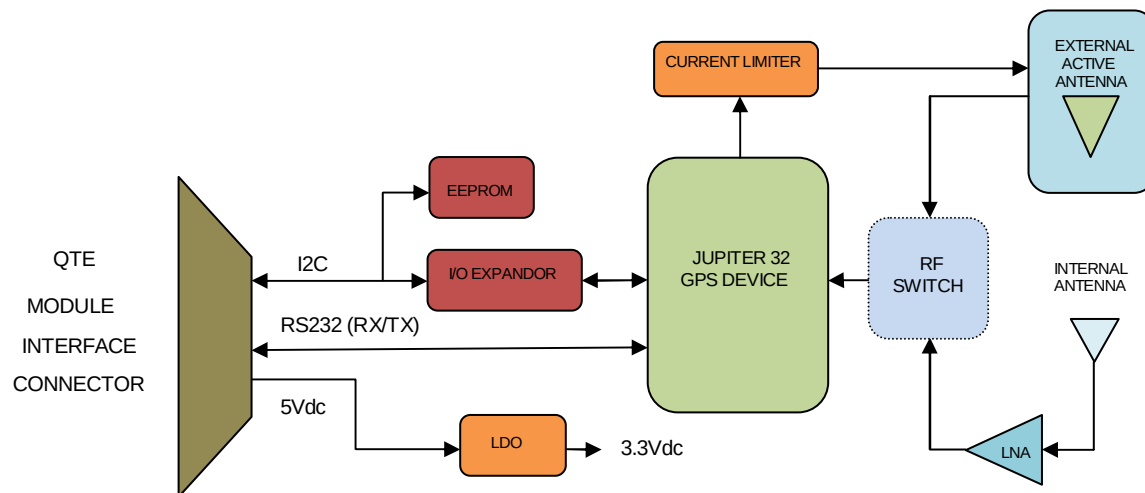


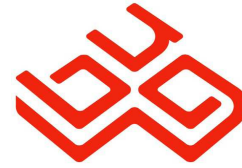
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1 Introduction

This document describes the design features of the Bug Labs BUGlocate Module. The document contains sections describing all software accessible devices and resources on the module, as well as some information about the hardware design. It is intended to be the source of information for the BUGlocate Module user documentation. This document assumes that the reader is familiar with basic Bug architecture and the Base Unit. The intent of this document is to provide interface specifications and reference material for all software accessible resources on the module. Section 2 contains a high-level description of the BUGlocate Module. Section 3 describes the features common among Bug Modules, with some details about the functions on this particular module. This section includes discussions of each Base Unit interface, with bus addresses where appropriate. In Section 4, each functional hardware block on the module is described in detail with each specific device identified, and with information about how the device is connected on the board and to the Base Unit. No attempt was made to duplicate information contained in device data sheets, and of course the data sheet is the final word on device operation. The circuit design is based on the hardware architecture as shown in figure 1.

Figure 1 - BUGLOCATE MODULE, HARDWARE ARCHITECTURE





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2 Module Description

The Bug Labs BUGlocate module is a very sensitive design that utilizes the Navman's JUPITER 32 device for acquiring GPS navigation data. All the functions that are necessary for the acquisition of GPS satellite data are integrated in the JUPITER 32 device. The BUGlocate module has a signal sensitivity of -159 dBm, and contains a 20-channel receiver that continuously tracks all satellites in view and provides accurate positioning data. The module supports selected NMEA data messages and SiRF Binary protocols. The operating temperature range of the module is -40°C to $+85^{\circ}\text{C}$. The module's power consumption at 5Vdc is shown in table 1.

TABLE 1 – BUGlocate Module Power Consumption @ 5Vdc

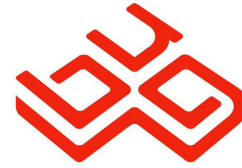
Operating Mode	TYPICAL		MAXIMUM	
	Current (mA)	Power(mW)	Current(mA)	Power(mW)
With Internal Antenna	48	239	63	315
With Active External Antenna	93	464	108	540

Figure 1 provides a block diagram of the BUGlocate module hardware architecture. The module interfaces to the Bug Labs Bug base via a Samtec QTE interface connector. The base unit provides 5 Volts dc to the module; the module then uses a low drop-out linear voltage regulator (LDO) to down-convert the 5Vdc to 3.3Vdc for use by the module. All data and control signals are interfaced between the base and the BUGlocate module via the SAMTEC QTE connector. The EEPROM is accessed via the I2C bus, and is used to store the module identification, serial number and build version. Due to the limited number of General Purpose I/O signals that available on the QTE connector, an I/O expander is used. The expander is accessed via the I2C bus. Communication between the base and the JUPITER-32 is implemented via the RS232 bus. A software controlled RF switch is used to switch between an active, external antenna, and an internal antenna. Power to the external antenna is current limited and provided via the SAMTEC MMCX connector J2. Detailed circuit description and signal assignment tables are presented in subsequent paragraphs.

3 Common Module Design Features

3.1 Module Connector, Mechanical Design, LED, Power

The BUGLOCATE Module uses the standard Bug Labs Base Unit connector, which is the high-density Samtec QTE connector with 40 positions. The BUGlocate module has the typical Bug Labs bi-color Red/Green LED indicator to represent module status. The LEDs are controlled entirely by software on the Base Unit, not automatically by any hardware. The LEDs are powered from the module power, so the LEDs cannot operate when the module is powered off. The BUGlocate Module receives 5V input power from the Base Unit through the Samtec connector. There is a local low-power LDO to develop 3.3V power for use on the module.



