

User Manual – ADR1





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1 Contact Details

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2 Introduction

The Emvexis ADR1 is a high-performance, robust and cost-effective Accident Data Recorder system designed primarily for motorsport applications and is homologated in accordance with the FIA 8872-2018 Accident Data Recorder standard, under homologation number ADR.003.24.

The FIA technical lists, which detail homologated manufacturers and their products, are published at <u>https://www.fia.com/regulation/category/761</u>

The ADR is suitable for use in motorsport applications which mandate FIA 8872-2018 ADRs, in series where their use is not mandated, and even in series not controlled by the FIA. In the latter case, specific functionality modifications and software features may be supported by Emvexis upon request.

The ADR is also particularly suited for a variety of other applications:

- non-track motorsport applications such as powerboat racing
- law enforcement and coastguard marine applications
- high-performance automotive applications.

The system is comprised of 2 parts:

- The ADR hardware
- Emvexis ADR Utility software application

The ADR hardware internally performs high speed sensing, acquisition, real-time signal processing and event-triggered logging of tri-axis acceleration and gyroscopic rate data, in addition to capturing additional parameters from the vehicle via CAN.

It is designed and tested to operate in all weather conditions, with a BS EN 60529 IP66/IP67 rating, protected from dust ingress, powerful water jets and the effects of temporary water immersion, across a wide temperature and operating voltage range.

All electrical I/O is protected against typical automotive transient and EOS conditions, allowing it to operate in electrically harsh environments without additional external protection.



2.1 Definitions, Acronyms and Abbreviations

The following acronyms and abbreviations are used extensively throughout this document and are detailed below for brevity.

Acronym	Expansion	
ADR	Accident Data Recorder	
ASI	Accident Severity Index	
ASN	Autorité Sportive Nationale	
CAN	Controller Area Network	
CAN-FD	CAN Flexible Data-Rate	
DFU	Device Firmware Update	
EOS	Electrical Overstress	
ESD Electrostatic Discharge		
FIA	Fédération Internationale de l'Automobile	
GUI	Graphical User Interface	
LED	Light Emitting Diode	
LSB	Least Significant Bit	
mA	milliamps	
ms	milliseconds	
MWL	Medical Warning Light	
RTC	Real Time Clock	
UI	User Interface	
USB Universal Serial Bus		



3 Device Overview

3.1 Product Features

•

- Internal 3-axis high range accelerometer
 - Internal 3-axis low range, high resolution accelerometer
 - Synchronization between low and high range guaranteed
- Internal 3-axis high resolution gyroscope
 - o Synchronization between gyroscope and accelerometers guaranteed
- Data channels compliant with ISO 6487, CFC60
- Internal backup power supply to allow continued operation after loss of power supply
 - Software configurable charging current limit
- Wide operating voltage front end, including cold crank operation
- Internal storage for up to 25 events worth of data
- Onboard status LED
- 2x constant current LED drivers for external indicator LEDs
- Internal pressure sensor for case seal integrity verification
- Deutsch Autosport / Souriau 8STA electrical connector
- Internal low-drift real time clock with battery backup for time and date stamping of events
- CAN 2.0B for capturing vehicle parameters such as steering angle and brake pressures
 - Hardware is CAN-FD capable
 - \circ Software selectable 120 Ω bus termination resistance
 - o Software selectable 4.7nF termination split filter capacitor
 - o Extensive CAN physical fault tolerance
- USB 2.0 for communication with <u>ADR Utility PC Software</u>
- RS232 hardware for communication with legacy devices

3.2 Product Specifications

3.2.1 Internal Sensor Specifications

Table 1 - Inertial Sensor Specifications

Sensor	Parameter	Typical	Units	
	Range	±200	_	
High range accelerometer	Resolution	0.1	g	
High range acceleronneter	Non-linearity	±0.5	04	
	Cross-axis sensitivity	±2.5	90	



	Sampling rate		Hz	
	Logging rate	1000	ПΖ	
	Range	±16	a	
	Resolution	0.000488	б	
Low range, high resolution	Non-linearity	±0.05	04	
accelerometer	Cross-axis sensitivity	±1	90	
	Sampling rate	1000	LI →	
	Logging rate	1000	ПΖ	
	Gyroscope range	±2000	°/sec	
	Gyroscope resolution	0.060975		
	Non-linearity	±0.1	04	
Gyroscope	Cross-axis sensitivity	±1	70	
	Sampling rate	1000	LI-7	
	Logging rate	1000	П	
	Time synchronisation between high and low range	. 1	ms	
	accelerometers, and gyroscope	ΞI		
All	Time from power on to ADR functional, including	8 note 1	sec	
	automatic zeroing complete	13 note 2	sec	

1. USB **not** connected to PC

2. USB connected to PC, ADR waits 5 seconds listening for a firmware recovery command before booting main application firmware

3.2.2 Electrical Specifications

The device must be operated within the ratings listed in the table below in order for all homologated performance characteristics to be valid.

Table 2 – General System Specifications

Parameter	Min	Typical	Max	Units
Supply voltage	6	-	40	V _{DC}
Operating	40		QE	۰ ۲
temperature range	-40	-	65	C
Backup Power		5		minutos
Supply duration	-	5	-	minutes
Constant current		10		mA
LED driver current	-	19	-	

3.2.3 Current Consumption

The ADR is optimised for low power consumption, and whilst its current consumption is heavily dependent upon configuration options, under normal conditions its current



consumption is extremely low. The baseline current consumption, and factors affecting current consumption are listed in the table below.

Values listed as +, are additive to the baseline consumption.

Table 3 - Current Consumption

Parameter	Conditions ¹	Typical	Units
	Baseline: CAN bus and termination disabled, no external LEDs connected, backup supply charged, no faults present CAN bus termination enabled	14 +2	
	CAN bus termination split filter enabled	+2	
Current consumption	External Medical Warning Light LED enabled and illuminated	+6	mA
	CAN bus active, with bus activity limited to the CAN messages defined in <u>FIA standard messaging</u> protocol	+2	
	Backup power supply charging at <u>maximum</u> <u>configured rate</u>	+196	

1. All currents given at 13.8V_{DC} supply voltage

3.3 Mechanical and Environmental

- Electrical connector: see Electrical Connector Pinout
- Construction: machined billet aluminium case, blasted and anodised
- Ingress Protection Rating: BS EN 60529 IP66 / IP67
- Weight: 260 grams
- Physical dimensions:





4 ADR Utility PC Software

The ADR is supported by our free-of-charge Windows® PC software application, *ADR Utility*, which may be downloaded from <u>here</u>. The software is used to configure and interact with an ADR, and to download and view event files.

Throughout this User Manual, usage of ADR Utility is demonstrated as and when each functionality of the ADR is described, such that both ADR and ADR Utility functionality are introduced together.

4.1 System Requirements

- Operating system
 - Windows® 10 (Home, Professional, IoT Enterprise) 64-bit
 - Version 10.0.17763.0 or higher
 - Windows® 11 (Home, Professional, IoT Enterprise) 64-bit
- Hardware Requirements
 - Processor: 1GHz minimum
 - Memory (RAM): 4GB minimum
 - Storage: 1GB free space
- Display:
 - Minimum 1024x768 pixels
- Additional:
 - Dedicated GPU not required
 - Installation is not required, application is portable
 - Internet connection is preferable, but not required

4.2 Installation

ADR Utility does not require installation on a PC, the application is a single standalone Windows® executable, and is launched by a double-click on the file, as per any other file or shortcut.

It is even possible to run the application directly on a USB stick, although it is strongly recommended to copy the application locally to your PC – this is because removing the USB stick will close the application unexpectedly.

4.3 Features

ADR Utility includes features to enable use of all of the ADR's capabilities, in addition to productivity enhancing features. The software includes:



- A graphical, interactive data visualization user interface, allowing ADR event data to be plotted, zoomed, isolated etc
- Ability to view, download and delete stored event files
- ADR configurator, to <u>configure</u> both user settings and <u>FIA restricted settings</u>
- ADR health information, displaying extensive <u>diagnostic</u> and <u>fault</u> information
- Numerous tools such as the ability to <u>manually trigger an event</u>, explicit <u>sensor</u> zeroing etc

4.4 Getting Started

ADR Utility is a simple graphical user interface that will immediately feel familiar to any PC user with experience using traditional Windows® desktop applications.

On first launch of the software, an onboarding screen is displayed. To use the software you must read and accept the privacy policy.

Figure 1 - ADR Utility Onboarding Screen

Emvexis ADR	Utility v1.1.0
Welcome	Permissions
Welcome to Emvexis ADR Utility. If this is your first time using the software, we strongly recommend you visit the online documentation, and read or watch the Getting Started information.	This software collects usage and diagnostic information relating to both this software, and any Accident Data Recorders connected to this software, in accordance with our Privacy Policy below.
Open Help Information	Last Updated: 4th August 2024
	Welcome to Emvexis ADR Utility, This Privacy Policy
Installation No installation is required, the software runs directly from the file that you just opened. You may share this file with anybody else that needs to use the software, without them having to install anything.	In addition, ADR event files are optionally collected. If you wish to opt-out of event files being collected, please un-tick the permissions box below before continuing.
✓ Show this window at startup	Accept and Proceed Reject and Quit

After proceeding past the onboarding screen, the main software UI is displayed. The three highlighted regions of the UI, remain constant at all times in the UI:

- Blue main tool strip, includes typical application functionality such as application settings and help menu, and multiple ADR tools
- Green application tabs, opening different environments used for purposes such as viewing events, downloading events and configuring the ADR



• Red – lists current ADR connection status, serial number etc, and includes controls for connecting to an ADR

Figure 2 - ADR Utility Main UI



4.5 Connecting to an ADR

To connect to an ADR requires only a few steps

- 1. Connect the PC to the ADR using an ADR Interface Cable
- 2. Open the 'Connection Controls' menu in the lower left corner
- 3. Select an ADR from the drop-down list. The list contains **only** Emvexis ADR1 devices, and excludes all other connected USB devices
- 4. Click 'Connect', and ADR Utility will connect with the ADR, and display the serial number of the connected ADR in the status strip



Figure 3 - Connecting to an ADR

Figure 4 - Connection Made

	Connect Disconnect Show Comms Logs Show ADR Properties	1	ø	x x y	» » -11
₽ Co	ADR on: COM36 ADR on: COM34 ADR on: COM36 CMType here to	Connection Search	Status: Disconne	ected ADR 日	Serial: ?
	Plot All	Clear All	Ø	0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	» » -11
Cor	nection Controls 👻	Connection	Status: Connecte	ed ADR Sei	rial: 13

Further details about the connected ADR may be viewed under Connection Controls > Show ADR Properties.

4.6 Restricted Functions

Numerous functions performed using ADR Utility, are required by the FIA 8872-2018 standard to be passcode protected, such that these functions are restricted to the FIA, or an authorised delegate such as an ASN or championship organiser.

