MN5515HS
GPS Receiver Module

1 Description

The Micro Modular Technologies MN5515HS Global Positioning System (GPS) Receiver Module is a complete 20-channel receiver with improved cold-start acquisition sensitivity of -145dBm. Cold-start acquisition sensitivity specifies the lowest signal level at which the receiver can get a valid position fix, versus tracking sensitivity, which only means the receiver can track the satellites, but cannot determine a position fix. It measures only 15 x 15 x 2.9 mm, and features fast-acquisition hardware, integrated RF filtering, TCXO, and a real-time clock with on-board crystal. The user needs only provide DC power and a GPS signal; the MN5515HS will output the navigation solution in the widely-used NMEA-0183 protocol or in SiRF binary protocol.

The 20-channel receiver allows all satellites in view to be tracked, providing an over-determined solution to minimize position jumps caused by individual satellite blockage. The fast-acquisition hardware design greatly reduces the time for signal acquisition when the receiver is initially powered up. The MN5515HS operates from a single battery supply between 3.0 and 3.6 VDC. For even further power reductions, the OEM design may use a power-saving mode via binary commands.

An evaluation kit with test software is available to speed development. The MN5515HS is machine placeable by standard surface mount equipment and is available in tube or tape and reel. A metal shield is provided for RF protection and for automated nozzle pickup.

1.1 Features

- Complete SiRFstarIII-based 20-channel GPS receiver
- Highly integrated design includes on-board TCXO, RF filtering, and a Real Time Clock circuit with crystal
- Ultra-small 15 x 15 x 2.9 mm package
- Cold-start acquisition sensitivity of -145dBm, tracking -159dBm
- Less than 80 mW typical power consumption
- Fast-acquisition design for rapid position determination under all startup and operating conditions.
- Full industrial temperature operation (-40℃ to + 85℃)
- Supports SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Standard serial protocols: NMEA-0183 or SiRF binary
- Extended Ephemeris upload capable
- Evaluation Kit available
- Pb free RoHS compliant

1.2 Block Diagram

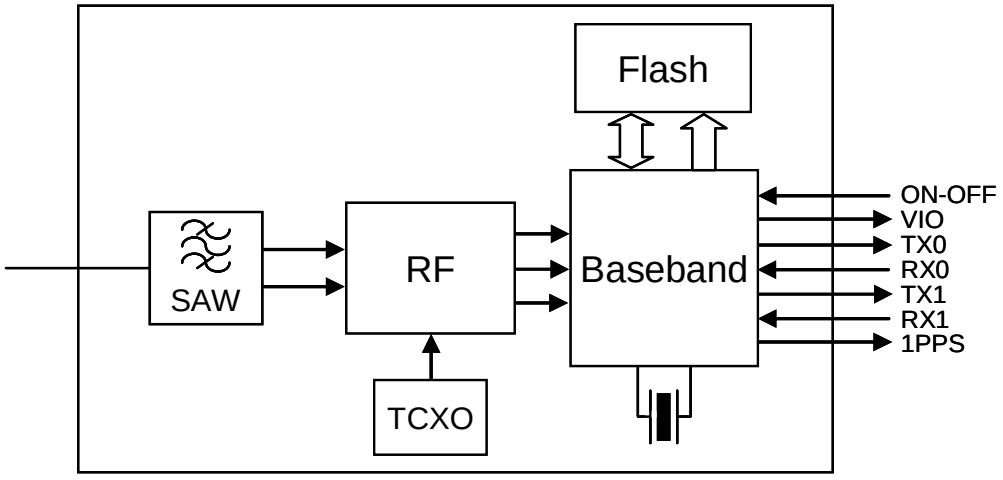


Figure 1 - MN5515HS Block Diagram

2 GPS Performance

Parameter	Specification
Acquisition Time	
Cold start TTFF (no time, no position, no ephemeris), typical	<35 seconds
Warm start TTFF (approximate time and position, no ephemeris), typical	<35 seconds
Hot Start TTFF (time, position and ephemeris), typical	<1 second
Horizontal Position Error	
CEP	<2.5 meters
Signal Sensitivity	
Tracking, typical	-159 dBm
Acquisition (Cold Start), typical	-145 dBm
1 Pulse per Second Signal	
1PPS Signal Accuracy	200 nSec
1PPS Signal Offset from UTC 1 Second Epoch	450 nSec, trailing

Table 1 – GPS Performance Parameters

3 General Specifications

Parameter	Specification
Temperature (operating, storage)	-40℃ to +85℃
Humidity (operating, storage)	Up to 95% non-condensing or a wet bulb temperature of +35℃, whichever is less
Altitude (operating)	-1000 feet to 60,000 feet
Shock (storage)	18G peak, 5 millisecond duration
Shock (storage, in shipping container)	10 drops from 75 cm onto concrete floor

Table 2 – General Specifications

4 DC Operating Characteristics

V_{DD} is nominally 2.85 VDC.