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4 Module Interfaces

The interfaces used on the BUGlocate Module are listed in the tables below. Buses not listed are not used on the module, and are labeled "NC" on connector (J1).

4.1 I²C Bus

The I²C bus is used to access the EEPROM and the I/O Expander as listed in Table 2. The EEPROM is programmed in the Bug Labs factory with module specific info that is used by the Base Unit driver software to identify the module type (BUGlocate Module in this case) and initialize it. The contents of this EEPROM must not be modified by the User.

Table 2 - BUGlocate Module – I²C Bus Devices

I ² C Device	Device Addr	Notes
AT24C02 EEPROM	0xA0	Size=256B
PCA9538 I/O Expander	0xE2	8-bit I/O + Interrupt

4.2 RS232 Interface

The Jupiter-32 device communicates with the Bug base over the RS232 interface. Only the RX and TX lines are used with no flow control. The default protocol is NMEA, at a baud rate of 9600bps. The frame format is 8 data bits, no parity bit and 1 stop bit.

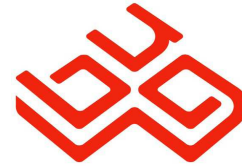
4.3 GPIOs

Three GPIO pins are used, and are assigned as listed in Table 3. These GPIOs are provided by the Bug Base processor via the QTE connector. Other GPIOs are provided in the module via an I/O Expander device. Those are discussed in section 5.6

Table 3 - BUGlocate Module – GPIO Pin Assignments

GPIO	Signal Name	Init	Function
GPIO3	GPIO3_REDLED	0	Red LED control L=LED ON; H=LED OFF
GPIO2	GPIO2_GRNLED	1	Green LED control L=LED ON; H=LED OFF
GPIO1	JUP_32_RST*	1	Module Reset
GPIO0	Not Used		

Upon detecting the modem module, the Base CPU should initialize these functions as indicated in the Init column for the most benign operation of the board after insertion. Thus, the red LED will be ON steady and the green LED off, indicating that the board has power and was detected, but has not been placed into service yet.



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5 Module Devices

5.1 JUPITER-32 GPS Receiver

The GPS functionality is implemented by the JUPITER-32 from *Navman*. The device is powered by a 3.3 Vdc source provided on the BUGlocate module by the LDO as described in section 5.4. The device offers power saving modes, write to flash configuration and SiRFInstantFix support amongst other features. The JUPITER-32 is packaged on a miniature PCB substrate with BGA footprints for surface mounting. Additionally, the device is shielded and has been certified for FCC part 15 B compliance.

5.2 Antenna

The antenna used in the BUGlocate module is a 50 Ohm, chip antenna from Wurth Electronics. The antenna designed for operation at the 1.575 GHz. The antenna occupies a relatively small real state on the PCB of the BUGlocate module.

5.3 EEPROM

The EEPROM used is the Atmel AT24C02 which is 256 bytes device. The device is used for storing Module specific information. Table 3 provides the address associated with the EEPROM.

5.4 Linear Regulator

The voltage regulator used in the module down-converts the 5 Vdc input from the Bug Base to a 3.3 Vdc level used internally by the BUGlocate module. The regulator is the National Semiconductors' LP38693SD-ADJ which can deliver 500 mA at 3.3 Vdc.

5.5 Module LEDs

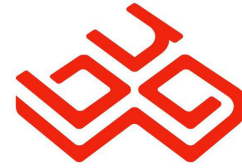
The module LED provides an indication of the module status. When the module is initially powered up, the RED LED is turned ON. After the module is verified by the BUG unit, if the module is recognized, the red LED is turned off and the green LED is turned on and then off. The LEDs can also be used for packet transfer and network activity status as determined by the software application.

5.6 I/O Expander

In addition to the 4 GPIO signals provided by the Bug Base unit via the QTE connector, the PCA9538 I/O Expander device from NXP provides additional GPIO Control/Status signals. Table 4 identifies the additional I/O signals and their functions. The I/O expander operates at 3.3 Vdc, and is accessed by the Bug Base via the I2C bus.

TABLE 4 - I/O EXPANDER SIGNALS

PIN #	Expander I/O	Signal Name	Direction	State	Function
4	IO0	N_GPS_FIX	IN	ACTIVE LOW	Fix data is available
5	IO1	FLAG	IN	ACTIVE LOW	Over-current flag from current limiter
6	IO2	WAKEUP	OUT	ACTIVE HIGH	Wake up unit after push to fix
7	IO3	BOOT	OUT	ACTIVE HIGH	Download firmware to flash
9	IO4	1PPS	IN	-	1 PPS signal from JUPITER-32
10	IO5	NC	-	-	-
11	IO6	VRF1	OUT	ACTIVE HIGH	Internal Antenna select
12	IO7	VRF2	OUT	ACTIVE HIGH	External Antenna select



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6 Module EMI Considerations

The Jupiter-32 device from *Navman* is shielded. The shielding has been provided on the module for compliance to FCC and EU EMI/EMC requirements. Removal of the shield, changes to the RF front end of the BUGlocate module, or use of antennas other than the antennas mounted on the module will require FCC and/or EC re-certification.

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Date: 7/28/09