Dart User Manual

Revision 1.0 – 14 January 2016

LOW COST, VERSATILE AND RELIABLE GPS/GLONASS TRACKING

For the latest version of this document, pricing and other product information please contact your local Digital Matter office.

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Revision History

Rev	Date	Description
1.0	7 Jan. 2016	First revision

2. INTRODUCTION

The Dart is a compact 2G or 3G tracking device with ignition, two additional digital inputs and one output. It caters for entry-level tracking applications, without sacrificing tracking and communications performance and reliability. Its compact housing contains the GPS and cellular antennas. All of the Dart's functionality is exposed through a 12 wire connector, allowing for quick and simple installations. The internal backup battery provides alerts and tracking operations even when external power is removed.

The Dart can simultaneously use GPS and GLONASS satellites, providing double the number of positioning satellites available to standard tracking products. It uses offline satellite aiding technology. The result is faster acquisition and more accurate and reliable tracking in locations where other devices just give up.

This user manual provides information commonly needed when evaluating, installing, supporting and maintaining the Dart. The manual will be updated as more functionality becomes available and as the support knowledge base grows. Please check the website for newer versions.

1. Background

The Dart is designed and manufactured by Digital Matter in South Africa and Australia. Both the device firmware and the supporting server infrastructure are written and maintained by Digital Matter.

2. Technical Specifications

For detailed technical specifications, please see the Dart Datasheet, available on the Digital Matter website. The datasheet also contains the product variants and product codes for ordering.

3. PRECAUTIONS

1. Static damage

The Dart may be damaged by electrostatic discharge if not handled correctly during installation. Ensure adequate static precautions are taken while the housing is open.

Take special care not to touch the ceramic GPS antenna.

2. Battery precautions

The Dart uses a Li-Po battery. If these batteries are not cared for correctly, their performance will degrade and they can be hazardous. For a complete guide to battery care, see the Digital Matter Battery Notice. This is a summary:

- Store batteries at room temperature.
- Maintain stored battery levels at 60% (about 3.8V) for maximum life.
- Check and recharge batteries every 4-6 months.

3. Not IP67 Rated

The Dart is **NOT** an IP67 rated device, unlike many other Digital Matter devices. To obtain an IP67 rated device, contact DM.

4. CLOUD INFRASTRUCTURE

The Dart relies on three backend web services for operation: OEM Server, the Software Platform Front Ends, and the u-Blox AssistNow Offline servers.

1. OEM Server

The Dart connects to the OEM Server for firmware upgrades and configuration. This server is hosted by Digital Matter, but can be licensed to 3rd parties to meet special requirements.

1. Data Connectors

The OEM Server provides Data Connectors that forward data records on to the software platform of your choice, including Digital Matter's own Telematics Guru and GPS Log Book platforms.

2. Device Administration

All Digital Matter devices are fully managed over the air via the OEM Server web interface. The OEM Server seamlessly manages:

- Device firmware – firmware updates can be done remotely.
- Network ('Admin') parameters relating to critical communications.
- System parameters, including GPS parameters, IO configuration, logging options and general device behaviour settings.
- Remote debugging of devices, including data trace, detailed debug message logging, and live debug message viewing capabilities.
- Remote disconnect and reboot of devices.
- Geo-fence syncing with the devices. This allows the device to do advanced alerting and monitoring, such as geo-fence arrival and departure detection, speed limit alerting, and disabling of communications inside intrinsically safe zones such as gas plants. These features are still in development on the Dart.
- Command and message queueing for the devices, which is incorporated in the remote management and debugging applications.

2. Software Platform Front Ends

Using the OEM Server's Data Connectors, the Dart can be used with a number of Software Platforms.

Current integrations include: Telematics Guru (DM), Key Telematics, and a number of other high profile platforms.

New platforms can be added in two ways:

- The software platform implements the DM protocols and a data connector is setup to forward the data to the platform. The two options for DM Protocols are raw data over TCP, and JSON over HTTP. Please contact DM for more information.
- DM can create a custom data connector to deliver the data in your platform's format and transport mechanism. Please contact DM for more information.

