JUNE 4, 1996

VP ONCORE™ Engineering Notes

Derived from Motorola ONCORE™ technical data and reformatted by Synergy Systems, LLC for fax clarity

This document consolidates general information and technical data available for the Motorola VP ONCORE™ GPS Core Receiver. Subjects covered are:

- Operating Voltages and Current Ranges,
- Product Specifications (Data Sheet),
- Dimensions and Pin Out Designations,
- EMC Considerations,
- Real-Time Clock (RTC) description,
- 1 pps Signal Definition,
- TTL Serial Interface data,
- Active versus Passive Antenna data, and
- RF Applications.

Operating Voltage and Current Ranges

5 VDC Main Power:

Voltage: 4.75 VDC to 5.25 VDC, 50 mV maximum peak to peak ripple

Power: 1.1 Watts @ 5 VDC over temperature range

Current:

with Active Antenna (no LNA option on-board)
230 mAmps typical @ 5 V at 25° C
275 mAmps max @ 5.25 V over temperature range

with Passive Antenna (LNA option on-board)
215 mAmps typical @ 5 V at 25° C
250 mAmps max @ 5.25 V over temperature range

Battery:

Externally Applied Back-up Power:
Voltage: 2.5 VDC to 5.25 VDC
Current:
15 µAmps typical
60 µAmps max over temperature range

Or Lithium Battery Option (on-board):
Voltage: 3 VDC
Current:
5 µAmps typical @ 25° C
10 µAmps max @ 25° C
60 µAmps max @ 60° C
Battery Life: (Typical)
25 mAh life between charges,
(at 10 µAmps, a fully charged battery will last 3 months without recharging)
Full component life: 5+ years
Recharge:
Automatically recharged by 5 VDC main power
Recommended first time charge 24 hours

Lithium Battery option Users

CAUTION

Production Units: For products containing the optional Lithium Back-Up Battery, no connection exists between the Lithium Battery and pin 1. This opening was designed intentionally for safety. It is highly recommended that this pin be left open and unused.

Recharging: Lithium Battery recharge is accomplished automatically while the receiver is powered on. A one time, 24 hour recharge is recommended prior to use to ensure the battery is fully charged.

For configuration assistance, order placement and technical support call:

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MOTOROLA VP ONCORE™ Product Specifications

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General Characteristics	Receiver Architecture	• 8 Channel Parallel • L1 1575.42 MHz • C/A code (1.023 MHz chip rate) • Code plus carrier tracking (carrier aided tracking)
	Tracking Capability	• 8 simultaneous satellite vehicles
Performance Characteristics	Dynamics	• Velocity: 1000 knots (515 M/S) >1000 knots at altitudes <60,000 ft. • Acceleration: 4 g • Jerk: 5 m/s^3 • Vibration: 7.7G per Military Standard 810E
	Acquisition Time Time to First Fix (TTFF)	• 20 sec. typical TTFF (w/current almanac, pos., time and ephemeris) • 45 sec. typical TTFF (w/current almanac, position and time) • 2.5 seconds typical reacquire
	Positioning Accuracy	• Less than 25 Meters, SEP without SA (DOD may invoke Selective Availability (SA), potentially degrading accuracy to 100 m (2dRMS) • DGPS accuracy 1-5 Meters (typical)
	Timing Accuracy 1 Pulse per Second (1PPS)	• 130 nanosecond observed (1σ) with SA on • In position hold mode, <50 nanoseconds observed (1σ) with SA on
	Antenna	• Active micro strip patch Antenna Module • Powered by receiver module (25 mA @ 5Vdc) • Passive antenna configuration (see optional features)
	Datums	• 49 std. Datums, 2 user defined, default WGS-84
Serial Communications	Output Messages	• Latitude, Longitude, height, velocity, heading, time, Satellite tracking status (Motorola Binary Protocol) • NMEA-0183 Version 2.00 (selected formats) available • Software selectable output rate (Continuous or Poll) • Broad list of command/control messages • TTL interface
Electrical Characteristics	Power Requirements	• 5Vdc ±0.25 Vdc 50mV p-p ripple (max)
	"Keep-Alive" BATT Power	• External 2.5 Vdc to 5.25 Vdc at 15µA (typ) 60µA (max) • 3 V on-board battery; 15µA (typ) 60µA (max)
	Power Consumption	• 1.1 Watts @ 5 Vdc
Physical Characteristics	Dimensions	• Receiver 2.00 X 3.25 X 0.64 inches (50.8 X 82.6 X 16.3 mm) • Active Antenna Module 4.01 (dia.) X 0.89 in. (102 dia. X 22.6 mm)
	Weight	• Receiver 1.8 ounces (51g) • Active Antenna Module 4.8 ounces (136.2g)
	Connectors	• Data/Power: 10 pin (2X5) unshrouded header on 0.100" centers • RF: Right Angle OSX (subminiature snap-on)
	Antenna to Receiver Interconnection	• Single coaxial cable (for active antenna - 6dB max loss @ L1; 1575.42 MHz)
Environmental Characteristics	Operating Temperature	• Receiver Module -30°C to +85°C Active Antenna -40°C to +100°C
	Humidity	• 95% non-condensing + 30°C to +60°C
	Altitude	• 60,000 feet (18km) max • >60,000 feet (18km) for velocities <1000 knots
Miscellaneous	Optional Features	• 1PPS timing output with T-RAIM (timing integrety monitor) • Raw measurement data • On board Rechargeable Lithium Battery • On board LNA option for use with passive antenna
	DGPS	• Differential GPS - standard software feature • RTCM-104 format (remote input) • Motorola custom format (master output and remote input)

