

Race Technology

IMU06

Instruction manual



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IMU06 MK2



What is the IMU06?

The IMU06 is a compact 6 degree of freedom inertial measurement unit. It provides 3 axis acceleration (maximum 10G) and angular velocities (maximum 300 degrees/s) on both CAN and RS232 at user configurable data rates of up to 100Hz. The unit can also provide a timing pulse to indicate the moment at which the sample has been taken for data alignment purposes.

Who is the IMU06 designed for?

The IMU06 is designed for vehicle dynamics testing applications, particularly for suspension of braking testing. It can also find application in a number of other position sensing applications such as stability control.

How does the IMU06 integrate in to an existing data logging system?

There are two output formats available on the IMU06, RS232 and CAN data. The RS232 data is formatted using the Race Technology data format, detailed in Appendix A. This data can be fed directly in to a Race Technology data logger such as the DL1 or DL2, alternatively it can be viewed directly on a PC or Race Technology display product.

The CAN data can be user configured to use any two CAN channel IDs. This data is transmitted at selectable rates of up to 100Hz.

IMU06 MK2 Specifications

IMU06 MK2 General Specification

General Specification IMU06	
Power requirements	8-15v dc, 150mA
Case construction	Anodised aluminium
Maximum dimensions	60.4(W) X 70 (L) X 35 (H)
Mass	175g
Fixing method	5mm mounting holes machined for M4 shoulder screws
Sensor orientation	<p>The diagram illustrates the sensor orientation on a car. The top part shows a car with three curved arrows representing rotation: a red arrow for Yaw, a green arrow for Pitch, and a yellow arrow for Roll. The bottom part shows a car with three straight arrows representing acceleration: a red arrow pointing up for +ve vertical acceleration, a green arrow pointing forward for +ve longitudinal acceleration, and a yellow arrow pointing right for +ve lateral acceleration.</p>

IMU06 MK2 General Specification (Continued...)

IP rating	IP55
Operating temperature	-20 to +60°C
Humidity	5-90% non condensation
Vibration	20g all axis 5 minutes
Sensor alignment	Internal sensor ± 0.2 degrees from case mounting holes
Pulse Output	5v, 25% duty cycle approx 100Hz. Rising edge synchronised with data

