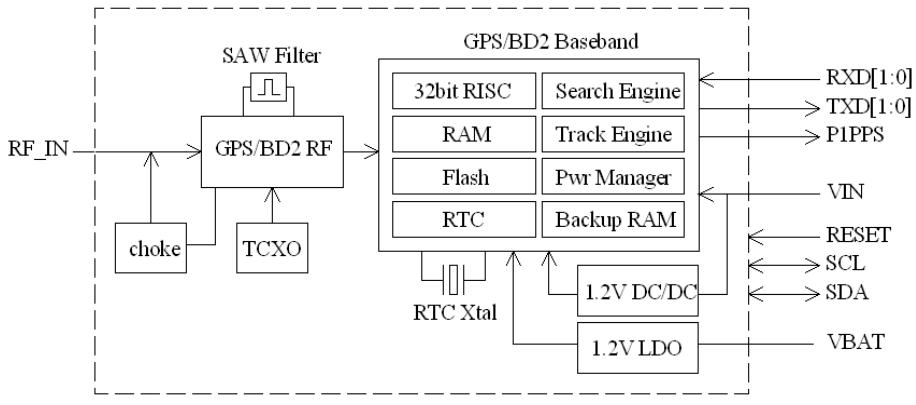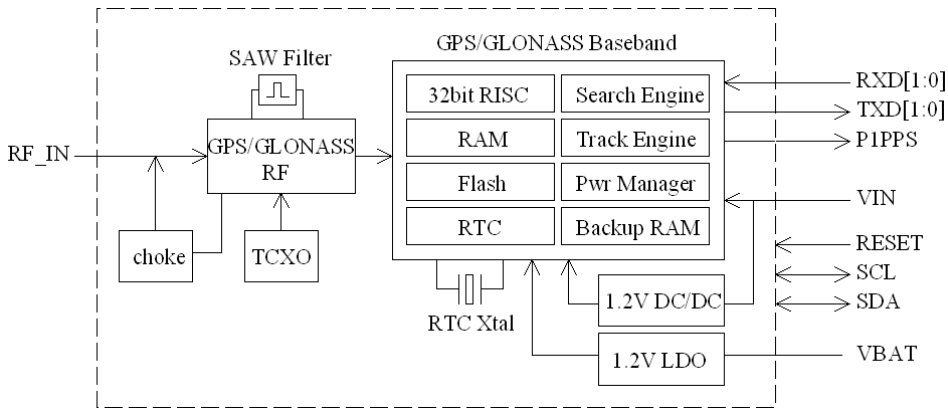## BLOCK DIAGRAM



S1722R8



S1722F8 / S1722F8-RAW



S1722F8-BD / S1722F8-BD12 / S1722F8-BD-RAW



S1722F8-GL / S1722F8-GL12

The S1722 is a high performance satellite navigation receiver in a compact surface mount package. It is based on the SkyTraq Venus 8 positioning technology, providing exceptional signal acquisition performance, and continuous operation even in dense foliage and urban canyons. The module includes internal SAW filter and high performance integrated LNA, works with both active and passive antenna. The simple UART serial interface and the standard NMEA-0183 protocol make usage of S1722 very easy and straightforward.

The S1722 module performs all the necessary system initialization, signal acquisition, signal tracking, data demodulation, and calculation of navigation solution autonomously.

