

# MS20 GPS Receiver User Manual



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## 1. Description

### 1.1 Introduction

The MS20 uses the physical form factor of the earlier generation CW20 module with changes in the power and voltage requirements.

The MS20 GPS module is a highly sensitive, compact single chip solution for GPS applications. It includes an RF receiver, complete baseband processor, flash memory and a power control unit. The RF receiver uses a single conversion low-IF digital architecture, with the high-level integration leaving a few off-chip matching and decoupling components, minimizing system cost. The baseband processor is controlled by adaptive signal processing, and the navigation firmware is optimized for execution on a low power microprocessor. Optimal signal acquisition and tracking strategy are enabled by sophisticated adaptive control algorithms.

Sophisticated adaptive control algorithms provide optimal signal acquisition/tracking strategy.

### 1.2 Applications

- PND
- Mobile Phone
- UMPC
- Vehicle Tracking
- Asset Tracking
- Personnel Tracking
- DSC and GPS Related
- Marine and Timing Navigation

### 1.3 Features

- GPS L1 C/A code
- High sensitivity of -159 dBm in tracking & -144 dBm in acquisition
- Build in power-on-reset and calibration circuits
- Assisted/autonomous operation
- Fast TTFF in all modes (a typical outdoor)
  - hot-start in 1.5s,
  - warm-start in 32s
  - cold-start in 35s
- Up to 60,000 simultaneous search windows
- 48 acquisition & 12 tracking channels
- SBAS (WAAS/EGNOS/MSAS) capable
- Support standard NMEA-0183
- TCXO & RTC integrated
- Integrate a high-performance MIPS M4K CPU
- Integrated a 512 kB NOR flash memory
- Easy to integrate
  - UART data interface
  - 3.3V tolerant I/O pins
  - 1 PPS (200 ns RMS)
  - 3.2 - 5V Supply
- Operates at 1.2V/3.0V (core/IO), integrate LDO
- Battery backed RAM & RTC and direct connection
- 0.18um CMOS for RF and 0.11um CMOS for Baseband
- Avg current (33mA @ 3.3V, 29mA @ 5V)
- 21.0 x 16.44 x 2.82 mm

## 2. SPECIFICATIONS

### 2.1 Performance

<b>Physical</b>			
Module Dimensions	21mm (D) x 16.44mm (W) x 2.82mm (H) ±.2mm		Notes
<b>Electrical</b>			
Supply Voltages	3V3 (NVDD), 2V5 (VBAT)		1
Operating Temperature Range	-30°C to 70°C		
Storage Temperature Range	-40°C to 85°C		
<b>GPS Performance</b>			
GPS Channels	12 tracking (48 acquisition)		
Frequency	1575.42 MHz – L1 C/A Code		
TTF Cold Start	34 seconds		2, 8
TTF Warm Start	32 seconds		2, 8
TTF Hot Start	1.5 seconds		2, 8
Re-acquisition time	<1 seconds		3
Acquisition Sensitivity (fix not available)	TTF (Hot) with all signals at -138 dBm: 30 s		4
Acquisition Sensitivity (dBm)	-144 dBm		5
Tracking Sensitivity (dBm)	-159 dBm		6
Acquisition Sensitivity SBAS Satellites (dBm)	TBD		7
Tracking Sensitivity SBAS Satellites (dBm)	TBD		7
Static Accuracy (without SBAS)	50% Confidence (CEP)	1.7 m	8
	95% Confidence	2.9 m	
Static Accuracy (with SBAS)	50% Confidence (CEP)	1.2 m	9
	95% Confidence	2.4 m	
Maximum Horizontal Speed	515 m/s (1000 Knots)		10
Maximum Altitude	18 Km (60000 feet)		10
Maximum Acceleration, Jerk	4 g, 7 g/s		
<b>Power</b>			
During acquisition (fully active) @ 3.3V	145 mW		
While tracking (fully active) @ 3.3V	110 mW		
During Sleep Mode (NVDD)	TBD		
VBAT Current	25µa @ 3v		
<b>Interfaces</b>			
I/O Port	UART x 2 (9600 8N1)		
Protocols	NMEA 0183		
<b>Antenna</b>			
Configuration Supported	Active or Passive		
Impedance	50Ω		
Voltage	2.8 - 3.1V		

**Table 1. Performance Specifications**

*Notes:*

1. Typical listed
2. These are RMS values
3. Maximum Sensitivity -147 dBm
4. Simulator Test, all signals at specified power level.
5. Estimated
6. Simulator Test, continuous fix with all signals at specified power level.
7. Simulator Test with signal at specified power level.
8. Open-sky, 24 hrs statistic, active antenna (signal range is between 30 to 49 dB/Hz).
9. Open sky, 24 hrs statistic, active antenna (WAAS signal used).
10. Limited by International Traffic in Arms Regulation (ITAR)

## 2.2 Electrical Characteristics

### 2.2.1 Absolute Ratings

Symbol	Min	Typ	Max	Units	Notes
NVDD	-0.2	-	5.5	V	
VBAT	-0.2	-	5.5	V	1

Notes: 1. Absent a battery, this should be connected to NVDD. Below minimum voltage module will not power up.

### 2.2.3 Recommended

Symbol	Min	Typ	Max	Units	Notes
Temp	-30	25	+70	°C	
NVDD	3.2	3.6	5.0	V	
VBAT	2.2	3.6	5.0	V	1

Notes: 1. Absent a battery, this should be connected to NVDD. Below minimum voltage module will not power up.

### 2.2.3 CMOS Interface Levels

Symbol	Min	Typ	Max	Units	Notes
VCC30	-	2.9 ±5%	-	V	
VOH	VCC30 -0.1	-	-	V	1
VOL	-	-	0.1	V	1
Output Current	-	-	4.0	mA	
VIH	2.5	-	-	V	1
VIL	-	0.8 V	1	V	
Input Capacitance	-	5	-	pF	
Input current	-	-	1.0	uA	

Notes: 1. Digital Inputs and Outputs are 3V CMOS.

