ADR

- Configuration and Functionality

USER MANUAL

MoTeC

Contents

Installation

Mounting to a suitable surface is critical for reliable ADR operation and useful accident data. Install in accordance with the following notes.

Note:
The ADR must be mounted with each side parallel to one of the 3 primary axes of the vehicle. There are 24 possible mounting orientations. See the Orientation section on page 13 for more detail.

- It is recommended that the ADR is securely mounted on a rigid structural member, close to the driver's seat. Avoid mounting to sheet metal bodywork or other vibrating surfaces.
- The mounting location should allow the LEDs to be easily seen by the race crew, officials and emergency personnel.

Dimensions

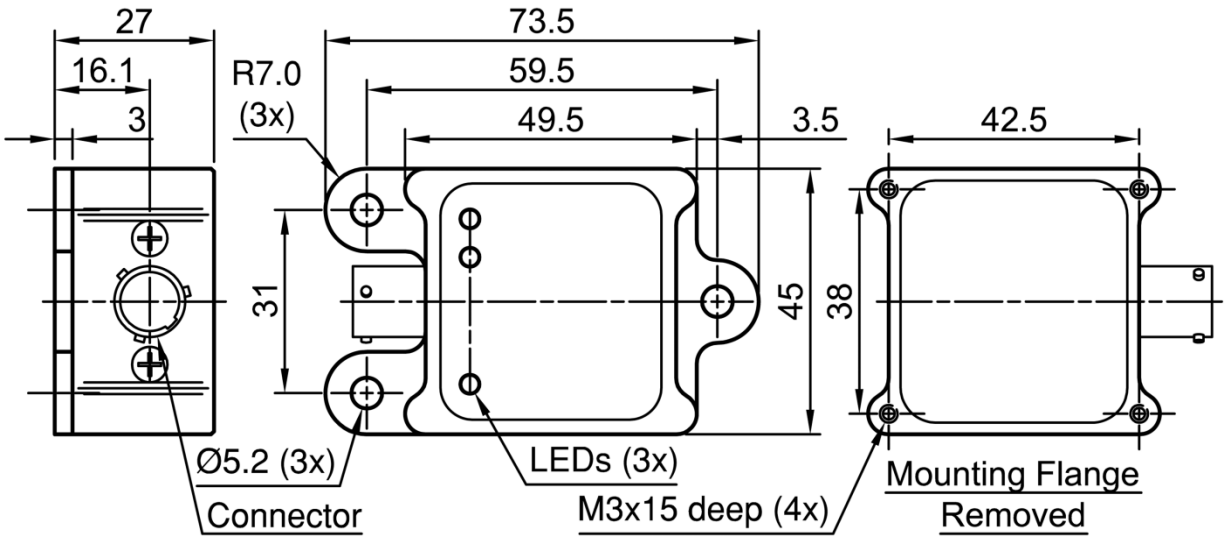

Figure 1 – Dimensions and mounting

Configuration

The ADR Manager application is used to configure the ADR, upgrade the firmware, and carry out event management activities such as downloading and erasing data.

Connection to the ADR

ADR Manager connects to a powered ADR unit over the CAN bus. The connection can be made through a MoTeC UTC (USB to CAN), or through a MoTeC Ethernet connected logger or ECU wired on the same CAN bus as an ADR.

MoTeC Ethernet devices include ACL, ADL3, CDL3, SDL3, C185, C125 and M1 ECUs.

Note: To allow a connection through a MoTeC Ethernet device, the UTC connection setting accessed via the **Tools > Options** menu must be disabled.

If the ADR being connected has a password set, the password prompt is displayed. The correct password must be entered before any other operations can be performed.

When an ADR is connected, a summary of the logged events is listed as shown in figure 2. The connection status and ADR serial number are shown in the ADR Manager Status bar.