Parameter	Symbol	Min	Typ	Max	Units
Power Supply Voltage	V_{CC}	3.2		3.6	V
Power Supply Current	I_{CC}		26	32	mA
Backup Power Supply Voltage	V_{BK}	1.8		3.6	V
Backup Power Supply Current (operating)	I_{BK}		25		uA
Backup Power Supply Current (hibernate)	I_{BK}			15	uA
High Level Input Voltage	V_{IH}	$0.7*V_{DD}$		V_{DD} +0.3	V
Low Level Input Voltage	V_{IL}	-0.3		$0.3* V_{DD}$	V
Switching Threshold	V_T		$0.5* V_{DD}$		V
High Level Input Current	I_{IH}	-10		10	uA
Low Level Input Current	I_{IL}	-10		10	uA
High Level Output Voltage	V_{OH}	V_{DD}-0.2			V
Low Level Output Voltage	V_{OL}			0.2	V

Table 3 – DC Operating Characteristics

5 Pin Descriptions

Pin	Name	Description
1	VCC	Primary power supply to the module (+3.0 to +3.6 VDC).
2	GND	Ground.
3	TX0	Serial port 0 data output.
4	RX0	Serial port 0 data input.
5	BOOT	Boot select.
6	TX1	Serial port 1 data output.
7	RX1	Serial port 1 data input.
8	ON-OFF	Toggles the state of the module between On and Hibernate.
9	GND	Ground.
10	RFIN	RF Input.
11	GND	Ground.
12	VBK	Backup power supply to the internal RTC and SRAM (+3.0 to +3.6 VDC).
13	VANT	DC input (internally connected to RFIN) to supply power for an active antenna.
14	VRF	2.85 VDC supply.
15	1PPS	One-pulse-per-second (1PPS) output.
16	VIO	2.85 V I/O voltage (output).

Table 4 – MN5515HS Pin-out

6 Power Supply & Power Management

The MN5515HS GPS Receiver Module is designed to operate directly from a battery with a supply range of 3.2 volts DC minimum to 3.6 volts DC maximum. If the primary power supply is removed, V_{BK} (1.8 to 3.6 VDC) should be present in order to keep the internal RTC clock and SRAM alive, even when the receiver is in hibernate mode. If both V_{CC} and V_{BK} are removed, a factory start will be performed upon powerup. V_{BK} must be supplied whenever V_{CC} is applied.

6.1 On–Off Control

Power is controlled via the ON-OFF signal pin (pin 8) of the MN5515HS. If this line is left floating or tied to ground, the receiver will power up and run continuously whenever V_{CC} (and V_{BK}) are applied. Although V_{CC} and V_{BK} could be switched off to completely power down the receiver, all data stored in the receiver's RAM will be lost, with the following results:

- Internal TCXO calibration data is lost, lengthening the time for a cold start.
- The current time is lost, eliminating the possibility of a hot start or warm start.
- The current location is lost, eliminating the possibility of a warm start.
- Current ephemeris data is lost, requiring download of the latest ephemeris data.
- Current almanac data is lost so the receiver will revert to the factory almanac.
- Patch RAM contents (if any) are lost and will require a new download.

To place the receiver into hibernate state (all internal power supplies off except RTC and SRAM) from the full power operating (ON) state, pulse the On-Off control high for a minimum of 1 millisecond. To return the receiver to full power operate state from hibernate state, pulse the On-Off control high for a minimum of 1 millisecond. The Power On–Off pulse must not occur more than once per second.