Tables 2. Electrical Characteristics

## 2.3 Block Diagram

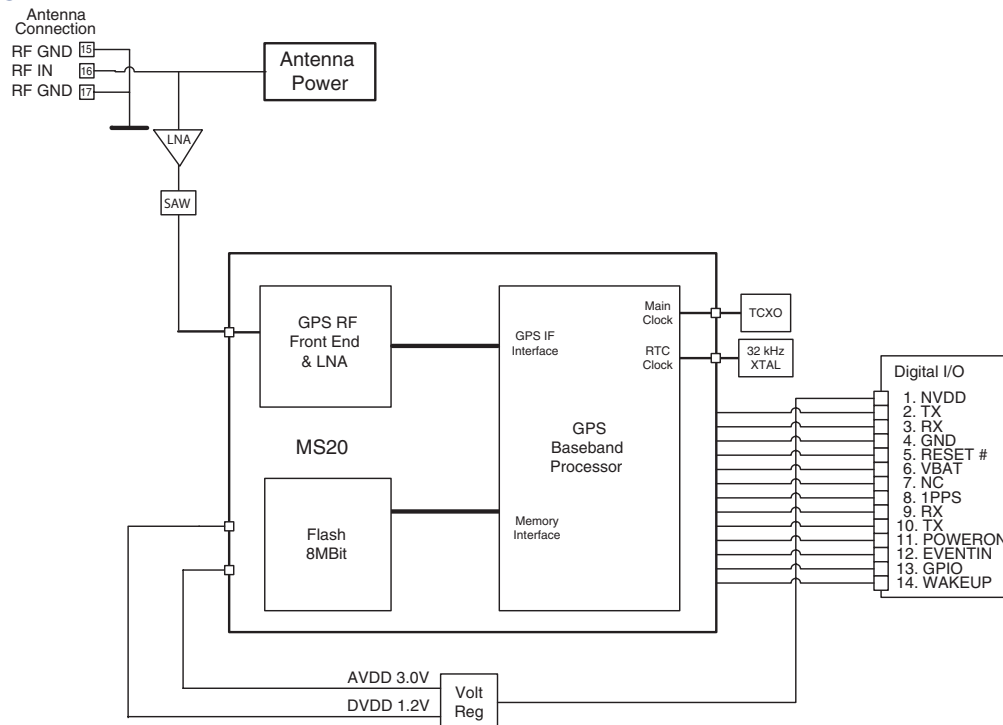
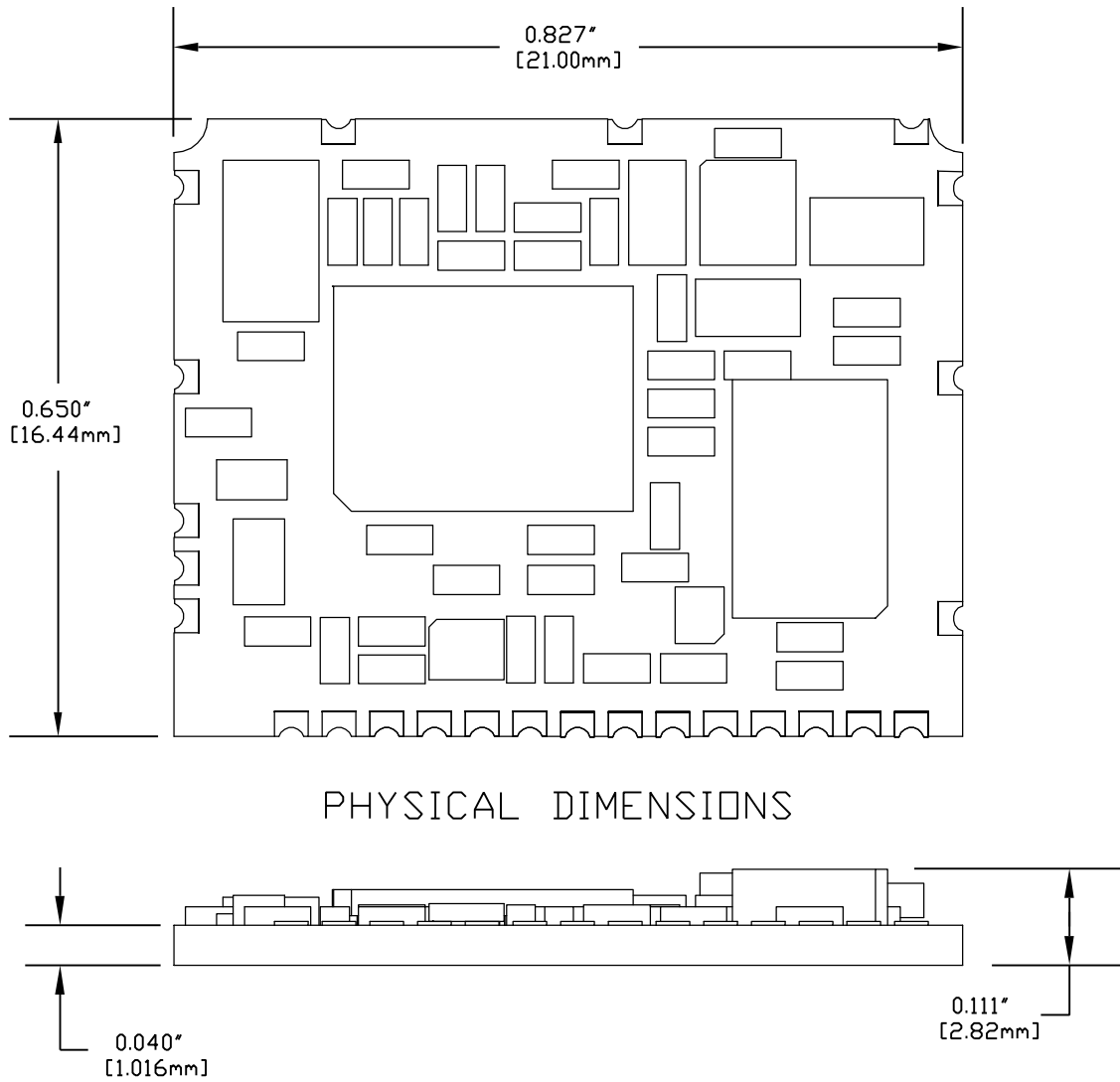


Figure 1. MS20 Block Diagram

### 3. PHYSICAL CHARACTERISTICS

#### 3.1 Form and Size

The MS20 is a multi-chip module built on an FR4 fiberglass PCB. All digital and power connections are via castellations on the 21 x 16.44 mm PCB. The general arrangement of the MS20 is shown in the diagram below.



**Figure 2: Mechanical Dimensions**

### 3. PHYSICAL CHARACTERISTICS continued

#### 3.2 Physical Interface Details

The interface to the MS20 is via 0.90 mm castellations on a 1.27 mm pitch. There are 25 castellations in all. The details of the interface connections are given below.

#### 3.3 Pin Out

1	NVDD	Primary Supply (3.2 - 5.0V)
2	TX (PRIMARY)	Serial Data Transmit from Module (NMEA Output 9600 8N1)
3	RX (PRIMARY)	Serial Data Receive to Module
4	GND	Ground
5	RESET#	Active Low Device Reset
6	VBAT	Backup Supply (2.2 - 5.0V) Required, if no battery connect to primary
7	NC	Not Connected (CW20:DSUMUX)
8	1 PPS	One Pulse Per Second
9	RX (SECONDARY)	Serial Data Receive to Module (CW20:DSU_RX)
10	TX (SECONDARY)	Serial Data Transmit from Module (CW20:DSU_TX)
11	POWERON	Ground to Turn Internal Regulators Off (CW20:DSUEN)
12	EVENTIN	Event Input with Custom Firmware (CW20:DSUBRE)
13	GPIO	General Purpose IO with Custom Firmware (CW20:DSUACT)
14	WAKEUP	Pull High to Suspend.
15	RF GND	RF Ground
16	RF IN	RF Input, with ~3.0V DC Bias for Active Antenna
17	RF GND	RF Ground