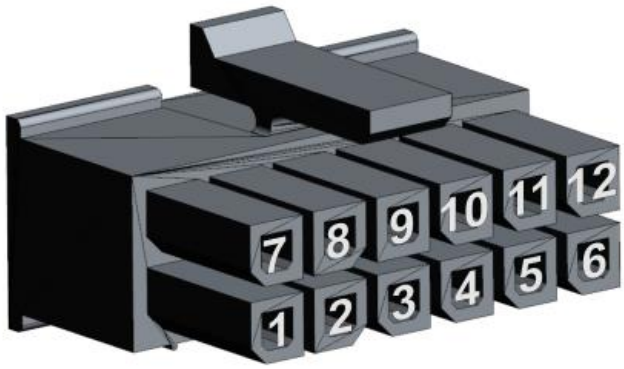
3. AssistNow Offline

The Dart relies on Aiding Data to improve GPS performance. Fresh aiding data allows rapid satellite acquisition even in low signal levels.

By default, the Dart will download new aiding data every 5 days, directly from u-Blox AssistNow Offline servers. When downloads occur, they are scheduled directly after an upload attempt. Aiding data works best when fresh, but remains useable for 2-3 weeks.

5. HARNESS DIAGRAM

The standard harness is a 12 way Molex connector, exposing 12 wires. There are other options for a cigarette lighter plug and an OBDII connector. The OBDII connector allows the Dart to source power and does not provide any vehicle diagnostic information.



Number	Colour	Function	Notes
1	Red	Voltage Input	7 – 36 Volts DC External Power
2	Black	Main Ground	Ensure this is grounded.
3	Purple*	System Rail Out	Pin 3 of 4 way Molex. Powers peripherals
4	Green*	TTL Receive	Pin 2 of 4 way Molex. TTL communication with peripherals
5	Pink	Digital Input 1	0 – 48 Volts DC
6	Black	Ground	Optional ground point
7	Black	Ground	Optional ground point
8	White	Ignition	0 – 48 Volts DC
9	Black*	Ground	Pin 1 of 4 way Molex. Ground for peripherals
10	Brown*	TTL Transmit	Pin 4 of 4 way Molex. TTL communication with peripherals
11	Blue	Digital Input 2	0 – 48 Volts DC
12	Yellow	Switched Ground 1	Low side switch. Use with a relay, LED, or buzzer.

* indicates that the wire is part of the 4 way Molex connector for TTL communication with periperhals.

6. INSTALLATION

1. SIM Installation

The SIM holder is on the top of the main board, between the two antennas.

When handling the Dart be careful not to touch the GPS antenna, to minimise the risk of damaging the sensitive GPS amplifiers with static discharge.

1. Unplug the battery and disconnect external power to ensure the mobile data connection is not active.
2. Unlock the sim holder by sliding the plastic bracket towards the hinge, in the direction of the harness side of the PCB.
3. The SIM should be inserted with the keyed corner on the non-hinged side, and the SIM contacts orientated down to the main board.
4. Press the SIM down, and relock the holder by sliding the plastic bracket away from the hinge.

The SIM card should either have no PIN set, or should have a PIN matching the Dart's PIN. The Dart's PIN can be retrieved from the OEM Server web interface.

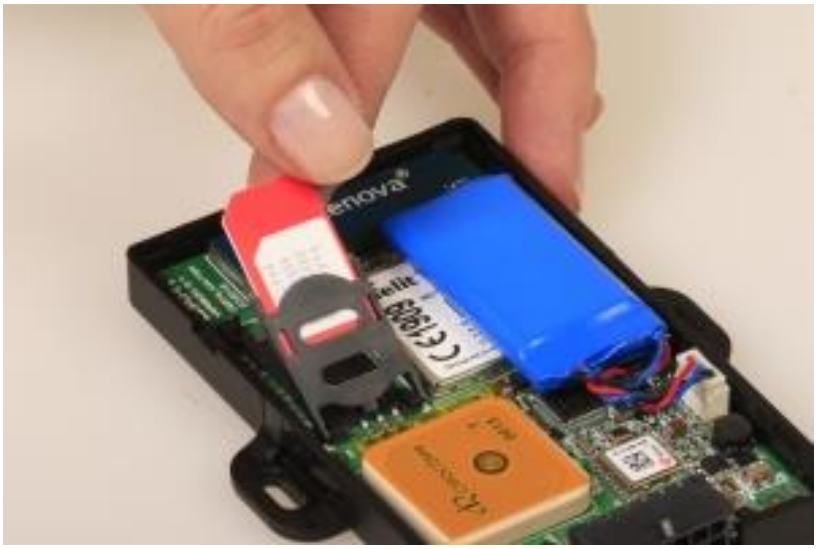


Figure 1: Inserting the SIM card.