## MECHANICAL CHARACTERISTICS
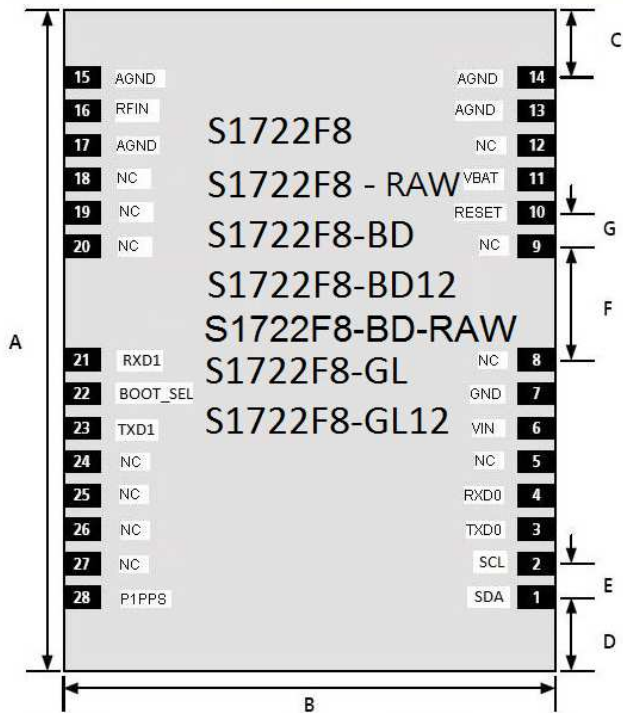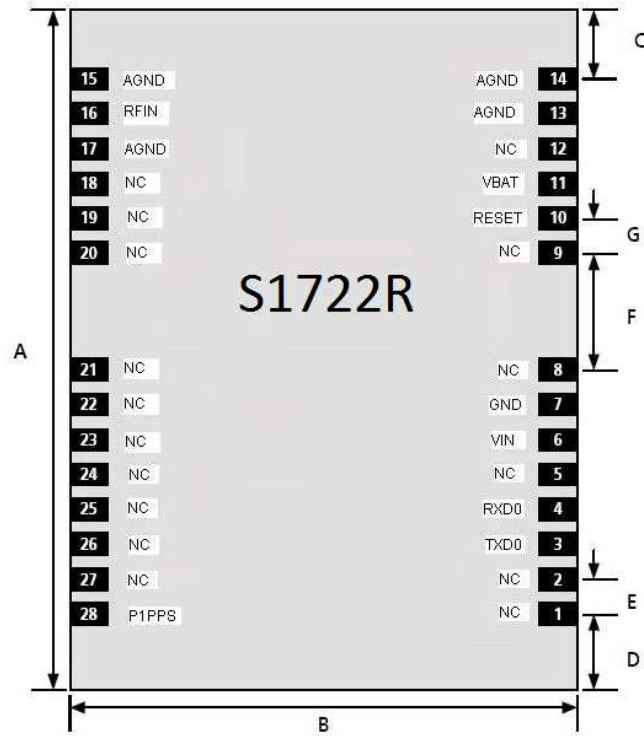


| | |
|---|---|
| A | 22.4mm |
| B | 17.0mm |
| C | 2.85mm |
| D | 2.55mm |
| E | 1.1mm |
| F | 3.8mm |
| G | 1.1mm |

## PINOUT DESCRIPTION

| Pin No. | Name | Description |
|---|---|---|
| 1 | SDA | I2C interface data signal, 3V LVTTL. Currently unused. |
| 2 | SCL | I2C interface clock signal, 3V LVTTL. Currently unused. |
| 3 | TXD0 | UART serial data output, 3V LVTTL.<br>One full-duplex asynchronous serial UART port is implemented. This UART output is normally used for sending position, time and velocity information from the receiver in NMEA-0183 format. When idle, this pin output HIGH. |
| 4 | RXD0 | UART serial data input, 3V LVTTL.<br>One full-duplex asynchronous serial UART port is implemented. This UART input is normally for sending commands or information to the receiver in SkyTraq binary protocol. In the idle condition, this pin should be driven HIGH. If the driving circuitry is powered independently of S1722, ensure that this pin is not driven to HIGH when primary power to S1722 is removed, or a 10K-ohm series resistor can be added to minimize leakage current from application to the powered off module. |
| 5 | NC | No connection |
| 6 | VIN | Main power supply, 3.0V ~ 3.6V DC |
| 7 | GND | System ground |
| 8,9 | NC | No connection |
| 10 | RESET | External active-low reset input.<br>Only needed when power supply rise time is very slow or software controlled reset is desired. |
| 11 | VBAT | Backup supply voltage for internal RTC and backup SRAM, 2.5V ~ 3.6V. VBAT must be applied whenever VIN is applied. This pin should be powered continuously to minimize the startup time. If VIN and VBAT are both removed, the receiver will be in factory default mode upon power up, all user configuration set is lost. For applications the does not care cold starting every time, this pin can be connect to VIN. |
| 12 | NC | No connection |
| 13,14,15 | AGND | RF ground |
| 16 | RFIN | RF input, connects to antenna. There is 3V DC bias output for powering active antenna. Active antenna detection and short protection is provided. |
| 17 | AGND | RF ground |
| 18,19,20 | NC | No connection |
| 21 | RXD1 | UART serial data input, 3V LVTTL. Currently unused. |
| 22 | BOOT_SEL | No connection for normal use. Pull-low for loading firmware into empty or corrupted Flash memory from ROM mode by the module maker. |
| 23 | TXD1 | UART serial data output, 3V LVTTL. Currently unused. |
| 24,25,26,27 | NC | No connection |
| 28 | P1PPS | One-pulse-per-second (1PPS) time mark output, 3V LVTTL. The rising edge synchronized to UTC second when getting 3D position fix. The pulse duration is about 4msec at rate of 1 Hz. |

## ELECTRICAL SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS

| Parameter | Minimum | Maximum | Condition |
|---|---|---|---|
| Supply Voltage (VIN) | -0.5 | 3.6 | Volt |
| Backup Battery Voltage (VBAT) | -0.5 | 3.6 | Volt |
| Input Pin Voltage | -0.5 | VCC+0.5 | Volt |
| Input Power at RFIN | | +5 | dBm |
| Storage Temperature | -55 | +100 | degC |