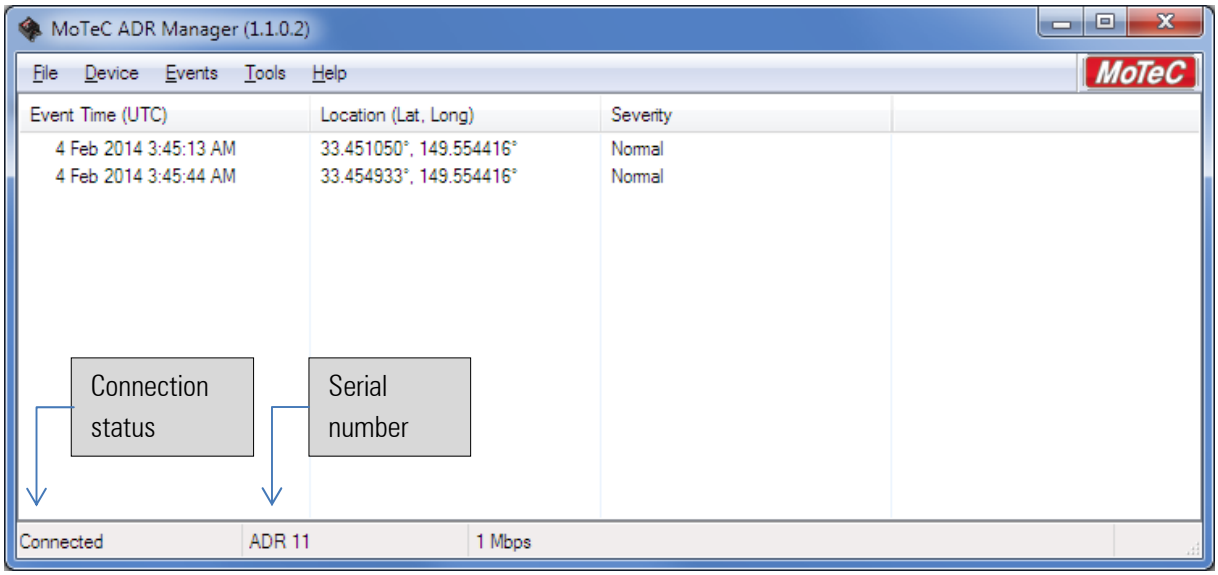

Figure 2 – Example ADR Manager window on connection to an ADR

Password Support

An ADR unit can be password protected to prevent unauthorised access to all ADR features (configuration, upgrading and event management).

Note:
A password can only be set on an ADR that does not have an existing password. If you want to change a password, first clear it and then set a new password.

To set a password:

1. Select **Device > Set Password** menu option.
2. Enter the new password as directed.

To clear a password:

1. Select **Device > Clear Password** menu option.

Device Configuration

To configure the ADR:

1. Select the **Device > Edit Configuration** menu option.

   Initially the *Device Configuration* window displays the configuration retrieved from the connected ADR. The configuration may then be edited or loaded from disk.

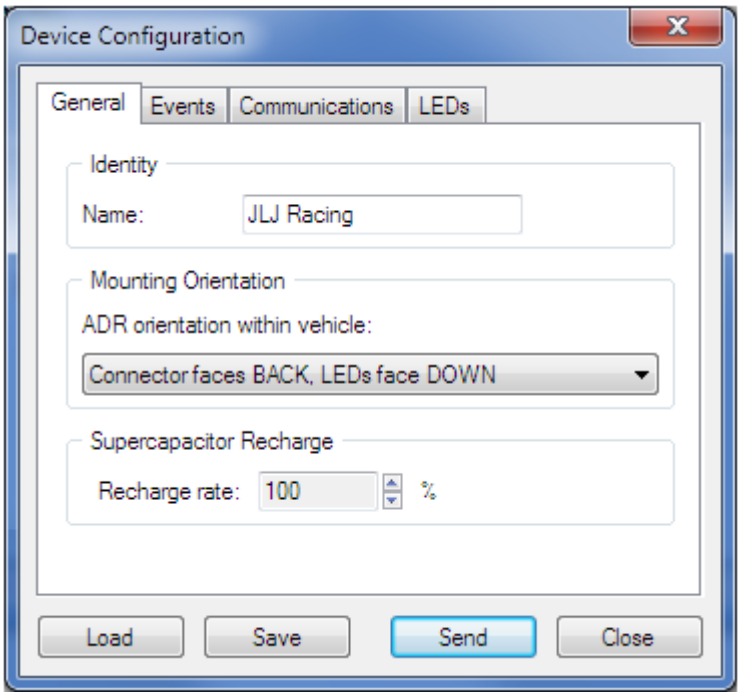

Figure 3 – Example Device Configuration window

Note:
Viewing, editing, saving or loading a configuration from disk is all performed via the *Device Configuration* window.

2. Use the information that follows to perform the required configuration activities.

Device Configuration Buttons

The **Load**, **Save**, **Send** and **Close** buttons are used to perform the following functions:

Load	Load an existing configuration to the ADR Manager from disk.
Save	Save the current configuration in the ADR Manager. This **does not** apply the configuration to the ADR.
Send	Apply the configuration to the ADR. The ADR configuration remains unchanged until another configuration is sent.
Close	Closes the *Device Configuration* window.

General Tab

See Figure 3, the function of the parameters on the *General* tab is as follows.

Identity/Name	Optional name for the ADR.
Mounting Orientation	The orientation of the installed ADR must be specified. This allows the accelerometer readings to be correctly aligned to the vehicle. See the Orientation section on page 13 for more detail.
Supercapacitor Recharge/Recharge Rate	The rate determines how fast the super capacitor is charged. The maximum rate (100%) is recommended for most applications. The higher the charge rate, the quicker the supercapacitor reaches full charge. See the *Power* section on page *18* for more detail.