2. Insert the battery

The battery should be stuck to the device. Do not move it. It is placed to avoid interference with the antennas.

The battery plug is a three way connector on the top of the main board.

1. Insert the battery plug into the connector. It should only be possible in one orientation.
2. The LED on the board will light up and flash if the battery has sufficient charge. Batteries are supplied fully charged.

Figure 2: Inserting the battery.

3. OEM Server

On battery insertion, the Dart will immediately connect to OEM Server to announce its presence. It will try to establish a GPS fix. It may be necessary to trigger another connection to confirm the GPS fix. Trigger a connection by connecting or disconnecting external power or toggling ignition.

It is essential to check that the device is connecting before placing it in the field. Refer to the document on OEM Server Setup. If you do not see a connection within a few minutes of battery insertion, double check that the device was reset correctly (LED flashed on battery insertion), that the SIM is correctly inserted, and that you have air-time and reasonable mobile reception.

Devices will either be pre-configured on OEM (firmware, system parameters, admin parameters, connector), or the distributor will need to set them up. The setup is important for the device to perform correctly. The default settings together with the automatic APN detection give a nearly plug-and-play experience. However, the connector must be set to forward data to the correct front end, and the front end must be setup to receive the data. Until the connector is set, the majority of uploaded tracking data is silently discarded.

4. Housing Assembly

Once the SIM and batteries are installed and the device is online, the housing can be closed. The lid of the housing clips into the base. No screws are required.

1. Place the lid on the base, and gently squeeze one side to engage the clips.
2. Squeeze the other side to engage the remaining clips.

Figure 3: A closed Dart housing.

5. Housing Disassembly

The housing can be opened by prying the lid from the base using a flat screw driver. A wide screw driver will ensure the housing is not marked.

Figure 4: The screw driver slot for opening the housing.

1. Locate the slot for the screw driver on the side of the housing.
2. Insert the screw driver and twist to pry the housing apart. Be careful with the clips.

6. Device Installation

The Dart can be mounted on the asset to be tracked using screws, bolts, cable ties, or industrial adhesives.

The high performance GPS and GSM antennas allow the device to be concealed. However, always check the GPS and GSM performance after installation.

The device is not IP67 rated, so be cautious when installing it in the engine bay or in an exposed location.

See section 5 for the wiring diagram.

7. MAINTENANCE

1. Battery Maintenance

Lithium Polymer batteries have a finite life. Depending on your application, battery maintenance may be important. For example, if used for stolen vehicle recovery, the backup battery is critical and should be replaced every 2-3 years.

When on external power, the Dart will run without a battery or with an old battery. There may not be any signs of aging or degradation until external power is removed.

8. DEVICE SETUP

There are three sets of non-volatile settings on the Dart:

1. The Admin Parameters, which contain critical connectivity settings
2. The System Parameters, which contain regular tracking settings
3. The Device State, which persists internal state across reboots

1. Parameter Setup on OEM Server

Device setup is primarily accomplished through the OEM Server web interface at http://www.oemserver.com. The Admin and System parameters can be configured using dialogs on the website, and pushed to devices individually or in batches. Both parameters sets are subdivided into various sections, which display as separate tabs in the web interface. Most users will only need to configure one or two sections of the System parameters, and none of the Admin parameters.

When the parameters are set on the web interface, they will be downloaded by the Dart on its next upload, and take effect as soon as the current trip ends.

Further details of the Admin and System parameters are given in sections 9, 10, 11, and 12.

2. Device State Changes on OEM Server

There are currently two properties on the Dart that live in the Device State, and are modified by menu options on OEM Server:

- Recovery Mode can be set or cleared in the Device Operations dropdown of the Devices screen. Recovery mode is an always-on live tracking mode meant for stolen vehicle recovery (see section 14).
- The Device Debug Flags control the volume of diagnostic messages logged, and can be set in the Device Operations dropdown of the Devices screen.

