

ADR2

- Accident Data Recorder



USER MANUAL

MoTeC

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Overview

The ADR2 is MoTeC's second generation Accident Data Recorder. It records critical data from vehicle accidents, such as lateral, longitudinal and vertical accelerations. This data can help to better understand forces in high impact collisions and may assist with the medical assessment of drivers.

The ADR2 captures minimum 30 seconds of data per event, including 15 seconds immediately before the accident which triggered recording. Subsequent impacts extend the event recording time.

The device can be used stand-alone or in conjunction with other devices such as a GPS, Display Logger or ECU.

The MoTeC ADR2 conforms to FIA standard 8872-2018 and is included in the FIA ADR Program.

Features

- Configurable thresholds to trigger an event - password protected feature
- Configurable thresholds to trigger the medical light output - password protected feature
- Support for external medical and status lights
- CAN and GPS inputs for data recording
- Internal backup power to continue recording if power is lost
- Real time clock for accurate time keeping
- Password protection restricts selected features to FIA access only

Specifications

Communications

- CAN for transmitting and receiving FIA specified data
- RS232 for receiving GPS data
- USB for communication with ADR2 Manager

Connectors

- 1 x 13 pin Autosport connector size 10

Physical construction and dimensions

- Case size: 86 mm x 45 mm x 25 mm
- Case material: anodized aluminium
- Ingress protection rating: IP66 / IP67
- Operating temperature: -40 to 85 °C
- Weight: 130 g

Power

- Power supply: 6 – 32 V
- Current: nominal 200 mA @ 12 V (with external GPS), maximum 1 A when charging backup power supply
- USB power when connected to PC (when no other power source connected)

- Backup power supply
 - provides power for at least 45 seconds of continued recording after vehicle power is lost
 - recharges in less than one minute after vehicle power is applied

Medical and status light outputs

- Topology: current limited open collector high-side drive
- External load: LED to GND or logic level input with pull-down resistor
- Voltage on: 5 V - Regulated
- Voltage off: 0.3 V (with external 10k load to ground)
- Voltage off: 2 V (approximately, when not connected)
- Current Limit: 20 mA
- Reverse polarity protected
- Voltage diagnostic feedback

Operational

- Recording of lateral, longitudinal and vertical accelerations at 3000 Hz
- Recording of CFC60 filtered acceleration data at 1000 Hz
- Acceleration channel resolution: 0.125G
- Recording of FIA specified CAN channels
- GPS data recorded:
 - Date and Time
 - Latitude and Longitude
- Accelerometers range: -480G to +480G
- Accelerometers overload: 1800G minimum
- Pre-accident recording: 15 seconds
- Total event recording: minimum 30 seconds, extended on subsequent impacts
- Data output format: CSV

Functional Reference

Lights

A single RGB LED indicator is visible on the enclosure. Support is provided for external medical and status lights.

RGB LED Indicator

Device State	Colour	Flash Rate	Duty Cycle [%]	Brightness [%]
Firmware starting	OFF			
Event stored*	RED	4 Hz	5%	100%
Recording event	GREEN	10 Hz	50%	50%
Normal operation (on vehicle power)	GREEN	Solid	100%	50%
Normal operation (on internal backup power)	GREEN	2 Hz	10%	25%
Backup power supply charging** (on vehicle power)	GREEN	1 Hz	20-100%	50%
Low power	GREEN	1 Hz	10%	5%
No GPS lock (on vehicle power)	GREEN	1 Hz	90%	50%
	ORANGE		10%	100%
USB communications***	CYAN			
Normal operation (on USB power)	BLUE	Solid	100%	50%
Diagnostics	ORANGE	refer to Diagnostics		

* When an event is recorded, the LED shows *Event stored* until the device is powered down. If the device is powered on and a recorded event has not been retrieved by ADR2 Manager, the LED will show *Event stored* for 60 seconds.

** Duty cycle equals charge level; i.e. 20% duty cycle = 20% charge level.

*** Flashing to indicate command in progress e.g. firmware update. All normal operations are suspended.

Diagnostics

When an error occurs, the RGB LED indicator will flash orange ON for 250 ms at 50% brightness, OFF for 250 ms, repeated according to the error number (see table), followed by a one second pause.

Only the highest priority error (lowest number) is displayed and this continues for as long as the error is active.