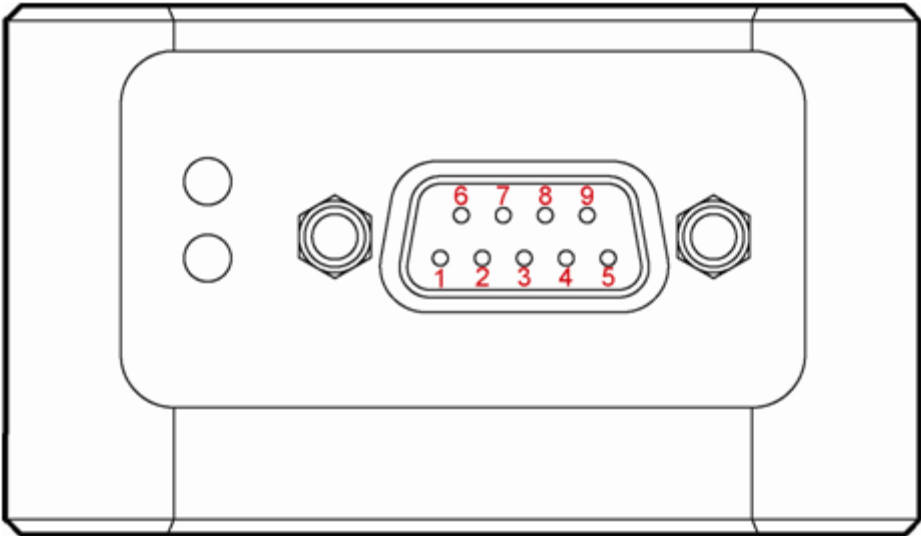
Technical Specification - Gyroscopes

Technical Specification Gyroscopes					
Parameter	Conditions	Min	Typ	Max	Unit
GYROSCOPE SENSITIVITY	Each axis				
Initial sensitivity	25°C, dynamic range = $\pm 300^\circ/s$	0.0725	0.07326	0.0740	$^\circ/s/LSB$
	25°C, dynamic range = $\pm 150^\circ/s$		0.03663		$^\circ/s/LSB$
	25°C, dynamic range = $\pm 75^\circ/s$		0.01832		$^\circ/s/LSB$
Temperature coefficient			40		ppm/ $^\circ C$
Gyroscope axis nonorthogonality	25°C, difference from 90° ideal		± 0.05		Degree
Gyroscope axis misalignment	25°C, relative to base-plate and guide pins		± 0.5		Degree
Nonlinearity	Best fit straight line		0.1		% of FS
GYROSCOPE BIAS					
In run bias stability	25°C, 1σ		0.015		$^\circ/s$
Angular random walk	25°C		4.2		$^\circ/\sqrt{hr}$
Temperature coefficient			0.01		$^\circ/s/^\circ C$
Linear acceleration effect	Any axis, 1σ		0.05		$^\circ/s/g$
GYROSCOPE NOISE PERFORMANCE					
Output noise	25°C, $\pm 300^\circ/s$ range, 2-tap filter setting		0.60		$^\circ/s$ rms
	25°C, $\pm 150^\circ/s$ range, 8-tap filter setting		0.35		$^\circ/s$ rms
	25°C, $\pm 75^\circ/s$ range, 32-tap filter setting		0.17		$^\circ/s$ rms
Rate noise density	25°C, $f = 25$ Hz, $\pm 300^\circ/s$, no filtering		0.05		$^\circ/s/\sqrt{Hz}$ rms
GYROSCOPE FREQUENCY RESPONSE					
3 dB bandwidth			350		Hz
Sensor resonant frequency			14		kHz

Technical Specification - Accelerometers

Technical Specification Accelerometers					
Parameter	Conditions	Min	Typ	Max	Unit
ACCELEROMETER SENSITIVITY	Each axis				
Dynamic range		±8	±10		<i>g</i>
Initial sensitivity	25°C	2.471	2.522	2.572	mg/LSB
Temperature coefficient			40		ppm/°C
Axis nonorthogonality	25°C, difference from 90° ideal		±0.25		Degree
Axis misalignment	25°C, relative to base-plate and guide pins		±0.5		Degree
Nonlinearity	Best fit straight line		±0.2		% of FS
ACCELEROMETER BIAS					
In-run bias stability	25°C, 1σ		0.7		mg
Velocity random walk	25°C		2.0		m/s/√hr
Temperature coefficient			0.5		mg/°C
ACCELEROMETER NOISE PERFORMANCE					
Output noise	25°C, no filtering		35		mgrms
Noise density	25°C, no filtering		1.85		mg/√Hz rms
ACCELEROMETER FREQUENCY RESPONSE					
3 dB bandwidth			350		Hz
Sensor resonant frequency			10		kHz

Connector Pinout Details

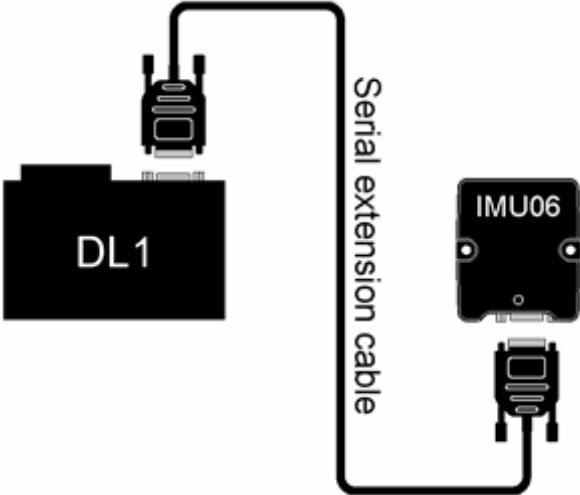


Connector pinout details	
Pin	Function
2	RS232 TX
3	RS232 RX
4	NC
5	GND
6	CAN L
7	Power in
8	CAN H
9	Timing signal