**Table 3. Pin-Out Descriptions**

### 3. PHYSICAL CHARACTERISTICS continued

#### 3.4 Solder Pad Size and Placement

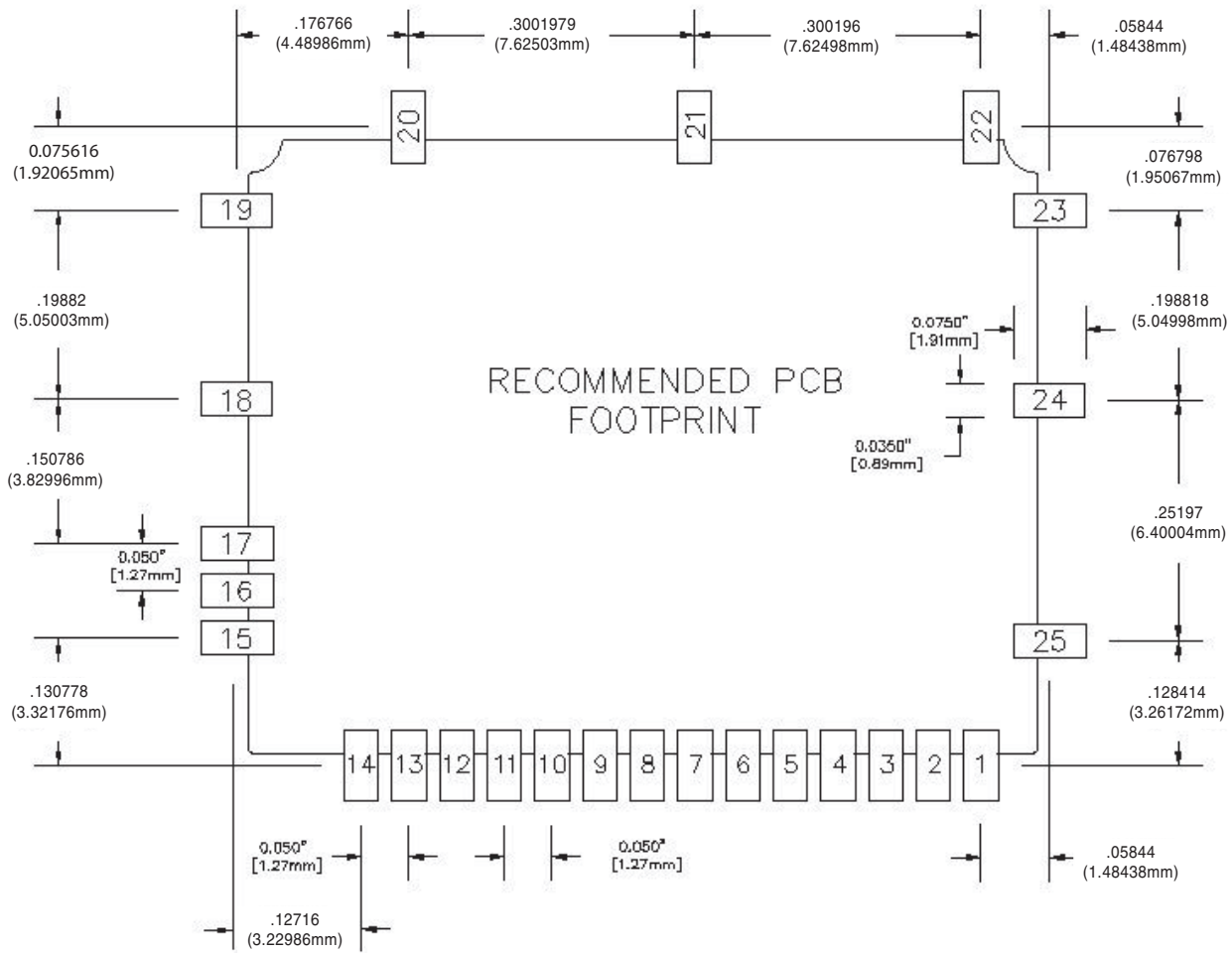


Figure 3: Solder Pad Size and Placement



## 4. SIGNAL DESCRIPTIONS

### 4.1 Signal Descriptions

<b>NVDD</b>	<b>Type: Power</b>	<b>Direction: Input</b>	<b>Pin 1</b>
	The supply input. This 3.3V input supplies power to RF and digital sections of the MS20 and should be properly filtered.		
<b>TX</b>	<b>Type: Signal</b>	<b>Direction: Output</b>	<b>Pin 2</b>
	The UART transmit signal for the MS20.		
<b>RX</b>	<b>Type: Signal</b>	<b>Direction: Input</b>	<b>Pin 3</b>
	The UART receive signal for the MS20.		
<b>GND</b>	<b>Type: Power</b>	<b>Direction: Input/Output</b>	<b>Pin 4</b>
	The ground pin for the MS20. The return path of the NVDD and ground reference for all signal pins.		
<b>RESET #</b>	<b>Type: Control</b>	<b>Direction: Input/Output - Open Collector</b>	<b>Pin 5</b>
	The system reset signal. This asynchronous signal must be held low for a minimum of 1ms following valid power on the NVDD pin to generate a device reset. Internal 47k pull-up to 3V		
<b>VBAT</b>	<b>Type: Power</b>	<b>Direction: Input</b>	<b>Pin 6</b>
	The backup battery supply input. Minimum voltage of 2.2V required to maintain NVRAM settings, and power on device.		
<b>nc</b>	<b>Type:</b>	<b>Direction: No connect</b>	<b>Pin 7</b>
	Debug and programming interface.		
<b>GPIO &lt;4&gt;</b>	<b>Type: Signal</b>	<b>Direction: Input/Output</b>	<b>Pin 8</b>
	Blinks for 1ms every time traffic is generated on the UART interface. May be left unconnected. General purpose input/output pin. The signal return path is Pin 4.		
<b>RX_SECONDARY</b>	<b>Type:</b>	<b>Direction: Input</b>	<b>Pin 9</b>
	Debug and programming interface.		
<b>TX_SECONDARY</b>	<b>Type:</b>	<b>Direction: Output</b>	<b>Pin 10</b>
	Debug and programming interface.		
<b>POWER_ON</b>	<b>Type:</b>	<b>Direction: Input - Open Collector</b>	<b>Pin 11</b>
	Ground to turn off, normally pulled high. Internal 47k pull-up to NVDD		
<b>EVENT_IN</b>	<b>Type:</b>	<b>Direction: Input</b>	<b>Pin 12</b>
	Event input with custom firmware		
<b>GPIO</b>	<b>Type:</b>	<b>Direction: Output</b>	<b>Pin 13</b>
	General Purpose IO with custom firmware..		
<b>WAKEUP</b>	<b>Type: Power</b>	<b>Direction: Input</b>	<b>Pin 14</b>
	Pull high to suspend. Internal 47k pull-down to GND		
<b>GND</b>	<b>Type: Power</b>	<b>Additional GND Pins for the MS20</b>	<b>Pins 15, 17-25</b>
<b>ANT</b>	<b>Type: Antenna</b>	<b>Primary Antenna Connection</b>	<b>Pin 16</b>
	~ 3V DC Bias		

**Table 4. Signal Descriptions**

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## 5. SPECIAL CONSIDERATIONS

### 5.1 Power Enable

The POWERON (11) pin is pulled high internally and gates the enable of the internal regulators. When high, the regulators will be enabled. The user may clamp this pin to ground to disable the internal regulator. A side effect of this, and to effectively perform a Power-On-Reset (POR), the Reset pin will be clamped to zero during the time POWERON is low, and for at least 100 ms after POWERON is high as the regulator resumes normal operation. The POR circuit is monitoring the output from the internal regulators, not the NVDD supply.

Holding POWERON will cause the least amount of power to be consumed by the MS20 via the NVDD pin. The CPU, flash, RF front end and TCXO will be powered down. The RTC and its oscillator will continue to be powered from the VBAT pin.

### 5.2 Reset

The RESET# (5) pin is an open collector pin designed to be clamped low by external circuitry when a reset is required. It will also be clamped low internally by the MS20 when the output from the internal regulator is less than 2.7V. This clamping will persist for at least 100ms after the supply has recovered. This behavior is designed to ensure the correct startup of the receiver. Be aware that connecting RESET# to other external reset inputs will result in the device resetting as well, or be held in reset, when the power to the MS20 is removed or disabled. This situation may occur in several ways: NVDD is currently below the drop out threshold of the regulator, which is below the minimum input voltage specification; NVDD or VDD30 (2.9V) has browned out because the supply has drooped or otherwise failed to provide enough current on demand; the POWERON pin has been, or is, pulled low; or external circuitry, either a POR or GPIO, is initiating or holding the device in reset.

*Note: The internal supplies on the MS20 are not exposed to the user of the device.*

### 5.3 Wake Up

The WAKEUP (14) Pin is pulled low internally, driving this pin high will cause the MS20 to enter the sleep/suspend state. The MS20 will exit the sleep/suspend state when the pin is released or driven low.

### 5.4 Battery Supply

GPS receivers use batteries to maintain time and non-volatile memory. In order to speed up reacquisition, GPS receivers want to maintain time/date/location information along with almanac data. The satellite constellation is in constant motion so in order to predict which satellites will be visible, you need to know what time it is, where you are (approximately), and have a way to compute the orbital position of all the satellites within the constellation. Using this information the receiver can commit correlators to search for satellites that are in-view, and improve the time to first fix (TTFF). That said, today's receivers can search the signal space for the satellite signals much more rapidly than when the system was initially conceived. Non-volatile memory can also hold ephemeris and almanac information which would otherwise have to be demodulated from the slow data signal. The GPS receiver will still be able to function without this information at startup. It will just have to do more work and will typically take longer to do so.

Given the separation of the supplies, and to permit the greatest flexibility in application circuits, power needs to be present on VBAT for the MS20 to function. Without power, the MS20 will not start.

In some implementations it is not desirable to have a battery or super capacitor in the receiver sub-system. In these situations VBAT and NVDD should be connected together. When the main supply is lost, any time, location and associated data previously held will be lost. The receiver can regenerate and reacquire this data, although it will take longer.

With a battery (primary cell, or rechargeable) or super capacitor, the voltage at VBAT should be 2.2 V or higher for the MS20 to function.

### 5.5 Firmware Updating

In order to perform firmware updates, or apply custom firmware, the secondary RX (9) and TX (10) pins should be exposed to a header. The software to update the device runs on a PC. These pins are not RS-232 compatible so direct connection to a PC is not possible, although there are several level converters and USB type adapters to achieve this. It is suggested that the header match off-the-shelf or other converters you are currently using.

## 6. USER INTERFACE MESSAGES

The following application protocols are implemented

### 6.1 NMEA Protocol

The MS20 software is capable of supporting the following NMEA message formats:

NMEA Message Prefix	Format	Direction
\$GPRMC	Recommended minimum specific GNSS data	Out
\$GPGGA	GPS fix data	Out
\$GPGLL	Geographic position latitude / longitude	Out
\$GPGSA	GNSS DOP and active satellites	Out
\$GPGSV	Satellites in view	Out
\$GPVTG	Velocity and track over ground	Out
\$GPZDA	Date and time	Out

**Table 5 NMEA Messages Summary**

### 6.2 NMEA Extensions

The MS20 software is capable of supporting the following NMEA extensions:

NMEA Extension Prefix	Format	Direction
\$PMST02	Software reset	In
\$PMST12	NMEA message rate control	In
\$PMST10	NMEA Baud rate control	In
\$PMST09	Non-volatile settings	In
\$PMST14	Polling specific NMEA messages	In
\$PMST100	Software version information	Out
\$PMST200	Command acknowledgement	Out

**Table 6 Extended Messages**

### 6.3 General NMEA Format

The general NMEA format consists of an ASCII string beginning with a '\$' character and terminated with a <CR><LF> sequence. NMEA standard GPS messages begin with 'GP' then a 3 letter message identifier. MS20 specific messages begin with '\$PMST' followed by a 2 digit number. NMEA proprietary messages begin with a 'P'.