Events Tab

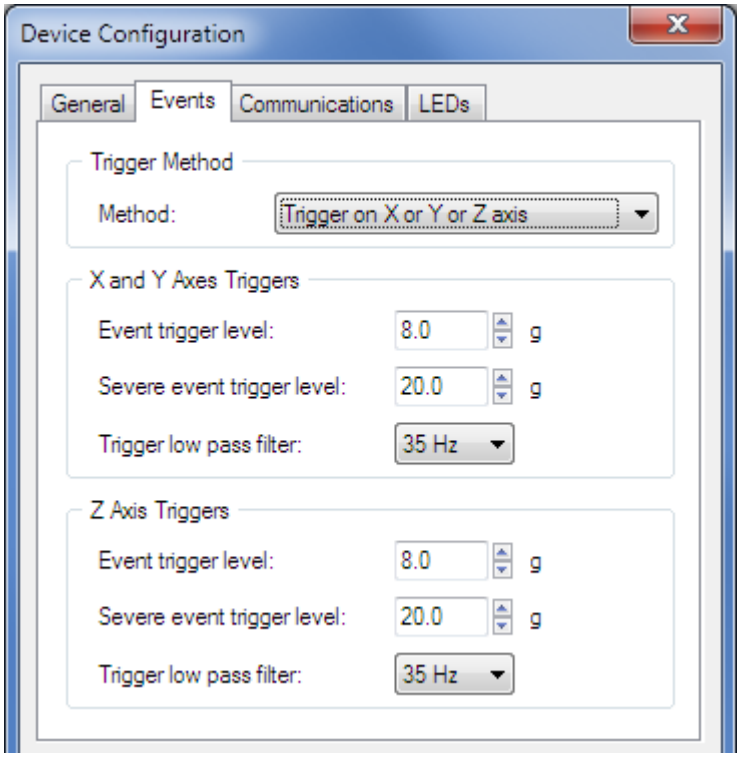

Figure 4 – Device Configuration – Example Event Tab

The functions of the parameters on the *Events* tab are as follows.

Important:
Before selecting triggering methods and thresholds it is important to have a good understanding of event triggering. Read Event Triggering on page 14 before configuring triggering.

Trigger Method	Determines how the three axes of acceleration are used in triggering.
Event trigger level	Threshold for triggering event logging.
Severe event trigger level	Threshold for treating a logged event as a severe event.
Trigger low pass filter	Sets the level of filtering applied to the accelerometer output before used in event triggering.

Communications Tab

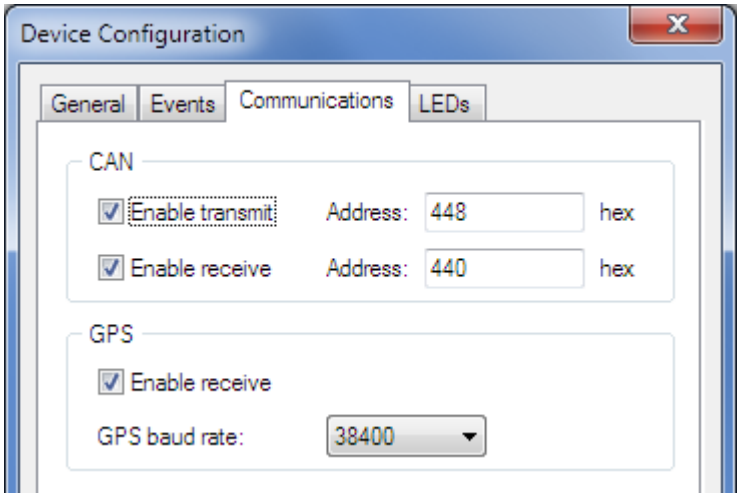

Figure 5 – Device Configuration – Example Communications Tab

The functions of the parameters on the *Communications* tab are as follows.

CAN Transmit (base) Address	This is the first of the two sequential addresses used for by the ADR for transmitting status messages.
CAN Receive (base) Address	This is the first of the five sequential addresses used by the ADR for receiving CAN channels.

Further Information:
See the *CAN Bus* section on page *19* for more detailed information on CAN messaging.

GPS / Enable Receive	Used to enable or disable GPS reception. Disabling the GPS will prevent the GPS diagnostic bits (in the CAN status messages) from being set.
GPS baud rate	This can be set to 9600, 19200, 38400, 57600 or 115200.

Further Information:
See the *GPS and Timekeeping* section on page *17* for more detailed information on GPS communications.

LEDs Tab

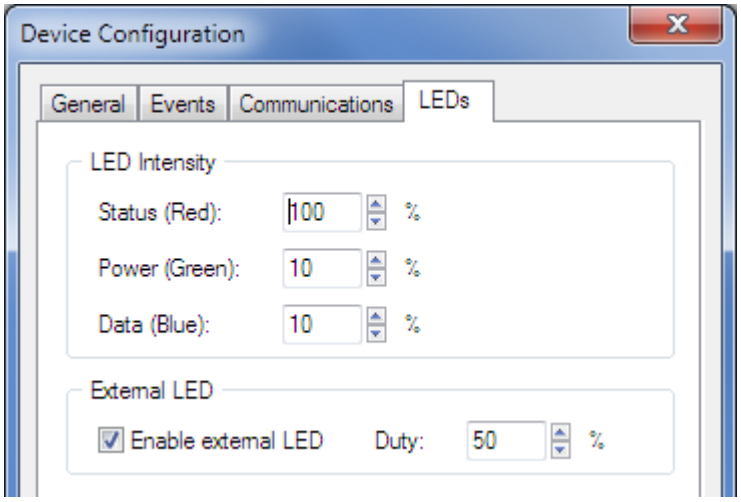

Figure 6 – Device Configuration – Example LEDs Tab

The Intensity of each of the three LEDs on the ADR can be individually configured.

The functions of the parameters on the *LEDs* tab are as follows.

LED Intensity / Status / Power/ Data	Used to set the brightness (1% to 100%).
External LED / Enable external LED	Enable or disable the external LED function. Disable this function if an external LED is not used. If not disabled, and an external LED is not used, an **External LED open circuit** fault is generated.
External LED / Duty	Used to set the brightness of the external LED during the power on lamp test.

