ONCORE ENGINEERING NOTE

SL Oncore

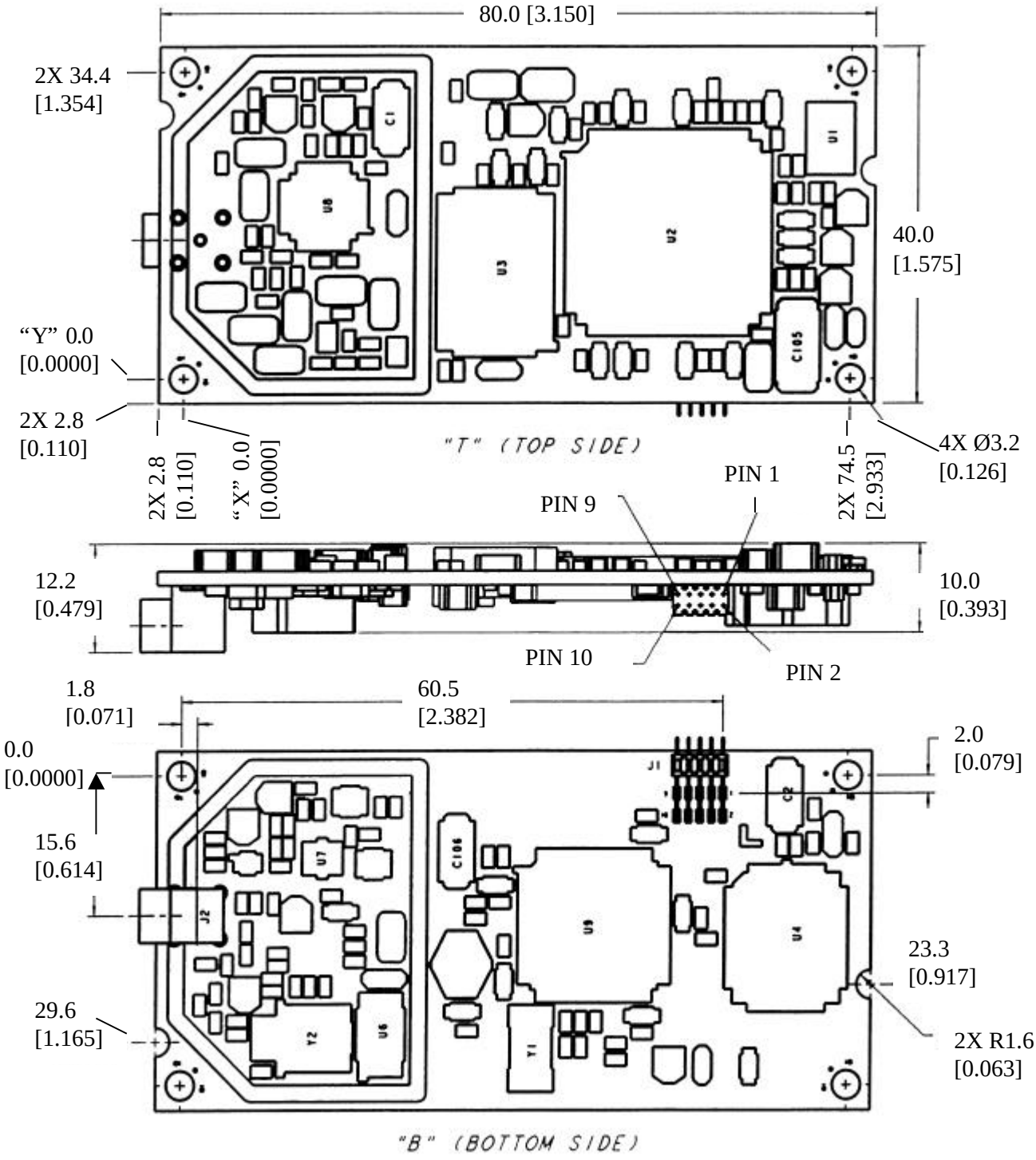
2. Product Description

The Motorola SL Oncore GPS receiver has the following basic features:

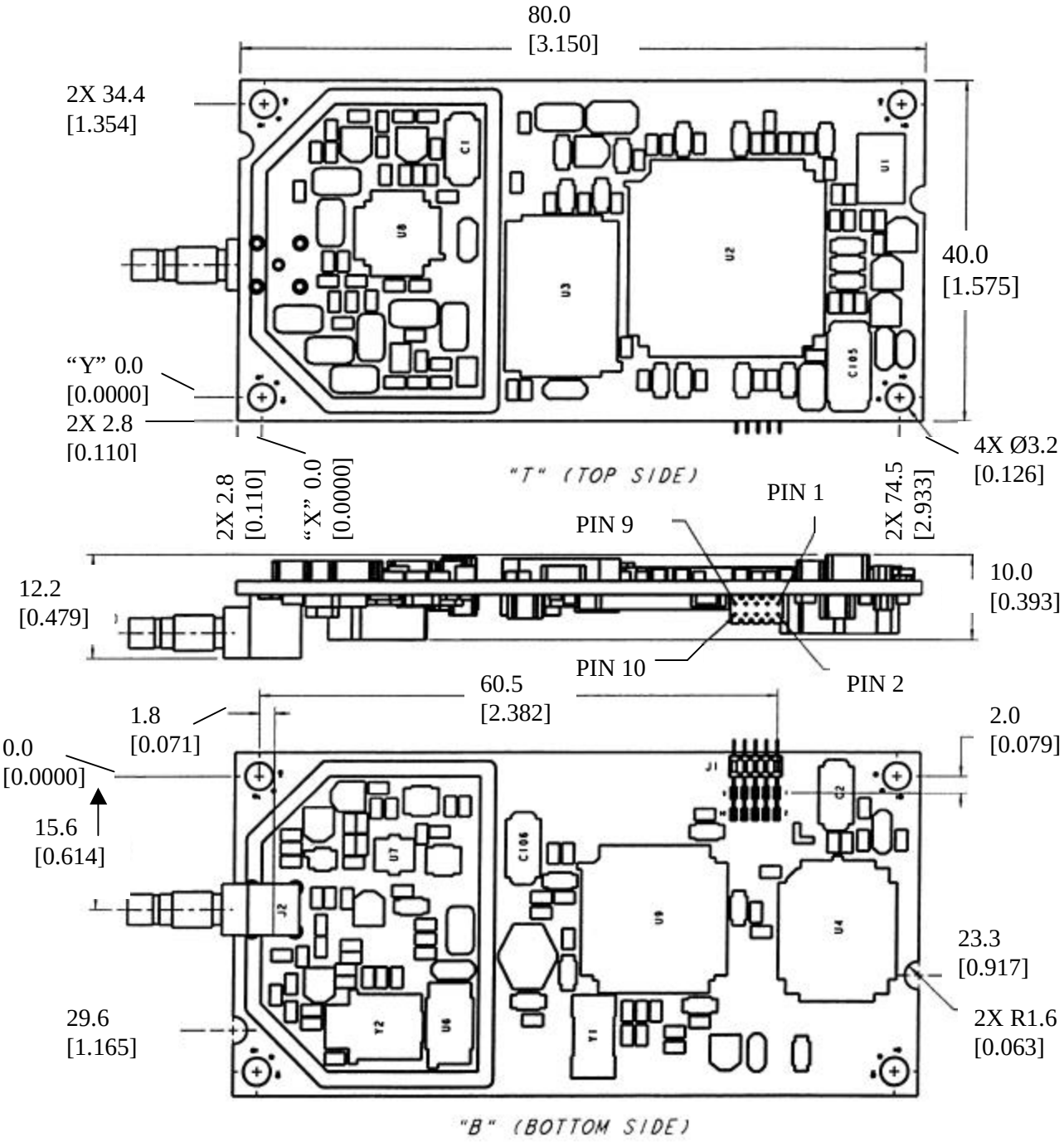
- L1 frequency C/A code receiver
- Searches for, acquires, and tracks satellites on 8 parallel channels; receiver will always attempt to track the 8 satellites with the highest elevation angles
- Optimized signal processing for operation in foliage environments and urban canyons
- Position filter reduces abrupt changes to position due to constellation changes
- Serial input/output using the Motorola binary, NMEA, and RTCM protocols
- Position, velocity and time solution:
  - height referenced to WGS-84 ellipsoid or other user defined datum
  - heading referenced to true north only
  - time referenced to GPS time or UTC
- Acquisition times (TTFF - time to first fix):
  - hot start (w/ ephemeris): 15 s typical
  - warm start (w/o ephemeris): 45 s typical
  - cold start (w/o almanac, time, date, position): 90 s typical
- Reacquisition times after view of satellites obstructed:
  - after 15 s obstruction: < 1.0 s typical internal
    3.0 s typical
  - after 30 minute obstruction: 300 s typical
- 1PPS (One Pulse Per Second) output accuracy of 1 µs (1 sigma)
- If battery backup power supplied:
  - uses last known position at power-up to minimize acquisition time
  - time and date retained by real-time clock (RTC) to minimize acquisition time
  - user entered data and settings retained
- Antenna sense circuit detects if antenna is properly connected
- Smallest form factor for Oncore GPS receiver
- Can be mounted vertically or horizontally
- SL Oncore model numbers:
  - R6111G111x - OSX antenna connector, right angle 10-pin connector
  - R6211G111x - OSX antenna connector, right angle 10-pin connector, battery
  - R6111G114x - SMB antenna connector, right angle 10-pin connector
  - R6111G117x - SMB antenna connector, straight 10-pin connector
  - R6111G118x - OSX antenna connector, straight 10-pin connector, battery