### OPERATING CONDITIONS

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Supply Voltage (VIN) | 3 | 3.3 | 3.6 | Volt |
| Acquisition Current (exclude active antenna current)  S1722R8 | | 33 | | mA |
| S1722F8, S1722F8-RAW | | 38 | | mA |
| S1722F8-BD, S1722F-BD12, S1722F-GL, S1722F-GL12, S1722F8-BD-RAW | | 45 | | mA |
| Tracking Current (exclude active antenna current)  S1722R8 | | 25 | | mA |
| S1722F8, S1722F8-RAW | | 30 | | mA |
| S1722F8-BD, S1722F-BD12, S1722F-GL, S1722F-GL12, S1722F8-BD-RAW | | 39 | | mA |
| Backup Voltage (VBAT) | 2.5 | | 3.6 | Volt |
| Backup Current (VCC voltage applied) | | | 0.5 | mA |
| Backup Current (VCC voltage off) | | | 35 | uA |
| Output Low Voltage | | | 0.4 | Volt |
| Output HIGH Voltage | 2.4 | | | Volt |
| Input LOW Voltage | | | 0.8 | Volt |
| Input HIGH Voltage | 2 | | | Volt |
| Input LOW Current | -10 | | 10 | uA |
| Input HIGH Current | -10 | | 10 | uA |
| RF Input Impedance (RFIN) | | 50 | | Ohm |
| RF_IN short circuit current limit | | | 70 | mA |
| VIN to RFIN voltage drop with 5mA active antenna loading | | 0.33 | | V |
| VIN to RFIN voltage drop with 10mA active antenna loading | | 0.42 | | V |
| VIN to RFIN voltage drop with 20mA active antenna loading | | 0.60 | | V |
| VIN to RFIN voltage drop with 30mA active antenna loading | | 0.77 | | V |

