ONCORE ENGINEERING NOTE

M12 Oncore

Preliminary

1. *Preliminary* M12 Oncore Product Specifications

General Characteristics	Receiver Architecture	• 12 parallel channel • L1 1575.42 MHz • C/A code (1.023 MHz chip rate) • Code plus carrier tracking (carrier aided tracking)
	Tracking Capability	• 12 simultaneous satellites
Performance Characteristics	Dynamics	• Velocity: 515 m/s (1000 knots); > 515 m/s at altitudes < 18,000 m • Acceleration: 4 g • Jerk: 5 m/s^3 • Vibration: 7.7G per Military Standard 810E
	Acquisition Time (Time To First Fix, TTFF) (Tested at -30 to +85°C)	• <15 sec. typical TTFF - Hot (current almanac, position, time, ephemeris) • <40 sec. typical TTFF - Warm (current almanac, position and time) • <60 sec. typical TTFF - Cold (No stored information) • <1.0 sec. internal reacquisition (typical)
	Positioning Accuracy	• 100 meters 2dRMS with SA as per DoD specification • Less than 25 meters, SEP without SA
	Timing Accuracy (1PPS)	• < 500 ns with SA on
	Antenna	• Active micro strip patch Antenna Module • Powered by Receiver Module (15 mA @ 3 Vdc) (optional 5 Vdc available)
	Datum	• WGS-84 • One user definable datum
Serial Communication	Output Messages	• Latitude, longitude, height, velocity, heading, time • Motorola binary protocol at 9600 baud • NMEA 0183 at 4800 baud (GGA, GLL, GSA, GSV, RMC, VTG, ZDA) • Software selectable output rate (continuous or poll) • TTL interface (0 to 3 V) • Second COM port for RTCM input
Electrical Characteristics	Power Requirements	• 2.75 to 3.2 Vdc; 50 mVp-p ripple (max.)
	"Keep-Alive" BATT Power	• External 2.75 Vdc to 3.2 Vdc, 5μA (typical @2.7Vdc)
	Power Consumption	• <0.225 W @ 3 V without antenna
Physical Characteristics	Dimensions	• 40.0 x 60.0 x 10.0 mm [1.57 x 2.36 x 0.39 in.]
	Weight	• Receiver 25 g (0.9 oz.) • Active Antenna Module < 40 g
	Connectors	• Power/Data: 10 pin (2x5) unshrouded header on 0.050 in. centers (Available in right angle or straight configuration • RF: Right Angle MMCX (subminiature snap-on)
	Antenna to Receiver Interconnection	• Single coaxial cable with 6 dB Maximum loss at L1 (active antenna) • Antenna Sense Circuit
Environmental Characteristics	Operating Temperature	• -40°C to +85°C
	Humidity	• 95% noncondensing +30°C to +60°C
	Altitude	• 18,000 m (60,000 ft.) maximum • > 18,000 m (60,000 ft.) for velocities < 515m/s (1000 knots)
Miscellaneous	Standard Features	• Motorola DGPS corrections at 9600 baud on COM port one • RTCM SC-104 input Type 1 and Type 9 messages for DGPS at 2400, 4800 or 9600 baud on COM port two • NMEA 0138 output • Inverse DGPS support
	Optional features	• Lithium battery

2. Basic Description

2.1 Receiver architecture

Channels	12 parallel
Frequency	1575.42 MHz
Code	C/A
Tracking	Carrier aided

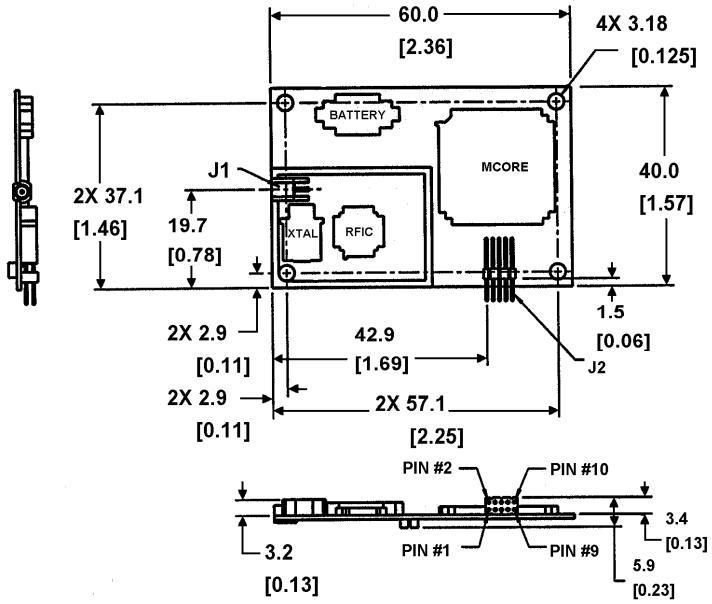
2.2 Description

The highly integrated single board GPS receiver module is optimized specifically for automotive applications. The GPS receiver tracks the NAVSTAR GPS constellation of satellites. The satellite signals received by an active antenna are tracked with 12 parallel channels of L1, C/A code then downconverted to an IF frequency and digitally processed to obtain a full navigation solution of position, velocity, time and heading. The solution is then sent over the serial link via the 10-pin connector.