Error	Number of flashes
CAN bus fault	2
No FIA CAN frames	3
External power supply failure	4
Over temperature	5
Internal fault	6

Additional information on errors or internal faults can be found in the diagnostic channels section in ADR2 Manager software.

External Status Light

Device State	Output State
Event stored*	Flashing
Vehicle power connected	ON
Vehicle power disconnected	OFF

* When an event is recorded the status light will flash until the device is powered down. If the device is powered on and a recorded event has not been retrieved by ADR2 Manager the status light will flash for 60 seconds.

External Medical Light

Device State	Output State
Medical event detected since device powered on	ON
No medical event detected since device powered on	OFF

GPS and Timekeeping

The ADR2 provides 5 V external power for a GPS receiver.

The ADR2 can receive time, speed and location data from a GPS receiver via either:

- CAN in the specified format. See [CAN Bus](#).
- RS232 NMEA 0183 GPRMC and GPGGA.

The RS232 baud rate can be specified in the device configuration: see [Communications Tab](#)

GPS time is used to synchronise the ADR2's internal Real Time Clock.

Event Triggering and Recording

An accident is an impact where the accelerations exceed set thresholds. This triggers the start of the recording process. The log file contains 15 seconds of pre-trigger data and 15 seconds of post-trigger data.

When recording is in progress and a subsequent impact exceeds the threshold, the recording duration will be extended with an additional 30 sec. This process will be repeated for any subsequent impact during the recording period to ensure there is always at least 15 sec of data available after the last impact.

The thresholds for triggering an event are set in the device configuration; see [Thresholds Tab](#). Separate thresholds are set to activate the medical light output.

The generated log file consists of a header containing the event date, start time (UTC) and the ADR2 serial number, and a listing of the following channels:

Channel Name	Unit / Format	Update Rate	Description	
tTime	[s]		Sample time	
gADRX	[G]	3000 Hz	Accelerometer readings with anti-aliasing filters applied	
gADRY				
gADRZ				
gCFC60X	[G]	1000 Hz	Accelerometer readings filtered to the SAE J211 CFC60 crash test standard	
gCFC60Y				
gCFC60Z				
ASI	[G]	on change	Accident Severity Index*	
NLap	[-]	on reception of CAN message	Lap number	
sLap	[m]		Lap distance	
vCarWheel	[kph]		Car speed (calculated from Wheel Speed)	
rThrottle	[%]		Throttle actuator position	
aSteer	[deg]		Steer angle	
pBrakeF	[bar]		Front brake pressure	
pBrakeR	[bar]		Rear brake pressure	
nEngine	[rev/min]		Engine rotational speed	
gpsLat	DDD.DDDDDDD		on reception of GPS message	GPS latitude coordinate
gpsLong	DDD.DDDDDDD			GPS longitude coordinate
gpsVCar	[kph]	Car speed (calculated from GPS)		
gpsStatus		GPS status		

* The Accident Severity Index - ASI is the maximum absolute acceleration recorded in either the X, Y or Z acceleration channel during the medical warning event.

Power

Power Supply

During normal operation, the ADR2 is powered from vehicle power via connector pin 12 (Battery positive). The internal backup power supply is charged while the ADR2 is powered from vehicle power.

For ADR2 Manager communications, the ADR2 can be powered from USB. Vehicle power is only required to [Simulate an Accident](#) or to [Zero Accelerometers](#).

Power Loss Handling

When vehicle power is lost the ADR2 switches to its internal power supply. If the internal power supply is fully charged the ADR2 will continue to trigger events and record accelerometer data for 45 seconds. The ADR2 then stops accident detection and event recording but continues to display status information via the LED until the internal power supply is depleted (typical > 60 seconds).

External 5 V Power Supply

An external power supply pin (connector pin 11) is provided to power a GPS receiver. The 5 V supply is current limited to 90 mA.

CAN Bus

The CAN bus is used to:

- receive vehicle data messages
- transmit ADR2 status messages

Receive Messaging

The ADR2 receives up to five CAN messages.

During an event, the data in the received CAN messages is recorded and included in the log files. Only valid CAN data is recorded. If the CAN connection is lost, no values will be recorded.