## APPLICATION CIRCUIT
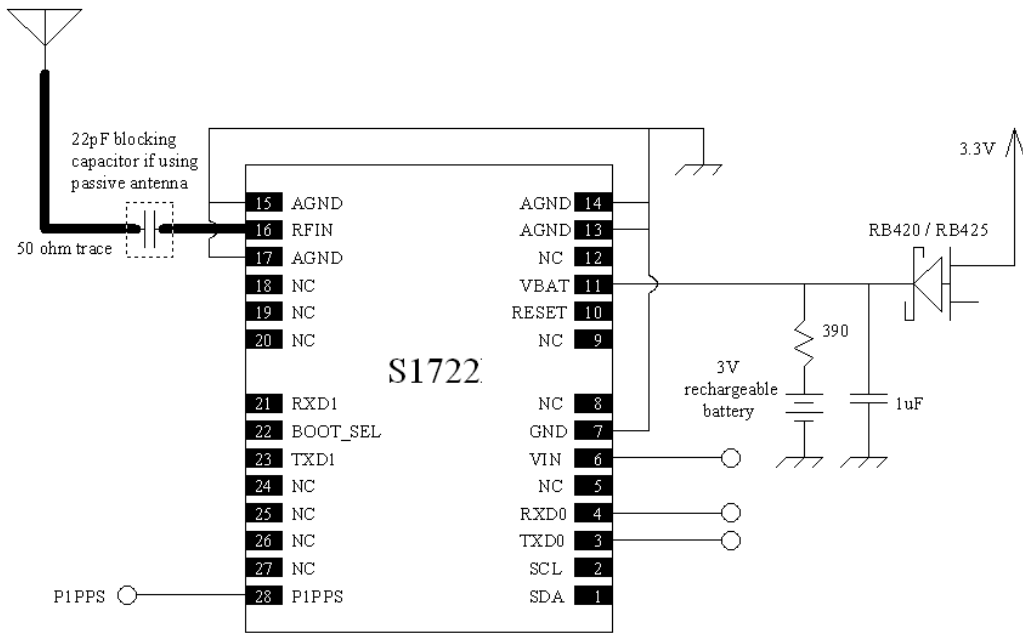


## RECOMMANDED FOOTPRINT
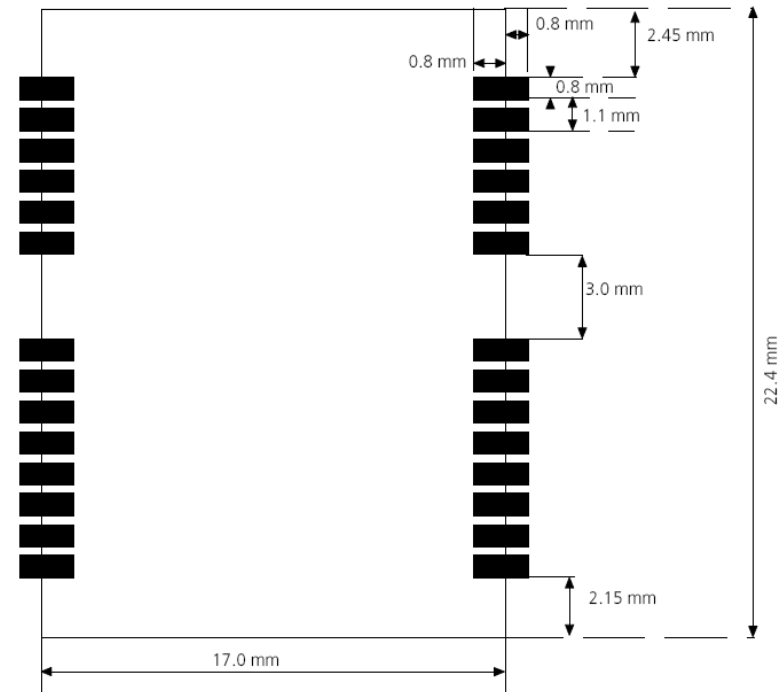
## RECOMMANDED REFLOW PROFILE
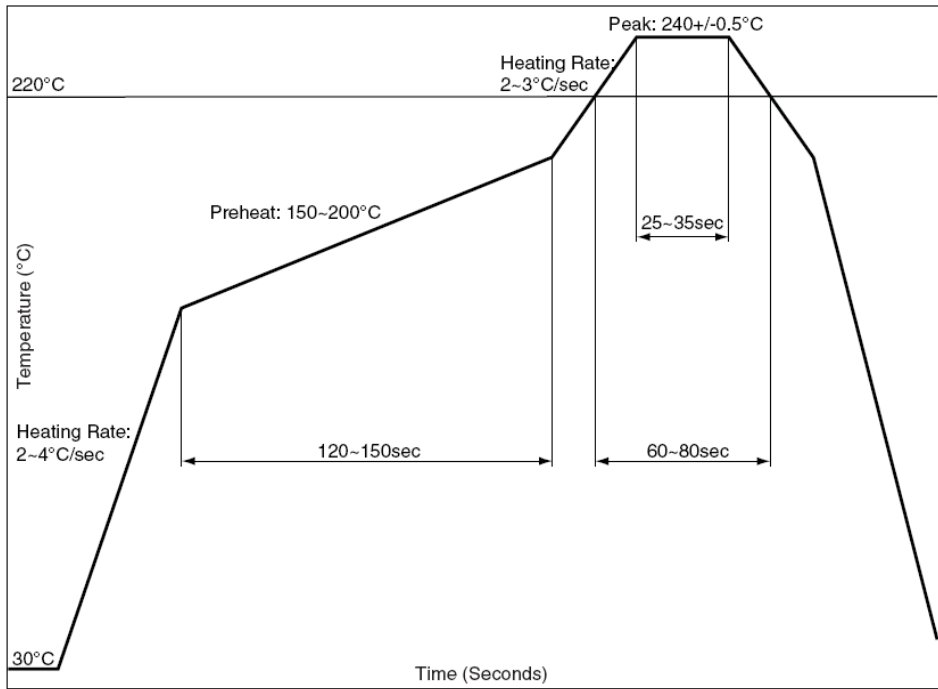


The reflow profile shown above should not be exceeded, since excessive temperatures or transport times during reflow can damage the module. Cooling temperature fall rate: max 3°C / sec

## ANTENNA CONSIDERATIONS

The S1722 is designed to use with a wide variety of active and passive antennas, but care must be taken during antenna selection to ensure optimum signal reception performance. There are many choices of antenna configurations; the best choice is often a tradeoff between size, gain, bandwidth and cost. The best way is to test multiple antenna solutions in the configuration of the final system to determine which provides the best overall performance.

Ceramic patch antenna is low-cost and provides good sensitivity. 50-ohm output ceramic patch antenna can be connected directly to RF input of the module. Usually the antenna and S1722 are mounted on opposite side of the PCB to reduce possibility of picking up digital noise. To improve signal reception performance, use larger ground plane under the patch antenna If possible; larger the ground plane, larger the overall antenna gain. The center frequency of the ceramic patch antenna changes with ground plane size. For optimal GPS/Beidou or GPS/GLONASS or GPS operation, frequency bandwidth of the antenna needs to cover 1559MHz ~ 1577MHz or 1574MHz ~ 1605MHz or 1574MHz ~ 1577MHz respectively when mounted on the PCB. It is usual to ask the ceramic patch antenna vendor to select or tune a patch antenna that best matches the customer PCB.

Active antenna is essentially a passive antenna with built-in LNA and a coaxial cable to connect the antenna to the module. It has the flexibility of being located remotely from the module, but requires antenna power. Active antenna usually costs more than passive patch antenna, but the performance in low signal environments is usually better. When using active antenna, an external bias choke inductor is used to provide DC bias for the active antenna. Active antenna with gain up to 30dB and noise figure less than 1.5dB can be used with S1722.