Installing, Configuring and Calibrating the IMU06

Installing the IMU06

Connection directly to a DL1 / DL2 data logger

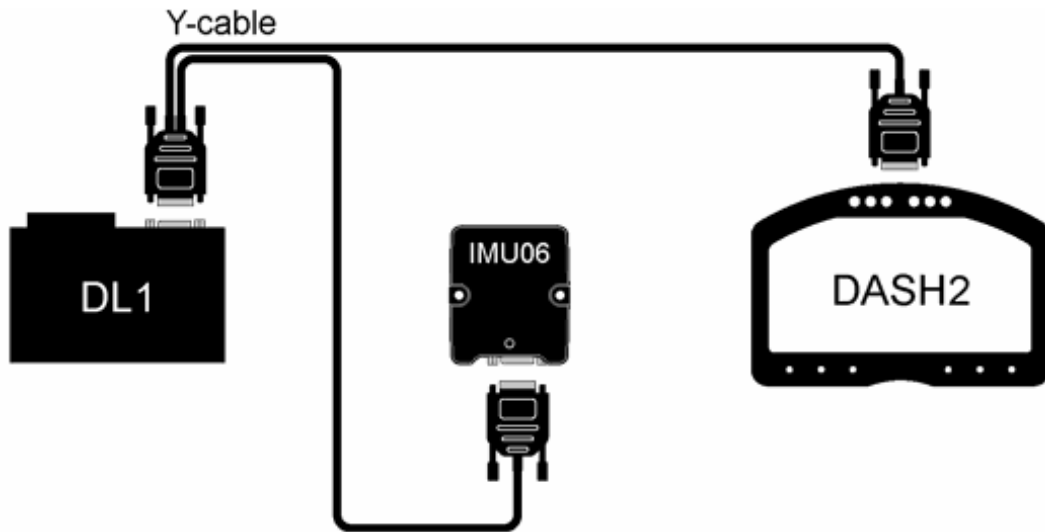


The IMU06 female d-type connector will plug directly in to the wiring loom of a DL2 or can be used with a straight through extension lead to connect directly to a DL1. In this case the IMU06 will receive power from the DL1/2. When using this installation, ensure that the **Pass through RT message format** option is disabled in the configuration.

Serial	
Update rate for gyro messages	100Hz
Update rate for accelerometer messages	100Hz
Pass through RT message format	<input type="checkbox"/>

In the DL1/2 configuration, ensure that the internal accelerometers are turned off for both storage to the memory card and to the serial port. Enable decoding of serial messages and logging of incoming serial data to the memory card.

Connecting to DL1 with DASH2



A Y-cable is required to connect the IMU06 to multiple units. When using this installation, ensure that the “Pass through RT message format” option is enabled in the configuration.

Serial	
Update rate for gyro messages	100Hz
Update rate for accelerometer messages	100Hz
Pass through RT message format	<input type="checkbox"/>

If additional ECU interfaces or CAN adapters are used in conjunction with the IMU06, they can be daisy chained on either side of the unit.

In the DL1/2 configuration, ensure that the internal accelerometers are turned off for both storage to the memory card and to the serial port. Enable decoding of serial messages and logging of incoming serial data to the memory card and transmission to the serial port.

Connecting to a CAN system

The IMU06 will require power and signal wires connecting to the 9 way d-type connector for operation. The required wiring is:

Pin 5	Gnd
Pin 7	+12v
Pin 6	CAN L
Pin 8	CAN H

Note: There is no termination resistor inside the IMU06. If one is not present on the system then a 120 ohm resistor should be attached across pins 6 and 8.