Message 1

Message Id: 0x200

Message rate: 100 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0-1	Engine rotational speed	1 rpm/bit	16-bit unsigned
2	Front brake pressure	1 bar/bit	8-bit unsigned
3	Rear brake pressure	1 bar/bit	8-bit unsigned
4-5	Lap distance	1 m/bit	16-bit unsigned
6-7	Throttle actuator position	0.1 %/bit	16-bit signed

Message 2

Message Id: 0x204

Message rate: 100 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0-1	Vehicle speed	0.1 km/h/bit	16-bit unsigned
2-3	Steering angle	1 °/bit	16-bit signed
4-5	Throttle pedal position	0.1 %/bit	16-bit signed
6-7	Not used		

Message 3

Message Id: 0x680

Message rate: 10 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0-3	GPS latitude	1e7 degrees	32-bit fixed point (7dps) value
4-7	GPS longitude	1e7 degrees	32-bit fixed point (7dps) value

Message 4

Message Id: 0x681

Message rate: 10 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0-3	GPS time	HHMMSS.sss	32-bit unsigned
4-5	GPS speed	0.1 km/h/bit	16-bit unsigned
6-7	GPS altitude	0.1 m/bit	16-bit signed

Message 5

Message Id: 0x682

Message rate: 10 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0-2	GPS date	DDMMYY	24-bit unsigned
3-7	Not used		

Transmit Messaging

There are two messages transmitted from the ADR2.

Message 6

Message Id: 0x7B

Message rate: 10 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0	Accident Severity Index	0 = no accident	8-bit unsigned
		1-255 = severity of last accident detected since power on	
1	ADR2 software version	e.g. 24 = version 1.2.4	unsigned
2-3	ADR2 status	See ADR2 Status	bitmapped
4-5	ADR2 serial number	-	16-bit unsigned
6-7	Not used		

ADR2 Status

Bit	Description	Value	
0	Logging is in progress	True = 1	False = 0
1	Recording configuration is OK	True = 1	False = 0
2	Receiving CAN messages from the team's ECU	True = 1	False = 0
3	Accident stored which has not been retrieved by ADR2 Manager	True = 1	False = 0
4	New accident detected since ADR2 powered on	True = 1	False = 0
5	USB connected for data download	True = 1	False = 0
6-15	0	Always zero	

Message 7

Message Id: 0x81

Message rate: 100 Hz

Format: Big Endian

Byte	Description	Scaling	Type
0-1	Not used		
2-3	Acc Y (G-lateral)	0.006125 G/bit	16-bit signed
4-5	Acc X (G-longitudinal)	0.006125 G/bit	16-bit signed
6-7	Acc Z (G-vertical)	0.006125 G/bit	16-bit signed

Installation

Correct installation is critical for reliable operation of the ADR2 and to record useful accident data.

! To ensure that your ADR2 installation complies with all FIA requirements, you are requested to follow **8872-2018 ADR - Installation specification** available on the FIA website.

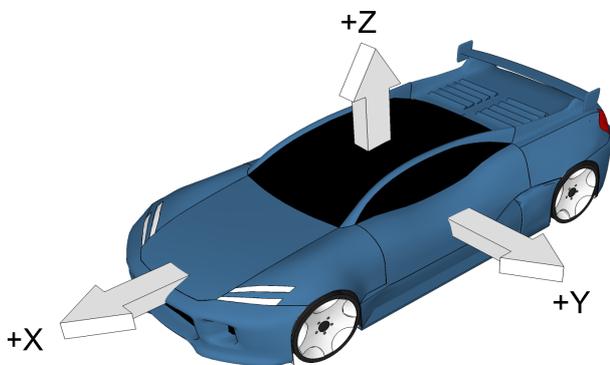
- Mount the ADR2 so that each side is parallel to one of the 3 primary axes of the vehicle. There are 24 possible mounting orientations. See [Orientation](#).
- Mount the ADR2 securely on a rigid structural member close to the driver's seat. Don't mount it to sheet metal bodywork or other vibrating surfaces.
- Mount the ADR2 so that the RGB LED indicator is clearly visible for race crew, officials and emergency personnel.

Orientation

The ADR2 must be installed in alignment with the primary axes of the vehicle. The orientation is specified in the device configuration; see [Orientation Tab](#). The position is defined using the orientation of the connector and the single point mount with respect to the vehicle axes. FIA has prescribed installation as shown.