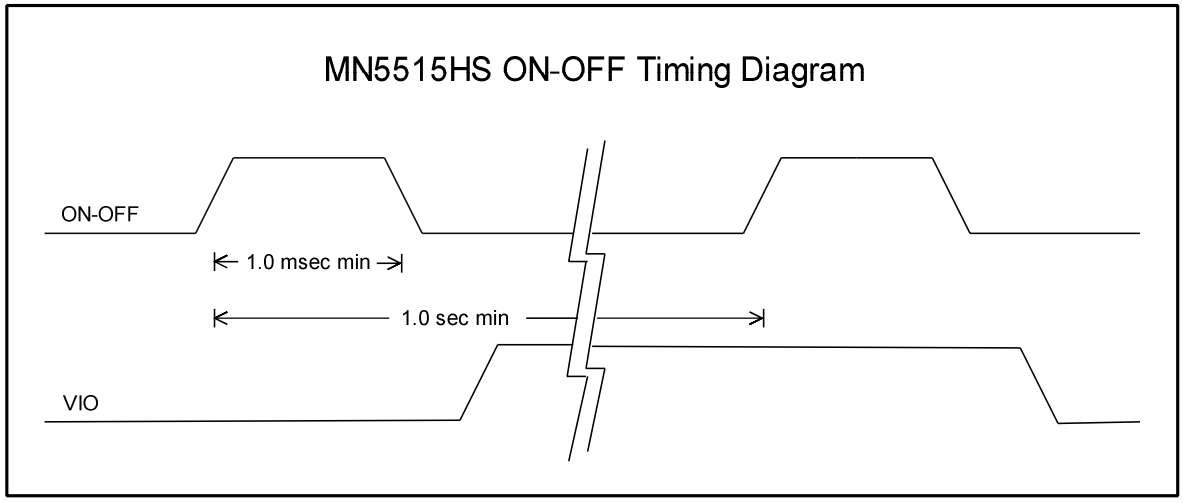


Figure 2 - ON-OFF Signal Timing

If the receiver is operating in one of the power management modes (Adaptive Trickle Power or Push-To-Fix mode), use the software commands to return the receiver to full power operating mode before sending the On-Off pulse. Sending an On-Off pulse during ATP or PTF mode could result in an undetermined power state.

The current power state of the receiver (On vs. Hibernate) can be determined by the level of the VIO pin.

Do not apply an On–Off pulse to the MN5515HS if V_{CC} (and V_{BK}) are not present.

The internal ON-OFF signal is a 1.8 volt logic level. A series resistor of 10K and a shunt resistor to ground of 10K to the internal ON-OFF node reduces the 3 volt external logic level to this 1.8 volt internal logic level. This network must be taken into account if designing an external resistive divider network to interface the 3 volt logic level ON-OFF signal to a higher voltage I/O controller.

6.2 VIO Pin

VIO (pin 16) is the output of the internal 2.85 volt I/O regulator. If VIO is approximately 2.85 volts, then the MN5515HS is in active (On) power state. If VIO is approximately 0 volts, then the MN5515HS is in the Hibernate state.

VIO can be used to provide power to an external buffer which would drive the MN5515HS RX line. Select a buffer that powers down with high impedance inputs and outputs thereby eliminating the possibility of back-driving the MN5515HS through the TX line.

VIO can supply no more than 5mA.

Under no circumstances should this pin be driven by any source.

7 Digital Signal Interface

7.1 Serial Interface

Two full-duplex asynchronous serial data ports provide data communications to and from the MN5515HS GPS Receiver Module.

TX0 (pin 3): This signal is the output of the first UART and is normally used to output position, time and velocity information from the receiver. This signal is a 2.85 volt CMOS I/O logic level with the idle condition being logic high. The protocol may be either NMEA-0183 or SiRF binary, depending upon the current configuration of the receiver. During hibernation, the TX data line will be at 0 volts. The user is cautioned to ensure that any downstream processing of this signal can tolerate a 0 volt condition (BREAK condition) whenever the MN5515HS is in hibernate state. If necessary, the VIO line may be monitored to determine if the receiver is in hibernate state.

RX0 (pin 4): This signal is the input for the first UART and is normally used to input commands or other information to the receiver in either NMEA-0183 or SiRF binary protocol, depending upon the current configuration of the receiver. This signal is a 2.85 volt CMOS I/O logic level. In the idle condition, this pin should be driven at logic 1. During hibernation and when primary power (VCC) is not present, take care not to drive this line high (the normal default idle state of this signal) to prevent partially powering the MN5515HS by backdriving the ESD diode protection circuitry. Use the VIO signal to determine whether or not it is safe to drive this line.

Do not hold this line low (BREAK state) while the receiver is active. Its idle state should be HIGH.

If command/data input is not needed, this pin can be connected to VIO through a 10 KΩ resistor

TX1 (pin 6): This signal is the output for the second UART. This signal is a 2.85 volt CMOS I/O logic level with the idle condition being logic high. In the Hibernate state, this pin will be at logic 0. In the default configuration, the MN5515HS software does not send data on this port.

RX1 (pin 7): This signal is the input for the second UART. This signal is a 2.85 volt CMOS I/O logic level. In the idle condition, this pin should be driven at logic 1. If the driving circuitry is powered independently of the MN5515HS, ensure that this pin is not driven to logic 1 when primary power to the MN5515HS is removed or when the MN5515HS is in the Hibernate state. In the default configuration, the MN5515HS software does not receive data on this port.