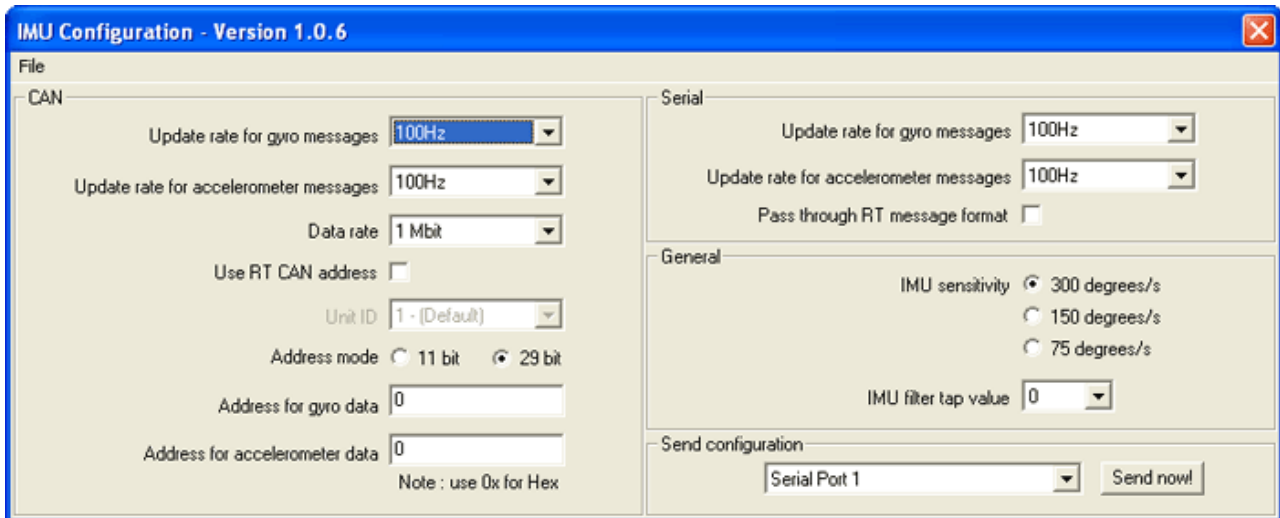
Connecting to other data logging systems

The IMU06 can be connected to a variety of data logging systems, using either the RS232 or the CAN interface. A timepulse output is also provided for data alignment purposes. The connections to the IMU06 are as follows:

Pin 2	RS232 TX
Pin 3	RS232 RX
Pin 5	Gnd
Pin 6	CAN L
Pin 7	+12v
Pin 8	CAN H
Pin 9	Timepulse output

Note: There is no termination resistor inside the IMU06. If one is not present on the system then a 120 ohm resistor should be attached across pins 6 and 8.

Configuration software



There are four sections to the CAN configuration software:

- [CAN](#) – Configuring the CAN output of the module
- [Serial](#) – Configuring the RS232 serial output of the module
- [General](#) – Configuring sensitivity and filtering
- [Send Configuration](#) – Sending the new configuration data to the IMU

CAN

Configures the CAN ports of the IMU06.

- **Update rate for gyro messages:**

Update rate for accelerometer messages. The update rate can be selected from **disabled** up to **100Hz**.

- **Data rate:**

This selects the data rate on the CAN port, standard supported rates are:

- 33.3kbit
- 125kbit
- 250kbit
- 500kbit
- 1Mbit

This rate must be set to match the rate of any other CAN devices on the system.

- **Use RT CAN Address**

This enables the setting up of the 29 bit message address based on the RT message format protocol. For more information about this refer the **Serial Data Format** section on the Race Technology Knowledge Base at the following address.