Further Information:
For details on how the LEDs function; see the *LEDs* section on page *12*.

Firmware Upgrades

Update the ADR firmware and bootloader through ADR Manager as follows.

1. Select the **Device > Update Firmware** menu option.

   The *Update Firmware* window displays showing the firmware and bootloader versions loaded on the ADR and the versions on disk.

2. Select the **Update** button if you want to update the firmware and bootloader on the ADR.

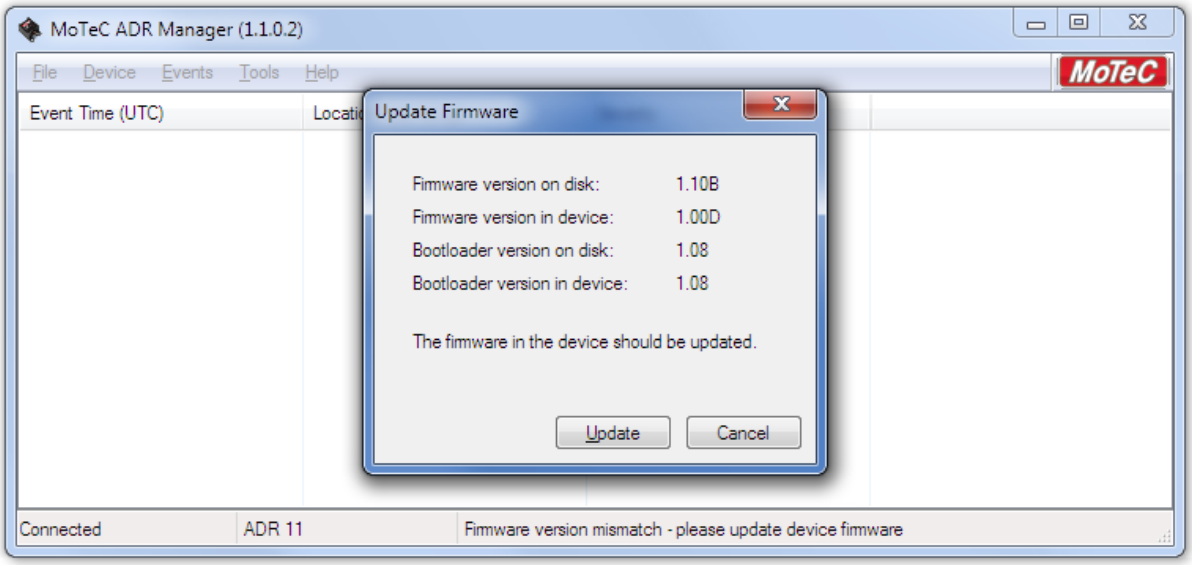

Figure 7 – Example Update Firmware window

Managing Events

Download Logged Events

A summary of available logged events is shown in the *MoTeC ADR Manager* window whenever an ADR is connected, see Figure 2.

The destination folders for downloaded event files (.CSV) and log image files (.mtcadrimg) can be configured via the **Tools** > **Options** menu.

To download **all** events from the ADR (cannot download individual events):

1. Select the **Events** > **Download** menu option.

   The downloaded events are stored in a single log image file (.mtcadrimg). When the download is complete, the individual event files (.CSV) are generated and a summary of created folders and files is displayed.

Notes on the event files (.csv):

- An individual event file (.csv) is created for each event that was downloaded.
- The file name contains the event time, date, ADR serial number and a sequence number, as shown in the following example.

ADR_LOG_SN11_20130124_135734_001.CSV	
_SN11	ADR serial number 11
_20130124	Event date Jan 24 2013
_135734	Event time 13:57:34 (UTC)
_001	Unique sequence number, incremented each time the same event file is generated.

Notes on the log image files (.mtcadrimg):

- The log image file name contains the ADR serial number and a sequence number. The sequence number is incremented each time the log image is downloaded for the same ADR serial number.
- The log image file contains all the downloaded events on the ADR, and the ADR configuration at the time of download.
- The event files can be regenerated from this log image at any time.

Regenerate Logged Events from the Image File

1. Select **File** > **Convert Logging Image** menu option in ADR Manager.

Erase logged events

1. Select **Events** > **Erase** menu option.

   ADR Manager prompts to confirm the action and then erases **all** logging from the ADR.

ADR Functional Reference

LEDs

LED settings can be changed using the **Device Configuration** function; see the *LEDs Tab* section on page *9*.

Status LED (Red)	• Turned ON at the configured brightness for 2 seconds after application of power (battery voltage or USB power). • Turned ON at the configured brightness if a fault is detected. • Pulsed at full brightness for a 10ms flash once per second if any severe event is present in the logged events. **Note:** If power is lost during an event, the ADR uses a supercapacitor to maintain power for event logging and severe event indication.
Power LED (Green)	• Turned ON when external power (battery voltage or USB power) is present.
Data LED (Blue)	• Turned ON at the configured brightness if any events are logged. • Flashes at 1Hz if the event log is full. • Flashes at 6Hz if an event is in progress.
External LED	The External LED pin is a 30mA constant current output. The LED output has a clamp circuit to protect the ADR if the output is open circuit. The output can drive a single LED or series chain of LEDs with a maximum forward voltage of 10V. • Turned ON as a lamp test at the configured duty for 2 seconds after application of power (battery voltage or USB). • Pulsed at full brightness for a 10ms flash once a second if any severe event is present in the log. • If the External LED is enabled in the configuration, then an open circuit test will be performed during the lamp test. The external LED is considered open circuit if the LED driver output voltage exceeds 11V. If an open circuit fault is detected during the lamp test, then the External LED output is disabled until the next power on lamp test. If a severe event is present and the External LED is configured, the ADR will still attempt to flash the External LED, even if an open circuit fault has been detected.