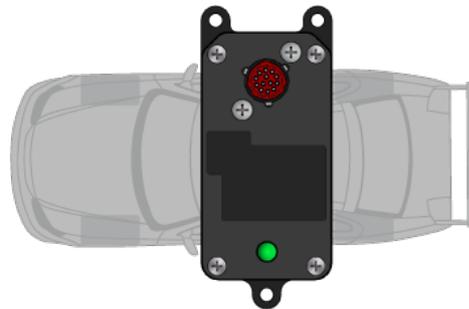
Primary vehicle axes

- X-axis, longitudinal, positive forward acceleration
- Y-axis, lateral, positive left acceleration
- Z-axis, vertical, positive upward acceleration

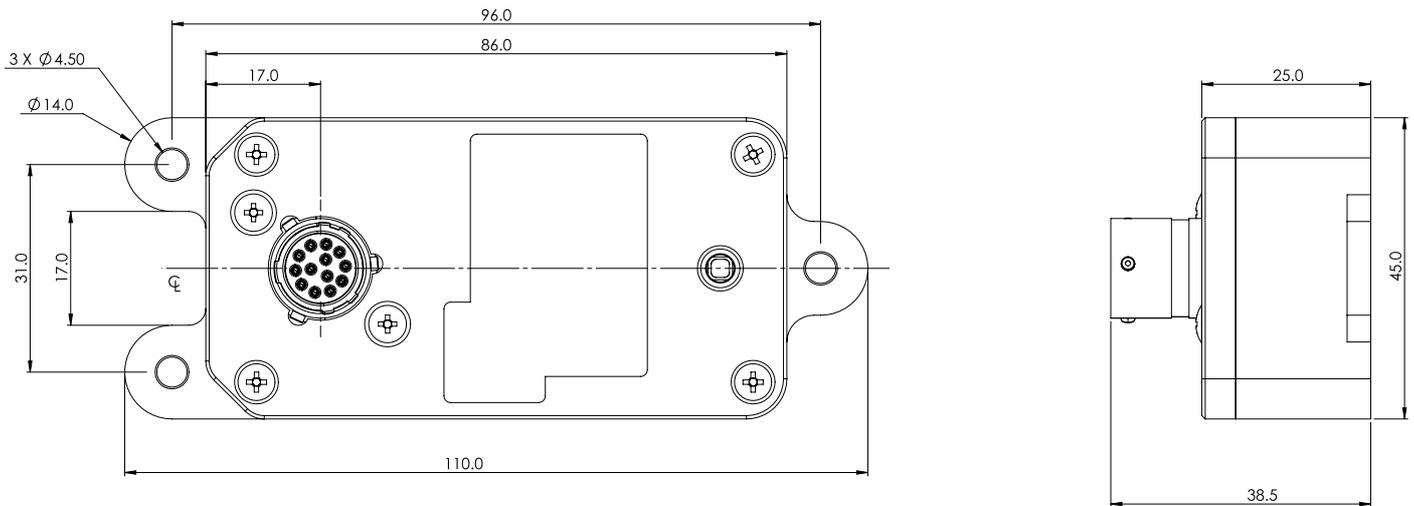


FIA prescribed mounting orientation

ADR2 mounting orientation where the connector points towards the ceiling and the single mount points towards the left of the vehicle.



Dimensions



Connector and Pinout

Connector: 13 pin Autosport size 10 (AS 2 10-35 PN)

Mating connector: AS 6 10-35 SN

Pin	Function
1	RS232 - receive
2	Medical light output
3	CAN-high
4	CAN-low
5	Status light output
6	Not used
7	USB 5 V
8	USB D+
9	USB D-
10	Not used
11	5 V supply (GPS power)
12	Battery positive
13	Ground and USB 0 V

ADR2 Manager Software

The ADR2 Manager application requires Windows 10, 64 bit.

The software is used to:

- Configure the device (password protected, FIA access only)
- Download data
- Format the ADR2 to erase stored events (password protected, FIA access only)
- Update the firmware

Managing Events

The ADR2 can store more than 100 events. When the ADR2 is connected to the PC via USB, ADR2 Manager automatically shows a summary of recorded events in the main window.