7.2 1PPS Signal

The 1PPS signal output (pin 15) is valid only when the receiver is in 3D navigation mode. The 1PPS signal pulses high for 1 microsecond at 1 Hz when the fix is valid. The 1PPS signal can vary by up to 200 nanoseconds and trails the UTC 1 second epoch by 450 nanoseconds.

7.3 BOOT Signal

The BOOT pin (pin 5) must be tied to ground for normal operation. It is recommended to go through a zero Ω resistor to permit re-programming the flash memory if that should be required in the future.

8 RF Interface

8.1 RF Input

The MN5515HS GPS Receiver Module accepts a standard GPS L1 C/A signal from an industry-standard GPS active antenna on the RF Input pin (pin 10). The active antenna may be powered by connecting the VRF pin (2.85 VDC supply) or appropriate external supply voltage for the antenna to the VANT pin. The RF input is isolated from DC levels to a maximum of ±15 V. If the end product requires tolerance to high levels of RF interference, consider selecting an active antenna with both a pre-select and a post-select filter to block the unwanted RFI.

VANT (pin 13): DC input to supply power for an active antenna via internal module connection to RFIN (pin 10).

VRF (pin 14): 2.85 VDC supply output which may be connected to VANT to power an active antenna. This pin can supply 15 mA max.

Signal Level	-160 dBm to -125 dBm typical
Frequency	L1 (1575.42 MHz)
Return Loss	Better than -10 dB
Noise Figure	2 dB typical
Impedance	50 Ohms nominal

Table 5 – RF Signal Characteristics

8.2 LO Leakage

The MN5515HS has an internal LO at 1571.424MHz that can appear at the ANT pad of the device. While this level is quite low (approximately –80 dBm), it is high enough that it could interfere with another GPS receiver in the vicinity. This is not a problem in normal operation, but during test and evaluation, several receivers could be operating simultaneously from a common antenna or other signal source. In this case, care must be taken to provide proper isolation between the receivers.

8.3 Spurious Signals

Due to the small size of the MN5515HS module and the tight IC geometries used internally, the MN5515HS does generate a fair amount of digital noise. Since this is all based upon the internal reference frequency of 16.369 MHz, it is synchronous within the receiver and does not impact receiver operation. However, some signals may interfere with external circuitry. Therefore, it may be necessary to shield the GPS module and related circuitry from other receivers in the end product.

8.4 Burnout Protection

The MN5515HS GPS Receiver Module can accept signal levels up to +10 dBm with a DC voltage of ±15 V on the RF input pin without permanent damage to the module.