The message header is followed by a comma delimited list of fields optionally terminated with a checksum consisting of an asterisk '\*' and a 2 digit hex value representing the checksum. There is no comma preceding the checksum field. All messages emitted by the MS20 have checksums, the checksum should be verified before using or relying on the data provided.

When present, the checksum is calculated as a byte wise exclusive OR (XOR) of the characters between the '\$' and the '\*'.

As an ASCII representation, the number of digits in each number will vary depending on the number and precision, hence the record length will vary. Certain fields may be omitted (blank) if they are not used or available. In this case the field position is reserved using commas to ensure the correct interpretation of subsequent fields. There are no spaces in NMEA messages. When parsing data, the routines should be robust and flexible to account for precision changes. The NMEA format was designed as a common interface to position reporting devices in the 1980's including TRANSIT and LORAN. The format of latitude and longitude was specifically designed for easy transfer to LED 7-segment type display devices with little translation by simple processors. The format of degrees and minutes is not immediately intuitive and needs to be decomposed to arrive at a decimal degrees form used in computer/software navigation applications. The NMEA messages report position in a DDDMM.mmmm form. The MM.mmm portion needs to be divided by 60 to compute the fractional degrees and the DDDxx integer portion needs to be divided by 100. The sign is then negated if the hemisphere is 'S'outh of the Equator or 'W'est of the Greenwich Meridian, depending on the latitude or longitude. Incorrect decomposition will produce results with significant offsets. Example code is available upon request. The validity field of the specific NMEA message should always be checked prior to using location information. The GPS constellation uses the WS85 datum.

## 6. USER INTERFACE MESSAGES continued

The following tables indicate the maximum and minimum widths of the fields to allow for buffer size allocation. The field width specifications represent the minimum and maximum digits of precision which must be present. When a field may be omitted, this is represented by (0) for omitted (blank), followed by the data when the field is not emitted. For instance, (0) 3 for checksum means the checksum is either blank, or 3 digits. All messages currently emit a checksum. When a value is signed this is represented by (-) followed by the number of digits.

### 6.4 \$GPGGA

This message transfers global positioning system fix data. The \$GPGGA message structure is shown below:

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPGGA	6	6	GGA protocol header
UTC Time	hhmmss.sss	2,2,2.3	2,2,2.3	Fix time to 1ms accuracy
Latitude	ddmm.mmmm	2,2.4	2,2.6	Degrees * 100 + Minutes (Nominally 4 decimal places)
N/S Indicator	char	1	1	N=North, or S=South
Longitude	dddmm.mmmm	3,2.4	3,2.6	Degrees * 100 + Minutes (Nominally 4 decimal places)
E/W Indicator	char	1	1	E=East, or W=West
Position Fix Indicator	int	1	1	0=Fix not available or invalid 1=GPS SPS mode. Fix available 2=DGPS SPS mode. Fix available (SBAS)
Satellites Used	int	2	2	Number of satellites used to calculate fix (00-12)
HDOP	float	1.1	3.1	Horizontal Dilution of Precision
MSL Altitude	float	1.1	5.1	Altitude above Mean Sea Level
Units	char	1	1	M Stands for Meters/Metres
Geoid Separation	float	(0)1	4	Separation from Geoid (WGS84), can be blank
Units	char	1	1	M Stands for Meters/Metres
Age of Differential Corrections	int	(0)1	5	Age in seconds, Blank (NULL) on MS20 SBAS operation reflected in fix indicator
Differential Reference	int	(0)4	4	Blank (NULL), Zero, or Station ID
Station ID				
Checksum	*xx	(0)3	3	2 Hex Digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

**Table 7. GPGGA Field List**

Examples:

\$GPGGA,215139.980,0000.0000,N,00000.0000,E,0,00,0.0,,M,,M,,0000\*61

\$GPGGA,215204.000,4147.9057,N,08816.2623,W,1,05,3.4,247.8,M,-43.5,M,,0000\*65

\$GPGGA,215253.000,4147.9055,N,08816.2649,W,2,08,1.2,242.1,M,-43.5,M,,0000\*6F

## 6. USER INTERFACE MESSAGES continued

### 6.5 \$GPGLL

This message transfers geographic position, latitude, longitude, and time. The \$GPGLL message structure is shown below:

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPGLL	6	6	GLL protocol header
Latitude	ddmm.mmmm	2,2.4	2,2.6	Degrees * 100 + Minutes (Nominally 4 decimal places)
N/S Indicator	char	1	1	N=North, or S=South
Longitude	dddmm.mmmm	3,2.4	3,2.6	Degrees * 100 + Minutes (Nominally 4 decimal places)
E/W Indicator	char	1	1	E=East, or W=West
UTC Time	hhmmss.sss	2,2,2.3	2,2,2.3	Fix time to 1ms accuracy
Status	char	1	1	A=Data Valid, V=Data Invalid
Mode Indicator	char	1	1	A=Autonomous, N=Data Not Valid
Checksum	*xx	(0)3	3	2 Hex Digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

**Table 8. GPGLL Field List**

Examples:

\$GPGLL,0000.0000,N,00000.0000,E,215139.98,V,N\*7D

\$GPGLL,4147.9049,N,08816.2642,W,215207.00,A,A\*7F

## 6. USER INTERFACE MESSAGES continued

### 6.6 \$GPGSA

This message transfers DOP (Dilution Of Precision) and active satellite information. The \$GPGSA message structure is shown below:

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPGSA	6	6	GSA protocol header
Mode	char	1	1	M=Manual, forced to operate in selected mode (2D/3D) A=Automatic, switching between modes
Mode	int	1	1	1=Fix not available 2=2D Fix 3=3D Fix
Satellites Used	int	(0)2	2	SV on Channel 1
Satellites Used	int	(0)2	2	SV on Channel 2
Satellites Used	int	(0)2	2	SV on Channel 3
Satellites Used	int	(0)2	2	SV on Channel 4
Satellites Used	int	(0)2	2	SV on Channel 5
Satellites Used	int	(0)2	2	SV on Channel 6
Satellites Used	int	(0)2	2	SV on Channel 7
Satellites Used	int	(0)2	2	SV on Channel 8
Satellites Used	int	(0)2	2	SV on Channel 9
Satellites Used	int	(0)2	2	SV on Channel 10
Satellites Used	int	(0)2	2	SV on Channel 11
Satellites Used	int	(0)2	2	SV on Channel 12
PDOP	float	(0)1.1	3.1	Position Dilution of Precision (3D)
HDOP	float	(0)1.1	3.1	Horizontal Dilution of Precision (2D)
VDOP	float	(0)1.1	3.1	Vertical Dilution of Precision (Up/Down)
Checksum	*xx	(0)3	3	2 Hex Digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

**Table 9. GPGSA Field List**

Examples:

\$GPGSA,A,1,,,,,,,,,,,,,\*1E

\$GPGSA,A,2,02,04,05,,,,,,,,,4.7,4.6,0.9\*38

\$GPGSA,A,3,01,04,13,16,20,23,24,25,,,,,1.8,1.2,1.4\*3F

\$GPGSA,A,3,05,06,09,10,15,18,21,22,27,29,51,,1.3,0.7,1.1\*38

## 6. USER INTERFACE MESSAGES continued

### 6.7 \$GPGSV

This message transfers information about the satellites in view. (Each record contains information for up to 4 satellites, allowing up to 16 or more satellites from the constellation that are visible to the receiver.) The list may include one or more geostationary SBAS satellites. The data is not guaranteed to be tied to specific channels and satellites may come/go as the receiver searches. The azimuth and elevation only appear when the receiver knows its location and the location of the satellites with respect to itself.