Chip antenna is often desired for its small size. Matching element of the chip antenna needs to be designed-in according to the chip antenna datasheet. If application doesn't have a large ground plane as shown in the datasheet for the measured performance spec condition, testing will be needed to determine if it can provide acceptable performance with the smaller sized application PCB.

| | S1722R8 / S1722F8/S1722F8-Raw | | S1722F8-BD / S1722F8-BD12 | | S1722F-GL / S1722F-GL12 | |
|---|---|---|---|---|---|---|
| Antenna Type | Passive | Active | Passive | Active | Passive | Active |
| GPS Frequency (MHz) | 1575.42 +/- 2 | 1575.42 +/- 2 | 1575.42 +/- 2 | 1575.42 +/- 2 | 1575.42 +/- 2 | 1575.42 +/- 2 |
| Beidou Frequency (MHz) | | | 1561.098 +/- 3 | 1561.098 +/- 3 | | |
| GLONASS Frequency (MHz) | | | | | 1602 +/- 4 | 1602 +/- 4 |
| VSWR | < 2 (typical) | < 2 (typical) | < 2 (typical) | < 2 (typical) | < 2 (typical) | < 2 (typical) |
| Polarization | RHCP or Linear | RHCP or Linear | RHCP or Linear | RHCP or Linear | RHCP or Linear | RHCP or Linear |
| Antenna Gain | > 0dBi | > -2dBi | > 0dBi | > -2dBi | > 0dBi | > -2dBi |
| LNA Gain | | 20dB (typical) | | 20dB (typical) | | 20dB (typical) |
| Noise Figure | | < 1.5dB | | < 1.5dB | | < 1.5dB |
| Total Gain | | > 18dBi | | > 18dBi | | > 18dBi |

The signal path from antenna to RF input of S1722 is the most critical part of application design. The goal is to provide optimal 50-ohm match between a 50Ω antenna and the module 50-ohm RF input for maximum power transfer. The 50-ohm grounded coplanar wave guide, consisting of the RF input signal with RF ground on either sides and a RF ground underneath, is a good choice for efficiency.
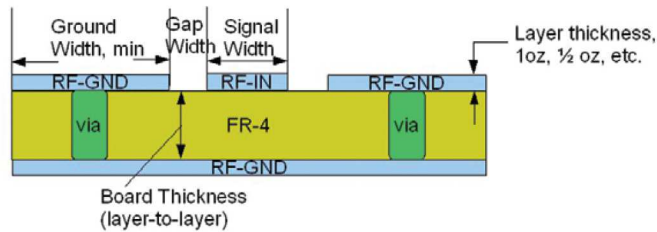


For a two-layer FR4 PCB design with 1.6mm thickness, 4.6 dielectric constant, and 1oz copper the RF-input trace should be 31mil in width, the gap to the adjacent grounds should be 6mil, and each of the RF grounds should be at least twice the width of the input signal trace (62mil). Freeware program such as AppCAD can be used to calculate values required for other configurations.
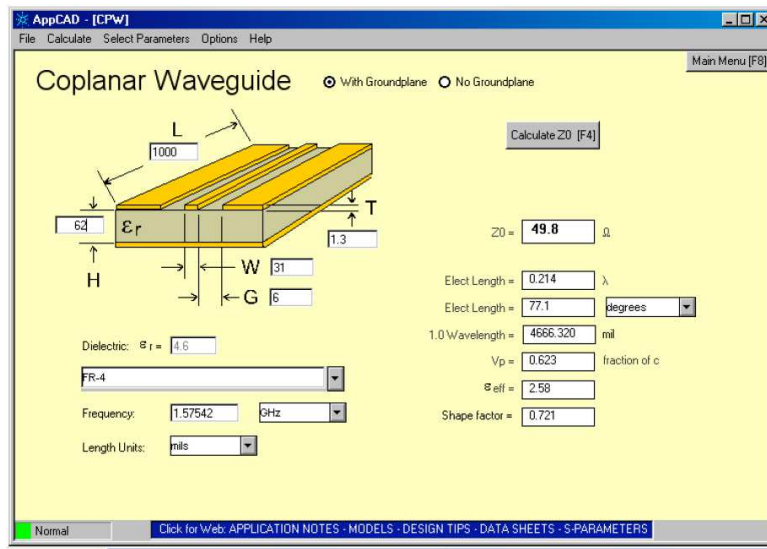


## POWER SUPPLY REQUIREMENT

S1722 requires a stable power supply, avoid ripple on VCC pin (<50mVpp). Power supply noise can affect the receiver's sensitivity. Bypass capacitors of 10uF and 0.1uF is recommended to be placed close to the module VCC pin; the values could be adjusted according to the amount and type of noise present on the supply line.