Since these settings are delivered by Asynchronous Message rather than through the parameter blocks, they take effect as soon as the Dart receives them, regardless of trip status. The Dart receives Asynchronous Messages on each upload, or immediately when connected in a trip or in Recovery Mode.

3. Setup by SMS

The most convenient way of changing parameters is through the web interface on OEM Server. However, if the Admin Parameters are set incorrectly, the Dart is unable to connect to the server. In these cases, the Admin Parameters can be set by SMS message to establish or restore connectivity, and the device can be remotely reset.

SMS's are received after each upload attempt. To force an upload attempt when setting a unit up, disconnect or reconnect external power. The device will wake up and attempt to connect to the server. After the attempt, the device will read SMS's from the modem. The device will reset after each SMS is received, leading to another upload attempt.

1. Format

The SMS text must start with a '#*' (without the quotes).

The SMS text command takes the form of a command followed by a variable list of comma separated parameters:

```
#*[<reply#>],<command>,…
```

The [<reply#>] is not yet supported by the firmware, but may be in future. Leave blank as per the examples below. In future, if specified then the device will send an acknowledgement SMS to the number. Specify '*' to reply to the number that the SMS came from.

String values are **not** contained in quotation marks.

Fields in [] are optional.

2. APN

```
#*[<reply#>],APN[,<apn name>[,<user name>,<password>]]
```

If the APN details are omitted, the APN will be erased and the device will use auto-APN.

Examples:

```
#*,APN,telstra.internet
```

```
#*,APN,custom.APN,user1,pwd1
```

```
#*,APN
```

3. Server

```
#*[<reply#>],SERVER[,<server URL>,<port number>]
```

If <server URL>,<port number> are omitted then the default OEM Server details will be used.

Examples:

```
#*,SERVER,s0.oemserver.com,8967
```

4. Reset

```
#*[<reply#>],RESET
```

Examples:

```
#*,RESET
```

9. CONNECTIVITY SETTINGS

The Dart requires a mobile data connection for configuration and telemetry upload. The settings for these critical communications functions are stored on the device in the Admin Parameters. A brand new device from the factory will ship to the distributor with default parameters, which attach to the mobile data network using the Auto-APN feature, and connect to the default OEM Server for configuration.

1. Auto-APN

Auto-APN allows the Dart to analyse the SIM card and select the correct APN details from a list that is pre-loaded in the device's firmware. This means that the Dart can be shipped world-wide without requiring special setup for SIMs.

The Dart obtains the Mobile Country Code (MCC) and Mobile Network Code (MNC) from the SIM card's IMSI. It tries to find a matching MCC and MNC entry in the list in firmware. There are multiple scenarios:

- No matching entry. The Dart will use the 'internet' APN with no username or password.
- Single matching entry. The Dart will use the details in the list.
- Multiple matching entries. The Dart will try the first entry. If it works, it will continue to use those details until it encounters three connection errors. If it doesn't work, it will move to the next matching entry.

Note that the IMSI is fixed on the SIM. If the SIM roams onto another network, the IMSI does not change and the Auto-APN details will be for that of the home network. For roaming, see the Multi-APN feature in section 2.

The device uses the Auto-APN feature if the admin parameter APN list is blank. See section 9.3.

The Auto-APN list in firmware version 1.3 is shown below. If a network is not listed, please contact Digital Matter to enquire about adding it to the list.

Also note that networks using "internet" will not be listed (e.g. Vodacom in South Africa).

Country	Network	APN Name	Username	Password
Angola	Unitel	internet.unitel.co.ao		
Australia	KORE (Optus SIM)	od1.korem2m.com	kore	kore123
Australia	Optus	connect		
Australia	Rio Tinto LTE	CORP		
Australia	TELSTRA	telstra.internet		
Australia	TELSTRA M2M	telstra.m2m		