🗣 Emvexis ADR Utility		
🞯 Utility Settings 🛛 💥 ADR Tools	Restricted ADR Tools (?) Help	
Event Viewer Event Download	Image: Sectory Reset (Format Memory) Image: Sectory Reset Medical Warning Light (MWL)	
File Displays Settings	Zero Sensor Channels	
Event Properties Event Faults	Level 1 Access Control Lock	
	Level 2 Access Control	



An attempt to perform these functions without unlocking the ADR, simply results in a rejection notification.

4.6.1 Access Control Levels

The functionality is protected by 2 different lock levels; a 'level 1', and 'level 2' lock.

The level 1 lock protects functions only permitted to be changed by the FIA, whilst the level 2 lock protects functions authorised to be changed by delegates. Each lock has a separate passcode.

Table 4 - Protected Functions by Lock Level

Function	Prote	cted By
Function	Level 1 Lock	Level 2 Lock
Deleting events	\checkmark	\checkmark
Factory reset	\checkmark	
Resetting the External Medical Warning Light	\checkmark	
Re-zeroing the internal sensor channels	\checkmark	
Changing restricted configuration	1	
parameters (orientation and triggers)	\checkmark	

The ADR is locked, and unlocked using the menu commands shown above, which raises a window to enter the passcode.

Level 2 Lock Release Auth	orisation	?	×
Certain actions may be authorised delegate of t below to rele	performed onl he FIA. Please ease the Level 2	y by the FIA, o enter the passo 2 Lock.	or an code
Releasing the Level	2 Lock grants p	ermission to:	
• Eras	se events only.		
The ADR may be re-lock Tools > Access Contr automatically re-locked between the ADR and PC	ed at any time rols > Level 2 Lo either when th is ended, or th	via Restricted ock, and will b ie USB connec e ADR is re-bo	ADR e tion ooted.
Password			
		Unlock	



4.7 Configuration

Configuration of the ADR is performed using *ADR Utility.* The configuration may be edited 'live', by changing parameters and settings on the connected ADR directly, or, configurations may be loaded from a configuration file.

The latter is useful where multiple ADRs need configuring with the same settings

4.8 Manual Event Triggering

Events may be triggered manually for the purposes of demonstration and test. A manually triggered event is the same as a triggered event in all respects as described in the Events and Event Files section, with the sole exception that a manually triggered event is marked as such, this is because a manually triggered event can be triggered with no impact acceleration data high enough to trigger an event present, and thus it is important to show why this event exists.

To manually trigger an event:

- 1. <u>Connect to the ADR</u> in question
- Click ADR Tools > Test Functions > Trigger Manual Event. In some cases the request will be rejected (if for example, an event erase is in progress). Either way, ADR Utility will inform if the command was accepted or rejected. When the event completes, a second notification will be displayed.

ADR not	tification ID	110.	×
	Manual Ev Your requ the event	vent Trigger Accepted est to manually trigger an event was accepter is now in progress.	d, and
			ОК
	ADR noti	fication ID 104.	;
	0	New Event A new event has just finished and complete memory. If you wish to download the event Download tab.	ed writing to t, go to the Event
			ОК



3. The event may be viewed in, and downloaded from, the event download list and will be shown with a tick in the 'Is Manual Event' box to display that this event was manually triggered

🔶 Emvexis	s ADR Utility				- O)	×
🔘 Utility	Settings 💥 ADR Tools 🔞 Res	tricted ADR Tools (?Help				
Event Vie	ewer Event Download ADR	Configuration ADR Health				
Downlo	oad Delete Refresh Event List					
Events st	ored in ADR					_
	Event Number	Date and Time	Accident Severity Index	Previously Downloaded	Is Manual Event	
	65	08/19/2024 19:26:54	10			
	66	08/19/2024 19:27:30	7			
	67	08/19/2024 19:27:45	1			
	68	08/19/2024 20:29:11	4			
	69	08/19/2024 20:38:42	4			
۱.	70	08/20/2024 01:29:14	1			
	51	08/10/2024 21:41:46	17			

4.9 Sensor Zeroing

In normal operation there is no need to zero the ADRs internal accelerometers and gyroscopes, as this is performed automatically on power up of the ADR.

However there may be some cases where this is necessary, for example:

- The ADR was powered on whilst removed from a vehicle, at an arbitrary inclination
- The vehicle itself was in a severely inclined position whilst the ADR was powered on

If such a scenario has occurred, the ADR will still fundamentally function, though the following should be noted:

- The zero offsets of each channel will be incorrect, for example if a vehicle was on a 45° incline in X or Y, when the ADR is powered on, when the vehicle returns to horizontal, the Z axis will report 1.293g at 1g, due to sensing a real 1g, plus the vector component of 1g at 45 degrees
- Trigger thresholds may be affected, for example if an ADR was powered on, on its side, the Z axis will sense 2g when the ADR is righted. This means impacts will falsely read 1g higher, thus reaching trigger thresholds earlier

Zeroing the sensors is a <u>restricted function</u>, per the requirements of the FIA 8872-2018 regulation. To zero the sensors:

- 1. <u>Connect to the ADR</u> in question
- 2. Click Restricted ADR Tools > Zero Sensor Channels. In some cases the request will be rejected (if for example, an event is in progress). Either way, ADR Utility will



inform if the command was accepted or rejected. When the process completes, a notification will be displayed.

🖶 Emvexis ADR	Utility		
🕲 Utility Setting	gs 🔌 ADR Tools	6 F	Restricted ADR Tools ⑦ Help
Event Minute		0	Factory Reset (Format Memory)
Event viewer	Event Download	ê	Reset Medical Warning Light (MWL)
File Displa	avs Settings	\oplus	Zero Sensor Channels
Event Properti	es Event Faults		Access Control
	Eventruand	-	
			~ ~

4.10 Updating ADR Firmware

The ADR firmware is easily updated if necessary, by ADR Utility. Firmware files are encrypted binary files, named using the following typical format:

adr-application-fw-6dde15d2afc25e32c0de5fd0088b26d34ec7ba99-clean

Firmware updates are made available through the Emvexis website and may be accessed from the following location in ADR Utility.

🔶 Emvexis ADR Uti	lity		
() Utility Settings	XA	DR Tools 🔞 Restricted ADR Tools	elp
Event Viewer	P	Check for Firmware Updates	alth
	0	Firmware Flash	aith
File Displays	s 🛗	Set Date and Time	
Event Properties		Test Functions	

Figure 5 - Firmware Update Web Link

To perform a firmware update:

- 1. <u>Connect to the ADR</u> to update
- 2. Open ADR Tools > Firmware Flash
- 3. In the window that opens, click Actions > Enter DFU Mode



ADK Fim	nware Update	×
File Acti	ons	
Contr 🚽	Enter DFU Mode	
Firm G →	Exit DFU Mode	
C	Flash Firmware Image	
		^
Update Pro	gress	

4. The ADR will reboot, and the onboard status indicator LED will show a <u>solid orange</u> status. Information on the DFU progress so far, is displayed

File	Actions				
Contr	ols				
Firm	ware Image Filepath				
nforn	nation				
)2:08: 500tle)2:08: Await	17 Reset command se bader 17 Communication lii ing handshake from b	nt, the ADR sho k configured fo ootloader	uld now atter r communica	npt to boot into the ation with ADR bootloader.	^
)2:08:	22 Handshake receive	d, communicati	on link establ	ished with ADR bootloader	
					~
Jodat	e Progress				
paa					

5. Click File > Open Firmware Image. Navigate to the firmware file using the standard file dialog window that opens.



	R Firmware Update	
File	Actions	
Contr	ls	
Firm	vare Image Filepath	
ıtpu	Release\adr-application-fw-6dde15d2afc25e32c0de5fd0088b26d34ec7ba99-clea	n
Inform	ation	
02:08: Await	7 Communication link configured for communication with ADR bootloader. ng handshake from bootloader	1
02:08: 02:10:	2 Handshake received, communication link established with ADR bootloader 2 Firmware image loaded	
02:10:	2 Firmware image length: 54148 bytes	
02:10: this w	2 Update ready to start, click 'Actions > Flash Firmware Image' to start, or close adow to cancel	
CI 11.2 VV	Now to cartchin	
		_
Updat	Progress	

6. Click Actions > Flash Firmware Image. Read and understand the warning notice that is displayed, and click OK

-	Abre and a spearce			
File	Actions			
Start Firn	nware Update?	×		
	You are about to start a firmware update of the ADR. The process may take several minutes, and the ADR will not be responsive during this time. A progress bar will be updated		pplication-fw-	60
	on-screen, and you will be notified whether the update succeeds or fails.		bootloader.	^
	In the event that the update fails, the ADR will roll back to the firmware that was already present.			i
	After a successful update, when the ADR reboots it may decide to erase all stored events, configuration data, fault		start, or close	
	therefore that you have downloaded any events, configuration data etc that you do not wish to lose.		l bootloader	-
	Are you sure you wish to proceed?			

7. The process takes only a few seconds to complete, and when complete the ADR will reboot into the new firmware. Click OK to return ADR Utility to normal operation



File Actions		
Controls		
Firmware Image Filepa	th	
Itput\Release\a Firmw	vare update complete.	×
12:12:52 Page tra 12:12:52 Page tra 12:12:52 ADR ver 12:12:52 Erase of 12:12:52 Erase of 12:12:52 Firmwar 12:12:52 Firmwar 12:13:05 Commu	The firmware update process completed successfully, and the ADR is now rebooting into the newly flashed application firmware. Click OK to close the firmware update window, and return normal Utility operation, or cancel to keep the firmware update window open, if you need to flash another firmware image.	he to re
Jpdate Progress	OK Cano	el



5 Modes of Operation

The ADR may operate in one of two modes:

- 1. Standalone, connected only to the vehicle's power supply
- 2. Networked, connected to the vehicle's CAN network, for the purpose of capturing additional vehicle parameters (steering angle, brake pressures etc) used to supplement the event data captured by the ADR

5.1 Standalone Operation

In this mode, the ADR uses its internal accelerometers and gyroscopes to measure and log acceleration and gyroscopic rate data. If an event is triggered in this mode, the event files contain two sets of 3 axis acceleration data (high range XYZ, and high resolution XYZ), in addition to 3 axes of gyroscopic rate data (XYZ).

All other event channels normally used in <u>networked operation</u>, will read as zero.

Therefore whilst standalone operation still captures the fundamental inertial data, the datasets lack the additional channels that are present when the ADR is networked, which are extremely useful in any crash analysis

5.2 Networked Operation

In this mode, the ADR functions fundamentally the same as in standalone operation, except for that an additional 12 data channels are captured from the vehicles CAN bus. These channels are defined in <u>Channels</u>.

Further to the 14 additional data channels, 2 additional <u>event properties</u> are captured via CAN:

- Lap number at the point of the event trigger
- GPS time

Wherever possible it is highly recommended that the ADR be used in this mode.



6 Events and Event Files

The ADR operates on the principle of continuously holding the last 45 seconds of data from all channels in memory. Each time a new sample is captured, the oldest sample is overwritten.