<http://www.race-technology.com/wiki/index.php/General/SerialDataFormat>

When the RT CAN address is selected, the only option available is to select the unit ID. If there is only one IMU being used in a system this should be kept as the default ID of 1. The CAN database file for the IMU is configured for use with the default address.

If the Use RT CAN address option is not selected. It is possible to select either an 11 bit or 29 bit address for the gyro and accelerometer output.

Addresses for the gyro and accelerometer can be entered either as hexadecimal or decimal addresses.

Serial

The update rate on the serial port of the gyro and accelerometer data can be selected in multiples at up to 100Hz.

- **Pass through RT message format:**

This box should be ticked if the IMU06 is required to retransmit RT format messages which it receives. A typical situation when this might be required is if the IMU06 is used along with a DL1 and DASH2. In this instance a special cable will be required to connect the units together. Contact RT for details on this cable.

If this box is ticked when the IMU06 is connected directly to a data logger it can cause problems if the data logger is set to decode and retransmit or log serial data.

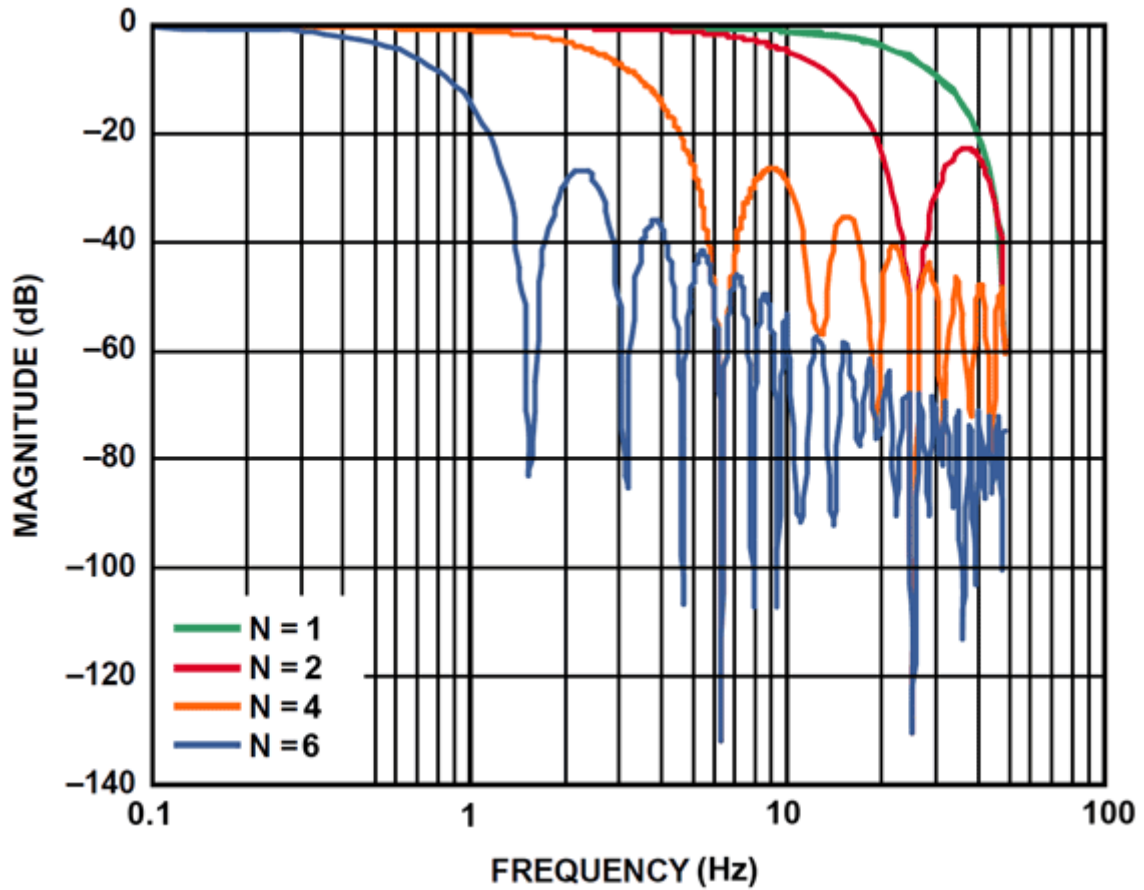
General

- **IMU sensitivity**

This option selects the nominal full scale deflection of the IMU. The actual maximum FSD can be higher. Lower levels give better internal resolution on the sensor output.