The number of records sent will expand and collapse based on the number of satellites and channels changes. In the final record of the sequence the unused fields are omitted, or left blank with commas to indicate the field has been omitted. The \$GPGSV message structure is shown next:

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPGSV	6	6	GSV protocol header
Number of Messages	int	1	1	Number of messages in the sequence 1 to 4
Message Number	int	1	1	Sequence number of message in current burst
Satellites in view	int	1	2	Number of satellites in view, this list
Satellite ID	int	0(2)	2	Satellite vehicle (1, 5, 9, ..)
Elevation	int	0(1)	2	Elevation of satellite in degrees (0..90)
Azimuth	int	0(1)	3	Azimuth of satellite in degrees (0..360)
SNR	int	0(1)	2	Signal to noise ratio in dB/Hz, null not tracking
Satellite ID	int	0(2)	2	Satellite vehicle (2, 6, 10, ..)
Elevation	int	0(1)	2	Elevation of satellite in degrees (0..90)
Azimuth	int	0(1)	3	Azimuth of satellite in degrees (0..360)
SNR	int	0(1)	2	Signal to noise ratio in dB/Hz, null not tracking
Satellite ID	int	0(2)	2	Satellite vehicle (3, 7, 11, ..)
Elevation	int	0(1)	2	Elevation of satellite in degrees (0..90)
Azimuth	int	0(1)	3	Azimuth of satellite in degrees (0..360)
SNR	int	0(1)	2	Signal to noise ratio in dB/Hz, null not tracking
Satellite ID	int	0(2)	2	Satellite vehicle (4, 8, 12, ..)
Elevation	int	0(1)	2	Elevation of satellite in degrees (0..90)
Azimuth	int	0(1)	3	Azimuth of satellite in degrees (0..360)
SNR	int	0(1)	2	Signal to noise ratio in dB/Hz, null not tracking
Checksum	*xx	(0)3	3	2 hex digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

Table 10. GPGSV Field List

Examples:

\$GPGSV,1,1,00\*79

\$GPGSV,1,1,01,17,,,41\*7B

\$GPGSV,2,1,08,01,,,51,02,,,50,12,,,50,04,,,49\*7F

\$GPGSV,2,2,08,05,,,51,13,,,46,18,,,23,10,,,50\*7C

\$GPGSV,3,1,12,21,63,309,51,27,17,133,46,26,04,206,45,18,47,271,50\*7E

\$GPGSV,3,2,12,05,19,068,47,22,13,260,47,29,34,197,49,06,09,322,41\*79

\$GPGSV,3,3,12,15,63,074,53,10,08,070,44,09,09,146,44,51,37,207,51\*72

\$GPGSV,4,1,14,20,70,191,51,23,59,339,50,16,47,078,50,13,30,305,50\*7C

\$GPGSV,4,2,14,24,23,264,49,01,17,091,49,25,16,052,49,27,14,245,25\*7C

\$GPGSV,4,3,14,04,11,304,49,11,04,200,,51,48,161,,48,47,205,\*75

\$GPGSV,4,4,14,35,42,218,,47,12,254,\*74



## 6. USER INTERFACE MESSAGES continued

### 6.8 \$GPVTG

This message transfers the velocity and tracking over ground information. The \$GPVTG message format is shown below.

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPVTG	6	6	VTG protocol header
Course (True)	float	1.1	3.2	Measured heading in degrees
Reference	char	0(1)	1	T Stands for true heading
Course (Magnetic)	blank	(0)	(0)	Not used – magnetic heading in degrees
Reference	char	0(1)	1	M Stands for magnetic
Speed	float	1.1	4.2	Speed in knots
Units	char	0(1)	1	N stands for nautical (knots) miles per hour
Speed	float	1.1	4.2	Speed in KPH
Units	char	0(1)	1	K Stands for kilometers per hour
Mode Indicator	char	1	1	A=Autonomous, N=Data not valid
Checksum	*xx	(0)3	3	2 hex digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII13, ASCII10

**Table 11 GPVTG Field List**

Examples:

\$GPVTG,0.0,T,,M,0.0,N,0.0K,N\*02

\$GPVTG,0.0,T,,M,0.0,N,0.0,K,A\*0D

\$GPVTG,179.98,T,,M,97.09,N,179.81,K,A\*02

\$GPVTG,315.03,T,,M,97.23,N,180.07,K,A\*08

### 6.9 \$GPZDA

This message transfers the internal timing information. The \$GPZDA message format is shown below.

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPZDA	6	6	ZDA protocol header
UTC Time	hhmmss.sss	2,2,2.3	2,2,2.3	Internal time to 1ms accuracy
UTC Day	dd	2	2	01 to 31, Day of Month
UTC Month	mm	2	2	01 to 12, Month of Year
UTC Year	yyyy	4	4	1980-2079 (Likely to exceed viability of constellation)
Local Zone Hours	int	(-)2	(-2)	Not used – 00
Local Zone Minutes	unsigned	2	2	Not used – 00
Checksum	*xx	(0)3	3	2 hex digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

**Table 12. GPZDA Field List**

Examples:

\$GPZDA,215139.980,16,11,2009,00,00\*56



## 6. USER INTERFACE MESSAGES continued

### 6.10 \$GPRMC

This message transfers recommend minimum specific GNSS data. The \$GPRMC message format is shown below:

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$GPRMC	6	6	RMC protocol header
UTC Time	hhmmss.sss	2,2,2.3	2,2,2.3	Fix time to 1ms accuracy
Status	char	1	1	A=Data Valid, V=Data Invalid
Latitude	ddmm.mmmm	2,2.4	2,2.6	Degrees * 100 + Minutes (Nominally 4 decimal places)
N/S Indicator	char	1	1	N=North, or S=South
Longitude	dddmm.mmmm	3,2.4	3,2.6	Degrees * 100 + Minutes (Nominally 4 decimal places)
E/W Indicator	char	1	1	E=East, or W=West
Speed Over Ground	float	1.1	5.3	Speed Over Ground (SOG) in knots (1 Knot = 1852 m)
Course Over Ground	float	1.1	3.2	Course Over Ground (COG) in degrees
Date	ddmmyy	2,2,2	2,2,2	Current Date, 1980-2079
Magnetic Variation	blank	(0)	(0)	Not Used
E/W Indicator	blank	(0)	(0)	
Mode Indicator	char	1	1	A=Autonomous, N=Data Not Valid
Checksum	*xx	(0)3	3	2 Hex Digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

**Table 13. GPRMC Field List**

Examples:

```
$GPRMC,215139.980,V,0000.0000,N,00000.0000,E,0.0,0.0,161109,,,N*74
```

```
$GPRMC,215207.000,A,4147.9049,N,08816.2642,W,0.0,0.0,161109,,,A*76
```

### 6.11 \$PMST02 Software Reset

\$PMST02,0*04	HOT (Device is Restarted)
\$PMST02,48*38	WARM (Device is restarted, invalidate ephemeris)
\$PMST02,58*39	COLD (Device is restarted, invalidate ephemeris, and position)

**Table 14. \$PMST02 Software Reset**

The satellite constellation provides a continuous stream of navigation data modulated on to the pseudo random sequence ranging signal. This data is encoded at 50 bits per second, as five 300 bit sub frames. Three of these subframes contain ephemeris information, which expresses the position of the satellite at a given time, and coefficients to extrapolate the position into the future. The other two sub frames contain a rolling index of other data including a constellation wide almanac that can roughly estimate the location of satellites months into the future. If the receiver knows the current time and rough location it can make approximations about visible satellites from that time/location, effectively halving the search space required to acquire satellite signals. Once the receiver has acquired a satellite it will then attempt to demodulate the data signals and recover the ephemeris data. If the receiver already has this data it will save between 18-36 seconds and will be able to make measurements immediately after it has signal and timing lock with the satellite.

Each subframe contains timing information, both in it's header, and intrinsically in the bit timings, and those of the underlying pseudo random sequence and the carrier itself.

## 6. USER INTERFACE MESSAGES continued

### 6.11 \$PMST02 continued

In this context the receiver can be reset in several ways.

A HOT reset is where all the hardware is restarted and the signal is then reacquired. Information about the current time, location and ephemeris is retained in RAM to permit a quick re-establishment of a GPS fix.

A WARM reset is one where additional information is invalidated. Primarily, the ephemeris data providing information of the current/future estimations of the satellites position. Once the receiver re-acquires the satellite(s), it will have to extract the ephemeris data, which will add 18-36 seconds of additional delay in ideal conditions, before it can provide measurements into the solution engine.

A COLD reset is similar to a hard start of the receiver when no supplemental data is available. The absence of position and/or time means that the receiver must search the entire constellation signal space to determine which signals can be acquired. Satellites which are not visible to the receiver will also be searched for and the receiver will cycle through all possible satellites, skipping from one to the next until it finds signals it recognizes. The receiver has multiple correlators so much of this searching will occur in parallel. Once the receiver has enough position and timing information it can utilize almanac data to refocus the search on the most probably visible satellites. The searching algorithm is mostly transparent to the user and visible primarily as the receiver dwelling and cycling through satellite numbers on uncommitted receiver channels.