This temporarily held data is **not** stored in permanent memory.

For the ADR to permanently store data, it must be **triggered.** A **trigger** is what causes an **event** to be captured.

Triggers are acceleration thresholds, combined with time counters, that when exceeded - trigger an event. Triggers are discussed in more detail in 6.5.

In the following sections events and triggers are discussed in detail, including an overview of how to download, and view events is given.

6.1 Downloading Events from an ADR

ADR Utility displays a list of all events currently saved in the ADR, to view the event list:

- 1. Connect the PC to the ADR using an ADR Interface Cable
- 2. Open the Event Download tab in the main user interface
- 3. Click 'Refresh Event List'

The list of all events stored in the ADR will be displayed, including timestamps, <u>ASI</u>, whether the event has been downloaded before, by anybody, and whether it was a <u>manually</u> <u>triggered event</u>.

1	🗣 Emvexis ADR Utility — 🗆 🗙							
(🚳 Utility Settings 💥 ADR Tools 🔞 Restricted ADR Tools 🧿 Help							
	Event Viewer Event Download ADR Configuration ADR Health							
	Downlo	oad Delete Refresh Ev	vent List					
	Events st	tored in ADR						
		Event Number	Date and Time	Accident Severity Index	Previously Downloaded	ls Manual Event		
				10				
	P	65	08/19/2024 19:26:54	10				
	-	65 66	08/19/2024 19:26:54 08/19/2024 19:27:30	7				
		65 66 67	08/19/2024 19:26:54 08/19/2024 19:27:30 08/19/2024 19:27:45	7 1				
		65 66 67 68	08/19/2024 19:26:54 08/19/2024 19:27:30 08/19/2024 19:27:45 08/19/2024 20:29:11	7 1 4				
		65 66 67 68 69	08/19/2024 19:26:54 08/19/2024 19:27:30 08/19/2024 19:27:45 08/19/2024 20:29:11 08/19/2024 20:38:42	7 1 4 4				
		65 66 67 68 69 70	08/19/2024 19:26:54 08/19/2024 19:27:30 08/19/2024 19:27:45 08/19/2024 20:29:11 08/19/2024 20:38:42 08/20/2024 01:29:14	1 4 4 1				
		65 66 67 68 69 70 71	08/19/2024 19:26:54 08/19/2024 19:27:30 08/19/2024 19:27:45 08/19/2024 20:29:11 08/19/2024 20:38:42 08/20/2024 01:29:14 08/20/2024 03:01:06	7 1 4 4 1 2				



To download an event:

- 1. Highlight the event row to download
- 2. Click Download > Download Selected
- 3. Select where you wish to save the event in the dialog that is displayed

When the event download starts, a progress bar is shown, and the download can be cancelled at any time. Each download takes approximately 8.5 seconds.

🔶 Emvexi	is ADR U	Itility			
() Utility	/ Setting	is 💥 ADR Tools	Bestricted ADR Tools	? Help	
Event Viewer		Event Download	ADR Configuration	ADR Health	
: Downle	oad [Delete Refresh Ever	nt List		
Events st	tored in	ADR			
	Event	Number			Date and Time
•	65				08/19/2024 19:26:54
	66	6			08/19/2024 19:27:30
	67	Event Deven	load Drograss		
68			lioad Progress		
69			Cancel		
70			00/20/2024 01:23:14		
71					08/20/2024 03:01:06

Events may be deleted from the ADR using Delete > Delete Selected, or Delete All. Note however this is a <u>restricted function</u>.

6.2 Opening and Viewing Event Files

ADR Utility includes a graphical event viewer, under the 'Event Viewer' tab.





Event files <u>downloaded from the ADR</u> are opened into the Event Viewer from an event file saved on the PC. To open an event file:

- 1. Click File > Load Event > From File.
- 2. Navigate to the file using the dialog that is displayed



Selecting 'From ADR' instead of 'From File' moves to the <u>Event Download</u> tab, to allow you to first download events.

6.3 Event Structure

All events are 30 seconds in duration, and in normal cases the event captures 15 seconds of data prior to the trigger, and 15 seconds after the trigger. The image below demonstrates this; the ~40g impact in the middle of the display plot, is at 15 seconds, thus the event contains both pre and post trigger data.

Figure 6 - Event Trigger Location





Note however, that there are exceptions to this, described in <u>Special Conditions</u>.

6.4 Channels and Properties

During an event the ADR captures numerous **data channels**, which are continuously sampled and logged throughout the event, i.e. these data channels contain time history data.

In addition to the data channels, additional **event metadata** is captured. This metadata is comprised of parameters which do not change over the duration of the event, but rather are a snapshot in time at the point of event triggering. This metadata includes:

- <u>Event properties</u>, a collection of parameters related to the event itself, such as timestamps, ADR serial number, firmware version etc
- Event faults, a record of any fault codes set during the event
- <u>Channel properties</u>, parameters such as units, min/max values, and per-channel error checking CRC-32 fields
- <u>ADR configuration</u>, a full copy of the ADRs configuration as it was at the time of the event

Each of these channels and properties are described below.

6.4.1 Channels

The ADR logs either 12, or 26 channels depending on whether it is used in <u>standalone or</u> <u>networked mode</u>, as per the table below.

Table 5 - Event Channel Descriptors

Channel Name	Channel Description	Source	Logging Rate, Hz	Units
gADRX	High range acceleration, anti aliaced no			
gADRY	further filtering vehicle XVZ			
gADRZ	Turther Intering, vehicle XTZ			
gCFC60X	High range acceleration, anti-aliased &			
gCFC60Y	digitally filtered to ISO 6487 CFC60, vehicle			g
gCFC60Z	XYZ	ADR	1000	
g_lo_CFC60X	Low range, high resolution acceleration, anti-	internal	1000	
g_lo_CFC60Y	aliased & digitally filtered to ISO 6487 CFC60,			
g_lo_CFC60Z	vehicle XYZ			
nADRX	High range gracespic rate anti aliaced pe			
nADRY	Further filtering VVZ			°/sec
nADRZ	iurther mering, Arz			
brake_pres_f	Brake hydraulic pressure		100	bar



brake_pres_f				
lap_distance	Distance travelled on current lap			meters
lap_number	Current lap number			n
engine_speed	Engine rotational speed			rpm
v_car_wheel	Vehicle speed calculated from wheel speed			kph
throttle_pedal	Throttle pedal demand	Vahiela		%
steer_angle	Steering angle	venicie		0
throttle_actuator	Throttle actuator demand	via CAN		%
gps_speed	Ground speed as measured by GPS			kph
gps_altitude	Altitude as measured by GPS			meters
gps_lat	Latitude as measured by GPS		10	1.070
gps_long	Longitude as measured by GPS		10	Ter
and status	Connected (via BS 222) CBS module status			Module
ghs_status	Connected (via KS-252) GPS Houdile status			specific

6.4.2 Event Properties

Each event file contains a set of Event Properties, viewable under the Event Properties tab in Event Viewer.

Figure 7 - ADR Utility Event Properties

Utility Setting	s 💥 ADR Tools	Bestricted ADR Tools	? Help							
vent Viewer	Event Download	ADR Configuration	ADR Health							
File Display	/s Settings									
Event Propertie	Event Faults									
Parameter		Value ^								
Filename		ADR Event ID 42-SN	15	Reds: g	ADRX,Y,Z.					
Manually Trigg	gered Event	No	~ 1	Orange	s: gCFC60X	,Y,Z.	7			
ADR Internal E	vent ID	42	_	Greens	: Lap Distand	ce, Engin	<mark>∠.</mark> ie Speed			
Date & Time		23 July 2024 11:56:5	<u>∕</u> ?	Browns	: nADRX,Y,Z	Z. GPS A	ltitude.			
Accident Seve	rity Index	43	1	Blues:	Throttle and I	Pedal Po	sitions, S	teering Ar	ngle.	
ADR Firmware	Version	1.00	~ ²⁵	Teals: E	Brake Pressu	ure F,R.	peeu.			
ADR Serial Nu	mber	13	1	<u>9</u> .						
ADR Bootload	er Version	1.00	~							
ADR Firmware	Hash	37d2b0d522ce7673	1	2						
ADR Firmware	Build Status	Clean	0.15	-						
ADR Bootload	er Hash	37d2b0d522ce7673	-							
ADR Bootload	er Build Status	Clean	05						and the second sec	
Lap Number		0	rees							
Lap Distance (m)	0	rpn deg	-						
<		>	% °°	Ĩ						
Available Even	t Data Channels		listar % kph	<u>)</u>						
gADRX		^	bar,	-						
gADRY			ce,	9						



These parameters relate to both the ADR itself (for example, serial number that captured the event), and to the event (for example, date and time stamp).

Each of the parameters included in Event Properties are described in the table below.

Table 6 - Event Property Parameter Descriptions

Property	Туре	Description
Filename	Text	Filename of the event .XML file
Manually Triggered Event	Yes/no	Determines whether this event triggered manually using the Trigger Manual Event function in <i>ADR Utility</i> , or was it a real event
ADR Internal Event ID	Value	ID assigned to the event by the ADR, this ID combined with the ADR serial number uniquely identifies an Emvexis ADR event file
Date & Time	Datetime	Date and time stamp of the first sample within the dataset
Accident Severity Index	Value, g	Maximum absolute acceleration recorded at any time point within this event, in any axis
ADR Firmware Version	Version, X.Y	Version of the ADR application firmware in use at the time this event was captured
ADR Serial Number	Value	Unique hardware serial number of the ADR that captured this event
ADR Bootloader Version	Version, X.Y	Version of the ADR bootloader firmware in use at the time this event was captured
ADR Firmware Hash	SHA-1 hash	Cryptographic hash used to uniquely identify the ADR application firmware build with absolute certainly
ADR Firmware Build Status	-	Internal use only
ADR Bootloader Hash	SHA-1 hash	Cryptographic hash used to uniquely identify the ADR bootloader firmware build with absolute certainly
ASH Bootloader Build Status	-	Internal use only
Lap Number	Value	Current lap number when the event was triggered
Lap Distance	Value, meters	Current lap distance when the event was triggered
ADR Internal Pressure	Value, mBar	Pressure of the ADR internal air volume when the event was triggered
ADR Internal Temperature	Value, °C	Temperature of the ADR internal components when the event was triggered
Event Format	Value	Reserved for future use; identifies format of the event file to allow newer format versions of event files to be recognised by <i>ADR Utility</i> , to support new features
Number of Channels	Value	Number of Channels included within this event
Event Length	Value, seconds	Number of seconds of data within this event



6.4.3 Event Channel Properties

Event files contain properties specific to each data channel, as shown below. As each channel is selected in the Available Event Data Channels list (bottom left), the Channel Properties (top right) view will update to show the properties, for the selected channel.

Figure 8 - ADR Utility Event Channel Properties



Each of the channel properties, and their associated meanings are described in the table below.