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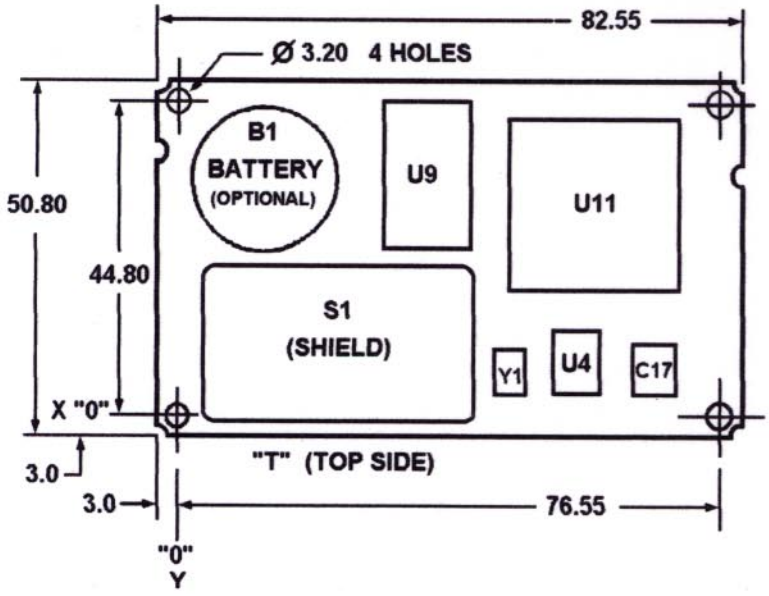
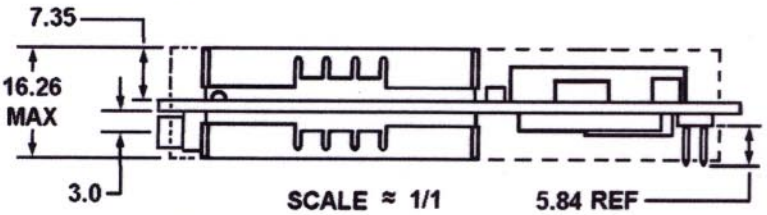
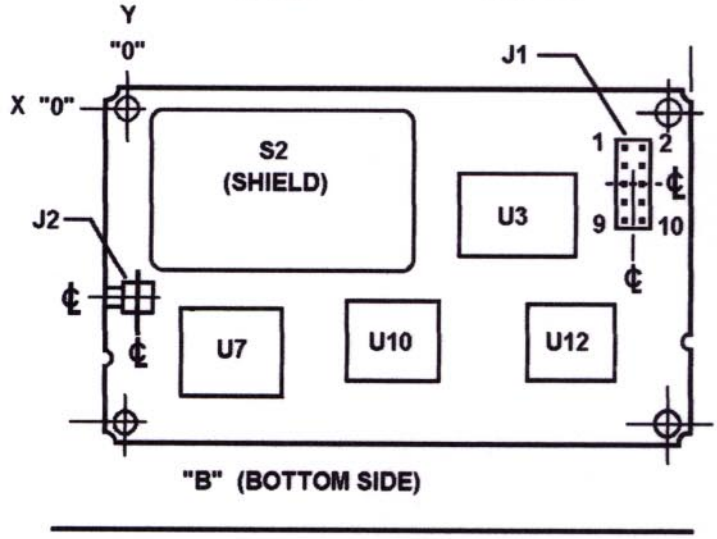
VP ONCORE DIMENSIONS AND PINOUTS