Orientation

The ADR may be installed in one of the 24 possible mounting orientations that align with the primary axes of the vehicle.

The 24 mounting orientations are defined in the following table.

	LEDs face back	LEDs face front	LEDs face up	LEDs face down	LEDs face left	LEDs face right
Connector faces back			X	X	X	X
Connector faces front			X	X	X	X
Connector faces up	X	X			X	X
Connector faces down	X	X			X	X
Connector faces left	X	X	X	X		
Connector faces right	X	X	X	X		

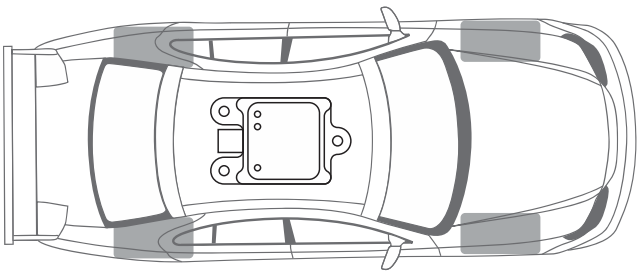

Figure 8 – Example Mounting Orientation (connector faces back, LEDs face up)

The readings from the three axes of the accelerometer are always aligned to a default vehicle orientation.

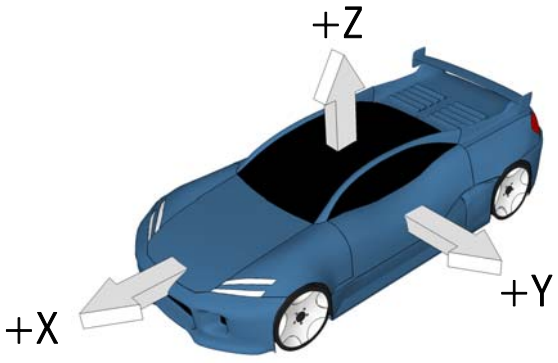

Figure 9 – Default Vehicle Orientation

Notes:

- All references to the X, Y and Z axes in triggering setup, and logging and CAN outputs, refer to the default vehicle orientation.
- The installed orientation must be specified using the Device Configuration function; see the General Tab section on page 6.

Event Triggering

The readings from the three axes of the accelerometer pass through several levels of low pass filtering before being used for triggering and logging.

Event Triggering can be set using the **Device Configuration** function; see the Events Tab section on page 7. The event triggering flow is as shown below.