Table 7 - Event Channel Property Descriptors

Property	Description
Channel Name Name of the currently selected channel, from the list of <u>Channels</u>	
Units	Units of the parameter in this channel, for example g, °/sec
Sample Rate	Number of samples per second, in this channel
Min Value	Minimum numerical value in this channel, in this event
Max Value Maximum numerical value in this channel, in this event	
	Error-detecting code, calculated by the ADR for this channel only, when the
Data CRC-32	event was stored. Used by <i>ADR Utility</i> to compare against when recalculating
	this channels CRC-32, to determine whether data corruption has occurred



Data Intact	See above, if a freshly calculated CRC-32 of this channel matches the saved CRC-32, the data has not been corrupted
CAN Data in Sync	For channels obtained via CAN, if any CAN faults occurred during capture of this event, this property warns for this

6.4.4 Event Configuration

Within each event file is a copy of the ADRs configuration that was in use at the time when the event was captured.

A good example of why this configuration data is included is, for example; even if it is known with certainty which orientation an ADR was installed in a vehicle at the time of a given event, if it is not known which orientation setting was configured, then it is impossible to know with certainty if the X,Y and Z channels are correctly mapped to the vehicle coordinate system.

6.5 Triggers

As described above, a **trigger** is what causes an **event** to be captured. There are independent triggers for each axis, and each axis direction has an independent trigger.

In addition, there is a secondary set of triggers used to independently trigger the <u>External</u> <u>Medical Warning</u> Light, allowing the MWL and events to be triggered at separate acceleration and time thresholds.

The image below shows a screenshot from the <u>ADR Utility PC Software</u>, where the triggers may be configured.



Figure 9 - ADR Utility Trigger Configuration



Each trigger is comprised of 2 parameters: acceleration, and time. For a trigger to be triggered, the measured acceleration in that axis must exceed the configured acceleration threshold, for **more than** the time specified.

The acceleration must be consecutive, for example if there are 4ms of 18g but the next millisecond is 14g, the time counter is restarted and the acceleration would need to be measured above 15g for another full 5ms.

Finally, the acceleration is treated as an absolute value, whilst considering the thresholds as signed. For example, 4ms of 18g, followed by 2ms of -18g **will** still trigger, as the absolute acceleration was above both the positive, and negative triggers, for more than the trigger duration.

Once an event is triggered, event detection is **disabled** until it is reenabled towards the end of the current event as described in <u>Special Conditions</u>. This is to prevent multiple events being triggered due to multiple closely space impacts, in for example a vehicle rollover condition.



6.5.1 Special Conditions

As described above, events are **always** 30 seconds, and typically contain 15 seconds of pre-trigger data, and 15 seconds of post-trigger data.

The 15 second pre/post-split is not always true however, when:

1. An event is triggered less than 15 seconds after the ADR is powered on and starts sampling, the event will still be 30 seconds long, but the trigger will not be at 15 seconds. For example if there is only 5 seconds of data available, the event will contain 5 seconds of pre-trigger data, and 25 seconds of post-trigger data, per the below image.



2. Once an event is triggered, further event triggering is disabled until 10 seconds before the end of the current event. That is, triggering is re-enabled at 20 seconds into the current 30 second event.

If an impact triggers an event after the trigger re-enable point, a **back-to-back** event is triggered, meaning that once the current event ends, a second event follows on immediately. In practice, this means the trigger point is not within the second event, and thus the entire second (or third, fourth etc) event is purely post-trigger data. Therefore in the below image, the second acceleration pulse will **not** trigger a backto-back event, because it occurs before the trigger re-enable point.

Figure 10 - Early Event Trigger



Figure 11 – Disabled Triggers



In the below image, the second impact pulse **will** trigger a back-to-back event, because it occurs **after** the trigger re-enable point.

Figure 12 – Back-to-back Event Trigger



6.5.2 Exporting Events to CSV

In some cases it may be desirable to export an event file to CSV, for use in other software. ADR Utility supports exporting to CSV, with the channel order defined by FIA 8872-2018.



Unless absolutely necessary, Emvexis advises against exporting to CSV, as much of the accompanying event metadata is lost, such as:

- Event properties
- Event fault information
- ADR configuration information

CSV file sizes are notably larger than the XML file from which they were created. The filename, channel order, and CSV headers included in the file are all defined by FIA 8872-2018 and are not configurable.

To perform an export:

- 1. Open the event .XML file in ADR utility that you wish to export to CSV
- 2. Click File > Export Event > To CSV
- 3. Choose the location to save the file to, in the dialog that is displayed

🗣 Emvexis ADR Utility					
Otility Setting	gs 🔌 ADR Tools	Bestricted ADR Tools			
Event Viewer	Event Download	ADR Configuration			
File Displa	ays Settings rent ults				
Save Ev	ent	Value ^			
📑 Export I	Event 🕨 📾 1	To CSV			
Manually Trig	gered Event	Yes			
A DD Internal	Fuant ID	71			



7 Electrical Connector Pinout

The ADR follows the pinout convention required by FIA 8872-2018, and uses either of the following connectors:

- Souriau 8STA2-1035PN, mates with 8STA6-1035SN, or
- Deutsch AS210-35PN, mates with AS610-35SN

Note that both connector options are interchangeable, and ADRs may be shipped with either Souriau or Deutsch connectors.

The pin physical positioning follows the diagram below, relative to the single master keyway slot in the connector shell. The diagram below is looking **into** the male-pinned ADR connector, not the female-socket cable plug.



The pinout functional mapping corresponds to the table below.

Pin Number	Pin Function	Notes
1	RS-232 RX	
2	External Medical Warning Light	See External Medical Warning Light
3	CANH	
4	CANL	
5	External Status Light	See External Status Light
6	RS-232 TX	
7	USB V _{BUS}	+5V _{DC} USB supply. Only used when connected via USB
8	USB D+	
9	USB D-	
10, 11	Not used	Reserved for future use
12	Battery positive	
13	0V	

Table 8 - Connector Pinout

Emvexis supplies USB only <u>ADR Interface Cables</u> using this connector and pinout specification, for USB connection to the ADRs.



8 Status Indicator LEDs

The ADR provides three methods of visually indicating status information:

- 1. an on-board multi-colour LED,
- 2. the ability to drive two external LEDs via its constant-current driver output pins (see <u>Electrical Connector Pinout</u>)
- 3. broadcast of status information via CAN, which may be received by a third-party device to either drive LEDs or display information on a screen

8.1 On-board LED

The ADRs on-board, multi-colour LED function is defined primarily by the FIA 8872-2018 standard and is thus fixed/not user configurable. Additional colour/flash states beyond those specified in FIA 8872-2018 are used and are not configurable.

The LED can display red, green and orange, and these colours combined with various flash states, are used to indicate the status of the ADR, as defined in the table below.

ADR State	Colour	Flash Frequency, Hz	Duty Cycle	Brightness, %
Normal, no faults	Green	0	-`\	
Busy ¹	Orange	0		
Hard fault present	Red	0	100%	50
Normal, <u>soft fault</u>	Green	1	-\overline{c}\overline{c}-	
present	Green	I		
Triggered	Green	10		
Booting	Orange	10		
Self test	Orange	2	50%	
Event Stored	Red	4	-```Q`- `_`_``Q`- 	100
Low power sleep	Orange	1	-```Q`- `_``````Q`- 	

Table 9 - Onboard LED States

1. Busy states include event download, event erase, firmware update in progress



8.2 External LEDs

The ADR can drive 2 external LEDs, via <u>pins 2 and 5</u>. These pins are constant current LED drivers, and thus require no external current limiting resistor. The drivers output a constant 19mA current, regardless of the connected LEDs forward voltage. It is therefore recommended to select external LEDs rated for a forward current of at least 25mA.

The equivalent control circuit for the external LEDs, is shown below, and is duplicated for both the <u>External Status Light</u>, and the <u>External Medical Warning Light</u>.

Note ESD protection input structures are present, but not shown in the diagram.

The status of the external LED is linked to the <u>On-board LED</u> states, as shown in the table below.

Table 10 - External LED States

ADR State	Ext Status LED ²
Normal, no faults	On
Busy ¹	Off
Hard fault present	Off
Normal, <u>soft fault present</u>	On
Triggered	On
Booting	Off
Self test	Off
Event Stored	On
Low power sleep	Off

1. Busy states include event download, event erase, firmware update in progress

2. External status LED disabled in low power mode

Figure 13 - LED Driver Equivalent Circuit





8.2.1 External Status Light

The external status light is a simplified duplication of the on-board status LED. It has only 2 states, on or off. <u>Table 9 - Onboard LED States</u> details when the external status LED is illuminated, or not.

The external status light may be enabled, or disabled via the ADRs configuration, using the *ADR Utility* software.

8.2.2 External Medical Warning Light

The external Medical Warning Light (MWL) is a configurable indicator light used to inform trackside staff attending an incident (for example, medical crews), that an impact of a certain severity has occurred, which is used to trigger appropriate medical procedures for example.

The MWL is <u>triggered</u> in the same way events are triggered, but must be <u>configured</u> equal to, or greater than the threshold used for event triggers, and any attempt to configure otherwise will be rejected by *ADR Utility*. This is to guarantee that any impact that triggers the MWL, will also trigger an event.

The MWL may <u>be enabled</u>, or <u>disabled</u> via the ADRs configuration, using the *ADR Utility* software. Once triggered, the MWL is cleared by 1 of 3 different mechanisms:

- 1. A power cycle of the ADR (including full discharge of the internal backup supply)
- 2. Erasing **all** events currently stored in the ADR
- 3. Manually resetting the MWL via ADR Utility

Note that for options 2 and 3 above, these are <u>passcode protected functions</u> that require either the FIA or authorised delegate to perform these.

To reset the MWL, <u>first unlock the ADR</u>, and then click Restricted ADR Tools > Reset Medical Warning Light (MWL)



Alternatively, <u>erasing all events</u> from the ADR will also reset the MWL.



8.3 Special case – low power mode

In the case of external power supply to the ADR having been lost, the ADR automatically switches to using its own <u>internal backup power supply</u>, which allows the ADR to continue operating normally for approximately 5 minutes.

During backup operation, to extend the period the ADR is able to operate from its backup supply, the LED behaviour is altered, specifically:

- The external status LED is disabled
- In the 'Normal, no faults' ADR state, the LED brightness is reduced from 50%, to 25%

9 Configuration

The ADR is configurable by the user to suit the application in which it is being used. Some of the configurable parameters must be configured by the vehicle manufacturer, or installer of the ADR, whilst other parameters may only be configured by the FIA, or authorised delegate, as per requirements of a given championship, such as event triggering thresholds.