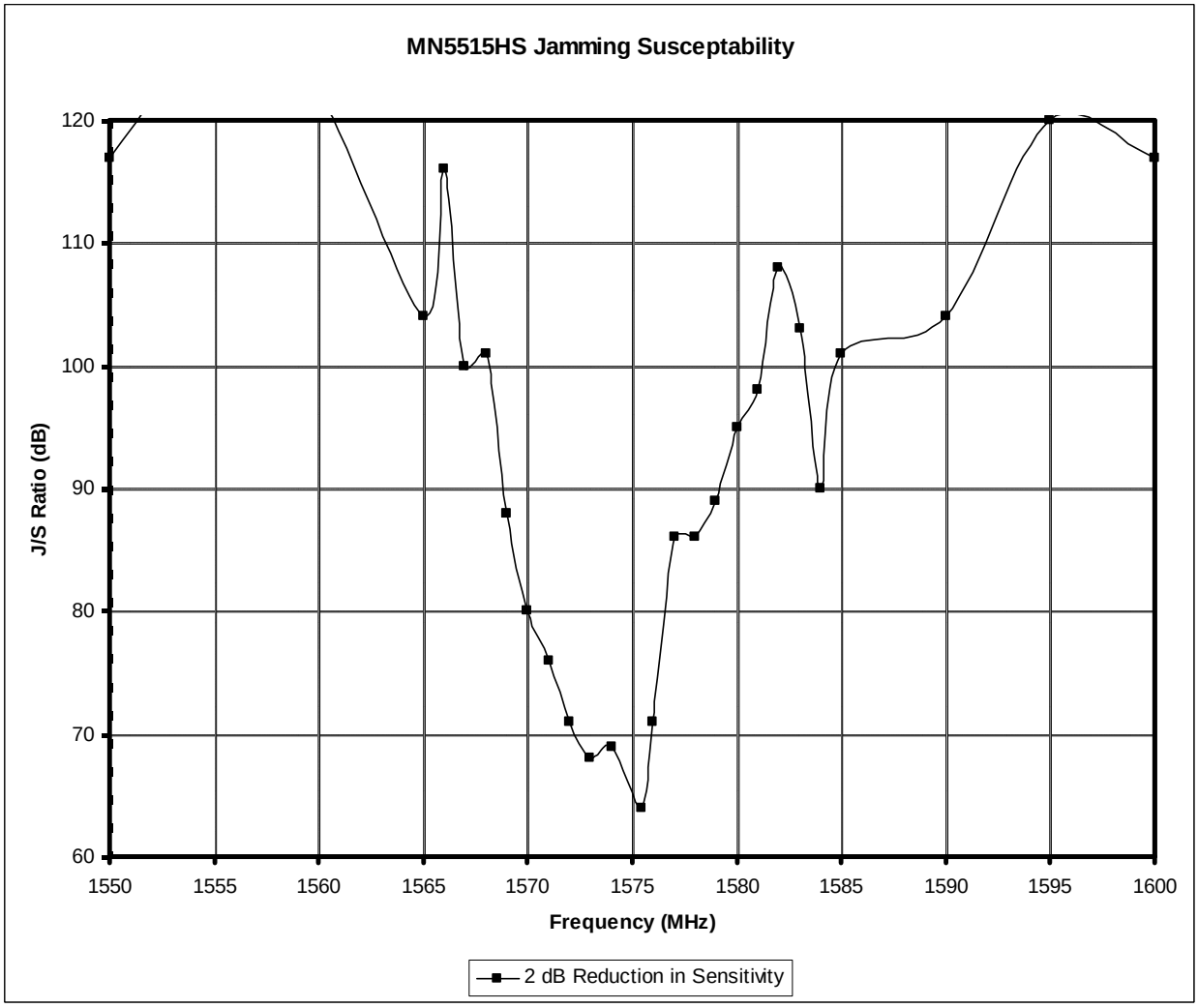


Figure 3 – Jamming Performance

9 Getting Started

Following are a few basic guidelines for initial startup of the MN5515HS GPS receiver.

1) Default startup configuration is NMEA protocol, 4800 baud. This can be changed later by issuing a NMEA command (100 – SetSerialPort). See SiRF NMEA Reference Manual for details.

2) The BOOT pin (pin 5) must be grounded, otherwise, the module may enter Boot mode.

3) The VBK pin (pin 12) must be powered whenever V_{CC} is applied.

4) When the MN5515HS is operating in active mode, the VIO pin (pin 16) will be high, approximately 2.85V. If VIO is approximately 0 volts, then the MN5515HS is in the HIBERNATE state. To return the receiver to full power operate state from hibernate state, pulse the On-Off control high for a minimum of 1 millisecond. See section 6.1, On–Off Control.

10 Software Interface

10.1 NMEA Data Messages

The MN5515HS supports the following NMEA-0183 v3.0 messages:

ID	Description	Default interval
GGA	GPS fix data	1 sec
GLL	Latitude and longitude	N
GSA	DOP and active satellites	1 sec
GSV	Satellites in view	5 sec
RMC	Recommended Minimum GNSS Data	1 sec
VTG	Course over ground and ground speed	1 sec
ZDA	Time and date	N

Table 6 – NMEA Messages

For detailed information regarding these messages, please refer to the SiRF NMEA Reference Manual.

10.2 NMEA Proprietary Commands

The MN5515HS recognizes the following NMEA proprietary commands:

ID	Description
$PSRF100	Set Serial Port
$PSRF101	XYZ Navigation Initialization
$PSRF103	Query/Rate Control
$PSRF104	LLA Navigation Initialization
$PSRF106	Select Datum

Table 7 – Proprietary NMEA Commands

For detailed information regarding these commands, please refer to the SiRF NMEA Reference Manual.

10.3 SiRF Binary Messages and Commands

For detailed information regarding the SiRF Binary protocol, please refer to the SiRF Binary Protocol Reference Manual.