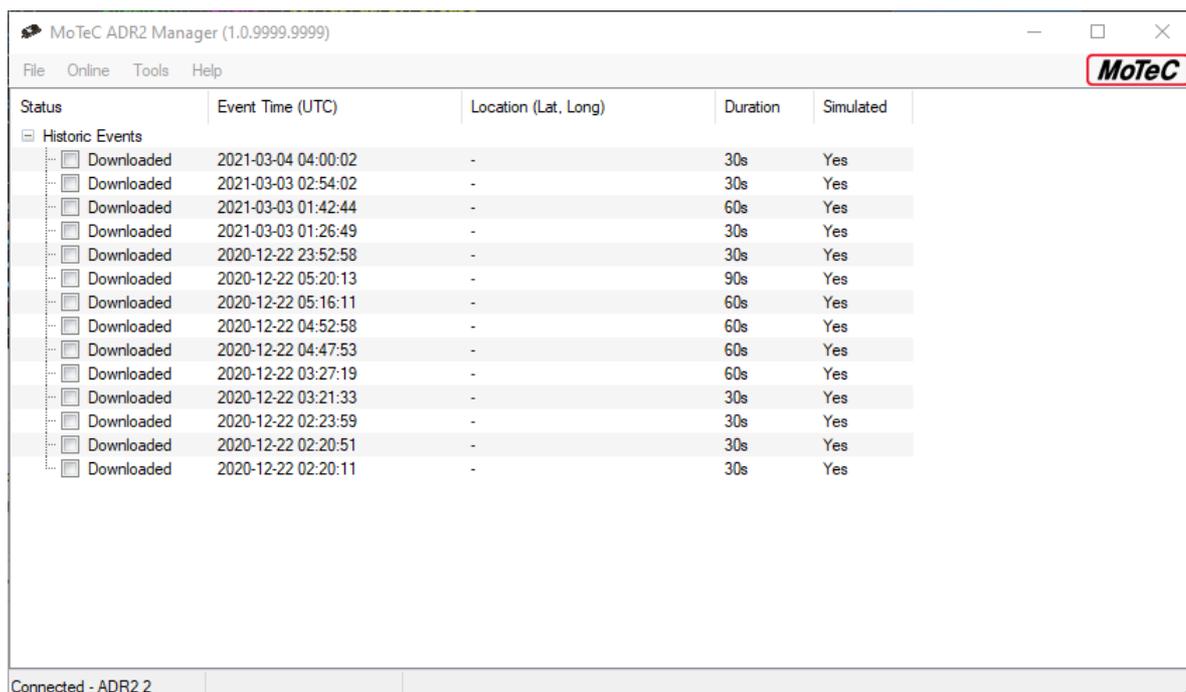
Each event has one of the following states:

- **New:** events will be listed as New if they are recorded after the last time the ADR2 was connected to this computer.
- **Historic:** events will be listed as Historic if they were already recorded when the ADR2 was last connected to the computer.
- **Unavailable:** older events that have been overwritten with more recent ones, will be listed as Unavailable.

The event file name contains the ADR2 serial number and event date and time.

For example: SN10_20210127_053141.CSV

- SN10: ADR2 serial number 10
- _20210127: Event date Jan 27 2021
- _053141: Event time 05:31:41 (UTC)



The screenshot shows the MoTeC ADR2 Manager (1.0.9999.9999) application window. The interface includes a menu bar with 'File', 'Online', 'Tools', and 'Help'. A MoTeC logo is visible in the top right corner. The main area displays a table of historic events with the following columns: Status, Event Time (UTC), Location (Lat, Long), Duration, and Simulated. The events listed are all 'Downloaded' and 'Simulated' as 'Yes'. The status bar at the bottom indicates 'Connected - ADR2 2'.

Status	Event Time (UTC)	Location (Lat, Long)	Duration	Simulated
Downloaded	2021-03-04 04:00:02	-	30s	Yes
Downloaded	2021-03-03 02:54:02	-	30s	Yes
Downloaded	2021-03-03 01:42:44	-	60s	Yes
Downloaded	2021-03-03 01:26:49	-	30s	Yes
Downloaded	2020-12-22 23:52:58	-	30s	Yes
Downloaded	2020-12-22 05:20:13	-	90s	Yes
Downloaded	2020-12-22 05:16:11	-	60s	Yes
Downloaded	2020-12-22 04:52:58	-	60s	Yes
Downloaded	2020-12-22 04:47:53	-	60s	Yes
Downloaded	2020-12-22 03:27:19	-	60s	Yes
Downloaded	2020-12-22 03:21:33	-	30s	Yes
Downloaded	2020-12-22 02:23:59	-	30s	Yes
Downloaded	2020-12-22 02:20:51	-	30s	Yes
Downloaded	2020-12-22 02:20:11	-	30s	Yes

Online

Most ADR2 Manager features require the ADR2 to be connected to the PC via USB. When the device is in this online state, the **Online** menu items become available.