3. Mechanical

OSX antenna connector and right angle 10 pin connector (model R6111G111x):



SMB antenna connector and right angle 10 pin connector (model R6111G114x):



Component Locations:

		Location (Nominal to center)	
Part	**PCB Side**	**X**	**Y**
C1	T	23.1	29.2
C105	T	68.6	3.7
C106	B	30.9	8.5
C2	B	67.4	2.3
J1*	B	60.5	2.0
J2	B	1.8	15.6
U1	T	72.1	26.9
U2	T	54.1	16.4
U3	T	34.8	11.9
U4	B	67.7	18.2
U6	B	22.5	28.8
U7	B	15.9	8.5
U8	T	15.6	19.3
U9	B	46.2	16.8
Y1	B	39.2	30.4
Y2	B	13.7	29.2

* Location measured to centerline of pin #1
All dimensions in mm

4. Electrical

Main Power

Voltage	4.75 V to 5.25 V 50 mV peak to peak ripple
Current	155 mA typical (without antenna)
Power	0.8 W maximum (without antenna)

Backup Power

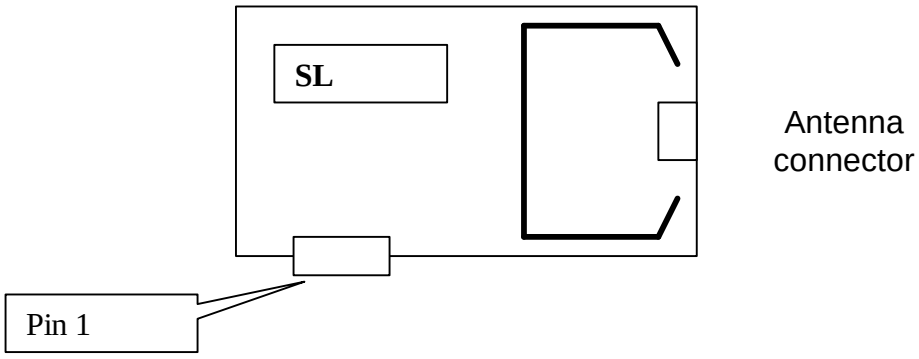
Externally applied backup power

Voltage	2.5V to 5.25V
Current	5 µA typical @ 2.5 V 100 µA typical @ 5.0 V

5. Pin-Out Diagram

Pin	Signal	Description
1	BATT	externally applied backup power
2	PWR	5 V main power
3	GND	ground
4	VPP	reprogramming voltage
5	TTL RXD2	RTCM input port
6	1PPS	timing pulse
7	1PPS RTN	timing pulse return
8	TTL TXD1	primary output
9	TTL RXD1	primary input
10	TTL RTN	return

SL Oncore Circuit Board



6. EMC (Electro-Magnetic Compatibility) Considerations

RF Shielding

When mounting the SL Oncore receiver near or around RF sources such as radios and cellular phones, it is recommended that the Oncore be tested in the target environment to identify potential interference issues prior to final design.

Interference

Because the Oncore GPS receiver contains a very sensitive RF receiver, you must observe certain precautions to prevent possible interference from the host system. Since the electromagnetic environment will vary for each embedded application, it is not possible to define exact guidelines to ensure complete electromagnetic compatibility.