11 Referenced Documents

SiRF NMEA Reference Manual
SiRF Binary Protocol Reference Manual

Table 8 – Referenced Documents

12 Packaging and Marking Information

12.1 Component Marking

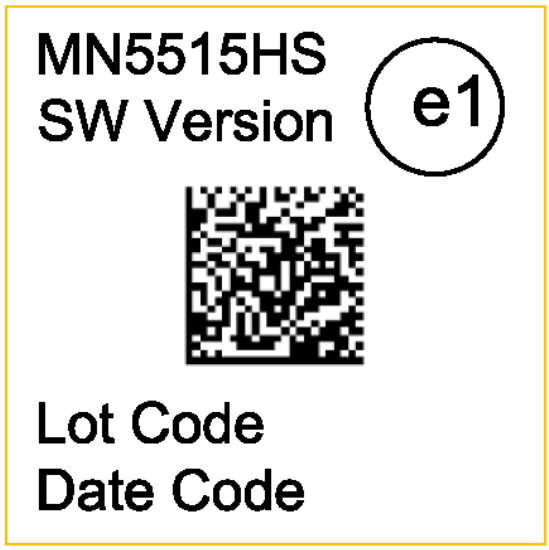


Figure 4 – Component Marking

12.1.1 Date Code

The date code is contained in the fourth line of text. The first character shall be a number indicating the last digit of the year of manufacture, starting from 2005 to 2014. The second character shall be an alphanumeric character indicating the month of manufacture (see Table 9 – Date Code: Second Character (month indicator)). The third character shall be an alphanumeric character indicating the day of manufacture (see Table 10 – Date Code: Third Character (day indicator)).

1 = January	4 = April	7 = July	A = October
2 = February	5 = May	8 = August	B = November
3 = March	6 = June	9 = September	C = December

Table 9 – Date Code: Second Character (month indicator)

1 = 01	6 = 06	B = 11	G = 16	M = 21	T = 26
2 = 02	7 = 07	C = 12	H = 17	N = 22	U = 27
3 = 03	8 = 08	D = 13	J = 18	P = 23	W = 28
4 = 04	9 = 09	E = 14	K = 19	Q = 24	X = 29
5 = 05	A = 10	F = 15	L = 20	R = 25	Y = 30
					Z = 31

Table 10 – Date Code: Third Character (day indicator)

12.2 Package Dimensions and Pin Identification

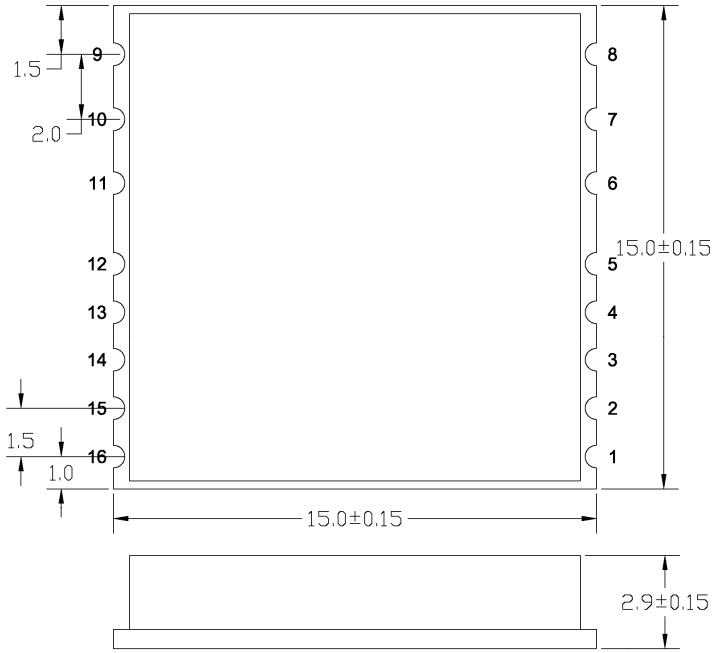


Figure 5 – Package Outline (in mm) with pin identification

12.3 Recommended PCB Footprint

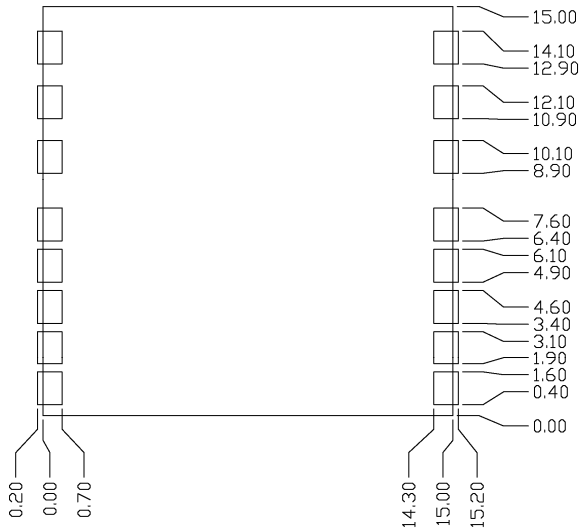
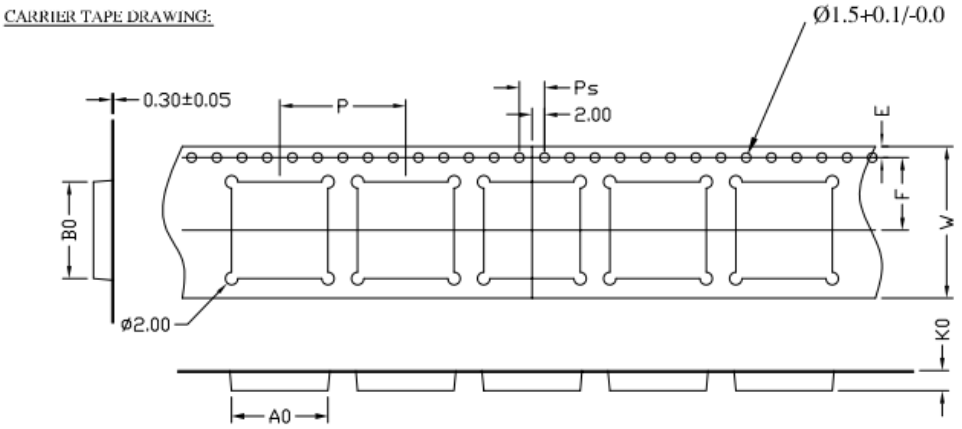