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COMPONENT LEGEND						
REF DESIG	PCB SIDE	LOCATION NOMINAL TO CENTER "X"	LOCATION NOMINAL TO CENTER "Y"	SIZE (NOMINAL) LENGTH	SIZE (NOMINAL) WIDTH	SIZE (NOMINAL) HEIGHT
B1	T	12.4	33.6	Ø 20.5	- - -	4.0
C17	T	67.1	6.4	4.3	7.3	2.8
J1	B	72.44	9.45	12.3	4.9	8.2
J2	B	3.35	28.75	6.0	6.0	6.0
S1	T	10.6	22.6	23.8	39.3	6.9
S2	B	10.6	22.6	23.8	39.3	6.9
U3	B	55.5	13.1	14.0	20.0	3.0
U4	T	56.8	7.2	10.3	7.5	2.5
U7	B	16.0	35.5	11.5	14.0	3.6
U9	T	34.1	35.1	21.0	11.7	3.2
U10	B	35.5	33.7	11.5	15.0	3.6
U11	T	60.0	29.8	24.2	24.2	4.6
U12	B	61.3	33.6	11.5	15.0	3.6
Y1	T	45.0	5.9	2.5	6.7	1.5

(J1) POWER/DATA LEGEND		
PIN #	SIGNAL NAME	DESCRIPTION
1	BACKUP POWER	EXTERNAL +2.5-5.25 VDC
2	5V MAIN POWER	+5 VDC REGULATED
3	GROUND	GND (5 VDC RETURN)
4	(NOT USED)	DO NOT USE
5	(NOT USED)	DO NOT USE
6	ONE PPS	1 PULSE/SECOND OUTPUT
7	ONE PPS - RTN	1 PULSE/SECOND RETURN
8	TTL - TXD	TRANSMIT 5V LOGIC LEVEL
9	TTL - RXD	RECEIVE 5V LOGIC LEVEL
10	TTL - RTN	TRANSMIT/RECEIVE RETURN

NOTES: 1. J-1 POWER/DATA CONNECTOR: MFR: AMP #104326-06 HEADER, 10 PIN WITH 2.54 CENTERS
2. J-2 RF CONNECTOR: MFR: MA/COM #5864-5002-10 (OSX) SUB-MINIATURE, SNAP-ON

THIS INFORMATION DERIVED FROM MOTOROLA TECHNICAL DATA AND REDRAWN FOR FAX CLARITY.

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VP ONCORE™

Electro-Magnetic Compatibility (EMC) Considerations

RF Shielding: The RF circuitry sections on the VP ONCORE™ GPS receiver board are protected with a tin plate shield to guard against potential interference from external sources. When designing the VP ONCORE near and around RF sources such as radios, it is recommended that the VP ONCORE be tested and tried in the target environment to identify potential interference issues prior to final design.

Note: Because the VP ONCORE™ receiver contains a very sensitive RF receiver, the OEM systems designer must observe certain precautions to prevent possible interference from the host system. Because the electromagnetic environment will vary for each OEM application, it is not possible to define exact guidelines to assure electromagnetic compatibility.

Real Time Clock (RTC)

The RTC is a feature on the VP ONCORE. The user has three options regarding time initialization:

1. Set time manually in idle mode, OR,
2. Set time in fix mode BEFORE receiver acquires any satellites, OR
3. Receiver will automatically set time in fix mode AFTER the receiver acquires satellites.

Note: Time cannot be set in fix mode while the receiver is tracking satellites.

With the Real-time clock and no Lithium battery option, the receiver will start up but will have an incorrect time unless it was previously set and maintained by an external battery. To ensure a faster time to first fix, the time, date and GMT offset should be reset if both the main power and battery backup power have been disconnected.

With the RTC and the Lithium battery option on-board, the receiver clock is set to UTC time prior to shipping and maintained by the on-board Lithium battery automatically.

1 PPS Signal Definition

- 0 to 5 V level pulse, maximum load = 15 pf
- 1 PPS time mark is synchronous with rising edge of pulse — rising from 0 V to 5 V. Rise Time is approximately 20 to 30 nanoseconds.
- 5 V pulse width is approximately 200 milliseconds (+ or - 1 millisecond), i.e., the falling edge will occur approximately 200 milliseconds after the rising edge.
- Accuracy: 130 nanoseconds observed (1 σ) with SA on. In position hold mode, < 50 nanoseconds observed (1 σ) with SA on.