All configurable parameters are grouped into two categories:

- 1. User Parameters these are parameters that any user can configure at any time
- 2. <u>Restricted Parameters</u> these are parameters that only the FIA, or its authorised delegates may configure, and are passcode protected

9.1 Loading Configuration from ADR

To edit the configuration in an ADR:

- 1. <u>Connect the PC to the ADR</u> using an <u>ADR Interface Cable</u>
- 2. Open the ADR Configuration tab in the main user interface
- 3. Click Actions > Load Configuration > From ADR



Figure 14 - Opening an ADRs Configuration

මී) Utili	ty Setting	s X ADR T	ools	Bestricted ADR Tools	? Help
Event \	/iewer	Event Down	oad	ADR Configuration	ADR Health
Actio	ons				
	Load Co	onfiguration	•	From File	
r	Save Co	nfiguration	•	From ADR	
\otimes	Close Co	onfiguration			
	Config F	actory Reset			
	Load Co	onfiguration			

9.2 Loading Configuration from files

Instead of loading a configuration directly from an ADRs memory, it is possible to load a configuration from a file stored on the PC.

This is useful where the same configuration needs to be applied to multiple ADRs quickly; whilst the ADR stores its configuration file in internal memory, if the same configuration is to be used for multiple ADRs, the configuration may be opened from file, and then saved into each ADR.

The configuration files are saved as human readable .XML files.

wer	Event Down					
		load	4	ADR Configurati	ion	ADR Health
s						
.oad Con	figuration	•		From File		
ave Conf	figuration	►		From ADR		
Close Cor	figuration					
Config Fa	ctory Reset					
.oad Con	figuration					
	oad Con ave Conf Close Cor Config Fa .oad Con	oad Configuration ave Configuration Close Configuration Config Factory Reset coad Configuration	oad Configuration	oad Configuration iave Configuration Close Configuration Config Factory Reset coad Configuration	oad Configuration From File iave Configuration From ADR Close Configuration Config Factory Reset cond Configuration Configuration	oad Configuration From File iave Configuration From ADR Close Configuration Config Factory Reset cond Configuration Configuration

Figure 15 - Opening an ADR Configuration File



9.3 Saving Configuration to ADR

Once changes are made to a configuration that has been loaded from an ADR, or from a file, the configuration needs to be saved back into the connected ADR, using Actions > Save Configuration > To ADR.

It is possible that the ADR may reject the configuration, if invalid configuration settings are applied, such as setting the MWL thresholds lower than the event thresholds. Whether the configuration is accepted or rejected, ADR Utility will notify you.

If the configuration update is successful, the ADR performs a soft reboot whereby all of the configuration settings are applied as if the ADR is powering up from cold, which includes performing a sensor zeroing, as the orientation settings may have been changed.



Figure 16 - Saving a Configuration to ADR

Figure 17 - Successful Configuration Update Notifications

ADR not	ificatior	n ID 117.	×
1	Config A new it will config	guration Update OK v configuration was just successfully applied to the ADR, now perform a soft reboot, to apply all of the juration settings to the relevant sub systems.	
		ОК	
A	DR noti	fication ID 121.	>
	1	Sensor zeroing complete. The ADR has successfully finished zeroing all of its iner sensor channels.	tial
		OI	(



10 Fault Handling

The ADR incorporates an extensive fault management system, which at the time of homologation monitors more than 80 possible fault conditions. The fault management system is designed to achieve several key objectives:

- 1. **Prevent physical damage to the ADR** some conditions require software interaction from the ADR, for example latching off CAN bus termination resistors under persistent thermal overload conditions due to damaged CAN bus wiring
- 2. **Maximise availability of the ADR system** if subsystems or specific functions of the ADR become faulty, but the ADR is able to continue functioning with a degradation in performance, or loss of a particular function, the fault management system enables this
- 3. **Maximise fault information to the user** allows an informed decision to be made as to the validity of captured event data. For example, if an ADR is heated above the maximum operating temperature, the accuracy of the internal sensors is degraded

10.1 Hard vs Soft Faults

Faults are categorised into 1 of the 2 following severity categories:

- 1. **Hard faults** these are high severity faults, which the ADR cannot recover from and results in a total loss of ADR function. The number of possible hard fault conditions is limited.
- 2. Soft faults these are low severity faults, which if present do not fundamentally prevent the ADR performing its function but may impact quality or correctness of data captured. For example, a fault with the backup power supply system may impact the ADRs ability to power itself should the main vehicle supply is lost, but so long as this external supply remains present the ADR is able to continue performing all of its functions

10.2 Inclusion in Events

Every event captured by the ADR includes within its <u>event file</u> a list of any faults that were set at any point during the event. This allows an informed assessment to be made as to the impact any faults may have on the validity of event data.



For example, a fault set due to intermittent reception of steering angle data via CAN, as opposed to a steady stream of data, informs the user that the events steering angle data is unreliable.

10.3 Viewing in ADR Utility

There are 2 different contexts in which ADR faults may be viewed in ADR Utility:

- 1. As a record of faults captured as part of an event
- 2. As a list of faults currently set within an ADR currently connected to *ADR Utility*, including historic fault information, via the ADR Health tab.

Both current, and historic faults are displayed viewed, including a count of the number of times a given fault code has been set.

Fault set counts may only be cleared (under the Actions menu) by the user for CAN related faults, as these faults are set due to external factors (such as damaged bus wiring), whereas all other faults relate to internal functions of the ADR.

In the image below, ADR Utility shows the current fault information for an ADR configured to communicate via CAN, but is receiving FIA message 2 at an incorrect frequency, thus raising a CAN_MSG_2_PERIOD_ERR fault.

A description of what each fault code means, and its associated implications is displayed directly in the fault list.

iewer Ev	vent Download ADR Configuration	ADR Health								
with Look										
restrugs										
tic Paramete	ers				Di	iagnostic Trouble Con	ies (Faults)			
splay Filters					11	Display Filters	Actions			
id	Name	Description	Value	Value Units		- Fault Code	Name	Description	Set Count	G
0	N SYSTEM RESETS LIFE	Internal use only.	34	count				The CAN message defined by FIA 8872 as 'message 2', has been recently		
1	N_WDT_RESETS_LIFE	Internal use only.	0	count				received within the duration of an event, at a frequency either too fast, or too		
2	N_EXTERNAL_RESETS_LIFE	Internal use only.	17	count		66		slow, i.e the standard requires this message be sent to the ADR at 100Hz, but if it's actually being received at for example 50Hz, or 300Hz, this fault will be		
3	N_BOD_VDD_RESETS_LIFE	Internal use only.	0	count				set. This fault is self clearing if it has not been seen for more than an event		
4	N_BOD_CORE_RESETS_LIFE	Internal use only.	0	count				durations length.		
5	N_POWER_RESETS_LIFE	Counts how many times the ADR has been power cycled. This counter is kept alive by the internal backup supply however -so an ADR which is disconnected from the vehicle supply, but does not switch off before being reconnected, due to the internal backup supply remaining powered, will not count a power cycle.	15	count						
6	TOTAL_CAPTURED_EVENTS	The total number of events triggered and captured by the ADR in it's lifetime.	53	count						
7	TOTAL_EVENTS_LOST_OVERWRITTE	The number of stored events in the ADR's lifetime, which were never downloaded before being overwritten by a new event.	0	count						
8	CFC60_X_MAX	Maximum absolute acceleration sensed whilst powered on the high range, CFC60 filtered, X axis acceleration channel. This channel has a maximum range of 200g.	13.6	9						
9	CFC60_Y_MAX	Maximum absolute acceleration sensed whilst powered on the high range, CFC60 filtered, Y axis acceleration channel. This channel has a maximum range of 200g.	54.32	9						
10	CFC60_Z_MAX	Maximum absolute acceleration sensed whilst powered on the high range, CFC60 filtered, Z axis acceleration channel. This channel has a maximum range of 200g.	68.03	9						
11	LO_RANGE_CFC60_X_MAX	Maximum absolute acceleration sensed whilst powered on the low range, CFC60 filtered, X axis acceleration channel. This channel has a maximum range of 16g.	16	9						
12	LO_RANGE_CFC60_Y_MAX	Maximum absolute acceleration sensed whilst powered on the low range, CFC60 filtered, Y axis acceleration channel. This channel has a maximum range of 16g.	15.32	g						
13	LO_RANGE_CFC60_Z_MAX	Maximum absolute acceleration sensed whilst powered on the low range, CFC60 filtered, Z axis acceleration channel. This channel has a maximum range of 16g.	16	9						
14	GYRO_X_MAX	Maximum absolute gyroscopic rate sensed whilst powered on the X axis gyroscope channel. This channel has a maximum range of 2000dps.	1089.17	deg/sec						
15	GYRO_Y_MAX	Maximum absolute gyroscopic rate sensed whilst powered on the Y axis gyroscope channel. This channel has a maximum range of 2000dps	739.14	deg/sec						
16	GYRO_Z_MAX	Maximum absolute gyroscopic rate sensed whilst powered on the Z axis gyroscope channel. This channel has a maximum range of 2000dps	1982.79	deg/sec						
17	TEMP_MAX	Maximum ADR temperature sensed whilst powered on.	33.62	degC						
18	TEMP_MIN	Minimum ADR temperature sensed whilst powered on.	22.41	degC						
19	TEMP_BINS	Internal use only.	0,0,0,0,0,0,0,0,0,0,0), %/bin	- 11					
20	PRES_MAX	Maximum ADR internal case pressure sensed whilst powered on.	1018	mBarA						

Figure 18 - ADR Utility Connected ADR Fault Information

Connection Controls 🔹 | Connection Status: Connected | ADR Serial: 13



Faults captured as part of an event, are displayed within Event Viewer under the Event Faults tab, per the image below. Capturing of this fault information is extremely important when it comes to assessing the validity of captured data.

For example, if data on one or more of the CAN channels appears to contain nonsensical data, but the internal channels appear OK, and the event contains <u>CAN related faults</u>, it is possible to determine that there was an issue with CAN communication during the event rendering the CAN channels untrustworthy.

Figure 19 - Event Faults





11 Diagnostics

At all times whilst the ADR is powered on, a diagnostic record is maintained, monitoring parameters such as temperatures, uptime duration, and number of events captured.

There are nearly 40 different diagnostic parameters monitored. The diagnostic record is viewable in ADR Utility, in the 'ADR Health' tab, similar to <u>viewing fault codes</u>.

The diagnostic record **cannot** be reset by the user.

As per the fault code information, a descriptor of each diagnostic parameter is displayed in the user interface.