### 6.12 \$PMST100 – Software Version Information

This message is emitted at startup and reflects the version numbers of hardware and software portions of the implementation.

The receiver contains a boot ROM which either acts as a boot loader for an empty device or executes a program stored within the flash memory of the receiver. Additional library code for high speed math is also contained within the ROM as this memory is fast (single cycle) and tightly coupled to the internal 32-bit CPU.

The firmware flash memory is divided into multiple pieces, there is kernel code that takes control of the system from the boot ROM, an area for storing non-volatile settings, and a large area to store the application code that implements the GPS solution. The version numbers and build timestamps for the kernel and application code is provided in this message.

There is also a checksum for the settings burned into the flash memory.

The message may be polled at run time by using PMST14,8\*OB

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$PMST100	8	8	Startup header
HW Version Major	int	0	2	Hardware version, nominally 00
HW Version Minor	int	0	2	Hardware version, nominally 01
App Version Major	int	0	2	Firmware application version, nominally 05 (5.12)
App Version Minor	int	0	2	Firmware application version, nominally 12
Legacy Field	int	0	1	Ignore, nominally 2
Legacy Field	int	0	1	Ignore, nominally 1
Kernel Version Major	int	0	2	Firmware kernel version, nominally 02 (2.01)
Kernel Version Minor	int	0	2	Firmware kernel version, nominally 01
Settings Checksum	hex	0	4	Four digit hexadecimal checksum
Customer ID	int	0	3	Customer Id, nominally 000
Customer Version	int	0	3	Customer version, nominally 001
Application Date	yymmddhh	2,2,2,2	2,2,2,2	Application date
Kernel Date	yymmddhh	2,2,2,2	2,2,2,2	Firmware kernel date
Checksum	*xx	(0)3	3	2 hex digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

Table 15. \$PMST100 Field List

Examples:

\$PMST100,01,00,05,12,2,1,02,01,F8CC,000,001,10041415,08030520\*77

## 6. USER INTERFACE MESSAGES continued

### 6.13 \$PMST200 – Command Acknowledgement

This message is emitted in response to certain configuration and command requests. If an error code is returned the command request failed to meet internal sanity checks or was otherwise malformed.

For example a reset without a control field \$PMST02\*18, will result in a 202 error response (negative acknowledge)  
\$PMST200,02,202\*1A

Field	Format	Min Chars	Max Chars	Notes
Message ID	\$PMST200	8	8	Acknowledge header
Command ID	int	0(1)	2	Command being acknowledged
Error Code	int	0	3	Blank or 0 for success, 202 for failure
Checksum	*xx	(0)3	3	2 hex digits, XOR sum of payload
Message Terminator	<CR><LF>	2	2	ASCII 13, ASCII 10

**Table 16. \$PMST200 Field List**

Examples:

\$PMST200,02,\*2A

\$PMST200,02,202\*1A

### 6.14 \$PMST12 – Changing Periodicity, Non-Permanent

The speed and rates on the receiver can be changed in a non permanent manner until the receiver is reset. When changing baud rates, one should be aware of the amount of data that is expected from the receiver. If more than 480 bytes of data are being sent at each second, the 4800 baud rate is not appropriate. Before selecting lower baud rates, the sentences and periodicity should be culled. Higher baud rates also permit lower latency in receiving the data. Remember GPS measurements are made at defined intervals (one second), these measurements are then solved to provide a location solution and finally transmitted to the host. (Measurements will have occurred in the past. If the receiver is moving, it will be in a different location by the time you process the data). Recognize that you may need to extrapolate/interpolate the location information using course-over-ground (direction) and speed-over-ground (velocity), to estimate the location at a different time. One should also be aware that computing a GPS solution is an iterative process of trilateration (expanding/overlapping spheres), measuring time-of-travel of the wave front for multiple satellites traveling at orbital speeds. That is to say that although a receiver may be static, everything else in the system is moving rapidly. Even if you reduce the output rate of the messages from the receiver, the receiver will continue to track the satellite signals and update it's internal measurements and solutions. Reducing the data output from the receiver will not significantly reduce power consumption beyond that used by the serial transmission circuitry.

The maximum output rate supported is 1 Hz. The output of individuals messages can be turned off or set with a periodicity of 1, 2, 3, 4, 5, 10, 15, 20, 30 or 60 seconds.

## 6 . USER INTERFACE MESSAGES continued

### 6.14 \$PMST12 continued

\$PMST12,Sentence,Frequency\*

Sentence	Frequency
0 RMC	0 Disable
1 GGA	4 1 Hz, Once every second
2 GLL	5 1/2 Hz, Once every 2 seconds
3 GSA	6 1/3 Hz, Once every 3 seconds
4 GSV	7 1/4 Hz, Once every 4 seconds
6 VTG	8 1/5 Hz, Once every 5 seconds
7 ZDA	9 Once every 10 seconds
	A Once every 15 seconds
	B Once every 20 seconds
	C Once every 30 seconds
	D Once every 60 seconds
	E Update Mode
	F Request Mode

Table 17. \$PMST12, Sentence, Frequency\*

For example GPGLL once every 10 seconds.

\$PMST12,2,9\*12 responds with \$PMST200,12,\*2B

For example GPGGA off

\$PMST12,1,0\*18 responds with \$PMST200,12,\*2B

For example GPGGA polled

\$PMST14,1\*02 responds with \$PMST200,14,\*2D and \$GPGGA,... in the next epoch

### 6.15 \$PMST14 – Polling Specific NMEA Messages

The speed and rates on the receiver may be changed with the \$PMST09 and \$PMST12 commands. If these rates are not suitable for your application, or you need an immediate and current response, you can request the sentence you want to receive, and a single copy will be sent along with an acknowledgement of the request.

For example you might turn all sentence reporting off, and then selectively request a \$GPGLL sentence when a position update is required. This will not save a significant amount of power, as the GPS computation is continuous, but might simplify parsing.

\$PMST14,Sentence\*

Sentence

0 RMC  
1 GGA  
2 GLL  
3 GSA  
4 GSV  
6 VTG  
7 ZDA  
8 PMST100

For example GPGGA polled

\$PMST14,1\*02 responds with \$PMST200,14,\*2D and \$GPGGA,... in the next epoch

## 6. USER INTERFACE MESSAGES continued

### 6.16 \$PMST10 - Changing Baud Rates, Non-Permanent

The baud rates may also be changed on both of the serial ports. Slower baud rates should work, but their use is not recommended and such applications will not be supported. Specifically – it is hard to provide comprehensive data at a lower rate, as the sentence's periodicity must be reduced or completely culled to achieve the bytes per second budgets. This lack of information will make debugging and diagnostics difficult and will increase the latency between the taking of measurements and the reception of results.

The two serial ports may be programmed to different speeds, however in standard software builds the data output by both will be the same. The sentences and periodicity cannot be configured differently for different ports. The secondary output is designed to permit a debug/diagnostic connector to monitor the receiver externally to the system to which it is installed. Providing a pin header to expose this debug port is strongly recommended.

#### \$PMST10,Port,Baud,Stop,Flow,Bits,Parity\*

Port		Stop	
0	COM0 - Primary	0	1 Stop Bit
1	COM1 - Debug	1	2 Stop Bits

Baud		Flow	
0	300 - Unsupported	0	None
1	600 - Unsupported	1	Xon/Xoff - Unsupported
2	1200 - Unsupported	2	RTS/CTS - Unsupported
3	2400 - Unsupported		
4	4800		
5	9600		
6	19200		
7	38400		
8	57600		
9	115200		

Bits		Parity	
0	8 Data Bits	0	No Parity
1	7 Data Bits	1	Odd Parity
		2	Even Parity

Table 18. \$PMST10, Port, Baud, Stop, Flow, Bits, Parity\*

For example setting the NMEA output of the debug port to 19200 8N1

\$PMST10,1,6,0,0,0,0\*1C

## 6. USER INTERFACE MESSAGES continued

### Changing periodicity and baud rates, permanent.

#### 6.17 \$PMST09

The setting within non-volatile memory can be changed in a two step process. The initial step is to configure the desired settings, and the second is to commit those setting to non-volatile (flash) memory and to start using them.