When the ADR2 device is password protected, it will restrict access to the following operations:

- [Online > Device Configuration](#)
- [Online > Zero Accelerometers](#)
- [Online > Format Device](#)

Export Events

- To select events from the ADR2 either:
 - check the relevant events in the main window
 - or right-click on any event in the main window and select **Check All** (or **Uncheck All**)
- To export the checked events to csv either:
 - right-click and select **Export Checked Events**
 - or go to **Online > Export Checked Events**
- Alternatively, when only one event is required, double-click the event to export it

The files will be downloaded in the destination location. See [Default download location](#).

Simulate

Accident

- To simulate an accident, the ADR2 needs to be connected to vehicle power.
- Go to **Online > Simulate**, then select **Accident** and **Simulate**.
This will store an event in the ADR2.

Medical Warning

- To simulate a medical warning, go to **Online > Simulate**, then select **Medical Warning**, enter an **Accident Severity Index*** and select **Simulate**.
- Select **Monitor Channels** to check the medical light output and ASI* channel.
This will not store an event in the ADR2.

* The ASI Accident Severity Index is the maximum absolute acceleration recorded in either the X, Y or Z acceleration channel during the medical warning event.

Device Configuration

This is a password protected feature.

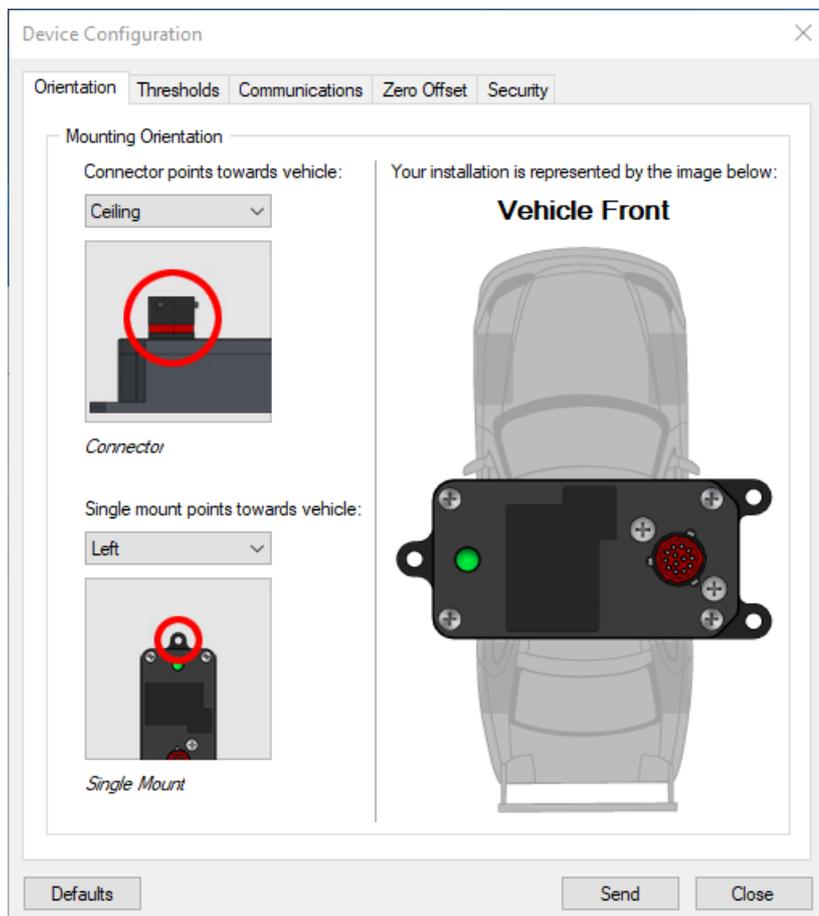
- To configure the ADR2, go to **Online > Configure**
This will display the configuration as retrieved from the connected ADR2.
- Edit the existing configuration in the **Orientation**, **Thresholds** and **Communications** tabs.
- On each tab there is the option to select **Defaults** to reset the settings to factory defaults.
- Select **Send** to apply the configuration to the ADR2.
- Select **Close** to exit **Device Configuration**.