Figure 20 - ADR Utility Connected ADR Diagnostic Information

Hit Parameters Japhy Filters A Normal States (1997) Keynthak (2015) 111 Normal States (1997) Keynthak (20									
Open Filter 0 New Construct APERTO LIFE Method and an analysis of the second and analysis of the second anal				Diagnos	stic Trouble Code	is (Faults)			
Id Name Description N_NOTRATESTS.UF Internal or exoly. 1 N_WOTRATESTS.UF Internal or exoly. 1 N_WOTRATESTS.UF Internal or exoly. 1 N_WOTRATESTS.UF Internal or exoly. 2 N_UTRATESTS.UF Internal or exoly. 3 N_UDO.URG_ESTST.UF Internal or exoly. 4 N_BOD.CRE_ESTSTS.UF Internal or exoly. 5 N_DOWR_ESTST.UF Internal or exoly. 6 TDIAL_CAPTURED_VINTS Memory and or exol or exo				170	isplay Filters 👌	Actions			
0 N_XYSTAM RESTLY.IF Internal use endy, 1 N_XDE_RESTL_VIF Internal use endy, 2 N_XDE_XDE_XST_VIF Internal use endy, 3 N_XDE_XDE_XST_VIFF Internal use endy, 4 N_XDE_XDE_XST_VIFF Internal use endy, 5 N_XDE_XDE_XST_VIFF Internal use endy, 6 XDEAL_CORE_XDE_XFFF Internal use endy, 7 XDEAL_CARTURED_XFFKF Internal use endy, 7 XDEAL_CARTURED_XFFKF The total mumber of endXFF total backs page phy bad do indy index. 8 XDEAL_CARTURED_XFFKF The total mumber of endXFF total backs page phy bad do indy index. 9 CFC60_X_MAX The total mumber of endXFF total backs page phy bad do indy index. 9 CFC60_X_MAX The total mumber of endXFF total backs page phy bad do indy index. 10 CFC60_X_MAX Maximum abolds as societation seres of white phy anew phy and do indy index. 11 LD_RAMES_CFC60_X_MAX Maximum abolds as conclusions end white phy anew phy and do indy index. 13 CD_RAMES_CFC60_X_MAX Maximum abolds as conclusions end white phy anew phy and do indy index. 14 OVRO_X_M		Value	Value Units		Fault Code	Name	Description	Set Count	Curr
1 N_WOT_RESTS_LIFE Internal use only. 2 N_UTENAL_RESTS_LIFE Internal use only. 3 N_UDO_NO_RESTS_LIFE Internal use only. 4 N_UDO_RESTS_LIFE Internal use only. 5 N_DOWR_RESTS_LIFE Internal use only. 6 TDIM_CAPTURED_FUNDTS The internal use only. 7 TDIM_CAPTURED_FUNDTS The internal use only. 8 TDIM_CAPTURED_FUNDTS The internal use only. 9 CFG6_X_MAX The internal use only. 9 CFG6_X_MAX The internal use only. 11 O_JANGE_CFG0_X_MAX The internal use only. 12 O_JANGE_CFG0_X_MAX The internal use only. 13 O_JANGE_CFG0_X_MAX The internal use only. 14 ON_JANGE_CFG0_X_MAX The internal use only. 15 ON_JANGE_CFG0_X_MAX The internal use only. 14 ON_JANGE_CFG0_X_MAX The internal use only. 15 ON_JANGE_CFG0_X_MAX The internal use only. 16 ON_JANGE_CFG0_X_MAX Maximum shoulde scocleations needed bind in the un		40	count				The ADR CAN is warning of a possible impending 'bus off' condition due to a		
2 N_DOTENAL_SIGST_UFF Internal use only. 3 N_DOD_DOTESTS_UFF Internal use only. 4 N_DOD_DOTESTS_UFF Internal use only. 5 N_DOVER_SIST_UFF Internal use only. 6 TOBM_CAPTURE_DOTESTS_UFF Internal use only. 6 TOBM_CAPTURE_DOTESTS_UFF Total use on more of events together and only use discovered from the which exapply, bard do in discovered to the structure of the structure of events together and only users. 7 TOBM_CAPTURE_DOVERNOWTH The total number of events together and only users. 9 CFC00_V_MAX Total users. 10 CFC00_V_MAX Total users. 11 U_DANAGE_CFC00_V_MAX Total users. 12 U_DANAGE_CFC00_V_MAX Total users. 13 U_DANAGE_CFC00_V_MAX Maximum should a code and on the more only users. 14 OYR0_V_MAX Total users. Total users. 13 U_DANAGE_CFC00_V_MAX Maximum should a code and on the structure on users. Maximum should a code and on the structure on users. 14 OYR0_V_MAX Maximum should a code and on the structure on usere structure on usere structure on users.		0	count				high number of bus faults, as defined by the CAN 2.08 standard. Note the		
3 N, BOD, 2000, RESTS, LIFE Internal case only. 4 N, BOD, CORE, RESTS, LIFE Internal case only. 5 N, POWRR, RESTS, LIFE Counts how may firme the ADR has been power only. 6 TDBL, CAPTURED, LYNEN Counts how may firme the ADR has been power only. 7 TDBL, CAPTURED, LYNEN The manual case only. 8 TDBL, CAPTURED, LYNEN The manual case only. 8 TDBL, CAPTURED, LYNEN The manual case only. 8 TDBL, DENKS, LOC, OXENNENT The manual case only. 9 CFGR, Z, MAX Maximum should as power only. 10 CFGR, Z, MAX Maximum should as calculated and the should be additionation. 11 C, J, MAX Maximum should as calculated and the should be additionation. 12 C, J, MAX Maximum should as calculated and the should be additionation. 13 C, GR, MAX Maximum should as calculated and the should be additionation. 14 C, MAX Maximum should as calculated and the should be additionation. 15 CFGR, Z, MAX Maximum should as calculated and the should and the should and the should as additis addit the should as additionation.		17	count		61	CAN_BUS_ERROR_WARNING	preventing correct transmission or reception of messages. Another possible		
4 N, BOD, CORE, JESTE, LIFE Internal aux only. 5 N, DOWR, RESTL, LIFE Coulds the many inners the ADD has been poor 6 TDIML, CATURED, SHITE Coulds the many inners the ADD has been poor 6 TDIML, CATURED, SHITE The state state of the mark state poor 7 TDIML, CATURED, SHITE The state state of the mark state poor 8 CFCR0, LMAX The state state of the state s		0	count				cause is having configured the ADR for message transmission or reception		
5 N. DOWR RESTS LFE in the second second second second second second second second in the second secon		0	count				without physical connection to the bus being made.		
3 N_DOWR_RESET; LIFE is argue and op the interval to be pay pay how the interval to be	n power cycled. This counte	f			62	CAN_ERROR_PASSIVE	in signalling bus errors, due to a high number of errors detected on the bus.	110	
6 UTDAL_CAPTURED_UNITS International of early the provide international capital and capital provides in the AGPY tables and tab	nowever - so an ADR which out does not switch off befo ckup supply remaining	re 15	count		71	CAN_MSG_1_RX_TIMEOUT	The CAN message defined by FIA 8872 as 'message 1', has not been received for >3 expected message periods within the duration of an event, Le this message was either being sporadically transmitted onto the burby the sending node, or not transmitted at all. This fault is self claimin if it has not	83	
7 TDIAL_PHENTS_LOST_OVERNMETTR The number of intered remet in the ADD's Melling ownerskie by area within the number of the rest operative high rest o	captured by the ADK in it's	61	count				been seen for more than an event durations length.		
Barrison Testing and the second	lifetime, which were never a new event.	0	count		72	CAN MSG 2 RX TIMEOUT	The CAN message defined by FIA 8872 as 'message 2', has not been received for >3 expected message periods within the duration of an event. Le this message was either being sporedically transmitted onto the bus by the	83	
9 CFC0, V_MAX manufacture with the second se	hilst powered on the high channel. This channel has a	13.6	9				sending node, or not transmitted at all. This fault is self cleaning if it has not been seen for more than an event durations length.		
10 CFC60_Z_MAX Imaging_CFC00000000000000000000000000000000000	hilst powered on the high channel. This channel has a	54.32	9		73	CAN_MSG_3_RX_TIMEOUT	for >3 expected message beinds up have don't as intestage 5, its indo been received for >3 expected message periods within the duration of an event. Le this message was either being sporadically transmitted onto the bus by the sending node, or not transmitted at all. This fault is self clearing if it has not	85	
11 O, JAAGE, CFGB, X, MAX Maximum headshift ac oblerity content white present white p	mist powered on the high channel. This channel has a	68.03	9				been seen for more than an event durations length. The CAN message defined by FIA 8872 as 'message 4', has not been received for >3 sepected message periods within the duration of an event. Le this		
12 O_,PAAGE_CFC60_Y_MAX Mainimum backbild exceleration sometal white groups of the second sometal model and groups of the second sometal model	hilst powered on the low channel. This channel has a	16	9		74	CAN_MSG_4_RX_TIMEOUT	message was either being sporadically transmitted onto the bus by the sending node, or not transmitted at all. This fault is self clearing if it has not been seen for more than an event durations length.	85	
ID U.S. ANGE_CFCBU_ZMAX Maximum backbut a scalatation consert whiting many field of the same scalatation consert white manimum range of TLB_max scalatation conserts with a maximum backbut as scalatation to maximum scalatation as maximum scalatating maximum scalatation as maximum scalatating maximum scalatatin	hilst powered on the low channel. This channel has a	15.32	9		75	CAN MSG 5 BY TIMEOUT	The CAN message defined by FIA 8872 as 'message 5', has not been received for >3 expected message periods within the duration of an event. Le this message was either being sconsolically transmitted onto the bus by the	85	
14 OHO_X_MAX Masumum hashafe genocopic rest served with ong proceed returns. This charaft has an any served return to the charaft has any served to genocopic returns. This charaft has any served on genocopic returns. This charaft has any served on genocopic returns. This charaft has any served on genocopic returns. This charaft has any served to genocopic returns. This charaft has any served to genocopic returns and the served with served returns and the served with served returns and the served with served to the served returns and the served with served to the served returns and the served returns and the served returns and the served returns and the served returns and served returns and served returns and the served returns and the served returns and the served returns and served returns and the served returns are served returns and the served returns and the served returns and the served returns are served returns and the served returns and the served returns are served returns and the served returns are served returns a	hilst powered on the low channel. This channel has a	16	9				sending node, or not transmitted at all. This fault is self clearing if it has not been seen for more than an event durations length.		
Sories 2, Maximum Absolute genocopie on tessender Mil Sories 2, MAX Sories in genocopie on tessender Mil Sories 2, MAX Sories and the same Sories 2, MAX Sories and the same Sories 2, MAX Sories and the same Sories Sories and the same Sories Sories and the same Sories S	d whilst powered on the X a maximum range of	1089.17	deg/sec						
GYRO,Z, MAX Maximum absolute gyroscopic rate erned whi an igryoscope charmel. This channel hara r mas 2000bps TEMP_MAX Maximum ADR temperature sensed while to power TEMP_MAX Maximum ADR temperature sensed while to power	d whilst powered on the Y a maximum range of	914.25	deg/sec						
17 TEMP_MAX Maximum ADR temperature sensed whilst pow 18 TEMP_MIN Minimum ADR temperature sensed whilst powe	d whilst powered on the Z a maximum range of	1982.79	deg/sec						
18 TEMP MIN Minimum ADR temperature sensed whilst powe	t powered on.	33.62	degC						
	powered on.	22.41	degC						
19 TEMP_BINS Internal use only.		0,0,0,0,0,0,0,0,0,0	,0, %/bin						
20 PRES_MAX Maximum ADR internal case pressure sensed wi	sed whilst powered on.	1018	mBarA						



12 Power Supply

The ADR can be powered via 3 separate voltage sources:

- 1. Main vehicle supply
- 2. USB 5V supply
- 3. Internal backup power supply

12.1 Main Vehicle Supply

This is the power source most commonly used; supplying the ADR via the <u>Battery Positive</u> and <u>OV pins</u>. This supply is heavily filtered and protected against typical automotive transients, including reverse polarity connection.