#### Serial Baud Rates

##### \$PMST09,Parameter,Setting\*

Parameter	
1	COM0 - Primary
2	COM1 - Debug
Setting	
0	2400 - Unsupported
1	4800
2	9600
3	14400 - Unsupported
4	19200
5	28800 - Unsupported
6	38400
7	57600
8	115200

**Table 19. Serial Baud Rates**

##### \$PMST09, Parameter , Setting\*

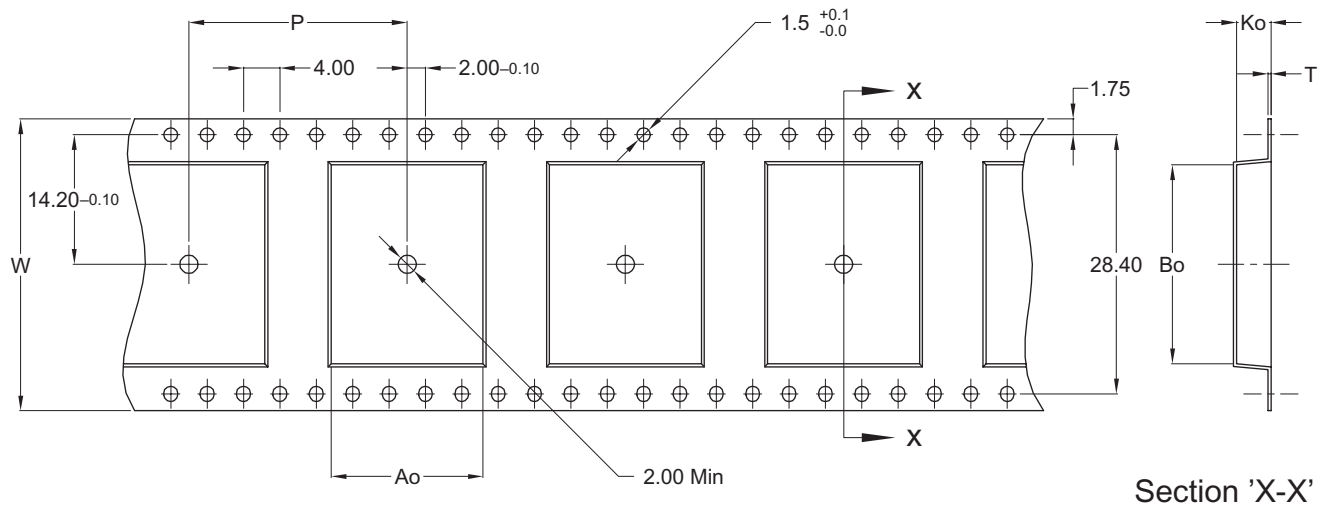
Parameter	
8	RMC
9	GGA
10	GLL
11	GSA
12	GSV
14	VTG
15	ZDA
Setting	
0	Disable
4	1 Hz, Once every second
5	1/2 Hz, Once every 2 seconds
6	1/3 Hz, Once every 3 seconds
7	1/4 Hz, Once every 4 seconds
8	1/5 Hz, Once every 5 seconds
9	Once every 10 seconds
A	Once every 15 seconds
B	Once every 20 seconds
C	Once every 30 seconds
D	Once every 60 seconds

**Table 20. Message Rates**

After one, or multiple changes in configuration are accumulated they can be committed, or “burned”, into flash memory with a single operation.

\$PMST09,0\*OF Write to Flash Settings Area

## 7. TAPE and REEL SPECIFICATIONS



DIMENSIONS	
Ao	16.70 -0.10
Bo	21.80 -0.10
Ko	3.80 -0.10
P	24.00 -0.10
T	0.35 -0.05
W	32.00 -0.30

NOTES:  
 ALL DIMENSIONS IN MILLIMETERS  
 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE - 0.20  
 MATERIAL: CONDUCTIVE POLYSTYRENE  
 CAMBER NOT TO EXCEED 1.0mm IN 250mm

**Figure 4: Tape & Reel Specifications**

## 8. SOLDER PROFILE

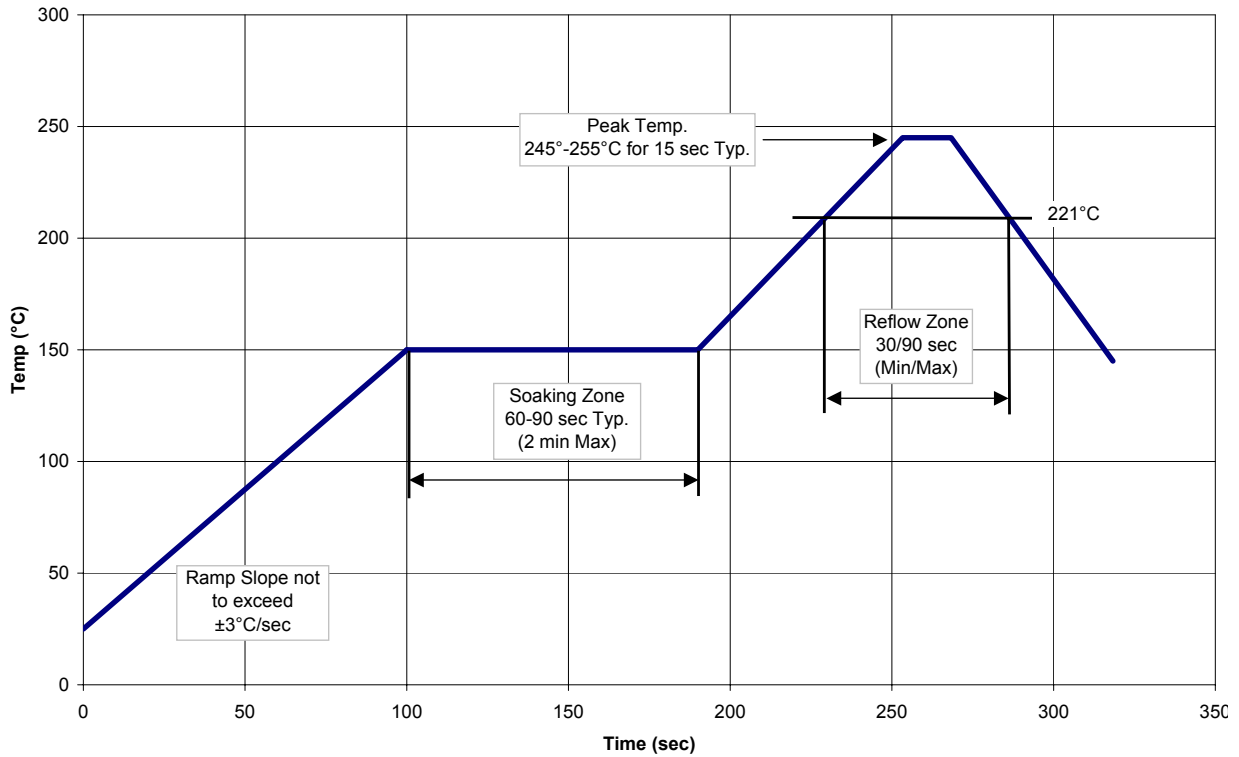


Figure 5: Solder Profile

## 9. ORDERING INFORMATION

MS20 Standard Build, SBAS not supported.

Note: MSL3 per 1PC/JEDEC, J-STD-020C, J-STD-033B. Please use appropriate processing and handling techniques.



---

## 10. APPENDICES

### Appendix 1

```
//*****  
//  
// Simple NMEA Checksum Tool - Copyright (C) 2007-2010 C Turvey, Navsync Ltd.  
//  
// Open Source - License Free - All Rights Reserved  
//  
// MSVC      cl -Ox nmeasum.c  
//  
//*****  
#include <windows.h>  
#include <stdio.h>  
#include <stdlib.h>  
//*****  
//  
// Win32 Console Application  
//  
// Compile with MSVC command line cl -Ox NMEASUM.c  
//  
// A NMEA command can be processed as a single argument, they do not contain spaces, and  
// you do not need to provide the initial $ or trailing checksum, for example  
//  
// NMEASUM PRTHS,U10P,ALL=0,GSA=1,RMC=1  
//  
// $PRTHS,U10P,ALL=0,GSA=1,RMC=1*73  
//  
// NMEASUM PNMRX111,COLD PNMRX111,HOT PNMRX600,INFO  
//  
// $PNMRX111,COLD*40  
// $PNMRX111,HOT*17  
// $PNMRX600,INFO*4D  
//  
//*****  
static const char Hex[] = "0123456789ABCDEF";  
//*****
```