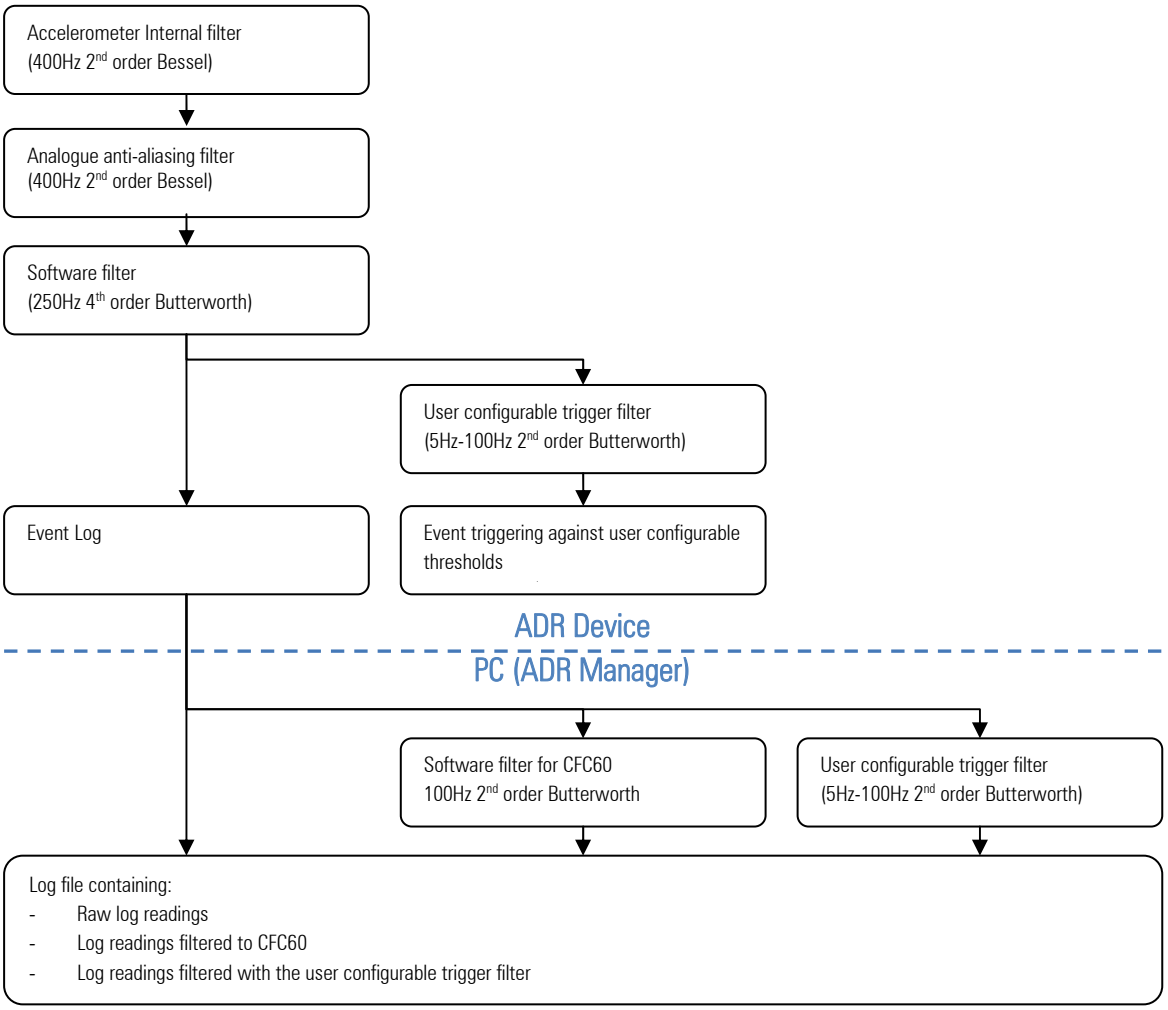

Figure 10 – Flow of Event Triggering

Event Triggering Methods

The ADR can be configured to use one of three event triggering methods:

The XYZ Vector is the recommended trigger method. A trigger method with separate Z axis settings can be useful in situations where large Z axis accelerations such as curb impacts are expected.

Trigger on XYZ Vector

An event is triggered when the magnitude of the XYZ acceleration vector exceeds the **Event Trigger Level**.

The event is marked as a severe event when the magnitude of the XYZ acceleration vector exceeds the **Severe Event Trigger Level**.

The same trigger filter settings are used for all axes.

Trigger on XY Vector or Z axis

An event is triggered when either:

- The magnitude of the Z acceleration exceeds the **Z Axis Event Trigger Level**, or
- The magnitude of the XY acceleration vector exceeds the **XY Vector Event Trigger Level**.

An event is considered as a severe event when either:

- The magnitude of the Z acceleration exceeds the Z **Axis Severe Event Trigger Level**, or
- The magnitude of the XY acceleration vector exceeds the **XY Vector Severe Event Trigger Level**.

The trigger filter setting used for the Z axis is separately configurable to the setting used for the X and Y axes.

Trigger on X or Y or Z axis

An event is triggered when either:

- The magnitude of the Z acceleration exceeds the **Z Axis Event Trigger Level**, or
- The magnitude of the X or Y acceleration exceeds the **X and Y Axes Event Trigger Level**.

An event is considered as a severe event when either:

- The magnitude of the Z acceleration exceeds the **Z Axis Severe Event Trigger Level**, or
- The magnitude of the X or Y acceleration exceeds the **X and Y Axes Severe Event Trigger Level**.

The trigger filter setting used for the Z axis is separately configurable to the setting used for the X and Y axes.

General Notes on Triggering:

- The event trigger starts the event logging process. The log contains 2 seconds of pre-trigger data and 30 seconds of post-trigger data.
- The log files generated by ADR Manager contain the trigger filter output that was used to trigger the event. These readings can be used to determine suitable filtering and thresholds.

Event Logging

Note:
If power is lost during an event, the ADR uses a supercapacitor to maintain power for event logging and severe event indication (flashing Status LED).

The following applies:

- The ADR can store up to 10 events in non-volatile flash memory.
- Each event contains 2 seconds of pre-trigger data and 30 seconds of post trigger data.
- The stored event contains:
    - Accelerometer readings (3 axes), updated at 1000Hz.
    - CAN bus channels (20 channels), updated at 100Hz.
    - GPS speed, date, time and location (lat/long), updated at 20Hz.
- The ADR always attempts to maintain free space so that a new event can be logged.
- Whenever there are more than 8 logged events, the oldest **non-severe** event in the event log will be automatically erased to free the log location for new events. Severe events are never automatically erased.
- Logging can be downloaded and erased using ADR Manager; see the Events Tab on page 7.