**BACKUP SUPPLY**

The purpose of backup supply voltage pin (V_BCKP) is to keep the SRAM memory and the RTC powered when the module is powered down. This enables the module to have a faster time-to-first-fix when the module is powered on again. The backup current drain is less than 35µA. In normal powered on state, the internal processor access the SRAM and current drain is higher in active mode

**1PPS OUTPUT**

A 1 pulse per second signal (4ms HIGH duration) is generated on 1PPS pin when the receiver has 3D position fix using 4 or more satellites. The rising edge of the pulse is aligned with UTC second, with accuracy of about 10nsec. It outputs constant LOW when no position fix is available.

**LAYOUT GUIDELINES**

Separate RF and digital circuits into different PCB regions.

It is necessary to maintain 50-ohm impedance throughout the entire RF signal path. Try keeping the RF signal path as short as possible.

Do not route the RF signal line near noisy sources such as digital signals, oscillators, switching power supplies, or other RF transmitting circuit. Do not route the RF signal under or over any other components (including S1722), or other signal traces. Do not route the RF signal path on an inner layer of a multi-layer PCB to minimize signal loss.

Avoid sharp bends for RF signal path. Make two 45-deg bends or a circular bend instead of a single 90-degree bend if needed.

Avoid vias with RF signal path whenever possible. Every via adds inductive impedance. Vias are acceptable for connecting the RF grounds between different layers. Each of the module's ground pins should have short trace tying immediately to the ground plane below through a via.

The bypass capacitors should be low ESR ceramic types and located directly adjacent to the pin they are for.

## HANDLING GUIDELINE

The S1722 modules are rated MSL4, must be used for SMT reflow mounting within 72 hours after taken out from the vacuumed ESD-protective moisture barrier bag in factory condition < 30degC / 60% RH. If this floor life time is exceeded, or if the received ESD-protective moisture barrier bag is not in vacuumed state, then the device need to be pre-baked before SMT reflow process. Baking is to be done at 85degC for 8 to 12 hours. Once baked, floor life counting begins from 0, and has 72 hours of floor life at factory condition < 30degC / 60% RH.

S1722 module is ESD sensitive device and should be handled with care.

# NMEA Output Description

The output protocol supports NMEA-0183 standard. The implemented messages include GGA, GLL, GSA, GSV, VTG, RMC, ZDA and GNS messages. The NMEA message output has the following sentence structure:

$aaccc,c–c*hh<CR><LF>

The detail of the sentence structure is explained in Table 1.

Table 1: The NMEA sentence structure

| character | HEX | Description |
|---|---|---|
| "$" | 24 | Start of sentence. |
| Aaccc | | Address field. "aa" is the talker identifier. "ccc" identifies the sentence type. |
| "," | 2C | Field delimiter. |
| c–c | | Data sentence block. |
| "*" | 2A | Checksum delimiter. |
| Hh | | Checksum field. |
| <CR><LF> | 0D0A | Ending of sentence. (carriage return, line feed) |

Table 2: Overview of SkyTraq receiver's NMEA messages for S1722R8, S1722F8, S1722F8-BD12, S1722F8-GL12

| $GPGGA | Time, position, and fix related data of the receiver. |
|---|---|
| $GPGLL | Position, time and fix status. |
| $GPGSA | Used to represent the ID's of satellites which are used for position fix. |
| $GPGSV | Satellite information about elevation, azimuth and CNR |
| $GPRMC | Time, date, position, course and speed data. |
| $GPVTG | Course and speed relative to the ground. |
| $GPZDA | UTC, day, month and year and time zone. |

Table 3: Overview of SkyTraq receiver's NMEA messages for S1722F8-BD, S1722F8-BD-RAW

| $GNGGA | Time, position, and fix related data of the receiver. |
|---|---|
| $GNGLL | Position, time and fix status. |
| $GNGSA<br>$GPGSA<br>$BDGSA | Used to represent the ID's of satellites which are used for position fix. When both GPS and Beidou satellites are used in position solution, a $GNGSA sentence is used for GPS satellites and another $GNGSA sentence is used for Beidou satellites. When only GPS satellites are used for position fix, a single $GPGSA sentence is output. When only Beidou satellites are used, a single $BDGSA sentence is output. |
| $GPGSV<br>$BDGSV | Satellite information about elevation, azimuth and CNR, $GPGSV is used for GPS satellites, while $BDGSV is used for Beidou satellites |
| $GNRMC | Time, date, position, course and speed data. |
| $GNVTG | Course and speed relative to the ground. |
| $GNZDA | UTC, day, month and year and time zone. |

Table 4: Overview of SkyTraq receiver's NMEA messages for S1722F8-GL

| $GNGGA | Time, position, and fix related data of the receiver. |
|---|---|
| $GNGLL | Position, time and fix status. |
| $GNGSA<br>$GPGSA<br>$GLGSA | Used to represent the ID's of satellites which are used for position fix. When both GPS and GLONASS satellites are used in position solution, a $GNGSA sentence is used for GPS satellites and another $GNGSA sentence is used for GLONASS satellites. When only GPS satellites are used for position fix, a single $GPGSA sentence is output. When only GLONASS satellites are used, a single $GLGSA sentence is output. |
| $GPGSV<br>$GLGSV | Satellite information about elevation, azimuth and CNR, $GPGSV is used for GPS satellites, while $GLGSV is used for GLONASS satellites |
| $GNRMC | Time, date, position, course and speed data. |
| $GNVTG | Course and speed relative to the ground. |
| $GNZDA | UTC, day, month and year and time zone. |