Orientation Tab

See [Orientation](#) for more details on device orientation.

- To specify the orientation of the installed ADR2 go to **Online > Configure** and select the **Orientation** tab.
- In **Mounting Orientation** set the orientation of the connector and the single mount point with respect to the vehicle.

The image on the right will change to show a representation of the orientation that is set.



Thresholds Tab

Important:

Before configuring the thresholds ensure you are familiar with the methods explained in [Event Triggering and Recording](#).

- To specify the event thresholds go to **Online > Configure** and select the **Thresholds** tab.
- In **Accident** set thresholds for impact and duration in all three axes that will trigger an accident.
- In **Medical** set thresholds for impact and duration in all three axes that will trigger the medical light output.

Communications Tab

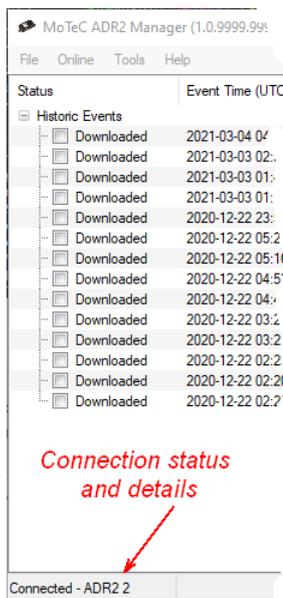
- To specify the communication bus speeds go to **Online > Configure** and select the **Communications** tab.
- In **Speeds** select the required values for **GPS baud rate** and **CAN bit rate**.

Firmware Updates

- To download available firmware updates select **Help > Check for Updates**. See also [Software Updates](#)
- To update the ADR2 firmware, select **Online > Update Firmware**
The **Current firmware version** loaded on the ADR2 is listed.
- Other available firmware versions are listed in **Version to send**. Select a different version if required and select **Send**.

Connecting

When an ADR2 is connected to the PC via USB, ADR2 Manager automatically shows the connected ADR2 in the status bar at the bottom of the main window.



- To change the connection to a different ADR2, select **Online > Select ADR2**.
All ADR2 devices connected are listed.
- Select the correct ADR2 serial number and select **OK**.

Other Online Actions

Monitor Channels

- Select **Online > Monitor Channels** to view the momentary value of any channel in the ADR2.
Keyboard shortcut **Ctrl+M** provides quick access to this function.
Use this function also to find additional information on errors or internal faults in the diagnostics section.

Zero Accelerometers

This is a password protected feature.

- Select **Online > Zero Accelerometers**
- Zero Accelerometers is only available when the ADR2 device is connected to vehicle power. The Zero Sensors window shows the current power connection in the channel Power.State value.
- Select **Zero** to apply the Zero Offset to all accelerometers.

Update Device Clock

- When the ADR2 internal Real Time Clock is different from the PC time, select **Online > Update Device Clock** and select **Set** to synchronise the RTC to the current PC time.

Format Device

This is a password protected feature.

- To erase all events stored in the ADR2 device, select **Online > Format Device** and select **Yes** to confirm this action.
This erases the events from the ADR2 internal memory, however, all events downloaded on the connected PC will still be listed in the main window as 'Historic Events'.

Device Information

- To retrieve device details about the connected ADR2, select **Online > Device Information**.

Refresh

- To refresh the list of events recorded in the ADR2 memory, select **Online > Refresh**. Use this function when recording is finished to ensure the latest events are listed. Keyboard shortcut **F5** provides quick access to this function.

Tools

Default download location

- To configure the destination folder for downloaded event files, go to **Tools > Options**.
- Select the **ellipsis button (...)** and navigate to the preferred folder.
- Optional: to reset to the default location, select **Reset**.
The default location is C:\Users\username\Documents\MoTeC\ADR2\Events

Beta Software

- Select **Offer Beta Versions** to take advantage of early access to new software features.

Software Updates

- To check for available software or firmware updates, select **Help > Check for Updates**.
- To update ADR2 Manager software, select the required version, select **Install Now** and follow the prompts.
- To update ADR2 firmware, first download it and then send it to the device:
 - Select the required version and select **Download Now**
 - To send it to the device, ensure the ADR2 is connected to the computer and go to **Online > Update Firmware**. See also [Firmware Updates](#).