Testing

To determine the effect of potential interference sources on the GPS receiver, perform a test using an evaluation kit receiver as a comparison. Use a satellite simulator if at all possible so that the input signal will be consistent. Mount one GPS receiver in the target application with all devices powered on. Mount the second GPS receiver in the Oncore evaluation kit housing. Connect both receivers to the type of antenna to be used in the product system. Use two computers to monitor the signal strength reported in the Position/Status/Data Message. If both receivers report a C/No value within 2 dB, then there is probably little or no damaging interference in the system. If the receiver in the target application reports signal strengths more than 2 dB lower, then the system performance will be sub-optimal.

7. RTC (Real Time Clock)

The real-time clock (RTC) is a standard feature on the SL Oncore. It is used to minimize the time to first fix (TTFF). The date and time will be retained in the RTC if battery backup power is applied when main power is off.

The user has two options regarding time initialization:

1) Set the date and time **BEFORE** the receiver acquires any satellites, or
2) Let the receiver automatically set the date and time **AFTER** the receiver acquires the first satellites.

Note: The date and time cannot be manually set while the receiver is tracking satellites.

Without battery backup, the receiver will have an incorrect time on start up. To obtain a faster time to first fix, the time, date and GMT offset should be initialized if both the main power and battery backup power have been disconnected.

8. 1PPS Signal Description

- 0 to 5 V pulse
- Pulse accuracy: < 500 ns (one sigma) with SA on
- Rise time from 0 to 5 V is approximately 20 to 30 ns with a recommended maximum line loading of 50 pF
- 1PPS time mark is synchronous with rising edge of pulse
- Pulse width is approximately 200 ms (± 1 ms), i.e. the falling edge occurs approximately 200 ms after the rising edge

9. TTL Serial Interface

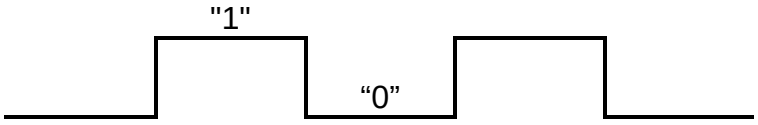
The serial interface signals **TTL TXD1**, **TTL RXD1**, and **TTL RXD2**, are used to configure and communicate with the Oncore GPS receiver. The **TTL RTN** ground signal is also required to complete the serial interface. These signals are regular TTL signals directly to/from the microprocessor with voltage ranges from 0 to 5V. There is no additional protection or signal conditioning besides the internal protection of the microprocessor. For input signals, minimum input high voltage is 2.0 V and the maximum input high voltage is 5.0 V. Minimum input low voltage is 0.0 V and the maximum input low voltage is 0.8 V. For output signals, minimum output high voltage is 2.4 V and the maximum output low voltage is 0.5 V. The maximum capacitance of TTL output signals is 50 pF.

This interface is not a conventional RS-232 interface that can connect to a PC (which is normally equipped with RS-232 interface) directly. An RS-232 driver/receiver is required to make this connection. The driver/receiver provides a voltage shifting from 0 to 5 V to a positive and negative voltage (for example, +/- 10 V), and also has an inversion process in it. Some RS-232 driver/receiver IC's (Integrated Circuits), such as the Motorola MC145407, will provide all these functions with only a +5 V power supply.

The microprocessor used on the SL Oncore is the standard MC68331.

- MC68331 DC characteristics:
  - sink/drain current: 5.3 mA maximum
  - source/drive: 0.8 mA
  - impedance: high

TTL Signals:



Signal Level Voltage Ranges:

	TTL		RS-232	
Level	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Logic "0"	0.0 V	0.8 V	5 V	15 V
Logic "1"	2.4 V	5.0 V	-5 V	-15 V

Nominal Voltage Levels (i.e. when transmit/receive lines are idle):

Signal	Pin	Level
TTL TXD1	8	Logic "1"
TTL RXD1	9	Logic "0"
TTL RXD2	5	Logic "0"

10. Serial Command Set

The SL Oncore supports Motorola binary input and output commands, NMEA output commands, and RTCM input commands. For detailed descriptions of the commands, refer to Chapter 6 of the Oncore User's Guide.