When powered from the main supply the internal backup power supply may charge at its maximum rate of approximately 3.3W (<u>if configured to do so</u>).

12.2 USB 5V Supply

To allow a user to connect to the ADR using only an <u>ADR Interface Cable</u>, with no additional power source required, the ADR capable of being powered solely by a USB connection.

The only restriction is that the charging rate of the internal backup power supply is limited to approximately 0.4W, however in practice this is no real limitation, as once the ADR is reconnected to the vehicle harness and power supply, it will resume charging at maximum <u>configured</u> power.

The ADR otherwise behaves exactly as if it were powered by the vehicle supply, allowing the user to perform all necessary functions.

12.3 Backup Power Supply

Under normal operation, the ADR is externally powered via one of the two external supplies described above.

However, in the event of an interruption or loss of the external supply (for example due to a severe accident which damages the vehicles electrical system), then to allow the ADR to continue performing all its functions, it utilises an internal backup supply.

The internal backup supply is a supercapacitor backup system, charged when connected to an external supply. These supercapacitors supply power into the input of the ADRs



various power supplies, such that it can continue normal functioning when operating from the backup supply.

The backup supply charge power is software configurable within ADR Utility.

The charge current may be configured between 0 and 400mA – note this is current at 5V, not at the supply voltage of the ADR. When the ADR is powered with >5V, the current drawn by the ADR due to charging will be less than the configured current, approximately in accordance with the formula power = voltage x current.

See <u>Table 3 - Current Consumption</u> for the current drawn at 13.8V supply voltage, for a 400mA configured charge current.

🗣 Emvexis ADR I	Jtility				
() Utility Setting	gs 💥 ADR Tools	(6) Restricted ADR Tools	? Help		
Event Viewer	Event Download	ADR Configuration	ADR Health		
Actions					
Read-Only Co	nfiguration Propertie	s		Backup Power Supply Charge Co	ntrol
				Maximum Charge Current	400 💌 mA (0-400) [at 5V charge voltage]
Configuration	User Parameters				
			? / ? characters		
Configuration	Categories				
. User Settin Contro Backup	igs iller Area Network (C. 9 Power Supply aicators	AN)			
	(FIA Only) Settings				
Configuration	Categories gs Iler Area Network (C. <mark>2 Power Supply</mark> Grators (FIA Only) Settings	AN)	? / ? characters		

Figure 21 – ADR Utility Configuring Charge Current



13 Real Time Clock

The ADR features an internal real time clock used to keep track of the current year, month, day, weekday, hour, minute and second, for the purposes of timestamping events.

The RTC automatically handles calendar exceptions such as leap years.

A dedicated internal backup battery ensures the clock remains continuously powered and is sized to last longer than the FIA homologation validity period of the ADR and is thus not user serviceable.

The battery is replaceable by Emvexis if required.

14 Communication

The ADR features multiple communication interfaces, for the following purposes:

- 1. Setup and configuration of the ADR
- 2. Capturing of additional data from the vehicle's communication networks
- 3. Broadcasting of data from the ADR, onto the vehicle's communication networks
- 4. Providing 'expansion' capability to interface with other devices, such as external GPS receivers

14.1 USB

The ADR features a USB 2.0 interface, used for both configuration and event download. No special software drivers are necessary, all the necessary drivers are built into Windows®.

14.2 CAN

The ADR hardware supports both classical CAN, and CAN-FD according to ISO 11898-1:2015, but implements only classical CAN, to comply with the requirements of FIA 8872-2018.

The physical interface is designed to be electrically robust, with multiple layers of fault protection and tolerance, in addition to extensive application-software level diagnosis to detect conditions such as missing messages, or incorrect message reception frequency.



Configuration of the ADRs CAN functionality is limited due to the requirements of the FIA 8872-2018 regulation. For example, the number of, frequency and contents of messages are all strictly defined by the regulation, and thus are not configurable.

CAN may be entirely enabled or disabled on an ADR, to account for the fact that some ADR installations will not make use of CAN, and disabling CAN will prevent the ADR raising <u>soft</u> <u>faults</u> indicating that CAN communication is not active.

Configurable settings include:

- Bus termination options
- Which incoming, and outgoing messages are enabled
- Single, <u>configurable out message</u> for external MWL triggering

14.2.1 Software Selectable Bus Termination

If bus termination is required at the ADR, no external termination resistors are required. The ADR features internal, software selectable 120Ω termination, comprised of two series 60Ω resistors with software selectable, center tap, split termination filtering.

The termination resistors are protected from thermal overload during short to VBAT and short to 0V conditions, at $24V_{DC}$.

Configuration of the termination is performed using *ADR Utility*, as per below. The CAN must be enabled for the ADR, **even if no messages are enabled**, for the option to enable termination to become available.



Figure 22 - CAN Bus Termination Configuration

🔶 Emvexis ADR Utility					o ×
Utility Settings 💥 ADR Tools 🔞 Restricted ADR Tools 🕜 Help					
Event Viewer Event Download ADR Configuration ADR Health					
: Actions					
Read-Only Configuration Properties	CAN				
	General Settings	FIA 8872 Messages			
	Node Enable	Enable Inbound Messages	Enable Outbound Messages		
	Enabled ~	Message 0	Message 5 Message 6		
	Node Termination	Message 2			
	Enabled - 120 ohm	Message 3	▼		
	Enabled - 120 ohm				
Configuration User Parameters	Nenabled 120 oprin, with split filter				
	The MWL message is a user configurable CAN. The message is sent as a CAN 2.0B	message used to turn on/off an external Standard Frame, with a user configurable	Medical Warning Light via ID and a single data byte.		
	The ID and data values must be specified	I by the user, and entered in hexadecimal I	ormat (e.g. 0xFB).		
	Enable Message Transmission				
	Message ID	Enable MWL Data Byte	Disable MWL Data Byte		
	0x00000010	0x01	0x00		
? / ? characters					
Configuration Categories					
- User Settings					
Controller Area Network (CAN) Backup Power Supply					
- LED Indicators					
B- Restricted (FIA Only) Settings					
🛱 Connection Controls 👻 Connection Status: Connected ADR Serial: 13					

14.2.2 FIA Standard Messaging Protocol

The FIA 8872-2018 standard defines a set of messages that must be sent to the ADR by the vehicles other systems, including the message IDs and data formats, in addition to the messages that the ADR transmits.

It is permissible for other messages to be present on the bus, the ADR will simply not accept those messages.

All multi-byte fields use big-endian byte order.

Byte	Description	Scaling	Туре	
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			
4-5	Lap distance	1 m/bit	16-bit unsigned	
6-7	Throttle actuator position	0.1 %/bit	16-bit signed	

Message 1, ID: 0x200, Rate: 100Hz, Direction: Input to ADR



Message 2, ID: 0x204, Rate: 100Hz, Direction: Input to ADR

Byte	Description	Scaling	Туре	
0-1	Vehicle wheel speed	0.1 kph/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, ID: 0x680, Rate: 10Hz, Direction: Input to ADR

Byte	Description	Scaling	Туре
0-3	GPS latitude	107 dograas	22 bit fixed point (7dps) value
4-7	GPS longitude	Ter degrees	52-bit fixed point (7 dps) value

Message 4, ID: 0x681, Rate: 10Hz, Direction: Input to ADR

Byte	Description	Scaling	Туре
0-3	GPS time	HHMMSSsss ¹	32-bit unsigned
4-5	GPS speed	0.1 kph/bit	16-bit unsigned
6-7	GPS altitude	0.1 m/bit	16-bit signed

- 1. GPS time encoding example: 23hrs 30mins 40secs 999millisecs, encoded as unsigned numerical integer whose value is 233040999, or 0xDE3EC67. Value is transmitted to ADR as:
 - a. Byte 0: 0x0D
 - b. Byte 1: 0xE3
 - c. Byte 2: 0xEC
 - d. Byte 3: 0x67

Message 5, ID: 0x682, Rate: 10Hz, Direction: Input to ADR

Byte	Description	Scaling	Туре
0-2	GPS date	DDMMYY ¹	24-bit unsigned
3-7	unused	-	-

1. GPS date encoding example: 18th June 2024, encoded as an unsigned numerical integer whose value is 180624, or 0x2C190. Value is transmitted to ADR as:

- a. Byte 0: 0x02
- b. Byte 1: 0xC1
- c. Byte 2: 0x90.



Message 6, ID: 0x7B, Rate: 10Hz, Direction: Output from ADR

Byte	Description	Scaling	Туре	
		0 = no accident		
0	Accident Severity Index	1-255 = maximum absolute acceleration	⁹ bit unsigned	
		of last accident detected since power on	o-bit unsigned	
1	ADR firmware version	10 (e.g. version 3.7 = 37 = 0x25)		
2-3		See table below	bitmapped	
4-5	ADR serial number	1	16-bit unsigned	

Table 11 - Message 6 Status Bitfield Descriptor

Bit	Description	State
0	Logging in progress	 1 if an event has been triggered, completed, and is now currently writing to flash. I.e. this bit only goes to 1 for a few seconds after an event has completed, else 0. Bit 4 is more likely to be useful for use by another system.
		1 if the ADRs configuration is OK (did not fail CRC-32
1	ADR configuration OK	integrity check) and is in use, else 0 and the ADR is
		using factory default configuration settings.
2	CAN communication OK	1 if CAN is enabled, and no CAN Protocol Faults are
2		set, else 0
3	Accident stored	1 if ADR contains at least one stored event, else 0
4	Accident active	1 if an event is currently triggered, and in progress, else 0
5	Download mode	1 if USB interface is connected to ADR Utility (not just plugged into PC), else 0
6-15	Unused	Always 0

Message 7, ID: 0x81, Rate: 10Hz, Direction: Output from ADR

Byte	Description	Scaling ^(2,3)	Туре
0-1	Gyroscope yaw rate (rate about Z axis)	7 LSB/0.060975dps	
2-3	Acceleration Y (gCFC60Y) ¹		16-bit signed
4-5	Acceleration X (gCFC60X) ¹	16 LSB/0.098g	
6-7	Acceleration Z (gCFC60Z)		



- 1. Note channel order of YXZ is correct per FIA 8872-2018. YXZ means lateral, longitudinal, vertical, as would typically be expected from a vehicle coordinate system.
- 2. Gyroscope field increments and decrements in steps of 7 LSBs, i.e. never will 4 LSBs be set for example, only 0, 7, 14, 21 etc. This CAN channel contains a nominal 0.35% error due to scaling, and resolution limitations of the CAN channels. This error is **not** present in event files downloaded from ADRs.
- 3. Acceleration fields increments and decrements in steps of 16 LSBs, i.e. never will 9 LSBs be set for example, only 0, 16, 32 etc. Accelerometer calibration values are **not** applied to data broadcast on these channels, therefore these channels contain data accurate only to +/- 10%. These channels contain a nominal 2.1% error due to scaling, and resolution limitations of the CAN channels. This error is **not** present in event files downloaded from ADRs.

