LIQUID ROBOTICS®

PCBA, IGM VMC Module WITH IRIDIUM 9603N:

Assembly P/N: 04901-01

User Manual

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FCC Regulatory Statement:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT! Changes or modifications not expressly approved by Liquid Robotics Inc could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This equipment complies with radiation exposure limits set forth for uncontrolled environment. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

1. Introduction

The Liquid Robotics PCBA,IGM VMC Module's primary purpose is to integrate satellite communication and location services into the Liquid Robotics command and control (CCU) framework. The module serves a secondary purpose as a "Module Controller" by providing appropriate boot commands to the VMC to initialize system power up.

The PCBA, IGM VMC Module must be protected and should be mounted inside the box. The connections for RF antennas should only be made inside the box.

The PCBA,IGM VMC Module can be loosely described as a standard STM32L152RDT6 microcontroller controlling, a GPS (U-blox Neo-6Q) and a Iridium modem module 9603N. See Figure 1.

Figure 1.

2. Power Architecture

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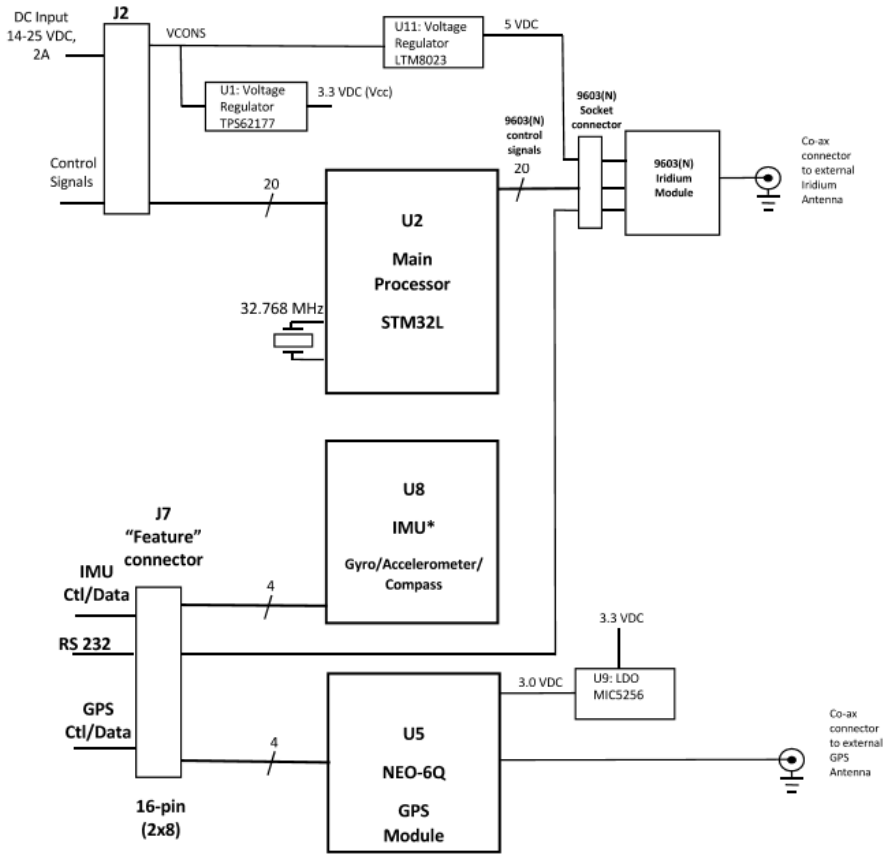
PCBA, IGM VMC Module

Block Diagram



*** IMU = Inertial Measurement Unit**

The Iridium Modem and GPS's module is powered through the SV3 CCU standard VCONS (Voltage Consumer) power pin provided through universal module connector. The corresponding pin out is reproduced below in Table 5 Standard Connector (HPMC-110-03-L-D-03)

Voltage Consumer is regulated by a TPS62177DQC manufacturing by Texas Instrument to 3.3V to power the microcontroller and the supporting communications logic throughout the board. This 3.3V signal is further regulated by a Micrel LDO to meet the Ublox Neo-6Q GPS unit's noise tolerances.

The Iridium Modem is powered by an LTM8023EV#PBF providing 5VDC from the VCONS power pin. To accommodate an Iridium 9523 Modem an additional "Boost" supply is required to drive the increased RF load.

2.1 Power Monitoring (I2C & Calibration Value)

The following power supplies are actively monitored by an INA226AIDGSR IC:

Device	I2C Address	Calibration Value
5V Regulator	0b1000101	31
Boost PWR	0b1000110	31
GPS PWR	0b1000111	1024

Table 1 Power Monitor I2C and Calibration

2.2 Power Control – Enable / Disable I/O

The module's onboard microcontroller has the ability to power up and power down the varying supplies present on the module as well as the main VCM. All supply enable pins are considered active high (as in the regulator is on and active).