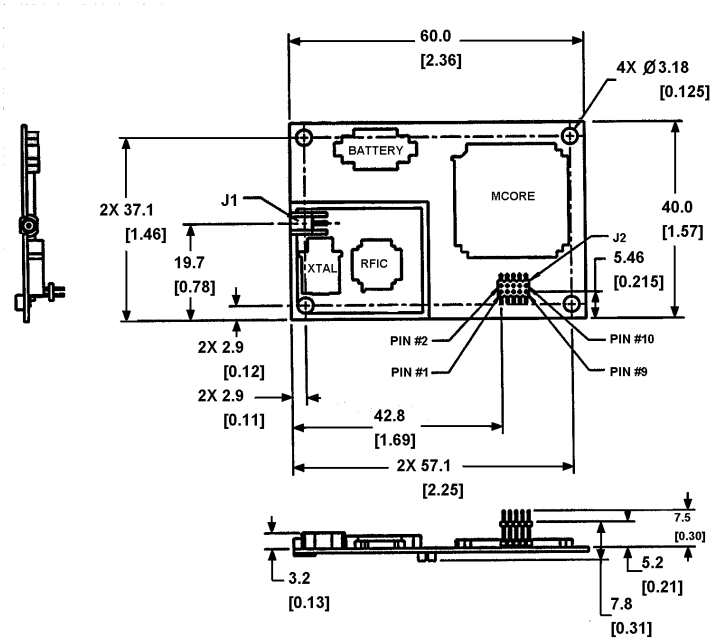
3. Mechanical

3.1 Mechanical Drawings

3.1.1 M12 Oncore with right angle I/O power/data connector



3.1.2 M12 Oncore with straight I/O power/data connector



3.2 Size

Dimensions	40.0 x 60.0 x 10.0 mm

3.3 Weight

< 25 g

3.4 Connectors

Power/Data	SamTech, FTSH-105-D2-L-DH header, 10 pin, 0.050 inch centers
Antenna RF	Sub-miniature MMCX connector type

4. Environmental

4.1 Temperature

Operating	-40°C to +85°C
Storage	-40°C to +105°C

4.2 Relative humidity

Operating	5% to 95% non-condensing 30°C to 60°C

4.3 Vibration

0.04 G^2/Hz, 20 Hz to 1000 Hz

7.7 G per Military Standard 810E

5. Electrical

5.1 Pin Outputs

Pin #	Signal	Description
1	TTL TXD1	Transmit 3 V logic
2	TTL RXD1	Receive 3 V logic
3	+3.0 V PWR	+3 V regulated main power
4	1 PPS	One pulse per second signal
5	GROUND	Ground (receiver)
6	BATTERY	Externally applied backup power (2.7 to 3.2 V)
7	Reserved	Not currently used
8	RTCM IN	RTCM input
9	ANTENNA VOLTAGE	3 V or 5 V antenna input voltage
10	Reserved	Not currently used

5.2 Main power

Voltage	2.75 to 3.2 Vdc regulated
	50 mV maximum peak-to-peak ripple
Power	0.225 W maximum (without antenna)

5.3 Backup power

Voltage	2.7 V to 3.2 V
Current	5 µA typical @ 2.7 V
Retention	Backup power retains date, time, position, satellite data and operating mode

5.4 Antenna feed power out of RF connector

Voltage	2.7 V to 3.2 V over current range for 3 V antenna
Current	15 mA to 80 mA
	Flags set in serial data when limits exceeded

5.5 1PPS signal definition

Level	0 V to 3 V
Time mark	Rising edge
Width	200 ms typical

5.6 Serial I/O signal definition

Levels	0 V to 3 V, active low
Baud rate	9600
Parity	None
Data bits	8
Start/stop bits	1

6. RF Characteristics of Receiver

6.1 Dynamic range

27 dB

6.2 Saturation

-110 dBm

7. RF Requirements for Antenna

7.1 General

Frequency	1575.42 MHz (L1)
Bandwidth	± 1.023 MHz
Polarization	Right hand circular
Impedence	50 Ω

7.2 Gain requirement

10 dB to 26 dB (at receiver input)

7.3 Gain Pattern

+0 dBic minimum at zenith

-10 dBic minimum at 0° elevation

7.4 Noise figure

1.8 dB typical

2.2 dB maximum

7.5 VSWR

1.5:1 typical

2.5:1 maximum

7.6 Axial ratio

3 dB typical at zenith

6 dB maximum at zenith

7.7 1 dB compression point

-14 dBm typical (at antenna output)

7.8 3 dB frequency bandwidth

45 MHz maximum

7.9 25 dB frequency rejection

± 95 MHz

7.10 Ground plane

15 x 15 cm recommended

7.11 Power

Voltage	2.75 V to 3.2 V
	3.0 V typical
Current	15 mA typical
	25 mA maximum

7.12 Temperature

Operating	-40°C to +85°C
Storage	-40°C to +100°C

8. Performance

8.1 Accuracy

Position	25 m SEP without SA
	100 m 2DRMS (95%) with SA
	1 to 5 m typical in differential mode
Altitude	156 m RMS (95%)
Velocity	0.02 m/s without SA
Time pulse	UTC ± 500 ns with SA on