The formats of the supported NMEA messages are described as follows:

### GGA – Global Positioning System Fix Data
Time, position and fix related data for a GPS receiver.
Format:
$--GGA,hhmmss.ss,llll.lll,a,yyyyy.yyy,a,x,uu,v.v,w.w,M,x.x,M,,zzzz*hh<CR><LF>

| Field | Name | Description |
|-------|------|-------------|
| hhmmss.ss | UTC Time | UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999) |
| llll.lll | Latitude | Latitude in ddmm.mmmm format. Leading zeros are inserted. |
| A | N/S Indicator | 'N' = North, 'S' = South |
| yyyyy.yyy | Longitude | Longitude in dddmm.mmmm format. Leading zeros are inserted. |
| A | E/W Indicator | 'E' = East, 'W' = West |
| x | GPS quality indicator | GPS quality indicator<br>0: position fix unavailable<br>1: valid position fix, SPS mode<br>2: valid position fix, differential GPS mode |
| uu | Satellites Used | Number of satellites in use, (00 ~ 24) |
| v.v | HDOP | Horizontal dilution of precision, (00.0 ~ 99.9) |
| w.w | Altitude | Mean sea level altitude (-9999.9 ~ 17999.9) in meter |
| x.x | Geoidal Separation | In meter |
| zzzz | DGPS Station ID | Differential reference station ID, 0000 ~ 1023<br>NULL when DGPS not used |
| hh | Checksum | |

### GLL – Geographic Position – Latitude/Longitude
Latitude and longitude of vessel position, time of position fix and status.
Format:
$--GLL,llll.lll,a,yyyyy.yyy,b,hhmmss.sss,A,a*hh<CR><LF>

| Field | Name | Description |
|-------|------|-------------|
| llll.lll | Latitude | Latitude in ddmm.mmmm format. Leading zeros are inserted. |
| A | N/S Indicator | 'N' = North, 'S' = South |
| yyyyy.yyy | Longitude | Longitude in dddmm.mmmm format. Leading zeros are inserted. |
| B | E/W Indicator | 'E' = East, 'W' = West |
| hhmmss.sss | UTC Time | UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999) |
| A | Status | A= data valid, V= Data not valid |
| hh | Checksum | |

### GSA – GNSS DOP and Active Satellites

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values.

Format:

$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,u.u,v.v,z.z*hh<CR><LF>

| Field | Name | Description |
|-------|------|-------------|
| a | Mode | Mode<br>'M' = Manual, forced to operate in 2D or 3D mode<br>'A' = Automatic, allowed to automatically switch 2D/3D |
| x | Mode | Fix type<br>1 = Fix not available<br>2 = 2D<br>3 = 3D |
| xx's | Satellite ID | 01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 65 ~ 96 are for GLONASS (64 plus slot numbers); 193 ~ 197 are for QZSS; 01 ~ 37 are for Beidou (BD PRN). GPS and Beidou satellites are differentiated by the GP and BD prefix. Maximally 12 satellites are included in each GSA sentence. |
| u.u | PDOP | Position dilution of precision (00.0 to 99.9) |
| v.v | HDOP | Horizontal dilution of precision (00.0 to 99.9) |
| z.z | VDOP | Vertical dilution of precision (00.0 to 99.9) |
| hh | Checksum | |

### GSV – GNSS Satellites in View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission.

Format:

$--GSV,x,u,xx,uu,vv,zzz,ss,uu,vv,zzz,ss,…,uu,vv,zzz,ss*hh<CR><LF>

| Field | Name | Description |
|-------|------|-------------|
| x | Number of message | Total number of GSV messages to be transmitted (1-3) |
| u | Sequence number | Sequence number of current GSV message |
| xx | Satellites in view | Total number of satellites in view (00 ~ 12) |
| uu | Satellite ID | 01 ~ 32 are for GPS; 33 ~ 64 are for WAAS (PRN minus 87); 65 ~ 96 are for GLONASS (64 plus slot numbers); 193 ~ 197 are for QZSS; 01 ~ 37 are for Beidou (BD PRN). GPS and Beidou satellites are differentiated by the GP and BD prefix. Maximally 4 satellites are included in each GSV sentence. |
| Vv | Elevation | Satellite elevation in degrees, (00 ~ 90) |
| zzz | Azimuth | Satellite azimuth angle in degrees, (000 ~ 359 ) |
| ss | SNR | C/No in dB (00 ~ 99)<br>Null when not tracking |
| hh | Checksum | |