Conversely, the Iridium 9523 Boost supply (If present) is controlled strictly by the Iridium modem. The 5 V supply powering either modem is controlled by a simple set of logic. If the VCM is on the VCM has modem on/off control. Otherwise, the modem's on state is dictated by the on board microcontroller.

VMC Status	Microcontroller Modem Enable Line	VMC Modem Enable Line	5.0 VDC Power State
Off	High	X	On
Off	Low	X	Off
On	X	High	On
On	X	Low	Off

Table 2 Modem Power On Truth Table

The relevant signals and their corresponding "Power Good" are represented in Table 8 STM32L152RDT6 Pin Out provided in the appendix.

2.3 VMC boot Control

The onboard microcontroller is responsible for the proper boot initiation of the SV3 CCU VMC. This is achieved by providing a Boot GPIO pin as well as a VMC "Power On" signal through GPIO. Once the VMC has successfully been powered up, a Power Good signal (VMC_POK) is expected in return.

Port	Signal	Pin
PC7	VMC_ON	38
PC9	VMC_POK	40
PA5	BOOT0	21

Table 2 VCM Boot Signals

Additionally, prior to signaling the VMC on the Microcontroller should switch its UART lines to the VMC to Microcontroller option (Detailed in Table 3 RS-232 Switching Parameters). This pairs UART 3 to the module Microcontroller allowing it to intercept boot parameters and specify boot sequence.

3. Communications Architecture

The Iridium Modem and GPS Module communicate off board with the larger SV3 CCU system via RS485. These communication processes conform to standards established for AMPS modules represented in the SV3 (ICD) Specification documentation.

3.1 Software Interface:

3.1.1 Before communicating with the PCBA, IGM VMC Module, first configure the host device serial port:

Ublox: port LX0, baudrate 9600, mode rs232

Iridium: port O2, baudrate 19200, mode rs232

3.1.2 Now be sure proper power is applied to the module.
Input Voltage = 14-25 VDC
Input Current = 2 A

3.2 RS232 Communication

The Microcontroller has the ability to communicate via RS232 through one of three logic paths determined by the state of PortA [2..4]. By toggling the values of these ports the microcontroller is able to pair itself, the VCM and the modem allowing serial communication. The corresponding I/O is represented in Table 3 RS-232 Switching Parameters

Port	Signal	MC Pin	Function
PA2	MC_TO_VMC	16	Micro Paired with VCM
PA3	MDM_TO_MC	17	Iridium Modem Paired with Micro
PA4	MD_TO_VMC	20	Iridium Modem Paired to VCM

Table 3 RS-232 Switching Parameters

3.3 I2C Communications

The Iridium Modem and GPS Module's Microcontroller communicates via I2C to both the power monitoring ICs and the Neo 6/7 GPS unit. The devices and their corresponding I2C Addresses are listed below in Table 4 I2C Addresses.

Device	I2C Address
SMC PreReg	0b1001000
GPS	0b0100001
5V Regulator	0b1000101
Boost PWR	0b1000110
GPS PWR	0b1000111

Table 4 I2C Addresses

4. Iridium Modem 9603(N)

The Iridium 9603 is constrained to SDB (Short Burst Data) communications to Iridium satellite and the Iridium 9603N is similar to 9603 and it is designed for the next generation constellation satellite.

The Iridium 9603 Datasheet

Initializing Communication with the Iridium modem:

The following commands are sent (in order)

- ATE0
- ATV0
- AT&D0
- AT&K0
- AT&W0
- AT&Y0
- AT
- AT+CGSN

If these commands were successful then starting writing messages to the modem. This entails writing AT commands (to check modem comms), AT+CSQF, AT+SBDWB, then AT+SBDIX.

5. Ublox GPS modem Neo-6Q

The Neo-6Q GPS modem provides GPS and PPS signal via NMEA string to CCU for the location (Latitude & longitude) and date (ZDA).

Initializing Communication with the u-blox GPS:

- send the enable antenna message, note that this is sent three times (a bunch of bytes in order written): 0xB5, 0x62, 0x06, 0x24, 0x00, 0x00, 0x5A, 0xA6

- send the enable ZDA message: $PUBX,40,ZDA,0,1,0,0,0,0*45

- send the enable GST message: $PUBX,40,GST,0,1,0,0,0,0*5A

- send the enable GSA message: $PUBX,40,GSA,0,0,0,0,0,0*4E

- send the enable GSV message: $PUBX,40,GSV,0,0,0,0,0,0*59

Neo-6 Datasheet

6. Board to Board Connectivity J2:

The Iridium Modem and GPS module has two Board to Board connectors. A standard HPMC-110-03-L-D-03 provides connectivity to the VCM backplane whereas feature connector paths the module specific signals to the VCM backplane. The pin outs for both connectors are provided below.