Motorola Binary Commands

Motorola binary commands can be used to initialize, configure, control, and monitor the GPS receiver. The Motorola binary commands are supported on the primary comm port at 9600 baud. The commands supported by the SL Oncore are:

@@Ab	GMT Offset
@@Aw	Time Mode
@@Ac	Date
@@Aa	Time of Day
@@Ad	Latitude
@@Ae	Longitude
@@Af	Height
@@Ag	Mask Angle
@@Ea	Position/Status/Data Message
@@Ep	Inverse Differential Output Message
@@Bb	Visible Satellite Status Message
@@Bj	Leap Second Pending Status
@@Aq	Atmospheric Correction Mode
@@Ap	Set User Datum
@@Ao	Select Datum
@@Cb	Almanac Data Input
@@Be	Almanac Data Output
@@Sz	Power-on Failure Message
@@Cj	Receiver ID
@@Fa	Self-Test
@@Cf	Set-to-Defaults
@@Eq	ASCII Position Message
@@Au	Altitude-Hold Height
@@Av	Altitude-Hold Mode
@@AN	Velocity Filter
@@AO	RTCM Port Mode
@@Bf	Ephemeris Data Input
@@Ce	Pseudorange Correction Input
@@Ck	Pseudorange Correction Response
@@Ci	Switch to NMEA

NMEA Commands

The SL Oncore supports NMEA 0183 Version 2.0 at 4800 baud on the primary comm port. Each of the supported commands can be output at user selectable update rates. The NMEA commands supported are:

GGA	GPS Fix Data
GLL	Geographic Position-Latitude/Longitude
GSA	GPS DOP and Active Satellites
GSV	GPS Satellites in View
RMC	Recommended Minimum Specific GPS/Transit Data
VTG	Track Made Good and Ground Speed
ZDA	Time and Date
FOR	Switch to Motorola binary

RTCM Commands

The SL Oncore accepts RTCM SC-104 Type 1 and Type 9 messages. The messages are input on the second comm port (pin 5) at a user selectable baud rate of 2400, 4800, or 9600 (see the @@AO RTCM Port Mode command). The RTCM messages are buffered and processed independently from the primary comm port.

Default Settings

When in the default mode, the GPS receiver is in Motorola binary communications mode and has no output messages enabled.

User selectable:

I/O format	binary
Mask angle	0 degrees
Time mode	UTC
Datum ID code	49 (WGS'84)
Atmospheric correction option	iono enabled
Velocity filter	100
RTCM port mode	4800 baud

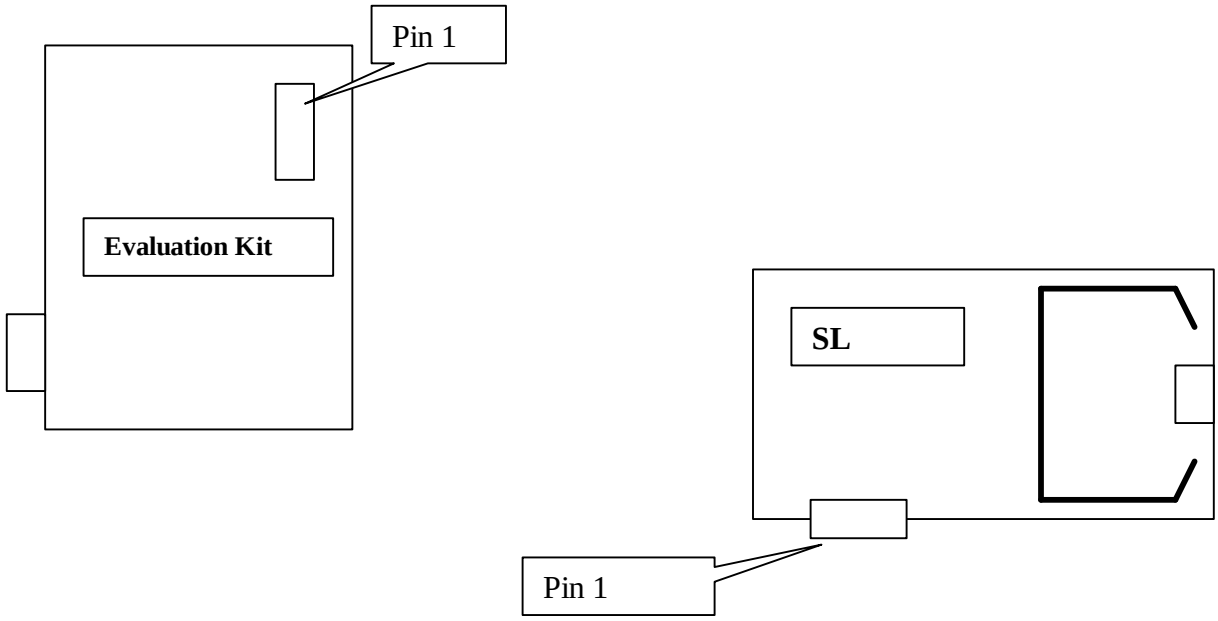
Not user selectable:

3-D to 2-D PDOP threshold	6.0
2-D to 0-D HDOP threshold	12.0

11. Use with Old Oncore Evaluation Kits

The SL Oncore may be used with existing Oncore Evaluation Kits. An interface cable is available from your Oncore reseller.

The interface board in the evaluation kit has a 10-pin socket to mate with a GT, UT, or VP Oncore receiver. Pin 1 of this socket is labeled in the figure below. The interface cable has a red line indicating line 1. Align the cable so that pin 1 on the SL Oncore connects to pin 1 of the evaluation kit board. One of the mounting holes can be secured to a standoff in the evaluation kit housing.



12. Active Antenna Information

The SL Oncore requires an active antenna. The Motorola Oncore Active Antenna has been designed for use with the SL Oncore. Other GPS antennas may also be used with the SL Oncore if they meet the requirements below.

Receiver-antenna interface:

Input impedance	50 Ω
VSWR	2:1 typical at L1 +/- 1MHz
Power	5 V, 15 to 80 mA on center conductor
Connector types	right angle OSX or SMB jack

Antenna requirements:

Frequency	1575.42 MHz (L1)	
Bandwidth	30 MHz typical	
Polarization	right hand circular	
Gain pattern	hemispherical	+3 dBic at the zenith
		0 dBic at 30° above the horizon
		-6 dBic at the horizon
Gain requirement	10 to 26 dB at receiver input	
Noise figure	2.2 dB maximum	
VSWR	1.5:1 typical at L1	
	2.5:1 maximum at L1	
Power	5 V, 15 to 80 mA	

13. Antenna Sense Circuit Description

The SL Oncore receiver is capable of detecting the presence of an antenna. The receiver utilizes an antenna sense circuit, which can detect **under current** (open) and **over current** (shorted or exceeding maximum limit) conditions. The status of the antenna circuit is reported in the serial output in the Position/Status/Data (@@Ea) and the Self-Test (@@Fa) messages.

The antenna sense circuit is useful in verifying that the antenna is properly connected to the receiver and is drawing the proper amount of current. The antenna sense status should be checked after installation and monitored regularly.

Under current condition:

Good indication: greater than 15 mA

Bad indication: less than 5 mA

Over current condition:

80 mA maximum for normal operation

45 mA maximum for short circuit

When the receiver detects an **over current** situation, it will automatically shut down the power to the RF section until the fault is cleared. Upon detecting an **under current** situation, the receiver will continue to operate as normal, but will flag the fault mode in the two serial messages.

An external power supply can be used if an application requires more than 80 mA to power the antenna system. If an external power supply is used, a DC block must be installed in the antenna cable connected to the GPS receiver.

14. RF System Guidelines

Both the gain and the noise of the overall system affect the performance of the A/D converter in a GPS receiver. The illustration below illustrates typical values for the Oncore family of GPS receivers when used with the Motorola antenna and standard RG-174 cable. The thresholds and ranges listed should be considered with a tolerance of 2 to 3 dB.

System constraints:

1) The gain in decibels is cumulative through all stages (i.e. G = G1+ G2 + G3...). For the SL Oncore receiver, optimal gain of the antenna, cabling and any in-line amplifiers and splitters is 18 dB ± 8 dB. The Oncore receiver may operate outside of the optimal gain range but performance will degrade. Therefore, Motorola does not recommend operating outside of the optimal gain range indicated. For the system below, the gain is 24 dB at the receiver connector.

2) System noise (F) is not to exceed 4 dB. The cascaded system noise figure formula is

$$f = f1 + \frac{f2 - 1}{g1} + \frac{f3 - 1}{g1 \cdot g2} + \ldots, \qquad (= 1.9 \text{ dB for the system below})$$

where $f1$ is the noise figure for stage one and $g1$ is the gain for stage one. Note that all of these values are absolute. Recall the formula for converting absolute values to decibels:

$$F(dB) = 10 \cdot \log(f)$$