- **Filter tap value**

The filter tap value selects the response of the internal low pass filter in the IMU06. The applicable values are from 0 (no filtering) up to 7. Some of the filter output responses are shown on the next page:



Send Configuration

The serial port to which the IMU06 is attached must be selected from the drop down list. To program the new settings in to the IMU06 click on the “Send now!” button and follow the on screen instructions

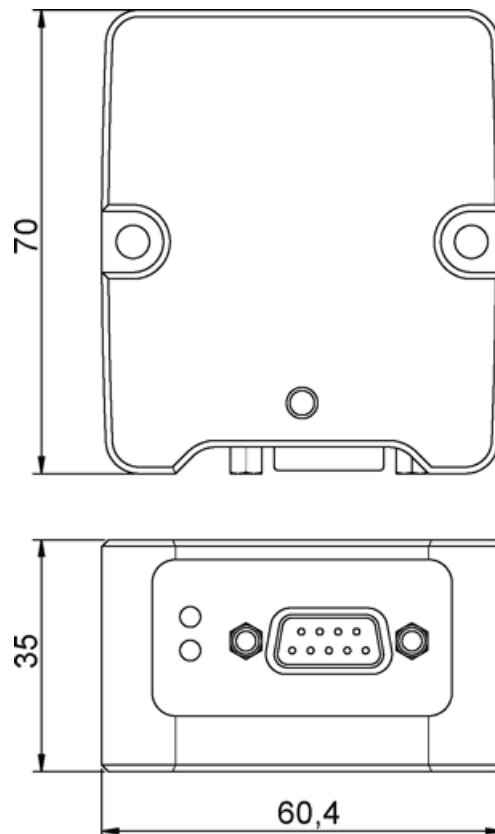
Calibrating the IMU06

The IMU06 can be calibrated to reduce the zero errors on the three axis gyro output. During the calibration procedure it is important that the unit remains stationary. **The orientation of the unit is not important, since the accelerometers are not being calibrated.**

Calibration is achieved using the following procedure:

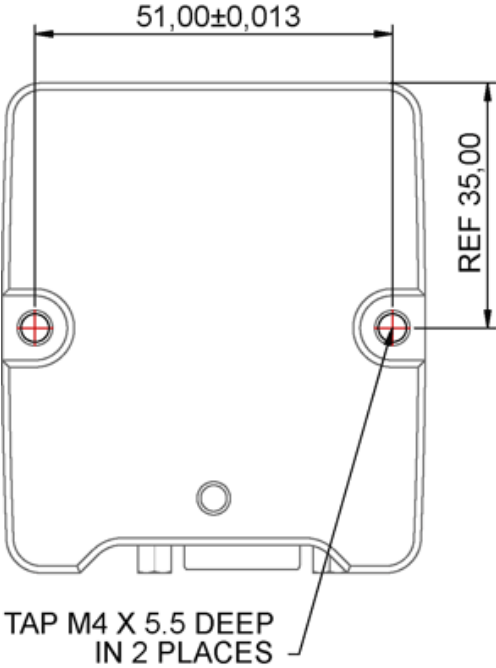
1. Press and hold the calibrate button as power is applied to the IMU06. The power and status lights will illuminate.
2. After 3-4 seconds the status light will go out, when this happens release the calibrate button. The status light will then slowly flash twice and stay on.
3. Whilst the status LED is on the calibration process is being carried out, do not move the unit. The calibration will take around 15-20 seconds
4. When the calibration is complete the status light will start flashing. Operation will now resume as normal.