---

## 10. APPENDICES continued

### Appendix 1 continued

```
void NMEAMessage(unsigned char *s)
{
    int i;
    int j;
    int Len;
    BYTE Checksum;
    BYTE Buffer[300];
    Len = strlen(s);
    j = 0;
    Buffer[j++] = '$'; // Add Initial $
    Checksum = 0; // Zero checksum
    for(i=0; i<Len; i++) // Compute XOR checksum across body
    {
        Checksum ^= (unsigned char)s[i];
        Buffer[j++] = s[i];
    }

    Buffer[j++] = '*'; // Add * termination

    Buffer[j++] = Hex[(Checksum >> 4) & 0x0F]; // Add hexadecimal checksum
    Buffer[j++] = Hex[(Checksum >> 0) & 0x0F];

    Buffer[j++] = '\r'; // Add CR, LF
    Buffer[j++] = '\n';

    Buffer[j++] = 0;
    puts(Buffer);
}
//*****

int main(int argc, char **argv)
{
    int i;
    for(i=1; i<argc; i++) // Process each argument as a NMEA sentence
        NMEAMessage(argv[i]);
    return(0);
}
//*****
```

---

## 10. APPENDICES continued

### Appendix 2

```
//*****  
//  
// Simple NMEA Parsing Tool - Copyright (C) 2007-2010 C Turvey, Navsync Ltd.  
//  
// Open Source - License Free - All Rights Reserved  
//  
// MSVC cl -Ox parse.c  
//*****  
#include <windows.h>  
#include <stdio.h>  
#include <stdlib.h>  
#include <math.h>  
//*****  
// Win32 Console Application  
//  
// Compile with MSVC command line cl -Ox PARSE.c  
//  
// PARSE $GPGLL,4157.209646,N,08844.518354,W,153731.845,A,A*46  
//  
// DecodeNMEA  
// $GPGLL,4157.209646,N,08844.518354,W,153731.845,A,A*46  
// Fields 08  
// #00 : $GPGLL  
// #01 : 4157.209646  
// #02 : N  
// #03 : 08844.518354  
// #04 : W  
// #05 : 153731.845  
// #06 : A  
// #07 : A  
// 41 57.209646 -88 44.518354 [+41.9534941000 -88.7419725667] @ 15:37:31.845  
//  
//*****  
int Verbose = 1;  
//*****  
// This code is provided for demonstrational purposes, additional  
// coding and testing would be required for more general use.  
//  
//*****  
// Parse $xxxxx,xx,...,xx*xx format sentences
```

---

## 10. APPENDICES continued

### Appendix 2 continued

```
#define FIELD_MAX 100

void DecodeNMEA(char *s)
{
    char *field[FIELD_MAX];
    int f;
    int i;
    char c;
    int x;

    if (Verbose)
    {
        puts("DecodeNMEA");
        printf("%s\n",s);
    }

    // Check the line synchronization

    if (s[0] != '$')
        return;

    // Verify the line checksum integrity

    c = 0;        // checksum

    i = 1; // Xor bytes between $ and *, but not including those bytes

    while((s[i] != 0) && (s[i] != '*'))
        c ^= s[i++];

    if (s[i] == 0)
        return;
    sscanf(&s[i + 1], "%x", &x); // Checksum byte - Note sscanf needs this to be an int, rather than a single byte
    if (c != (char)(x & 0xFF))    // Leave if checksum fails
        return;
    // Parse out fields on , and *
    f = 0;
    while(1)
    {
```

---

## 10. APPENDICES continued

### Appendix 2 continued

```
field[f++] = s;

while((*s != 0) && (*s != ',') && (*s != '*') && (*s != 0x0D) && (*s != 0x0A))
    s++;
if ((*s == 0) || (*s == '*') || (*s == 0x0D) || (*s == 0x0A) || (f == (FIELD_MAX - 1)))
{
    *s = 0;
    field[f] = NULL;
    break;
}
*s++ = 0;
}

if (Verbose)
{
    printf("Fields %02d\n",f);
    for(i=0; i<f; i++)
        printf("#%02d : %s\n",i,field[i]);
}

// Process a couple of NMEA sentences for illustration

if ((strcmp(field[0],"$GPGLL") == 0) && (f > 6)) // Geographic Position, Latitude, Longitude and Time
{
    double lat, lon;
    int lat_deg, lon_deg;
    double lat_min, lon_min;
    double fix_time;
    int fix_hour, fix_minute;
    double fix_second;
    char lat_hemi, lon_hemi, valid;

// Field 1 Latitude DDMM.mmmmmm
// Field 2 Lat Hemi N/S
// Field 3 Longitude DDMMM.mmmmmm
// Field 4 Lon Hemi E/W
// Field 5 UTC Time HHMMSS.SSS
// Field 6 Fix A=Valid, V=Not Valid
// Field 7 Mode A=Autonomous, D=Differential, E=Estimated, N=Not Valid [Optional] - Simulator Does not report this
    sscanf(field[1],"%lf",&lat);
    lat_hemi = field[2][0];
    sscanf(field[3],"%lf",&lon);
    lon_hemi = field[4][0];
    sscanf(field[5],"%lf",&fix_time);
    valid = field[6][0];
    if (valid == 'A')
    {
```

---

## 10. APPENDICES continued

### Appendix 2 continued

```
// Extract Time-of-Fix

    fix_minute = (int)fix_time / 100;

    fix_second = fix_time - (fix_minute * 100);

    fix_hour = fix_minute / 100;

    fix_minute = fix_minute % 100;

// Process Latitude DDMM.mmmmm

    lat_deg = (int)lat / 100; // Decompose NMEA form ASCII into DEGREES and MINUTES

    lat_min = lat - (lat_deg * 100);
lat = (double)lat_deg + (lat_min / 60.0); // Computed Latitude in DECIMAL DEGREES

    if (lat_hemi == 'S')
{
    lat_deg = -lat_deg;
    lat = -lat;
}

// Process Longitude DDDMM.mmmmm

    lon_deg = (int)lon / 100; // Decompose NMEA form ASCII into DEGREES and MINUTES

    lon_min = lon - (lon_deg * 100);

lon = (double)lon_deg + (lon_min / 60.0); // Computed Longitude in DECIMAL DEGREES

    if (lon_hemi == 'W')
{
    lon_deg = -lon_deg;
    lon = -lon;
}

    printf("%4d %9.6lf %4d %9.6lf [%+14.10lf %+14.10lf] @ %02d:%02d:%06.3lf\n",
        lat_deg, lat_min, lon_deg, lon_min, lat, lon, fix_hour, fix_minute, fix_second );
}
else
    puts("Invalid Fix");
}
else
    if ((strcmp(field[0], "$GPGSA") == 0) && (f > 17)) // GPS DOP and Active Satellites
{
    char mode, fix;
    double pdop, hdop, vdop;
    int i, sv;
```

## 10. APPENDICES continued

### Appendix 2 continued

```
// Field 1 A=Automatic(3D/2D), M=Manual
// Field 2 Fix 1=No Fix, 2=2D, 3=3D
// Field 3 SV List#1
// Field 14 SV List#12
// Field 15 PDOP
// Field 16 HDOP
// Field 17 VDOP

mode = field[1][0];
fix = field[2][0];

sscanf(field[15],"%lf",&pdop); // Position Dilution of precision (PDOP)
sscanf(field[16],"%lf",&hdop); // Horizontal Dilution of precision (HDOP)
sscanf(field[17],"%lf",&vdop); // Vertical Dilution of precision (VDOP)

switch(mode)
{
    case 'A' : puts("Mode : Automatic"); break;
    case 'M' : puts("Mode : Manual"); break;
    default : puts("Mode : Unknown");
}
switch(fix)
{
    case '1' : puts("Fix : Not Available"); break;
    case '2' : puts("Fix : 2D"); break;
    case '3' : puts("Fix : 3D"); break;
    default : puts("Fix : Unknown");
}
printf("SV :");
for(i=0; i<12; i++)
{
    if (field[3+i][0])
    {
        sscanf(field[3+i],"%d",&sv);
        printf(" %3d", sv);
    }
}
putchar('\n');
printf("PDOP : %5.2lf, HDOP : %5.2lf, VDOP : %5.2lf\n", pdop, hdop, vdop);
}
//*****
int main(int argc, char **argv)
{
    int i;
    for(i=1; i<argc; i++) // Process each argument as a NMEA sentence
        DecodeNMEA(argv[i]);
    return(0);
}
//*****
```

# MS20 GPS Receiver User Manual

Revision	Revision Date	Notes
P00	05/18/10	User Manual Preliminary Release
P01	08/19/10	Oscillator Update
P03	05/26/11	Signal Description Updates

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