Connector J2 Detailed listing of I/O's

Pin		Pin	Signal
P3	VCONS		
P2	GND		
P1	NC		
2	MA1	**1**	MA0
4	MA3	**3**	MA2
6	MA5	**5**	MA4
8	MA7	**7**	MA6
10	SDA_A	**9**	SDAT_B
12	ALERTn	**11**	NC
14	NC	**13**	NC
16	NC	**15**	NC
18	RSTA	**17**	RST_B
20	NC	**19**	NC

Table 5 Standard Connector (HPMC-110-03-L-D-03)

6.1 Board to Board Connectivity (Feature Connector) J7:

Pin Connection	Pin Number	Description
DF_RI	1	Modem Ring Indicator
BOOT0	3	VCM Boot Parameter
SDA	5	I2C
SCL	7	I2C
SMBA	9	RS485 alert
VMC_TX	11	Serial TX
GPS_DAT_RX	13	Serial GPS IN
TEST_ENABLE	15	/test mode
DF_CTS	2	Modem CTS
DF_RTS	4	Modem RTS
VMC_ON	6	VCM On signal
VMC_MODEM_CTRL	8	VCM Modem On/Off Control
VMC_POK	10	VMC_Power GOOD
VMC_PPS	12	VCM PPS
VMC_RX	14	VCM Serial RX
GPS_DAT_TX	20	Serial GPS OUT

Table 6 Feature Connector Pin Out

6.2 Physical Interface:

The Liquid Robotics PCBA, IGM VMC Module interfaces to the outside world through four hardware connections:

J2; Power and Control Signals.

The connector on the module is a SAMTEC P/N HPMC-110-03-L-D-03. This part is a .100" Signal/Power Combo Terminal Strip with .100" (2.54 mm) pitch signal; .200" (5.08 mm) pitch power pins.

Note: This part mates with the SAMTEC HPMC-110-01-L-D-03

7.0 RS-232 Logic automatic switching.

The primary purpose of this logic circuit is to route and re-route com signals between the VMC, the onboard Microcontroller and the modem. Signal routing and selection is handled by the Microcontroller and provides communications control during a complete VMC failure. Given no input, the logic configuration will default connecting the microcontroller and the modem. It should be noted that attempting to operate all three connections simultaneously could cause hardware damage.

Port	I:O Signal
PA4	MD_TO_VMC
PA3	MDM_TO_MC
PA2	MC_TO_VMC

Table 8 Logic Switching Ports & Signals

	MD_TO_VMC	MDM_TO_MC	MC_TO_VMC	Function
State	1	0	0	Modem Connected To VMC
	0	1	0	Modem Connected To Microcontroller
	0	0	1	Microcontroller Connected to VMC

Table 7 Logic Switching State vs. Function

1. Appendix – Useful Table's and Links

A (near) Complete Compilation of Datasheets used in this design

Pin Name	Pin Connection	Pin Number
AGND	AGND	12
BOOT0	GND	60
GND	GND	18
GND	GND	31
GND	GND	47
GND	GND	63
JTCK/SWCLK	TCK	49
JTDI	TDI	50
JTDO	TDO	55
JTMS/SWDIO	TMS	46
JTNRST		56
PA0	MODEM_PWR_EN	14
PA1	BOOST_PWR_EN	15
PA2	MC_TO_VMC	16
PA3	MDM_TO_MC	17
PA4	MD_TO_VMC	20
PA5	BOOT0	21
PA6	BOOT1	22
PA7	BOOT2	23
PA8	RS485_TXEN	41
PA9	RS485_TXD	42
PA10	RS485_RXD	43
PA11		44
PA12	RS485_RXENN	45
PB0	MA5	26
PB1	MA6	27
PB2/BOOT1	MA7	28
PB5	SMBA/	57
PB6	SCL	58
PB7	SDA	59
PB8		61
PB9		62
PB10	MC_TX	29
PB11	MC_RX	30
PB12	N15402405	33

PB13	N15402383	34
PB14	N15402387	35
PB15	N15402391	36
PC0	MA0	8
PC1	MA1	9
PC2	MA2	10
PC3	MA3	11
PC4	MA4	24
PC5	LED_EN/	25
PC6	GPS_PWR_ON	37
PC7	VMC_ON	38
PC8		39
PC9	VMC_POK	40
PC10	NTWRK_AVAIL	51
PC11	SUPPLY_OUT	52
PC12	MODEM_PGD	53
PC13	N518868	2
PC14	N518538	3
PC15	N518546	4
PD2	N519350	54
PH0	N15404066	5
PH1	N15373241	6
R\S\T	RSTN	7
VCC	VCC	19
VCC	VCC	1
VCC	VCC	64
VCC	VCC	48
VCC	VCC	32
VCCA	VCCA	13

Table 8 STM32L152RDT6 Pin Out