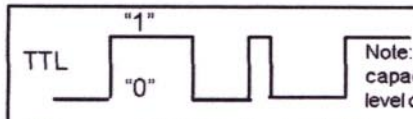
TTL Serial Interface

The serial interface signals, RXD and TXD, are available for user connection. A ground signal is also required to complete the serial interface. There is no additional protection and signal conditioning besides the internal protection of the micro. These signals are coming from the microprocessor directly. They are regular TTL signals with voltage ranges from 0 to 5 volts. For input signals, minimum input high voltage is 2.0 volts, and the maximum input high voltage is 5 volts. Minimum input low voltage is 0 volts and the maximum input low voltage is 0.8 volts. For output signals, minimum output high voltage is 2.4 volts, and the maximum output low voltage is 0.5 volts.

This interface is not a conventional RS-232 interface that can connect to a PC (which is normally equipped with an 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 volts to a positive and negative voltage (for example, + or - 10 volts), and also has an inversion process in it. Some RS-232 driver/receiver IC's (Integrated Circuits), for example, Motorola's MC145407, will provide all these functions with only a + 5 volt supply.

The microprocessor used in the VP **ONCORE™** is the MC68331. DC characteristics are as follows:

- Sink/drain current: 5.3 mAmp maximum
- Source/drive: 0.8 mAmp
- Impedance: High



TTL 0 V to 0.8 V = Logic "0"
TTL 2.4 V to 5.0 V = Logic "1"

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

TTL_TXD	(Pin #8)	Logic "1"
TTL_RXD	(Pin #9)	Logic "0"

Note: for RS-232 conversion reference:
Logic "1" = - 5 V to -15 V, Logic "0" = 5 V to 15 V

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VP ONCORE™ Active Versus Passive Antenna Information

Active Antenna:

24 dB amplification
25 mAmps @ 5 Volts (max. 50 mAmps)

Passive Antenna:

Assuming 0 dBic gain levels from the antenna, the acquisition and tracking thresholds for various cable lengths of RG 58 cable (i.e., 1 dB loss per meter) are shown in the table above.

Cable Length	Acquisition Threshold	Tracking Threshold
0 m	-137 dBm	-143 dBm
1 m	-136 dBm	-142 dBm
5 m	-132 dBm	-138 dBm

The Acquisition threshold is the minimum signal level of a GPS satellite signal received at the antenna in order for the receiver to acquire and lock onto that signal.

The Tracking threshold is the minimum signal level of a GPS satellite signal received at the antenna in order for the receiver to maintain lock (i.e., tracking) once acquisition is achieved.

GPS satellites by design are guaranteed to provide at least -130 dBm level signals on the earth's surface at the end of satellite life. This assumes direct line of sight to the satellite with no interference. In order to allow for a certain margin of attenuation of the signal caused by overhead foliage, etc. a 7 dB margin beyond the -130 dBm was designed into the receiver for acquisition and 13 dB for tracking. As the table above indicates, increasing the cable length narrows these margins due to signal loss along the cable. As the cable length increases, so does the total signal loss along the cable and consequently the tracking thresholds are not as low.

Please see attached *Active Antenna RF Interface Specification version 1.5.*

Active Antenna RF Interface Specifications V-1.5

Input Impedance	50 Ohms
VSWR	2:1 max @ 1575.42 MHz (+ or - 1 MHz)
Connector type	OSX Jack, Straight (Motorola antenna)
Preamplifier power	+ 5 V, 25 mA Available at connector

Recommended Antenna Design Guidelines:

Operating frequency	1575.42 MHz
Bandwidth	30 MHz typical
Polarization	Right hand circular
Pattern	Essentially hemispherical
Gain Characteristics	+ 3 dBic Minimum at 90° above horizon (zenith) 0 dBic minimum at 30° above the horizon - 6 dBic minimum at 0° (horizon)
VSWR	2:1 max @ 1575.42 MHz +/- 1 MHz into 50 Ω
Preamplifier Gain	18 dB minimum (including 6 dB cable losses
Noise Figure	2.5 dB maximum

Passive Antenna RF Interface Specifications

Input Impedance	50 Ohms
VSWR	2:1 max @ 1575.42 MHz (+ or - 10 MHz)
Connector type	OSX Jack

Recommended Antenna Design Guidelines:

Operating Frequency	1575.42 MHz
Bandwidth	30 MHz (typical)
Polarization	Right hand circular
Pattern	Essentially hemispherical
Gain Characteristics	+ 3 dBic minimum at 90° above horizon (zenith) 0 dBic minimum at 30° above the horizon - 6 dBic minimum at 0° (horizon)

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