## RMC – Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data provided by a GNSS navigation receiver.

Format:

$--RMC,hhmmss.sss,x,llll.lll,a,yyyyy.yyy,a,x.x,u.u,xxxxxx,,,v*hh<CR><LF>

| Field | Name | Description |
|---|---|---|
| hhmmss.sss | UTC time | UTC time in hhmmss.sss format (000000.000 ~ 235959.999) |
| x | Status | Status<br>'V' = Navigation receiver warning<br>'A' = Data Valid |
| llll.lll | Latitude | Latitude in dddmm.mmmm format. Leading zeros are inserted. |
| A | N/S indicator | 'N' = North; 'S' = South |
| yyyyy.yyy | Longitude | Longitude in dddmm.mmmm format. Leading zeros are inserted. |
| A | E/W Indicator | 'E' = East; 'W' = West |
| x.x | Speed over ground | Speed over ground in knots (000.0 ~ 999.9) |
| u.u | Course over ground | Course over ground in degrees (000.0 ~ 359.9) |
| xxxxxx | UTC Date | UTC date of position fix, ddmmyy format |
| v | Mode indicator | Mode indicator<br>'N' = Data not valid<br>'A' = Autonomous mode<br>'D' = Differential mode<br>'E' = Estimated (dead reckoning) mode |
| hh | checksum | |

## VTG – Course Over Ground and Ground Speed

The actual course and speed relative to the ground.

Format:

$--VTG,x.x,T,y.y,M,u.u,N,v.v,K,m*hh<CR><LF>

| Field | Name | Description |
|---|---|---|
| x.x | Course | Course over ground, degrees True (000.0 ~ 359.9) |
| y.y | Course | Course over ground, degrees Magnetic (000.0 ~ 359.9) |
| u.u | Speed | Speed over ground in knots (000.0 ~ 999.9) |
| v.v | Speed | Speed over ground in kilometers per hour (0000.0 ~ 1800.0) |
| m | Mode | Mode indicator<br>'N' = not valid<br>'A' = Autonomous mode<br>'D' = Differential mode<br>'E' = Estimated (dead reckoning) mode |
| hh | Checksum | |

### ZDA – Time and Date

UTC, day, month, year and local time zone.

Format:

$--ZDA,hhmmss.sss,dd,mm,yyyy,xx,yy*hh<CR><LF>

| Field | Name | Description |
|---|---|---|
| hhmmss.sss | UTC time | UTC time in hhmmss.sss format (000000.000 ~ 235959.999) |
| dd | UTC day | 01 to 31 |
| mm | UTC month | 01 to 12 |
| yyyy | UTC year | Four-digit year number |
| xx | Local zone hours | 00 to +-13 |
| yy | Local zone minutes | 00 to +59 |
| hh | Checksum | |

### STI,001 – Active Antenna Status Report

An output message, ID 0x001, contains information of active antenna status. The status indicator is output upon power-on reset and change of active antenna connection state.

Structure:

$PSTI,001,x*hh<CR><LF>

      0   2   3

Example:

$PSTI,001,3*1C<CR><LF>

| Field | Name | Example | Description |
|---|---|---|---|
| 1 | 001 | 001 | Proprietary NMEA message identifier |
| 2 | Antenna Status | 3 | 0 : active antenna input short circuit<br>1 : active antenna input open unconnected<br>3 : active antenna input connection OK normal |
| 3 | Checksum | 1C | |

## ORDERING INFORMATION

| Model Name | Description |
| --- | --- |
| S1722R8 | ROM Version GPS Receiver Module |
| S1722F8 | Flash Version GPS Receiver Module |
| S1722F8-RAW | Flash Version GPS receiver Module, Output Carrier Phase Raw Data |
| S1722F8-BD | Flash Version GPS/Beidou Receiver Module |
| S1722F8-BD12 | Flash Version GPS/Beidou Receiver Module |
| S1722F8-BD-RAW | Flash Version GPS/Beidou Receiver Module, Output carrier Phase Raw Data |
| S1722F8-GL | Flash Version GPS/GLONASS Receiver Module |
| S1722F8-GL12 | Flash Version GPS/GLONASS Receiver Module |

## Revision History

| Revision | Date | Description |
|---|---|---|
| 0.1 | June 11, 2013 | Initial release |
| 0.2 | June 16, 2013 | Updated pin-4 description |
| 0.3 | July 26, 2013 | Updated page-3 feature table |
| | | Updated page-5 figures |
| 0.4 | Aug 16, 2013 | Updated page-3,4 update rate |
| 0.5 | Aug 23, 2013 | Updated page-10 footprint |
| 0.6 | Sep 17, 2013 | Updated page-9 operating conditions |
| 0.7 | Aug. 4, 2014 | Update to include S1722F8-RAW |
| 0.8 | Sep. 29, 2014 | Update to include S1722F8-BD-RAW |