14.2.3 User Configurable MWL Trigger Message

In addition to the standard FIA messages described above, the ADR supports 1 user configurable outbound message, used to control an external Medical Warning Light via CAN.

To use the message, CAN must be enabled, and the 'Enable Message Transmission' option enabled underneath Medical Warning Light Message.

The message is a CAN 2.0B standard length frame, with a single data byte. The message ID must be set to avoid ID collisions with other CAN traffic in the vehicle.

The 'Enable MWL Data Byte' and 'Disable MWL Data Byte' are the values transmitted in the messages single data byte, that indicate when the MWL should be active, or not. Typically a value of 0, and 1 is used to indicate off/on, but they may be any value between 0-255. The device receiving and acting upon this message needs to be configured accordingly.

Emvexis ADF	RUtility					-	×
Otility Setting	gs 💥 ADR Tools	Bestricted ADR Tools	(?) Help				
Event Viewer	Event Download	ADR Configuration	ADR Health				
Actions							
Read-Only Co	onfiguration Properties		CAN				
			General Settings	FIA 8872 Messages			
			Node Enable	Enable Inbound Messages	Enable Outbound Messages		
			Enabled	V Message 0	Message 5		
			Node Termination	Message 1	Message 6		
Configuration	I lser Parameters		Enabled - 120 ohm	✓ Message 2	•		
Conniguration	r oser Parameters						
			Medical Warning Light Messag	e			
			The MWL message is a user o	onfigurable message used to turn on/off an externa	Medical Warning Light via		
			CAN. The message is sent as The ID and data values must	a CAN 2.0B Standard Frame, with a user configurabl	e ID and a single data byte. format (e.g. 0xEB)		
		?/?characte	rs	se specifica by the user, and entered in nexadecima	format (e.g. oxi b).		
Configuration	Categories		Enable Message Transmiss	ion			
🖃 User Setti	ngs		Message ID	Enable MWL Data Byte	Disable MWL Data Byte		
Contro	oller Area Network (CA	N)	0x00000010	0x01	0x00		
LED In	dicators						
- Restricted	(FIA Only) Settings					—	
- Event	Triggers						
_			•				
Connection (Controls 🔻 Con	nection Status: Connected	ADR Serial: 13				



14.2.4 CAN Protocol Faults

The ADR features extensive diagnostic of faults related to the CAN system, at both the hardware and communication protocol level. Whilst all of these faults are described in ADR Utility where they appear, the CAN Protocol Faults require special attention.

There are 2 types of CAN fault in particular that are particularly informative: period error faults, and timeout faults, displayed in ADR Utility with the following naming format:

- FAULT_CAN_MSG_n_PERIOD_ERR (fault codes 65-69)
- FAULT_CAN_MSG_n_RX_TIMEOUT (fault codes 71-75)

Period error faults indicate that whilst CAN message traffic is being received, it is being received either sporadically, or at the incorrect frequency. For example messages may stop being received in short bursts, resulting in 'windows' of missing CAN data.

Timeout errors indicate CAN messages have stopped being received altogether. In this case valid data may have been being received, until it stopped.

The two types of faults can co-exist, which would indicate sporadic reception of CAN messages, followed by the messages no longer being received.

14.3 RS-232

A full duplex RS-232 port is provided, with robust electrical protection. This port allows the ADR to interface with any other device implementing RS-232.

However, no software provision is made for this at the time of writing and is provided primarily as a requirement of the FIA 8872 technical regulations, which requires the inclusion of RS-232 hardware but prescribes no requirement for software support.

However, custom functionality may be implemented upon request - please contact Emvexis to discuss your requirements.



15 Installation Instructions

The ADR must be installed in accordance with the <u>FIA Installation Specification for FIA-Approved 8872-2018 Accident Data Recorders (ADR)</u> document.

The FIA specification controls almost all aspects of an ADR installation, except those specific to each manufacturer's ADR. For the Emvexis ADR1, the following supplementary installation instructions apply:

15.1 Orientation

For the ADR to record acceleration and gyro data in the correct event data channels, the ADR must be physically installed within the vehicle in the orientation that the ADR is configured for.

The vehicle coordinate system is defined by FIA 8872-2018 and is different from common automotive standards such as SAE J1733.

The FIA coordinate system is in accordance with the image below. Positive values represent the direction the vehicle must be accelerated in along a given axis, for the recorded data to contain positive values.

For example, a vehicle accelerating forward at a race start will capture positive X acceleration, and when braking into a corner will record negative X acceleration.

Figure 23 - Accelerometer Channel Orientations





Gyroscope orientation is aligned such that clockwise gyro rotation when looking in the direction of an acceleration axis, results in positive gyroscopic data, as per the below image.

Figure 24 - Gyroscope Channel Orientations



The orientation of the ADR within the vehicle is fully configurable using the *ADR Utility* software, but is a restricted configuration parameter requiring authentication by passcode to perform the configuration.

The orientation configuration ensures that regardless of the ADRs orientation within a vehicle, the event data channels always contain **vehicle aligned** data, not ADR aligned data. That is when properly configured, regardless of the ADRs orientation, the X axis acceleration dataset channel will always contain the vehicle's X axis acceleration, **not** the ADRs X axis acceleration.

In essence, the ADR itself does not have a coordinate system, per se.

The ADR shall therefore be installed in the default installation orientation as shown in the image below, unless absolutely necessary, and only with written permission from the FIA, and the ADR configured accordingly.



Figure 25 - Default Installation Orientation



15.1.1 Changing Orientation Configuration

As described above, only the FIA may configure the ADR installation orientation, using the tool shown below.

Figure 26 - ADR Utility Configuration Installation Orientation

🔶 Emvexis ADR Utility	-	×
Event Viewer Event Download ADR Configuration ADR Health		
i Actions		
Read-Only Configuration Properties Physical Installation Orientation Configuration User Parameters Orientation 3 ? /? characters Orientation 10 ? /? characters Orientation 10 ? /? characters Orientation 10 ? /? characters Orientation 10		
B Connection Controls → Connection Status Connected ADR Serial: 13		



15.2 Mounting

The ADR shall **always be hard mounted** within the vehicle. It does **not** require vibration isolation that is common with other electronics and **will not record accurate acceleration data if not hard mounted**.

To clarify heading 4.1 within the FIA installation requirements, the ADR does not need to be isolated from vibration to protect the ADR, but it should still not be installed in a location likely to experience high vibration, purely due to the possibility of such vibration being included in recorded event datasets.

For clarity, high frequency vibration is strongly attenuated by the ADRs internal hardware and software filters above 100Hz, but any low frequency vibration or 'panel panting' will be accurately recorded by the ADR.

15.3 Fasteners

The ADR shall be installed with 4x M4 mounting screws, at an installation torque appropriate for the hardware to which the ADR is being mounted.

It is recommended to use ensure \geq 8mm thread engagement into aluminium, or \geq 6mm into steel. These guidelines are not definitive, as they depend heavily upon the design of the surrounding structures.

Recommended fastener specifications:

- Geometric standard: DIN 912
- Material: Stainless steel A2-70
- Length: 25mm (provides ~10mm fastener protrusion from ADR underside)

Figure 27 - Recommended Fastener Length





15.4 Power Supply

The ADR shall be powered from a DC voltage source between the minimum and maximum voltage limits defined in <u>Table 2 – General System Specifications</u>. It is recommended to fuse the power supply with a 0.5A fuse.

The bare minimum electrical connections required are power and 0V. See <u>Electrical</u> <u>Connector Pinout</u>.

15.5 USB port accessibility

When the ADR is installed in a position within the vehicle where it can be easily accessed without tools, as per section 15.7, then a USB connection can easily be made to the ADR for the purposes of event download and configuration.

If however the ADR is installed in a position where it is not normally possible to access the ADR, the vehicle must feature a USB 2.0 bulkhead type connector, connected to the ADRs <u>USB pins</u>, in a location which can be easily accessed, such as a bulkhead or dashboard.

15.6 Connecting to CAN

When connecting the ADR to the vehicle's CAN network, the following points should be noted:

- When using the ADRs <u>software selectable</u>, internal 120Ω termination resistors to terminate the CAN bus, the termination is only active whilst the ADR is powered and running. Termination is disabled during ADR firmware update
- The ADRs CAN must be <u>enabled within the ADR configuration</u> before it will participate in CAN activity
- The ADR will only accept the incoming <u>CAN messages defined by the FIA regulation</u>, although it will continue to ACK non-accepted messages in accordance with the CAN 2.0B specification
- The ADR will only broadcast the <u>CAN messages defined by the FIA regulation</u>, in addition to <u>one user configurable message</u> used to trigger an external Medical Warning Light

15.7 External Indicator Lights

If the ADR is installed in a position such that the onboard status light is not visible, the vehicle must be equipped with 2 dedicated indicator LEDs:



- Status light, used to indicate general status of the ADR system
- Medical Warning Light, used to indicate to medical personnel when an accident of a configured severity has occurred

Both of these lights must be in a position that is normally visible to an FIA/ASN official when the occupant(s) is(are) seated normally and must be cleared marked 'ADR Status' and 'ADR MWL'.

The LEDs may be controlled by:

- The ADR's 2 constant current LED driver output pins, or,
- A third-party device such as a Power Distribution Module, capable of receiving and interpreting information via CAN from the ADR, to set the light states

The first option is strongly recommended, to mitigate the risk of misconfiguring third party systems, resulting in incorrect or non-functional indicator lights.



16 ADR Interface Cable

The electrical connection of the ADR within a vehicle is the responsibility of the vehicle designer, builder, or operator as the design of the harness depends upon the functionality of the ADR that is used or not and where the ADR is positioned in the vehicle etc.

However for simple interfacing with the ADR, Emvexis supplies ADR Interface Cables, which are simple USB male A, to the corresponding Deutsch/Souriau connectors <u>detailed here</u>. These allow you to perform all necessary functions, such as:

- Configure the ADR
- View diagnostics and fault information
- Download event and configuration files
- Clearing the Medical Warning Light

The cables are available in a standard length under the following part number, and available in custom lengths on request:

Length (minimum)	Part Number
3M	PN-131

The ADR connector is overmoulded onto the cable, in-house by Emvexis to produce a low-cost, mechanically robust cable assembly. Only pins 7, 8, 9 & 13 are populated in these cables.

The ADR is fully functional when powered only by USB using these cables, with the only restriction being the backup power supply <u>charge rate is limited</u> when on USB power only.

Figure 28 - Standard 3 meter ADR Interface Cable





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