The generated log file for a stored event contains the following channels:

Channel Name	Update Rate	Description
X (G) Y (G) Z (G)	1000Hz	Filtered accelerometer readings as logged by the ADR
CFC60 X (G) CFC60 Y (G) CFC60 Z (G)	1000Hz	Filtered accelerometer readings with further post-filtering to the SAE J211 CFC60 crash test standard
Trigger X (G) Trigger Y (G) Trigger Z (G)	1000Hz	Filtered accelerometer readings used for event triggering
Trigger XY Vector (G) Trigger XYZ Vector (G)	1000Hz	Acceleration vector magnitude of the filtered readings used for event triggering
GPS Time (H) GPS Time (M) GPS Time (S)	1000Hz	Time (UTC), set by the time received on the GPS input
GPS Speed (km/h) GPS Latitude (°) GPS Longitude(°)	20Hz	Speed and location received on the GPS input
Engine Speed (rpm) Throttle Pedal Position (%) Brake Pressure Front (kPa) Brake Pressure Rear (kPa)	100Hz	Optional channels from received CAN messages

Channel Name	Update Rate	Description
Wheel Speed FL (km/h) Wheel Speed FR (km/h) Wheel Speed RL (km/h) Wheel Speed RR (km/h) Steering Angle (°) Steering Position (mm) User 1 to User 10		

The log file additionally contains a header with the following information:

- Event date and start time (UTC) received on the GPS input
- ADR name (from the ADR configuration)
- ADR serial number

Note:
All references to X, Y and Z readings refer to the default vehicle orientation described in the Orientation section on page 13.

Further Information:
See the Event Triggering section on page 14 for details on accelerometer filtering.
See the *Receive Messaging* section on page *20* for details of CAN channels.

GPS and Timekeeping

The ADR can receive time, speed and location data from NMEA GPRMC sentences transmitted over RS232 from a GPS receiver. The GPS data is used to provide time and location stamping of ADR events, and to include vehicle speed during event logging.

For information on enabling and configuring the GPS; see the *Communications Tab* section on page *8*.

The following applies:

- If a GPS is not connected to the ADR, then the GPS functionality should be disabled in the device configuration to prevent GPS faults.
- The RS232 baud rate can be specified in the device configuration to 9600, 19200, 38400, 57600 or 115200.
- The ADR maintains time and date only when powered on. The time stamping clock starts at 00:00 1/1/2000 when the ADR is turned on. The clock is set to the correct UTC time whenever a valid GPRMC sentence is received from the GPS.
- GPS diagnostics are transmitted in the CAN status messages; see the *CAN Bus* section on page *19*.
- If a received GPS sentence has an invalid checksum, then the data is ignored and the GPS Invalid diagnostic status is set until a valid sentence is received.
- If no valid GPS sentence is received for 2 seconds then the GPS Timeout and GPS Invalid diagnostics statuses are set until a valid sentence is received.
- The ADR provides 5V external power for a GPS receiver.

Power

If power is lost during an event, the ADR uses a supercapacitor to maintain power for event logging and severe event indication (flashing Status LED).

Supercapacitor Charging

The following applies:

- Continuously charged when the ADR is powered from the battery voltage input (BATT+).
- Charge rate can be specified in the device configuration; see the *General Tab* section on page *6*.
  The higher the charge rate, the quicker the supercapacitor reaches full charge.
- It is recommended to use the maximum charge rate, except in specialised applications that require low current draw from the ADR on start up.

Note:
With the maximum charge rate configured, the supercapacitor is charged to full capacity in less than one minute. At this charge rate, the current drawn during charging from a 12V power source is less than 600mA.

Power Loss Handling

If the battery power is lost, the ADR enters a lower power utilisation mode to conserve supercapacitor power. The CAN interface, GPS input and external 5V supply are disabled, and the Power and Data LEDs are turned OFF. Events are still triggered and logged while enough power remains in the supercapacitor.

If the ADR has a severe incident already logged and the battery power is lost, and if no event logging is currently in progress, then the ADR enters an extreme low power utilisation mode. This mode allows the Status and External LEDs to flash for several minutes.

USB Power

During operation with ADR Manager, the ADR can be optionally powered by USB.

Note:
The supercapacitor is not charged when the ADR is powered by USB.

External 5V Power Supply

An external 5V power supply pin is provided to power a GPS receiver. The 5V supply is current limited to 90mA.

CAN Bus

The CAN bus is used for:

- Configuration, firmware upgrade and event download through ADR Manager.
- Transmission of ADR status.
- Receiving external channels to be stored in the event log.

Transmit Messaging

There are two status messages transmitted from the ADR at 50Hz on user configurable CAN Ids:

CAN Address	Bytes	Description	Units
Transmit Address (default 0x448)	0:1	X axis	0.1G
	2:3	Y axis	0.1G
	4:5	Z axis	0.1G
	6:7	Battery voltage	mV
Transmit Address + 1	0	Number of logged events	
	1	Event status bits: 0x01 Event in progress 0x02 Events logged 0x04 Severe Event logged 0x08 Event Log full	
	2	Supercapacitor charge level	1%
	4:5	Diagnostic Bits: 0x0001 GPS data invalid 0x0002 GPS timed out 0x0004 CAN receive timed out	
	6:7	Fault Bits: 0x0001 Corrupt calibration 0x0002 Corrupt or invalid configuration 0x0004 Accelerometer self-test failed 0x0008 Logging memory test failed 0x0010 External LED open circuit 0x0020 Oscillator failed 0x0100 Voltage rail fault (2.3V rail) 0x0200 Voltage rail fault (5.5V rail) 0x0400 Voltage rail fault (3.0V rail) 0x0800 Voltage rail fault (5V rail) 0x1000 Voltage rail fault (5V CAN rail) 0x2000 Voltage rail fault (5V external rail)	

Receive Messaging

The ADR receives up to five CAN messages starting at the user configured Receive Address.