Figure 6 – Recommended PCB Footprint (in mm) – Top View

Figure 6 is a suggested PCB footprint for the MN5515HS. The user may need to adjust the pad dimensions based upon their manufacturing process. While solder mask covered traces are permissible underneath the MN5515HS, exposed vias or pads should be avoided.

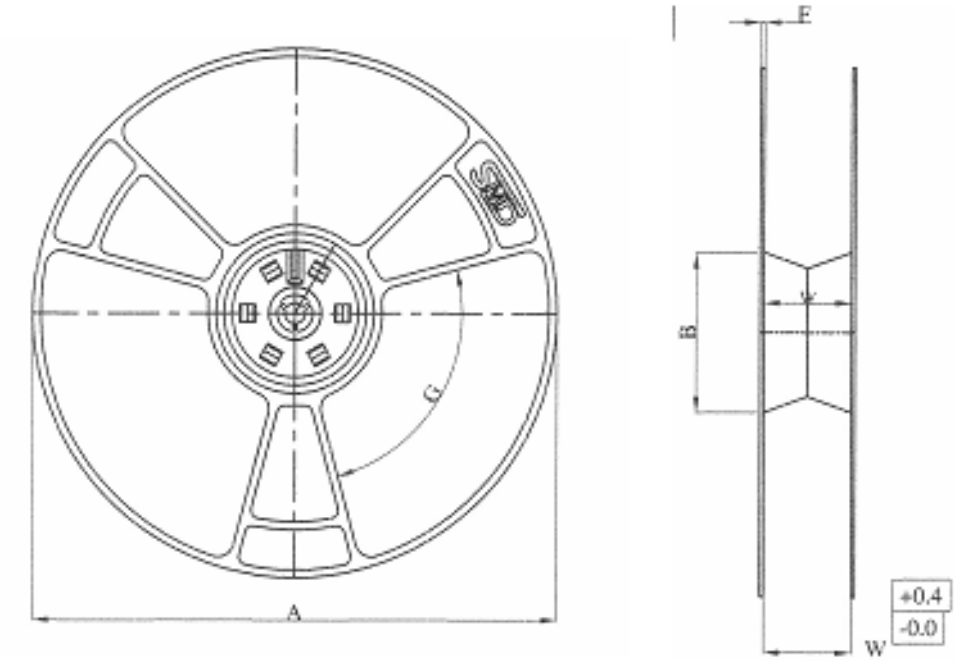
12.4 Tape and Reel Information

The MN5515HS is provided in standard tape and reel, with 1K devices per reel.



Dimensions	W	P	Ao	Bo	Ko	Ps	E	F
Nominal	24.00	20.00	15.30	15.3	3.4	4.00	1.75	11.50
Tolerance	0.30	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Figure 7 – Carrier tape dimensions (in mm)



Reel Part No.	A	W	B	F	G
SMD/H4/W24	330	24.4	100	2.2	90°

Figure 8 – Reel Dimensions (in mm)