8.2 Dynamic limits

Velocity	515 m/s maximum at altitudes > 18 000 m
Altitude	-1 000 m minimum
	18 000 m maximum at velocities > 515 m/s
Acceleration	4 G maximum
Jerk	5 m/s^3 maximum

8.3 Startup time (TTFF)

	50%	90%
Hot (date, time, position, almanac and ephemeris)	15 s	30 s
Warm (date, time, position and almanac)	40 s	65 s
Cold (no stored information)	60 s	210 s

8.4 Reacquisition time

After 60 s obstruction	2.0 s
Internal	< 1.0 s

8.5 RFI

Jamming resistance	Resistant to narrow band CW jamming at the receiver input of +20dBm at less than 1525 MHz and greater than 1625 MHz for loss of lock with a signal input of –130 dBm
Burnout protection	Protected from damage by RF signals at frequencies 100 MHz or more from L1 with received power up to 1 W at the antenna

8.6 EMI

Radiated	Complies with Class B, Part 15 of FCC rules
Conducted	Complies with European CE requirements
	Tested to IEC 801-4 spec for fast transients at 500 V, 5/50 ns, 5 kHz

9. Features

9.1 Differential operation

Motorola binary corrections on TTL RX1

RTCM SC-104 Type 1 and Type 9 corrections on TTL RX2

9.2 NMEA 0183 output

NMEA 0183	Output on TTL TX1 at 4800 baud
Messages supported	GGA, GLL, GSA, GSV, RMC, VTG, ZDA

9.3 User definable datum

One user definable datum may be defined using the @@Ap command. The default datum is WGS-84.

9.4 Antenna sense circuit

The M12 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 Position/Status/Data (@@Ha), the Short Position Message (@@Hb) and the Self-Test Message (@@Ia).

The antenna sense circuit is useful for 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.

Undercurrent indication	< 8 mA
Overcurrent indication	> 80 mA

9.5 Real time clock

The real-time clock (RTC) is a standard feature on the M12 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

2) Let the receiver automatically set the date and time **AFTER** acquiring the first satellite

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

Without battery backup, the receiver will start-up with a default time of 12:00:00. 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.

10. Serial I/O Messages

10.1 Solution

Update rate	1 Hz
Latency	< 1 s
Reported	Position, velocity, time, satellite status, receiver status, antenna status
Reference	WGS-84 or user defined datum

10.2 Resolution

Latitude/longitude	1 milliarcsecond
Height	0.01 m
Velocity	0.01 m/s
Heading	0.1°
Time	1 ns

10.3 Solution quality indicators

Receiver status	3D, 2D, propagation, acquisition
Geometry	HDOP when in 2D mode
	PDOP when in 3D mode
Satellite status	C/No (dB)
	Flag indicating satellite tracking status
	Flag indicating satellite is used in solution

10.4 Initialization

Startup mode	Acquisition based on information available
Battery backup provided	No initialization required
No battery backup	Receiver will be in default condition, entering date, time, position and almanac will speed up acquisition process
Default condition	No serial messages active unless there is a power-on self-test failure (see Oncore User's Guide)

10.5 Motorola binary I/O command list

Motorola binary commands can be used to initialize, configure, control, and monitor the GPS receiver. The Motorola binary commands are supported on the primary communications port at 9600 baud. The commands supported by the M12 Oncore are:

Ag	Satellite Mask Angle
Ao	Datum ID Codes
Ap	User Defined Datums
Aq	Ionospheric Correction Option
As	Hold Position Parameters
Au	Altitude Hold Height
Ay	1-PPS Time Offset
Az	1-PPS Cable Delay
AM	Position Lock Parameters Message
AN	Marine Filter Message
AQ	Position Filter Select
AS	Position Lock Select Message
Bb	Visible Satellite Data Message
Be	Almanac Data Request [response is Cb]
Bo	UTC Offset Output Message
Cb	Almanac Data (output) [response to Be] or Almanac Data (input) [response is Ch]
Cf	Set To Defaults
Ch	Almanac Data Response [response to Cb]
Ci	Switch I/O Format
Cj	Receiver ID
Ck	Pseudo-Range Correction Input [response to Ce]
Eq	ASCII Position Message
Ga	Position Message
Gb	Time Message
Gd	Position Control Message
Gj	Leap Second Pending
Gk	Vehicle ID
Ha	Position/Status/Data (12 Channel)
Hb	Short Position Message
Ia	Self-Test Message (12 Channel)

10.6 NMEA Commands

The M12 Oncore supports NMEA 0183 at 4800 baud on the primary communications 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

10.7 RTCM Commands

The M12 Oncore accepts RTCM SC-104 Type 1 and Type 9 messages. The messages are input on the second communications port (pin 8) at a user selectable baud rate of 2400, 4800 or 9600. The RTCM messages are buffered and processed independently from the primary communications port.