During an event, the data in the received CAN messages is logged as 20 individual 16bit channels at 100Hz. These logged channels are included in the log files generated by ADR Manager.

If the CAN connection is lost, the last received values continue to be logged.

The channels are labelled and scaled in the log file with the following channel names and scaling:

CAN Address	Bytes	Name	Units	Scaling of 16bit data	Decimal places
Receive Address (default 0x440)	0:1	Engine Speed	Rpm	Data*6	0
	2:3	Throttle Pedal Position	%	Data / 10	1
	4:5	Brake Pressure Front	kPa	Data * 1	0
	6:7	Brake Pressure Rear	kPa	Data * 1	0
Receive Address + 1	0:1	Wheel Speed FL	Km/h	Data / 10	1
	2:3	Wheel Speed FR	Km/h	Data / 10	1
	4:5	Wheel Speed RL	Km/h	Data / 10	1
	6:7	Wheel Speed RR	Km/h	Data / 10	1
Receive Address + 2	0:1	Steering Angle	deg	Data / 10	1
	2:3	Steering Position	mm	Data / 100	2
	4:5	User 1		Data * 1	0
	6:7	User 2		Data * 1	0
Receive Address + 3	0:1	User 3		Data * 1	0
	2:3	User 4		Data * 1	0
	4:5	User 5		Data * 1	0
	6:7	User 6		Data * 1	0
Receive Address + 4	0:1	User 7		Data * 1	0
	2:3	User 8		Data * 1	0
	4:5	User 9		Data * 1	0
	6:7	User 10		Data * 1	0

Faults

Various fault conditions are monitored by the ADR. The presence of a fault is indicated by the Status LED, and the fault information is transmitted in the CAN status messages.

The following checks are performed.

Fault check	Description
External LED open circuit fault	The external LED open circuit test is performed only during the power ON lamp test (on application of power to an unpowered ADR). See the *LEDs* section on page *12* for more detail on the lamp test. If an external LED is not used with the ADR then the external LED output should be disabled in the configuration; see the *LEDs Tab* section on page *9*.
Calibration and configuration faults	Whenever the ADR is restarted, the integrity of the stored calibration and configuration are checked.
Internal faults	Whenever the ADR is restarted, the internal accelerometer, flash memory and oscillator tests are performed.
Internal voltage rail faults	The internal voltage rails are constantly monitored for correct voltage.

Importing Events into MoTeC I2 Pro

The .csv event files generated by ADR Manager can be imported into the MoTeC i2 Pro tool for conversion to MoTeC .ld format log files and analysis.

Note:
To import .csv files into i2 Pro, the **Import MoTeC CSV Dataset** feature license must be installed in i2 Pro. The MoTeC .ld files generated by i2 Pro can then be viewed on any installation of i2 Pro.

To import CSV files:

1. Open i2 Pro and create a new project or open an existing project.
2. Select the **File** > **Import Data** menu option to start the File Conversion Wizard.
    a. Set the **File Type** to **MoTeC CSV Dataset (*.csv).**
    b. Select the **csv file** as the input file.
    c. Press the **Next** button to display the *Unit Mappings* window.
3. Press the **Convert** button to begin the conversion and display the conversion summary.
4. Tick the **Open Converted Files On Finish** box
5. Press the **Finish** button to close the Wizard and open the log file

Note:
The .ld files generated by the import process will be in the same folder as the csv file.

Specifications

Communications

- CAN
- RS232 (for GPS receive)
- USB (for future use)

Connectors

- 1 x 11 pin double density size 8 Autosport connector
- Matching connector: MoTeC #68109 - Autosport double density female (red)

Physical construction and dimensions

- Case size (mm): 73.5 x 45 x 27
- Case material: anodized aluminum
- Internal components encapsulated
- Weight (gram): 110

Power

- Power supply (vehicle battery): 6 – 30V
- Current: 1A peak, 200mA steady state
- USB power when connected to PC (if no other power source)
- Backup power (internal super capacitor): 30 seconds of logging and 10 minutes of LED operation when power supply lost (no battery required)
- Backup power recharge: under one minute after connection to a power source

Operational

- G force recording of lateral, longitudinal and vertical channels at 1000Hz
- Recording of up to 20 CAN channels at 100Hz
- G force range: -150G to +150G
- G force channel resolution: 0.1G
- GPS data recorded:
  - Date and time
  - Latitude and Longitude
- Pre-event (accident) recording duration: 2 seconds
- Event duration: 30 seconds
- Event capacity storage: 10 events
- Data output format: CSV

Connector and Pinout

Connector: 11 pin double density Autosport size 8.

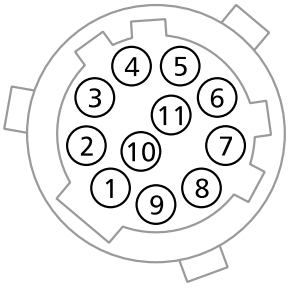

Figure 11 – Connector pinout, loom-side view

Pin	Function	Notes
1	Battery Negative	
2	Battery Positive	6 to 30V DC
3	CAN-Lo	
4	CAN-Hi	
5	RS232-Rx	
6	USB 5V	
7	USB D-	For future use
8	USB D+	For future use
9	USB 0V	
10	LED Output	Status output
11	5 Volt Supply Output	GPS power supply 90mA