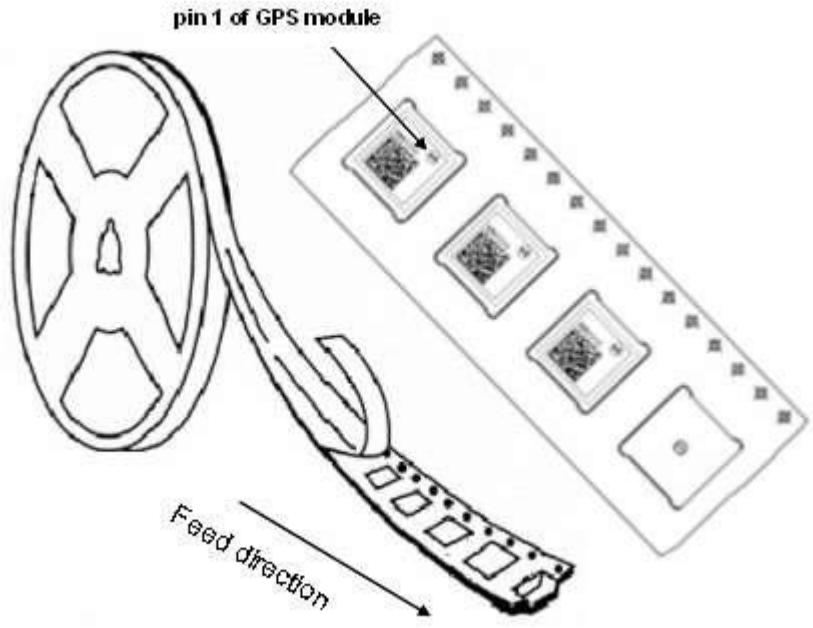


Figure 9 – Orientation in tape

12.5 Recommended Reflow Profile

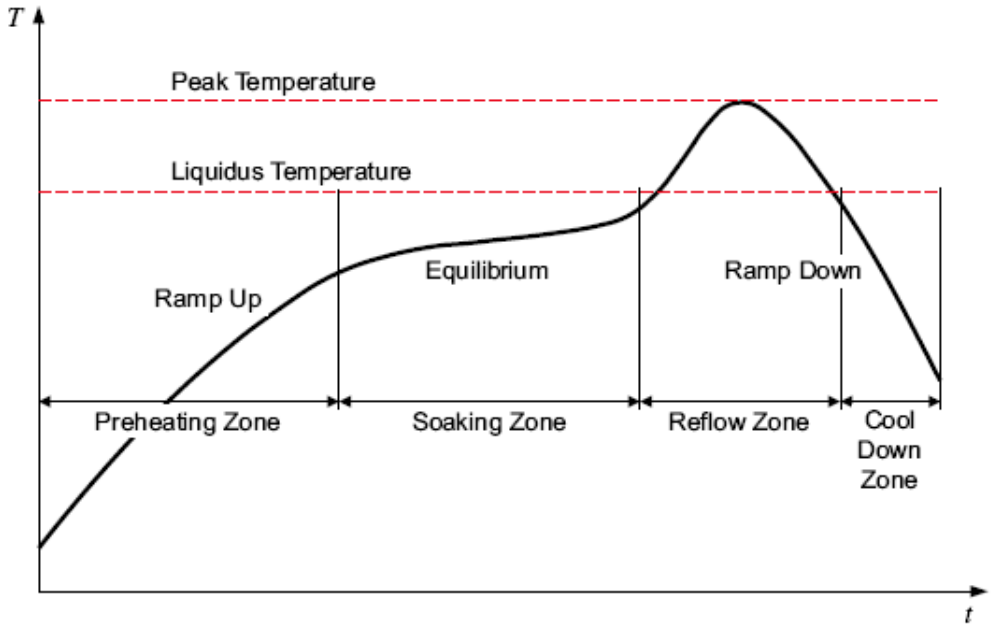


Figure 10 – Reflow Profile

Reflow Parameter	Specification
Preheating Rate	2.5℃/second
Soaking Temperature	140℃ to 170℃
Soaking Time	80 seconds
Peak Temperature	260℃
Reflow Time over Liquidus	60 seconds
Cool down Rate	2.5℃/second

Table 11 – Reflow Parameters

13 Ordering Information

The ordering part numbers are contained in the table below:

Ordering Part Number	Description
MN5515HS-RS	MN5515HS in tape & reel
MN5515HS-BS	MN5515HS in tray

Table 12 – Ordering Information

14 Notices

All reference and informational documents (including marketing information, specifications, reference designs, etc.) are provided for information only and are subject to change without notice. Reasonable efforts have been made in the preparation of these documents to assure their accuracy, however Micro Modular Technologies Pte. Ltd. assumes no liability resulting from errors or omissions in this, or any document, or from the use of the information contained herein. Micro Modular Technologies Pte. Ltd. reserves the right to make changes in the product design and specifications as needed and without notification to its users. Please check our website for the most current documentation. All information contained herein is the property of Micro Modular Technologies Pte. Ltd. and may not be copied or reproduced, other than for your information, without prior written consent.

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