Dimensions

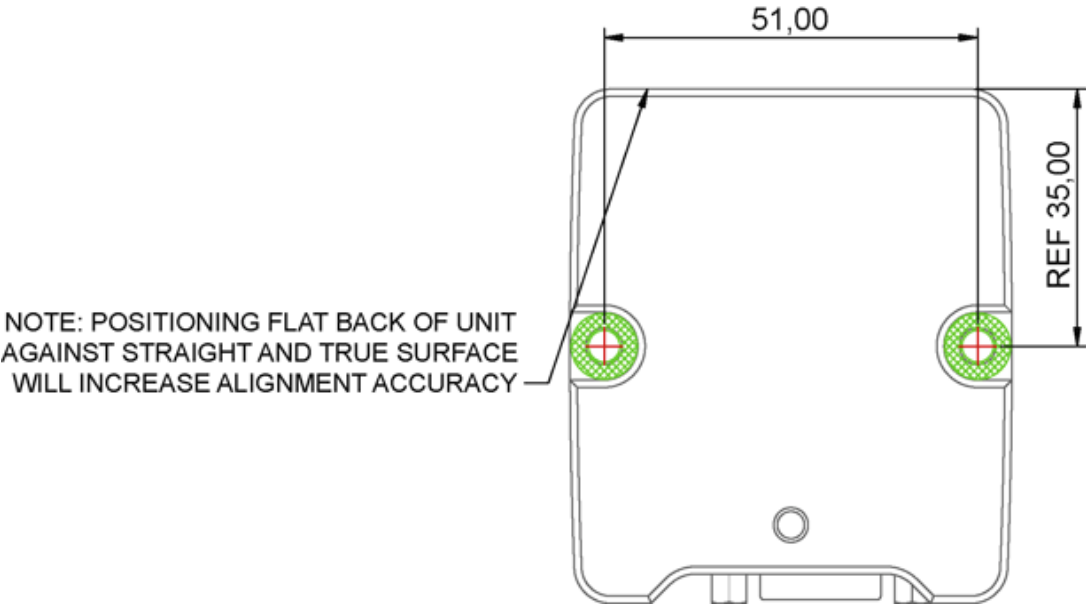


Mounting the unit

Two different mounting options are available. For a highly accurate alignment shoulder screws are used in the reamed 5mm diameter mounting holes. This option is recommended to ensure the correct alignment of the unit and the accuracy of the measurement.



For applications where this recommended mounting option is not possible to implement, a second non critical alignment option is available. We recommend that the flat back surface of the unit is used to align the unit against a flat aligned reference surface. The M4 clearance washers fit in the mounting recess and allow standard M4 mounting screws to hold the unit securely. This mounting option is not designed to ensure accurate alignment.



Data Formats

CAN Data Format

CAN data can be output at user selectable bit rates of 125k/250k/500k or 1Mbit. The output values can be transmitted at up to 100Hz. The address used by the CAN system can either be a Race Technology format 29 bit address, in which case the actual address used will be shown in the configuration software, or a user defined 11 or 29 bit address. The format of the output messages is as follows:

RT CAN Message Specification

For all messages, bit zero of the validity byte refers to the first data (not accuracy) packet, bit 1 to the next data packet, etc. When the bit is 1, the data is valid, when the bit is zero, the data is invalid. Since the last 5 bits of the address are made up of the unit id, this will need to be added to the addresses shown. The default unit ID is 2. A .dbc file containing all signals is available on request.

Inertial messages (group 128)

RT_Accel: 128, 0 (0x800020+ unit id)

```
----  
Byte 0: Validity  
Byte 1: Accuracy  
Bytes 2-3: Accel Longitudinal (g)  
Bytes 4-5: Accel Lateral (g)  
Bytes 6-7: Accel Vertical (g)  
----  
Accel resolution is g/1000.
```

RT_Gyro_Rates: 128, 1 (0x800120+ unit id)

```
----  
Byte 0: Validity  
Byte 1: Accuracy  
Bytes 2-3: Yaw rate (degrees/s)  
Bytes 4-5: Pitch rate (degrees/s)  
Bytes 6-7: Roll rate (degrees/s)  
----  
Rate resolutions are degrees/s/100.
```

Race Technology CAN Address Format

When the option is selected to use the Race Technology addressing system.. This should be selected whenever the IMU is used along with other Race Technology units on a CAN bus. The message contents are exactly the same irrespective of mode, but in the RT format mode the 29 bit address is used to carry data as to the data type, source, and destination. As follows:

All messages use a 29 bit address, made up as follows:

3 bit priority These are set by the transmitter. The lower the number the higher the priority.

2 bits for future expansion (currently set as 00)

16 bit data type If the MSB is <128 then this is a destination specific message, the destination address is given by the LSB (Data Format 1) If the MSB is >127 this is a broadcast message, the MSB determines the main data type, LSB determines the sub type (Data Format 2)

8 bit source address

The top three bits are the data group, the lower 5 bits are the particular unit within that group. Default values are set on units, these will only need to be changed when there is more than one of a particular unit on the CAN network. Groups are as follows.

- 1 Data source
- 2 Displays
- 3 Data stores

Units are assigned to a group based on their primary function. A data logger will be classed as a data store, even if it has some built in channels.

Default unit numbers are as follows:

Data source group

- 1 IMU06
- 2 SPEEDBOX
- 3 BRAKEBOX

RS232 data format

The RS232 data is transmitted in packets at 115200baud using the standard Race Technology format. Each message consists of a header byte, data bytes, and a checksum byte. The checksum is calculated as the sum of all preceding bytes MOD256.

Accelerometer data

Lateral and longitudinal acceleration –Channel 8, 4 bytes		
Data bytes 1 and 2	Lateral acceleration	
	Format	Big endian (raw hex). 15 data bits, 1 sign bit
	Signing	Sign-and-magnitude. First bit (msb) is sign (0 => -ve)
	Units	g
	Scaling	Output = g x 256
	Example	Acc(g) = (byte 1 & 0x&F) + (byte 2 / 256) If (byte 1 & 0x80) = 0, Acc = -Acc
Data bytes 3 and 4	Longitudinal acceleration	
	Format	All format the same as lateral acceleration above
Vertical acceleration –Channel 92, 2 bytes		
Data bytes 1 and 2	Vertical acceleration	
	Format	All format the same as lateral acceleration above

Gyroscope data

Yaw rate – Channel 79, 2 bytes		
Data bytes 1 and 2	Yaw rate	
	Format	Big endian (raw hex), 16 data bits
	Signing	Unsigned
	Units	Degrees
	Scaling	Output = 327.68 – degrees x 0.01

Pitch rate – Channel 81, 3 bytes		
Data bytes 1 and 2	Pitch rate	
	Format	Big endian (raw hex), 16 data bits
	Signing	Unsigned
	Units	Degrees
	Scaling	Output = 327.68 – degrees x 0.01
Data byte 3	Pitch rate accuracy estimate	
	Format	Big endian (raw hex), 32 data bits
	Signing	Unsigned
	Units	Undefined, lower is better

Roll rate – Channel 84, 3 bytes		
Data bytes 1 and 2	Roll rate	
	Format	Big endian (raw hex), 16 data bits
	Signing	Unsigned
	Units	Degrees
	Scaling	Output = 327.68 – degrees x 0.01
Data byte 3	Roll rate accuracy estimate	
	Format	Big endian (raw hex), 32 data bits
	Signing	Unsigned
	Units	Undefined, lower is better