Australia	Vodafone	live.vodafone.com		
Bahrain	Batelco	internet.batelco.com		
Botswana	Mascom	internet.mascom		
Chile	Entel 73001	bam.entelpcs.cl	entelpcs	entelpcs
Chile	Entel 73010	bam.entelpcs.cl	entelpcs	entelpcs
Chile	Movistar	web.tmovil.cl	web	web
Egypt	Mobinil	mobinilweb		
France	SFR	websfr		
Kenya	Airtel	ke.celtel.com		
Kenya	Safaricom	safaricom	saf	data
Kuwait	Wataniya	action.wataniya.com		
Luxemburg	Orange	orange.lu		
Mauritius	Emtel	web		
Mozambique	mCel	isp.mcel.mz		
Namibia	MTC prepaid	ppsinternet	ppsuser	ppsuser
Netherlands	Vodafone	public4.m2minternet.com		
New Zealand	Spark NZ M2M	m2mone.co.nz		
Nigeria	Etisalat	etisalat		
Nigeria	Glo	glosecure	gprs	gprs

Nigeria	Glo Halogen	halogen		
Nigeria	Airtel	internet.ng.airtel.com		
Nigeria	MTN	web.gprs.mtnnigeria.net	web	web
Oman	Oman Mobile	taif	taif	taif
Portugal	Vodafone	internet.vodafone.pt		
Portugal	MEO M2M	internetm2m_DHCP		
Papua New Guinea	Digicel	internet.digicelpng.com		
SA	MTN Geotab APN	geotab.co.za		
Swaziland	Swazi MTN	mymtn.co.sz		
Sweden	Tele2 (global m2m provider)	m2m.tele2.com		
UAE	etisalat.ae			
UAE/Dubai	Emirates ITC - DU	du		
UK	Eseye (global m2m provider)	eseye.com	user	pass
US	AT&T Cingular	wap.cingular	WAP@CINGULARGPRS.COM	CINGULAR1
Zimbabwe	Econet	econet.net		

2. Multi-APN

The Dart can be configured to roam across multiple networks and to automatically use different APN details for the roaming networks.

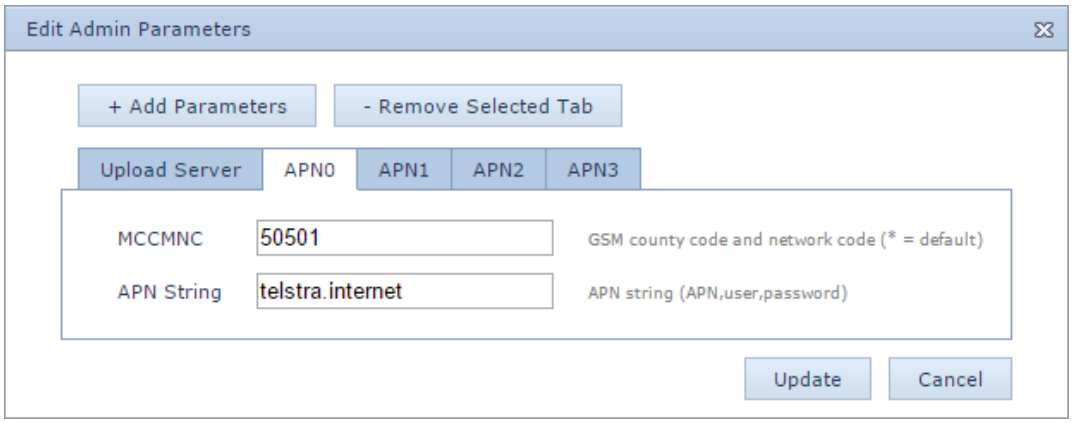
Note that this is different to Auto-APN. Auto-APN uses the SIM's IMSI, which is fixed, even when roaming. The multi-APN feature checks which network the SIM has registered on and checks the Admin Parameter list for a matching MCC MNC value.

The multi-APN feature is used if the admin parameter APN list contains at least one entry. In this case, the following process is followed:

1. The APN list in admin parameters is not blank, so the device knows not to use the Auto-APN feature.
2. On each connection, the modem is allowed to register on an automatically selected (SIM appropriate) network.
3. The MCC and MNC of the current network is queried.
4. The APN list in admin parameters is scanned for the first matching entry, or the wildcard character ('*').
5. If no entries match, the default APN 'internet' is used.

3. Admin Parameters

Admin parameters are a block of parameters containing the APN and server settings. They can be configured by SMS (see section 8.3) and through the OEM Server web interface. The web interface is shown below, with all five possible parameter sections added.



In the screenshots, APN details have been supplied, so the Dart will not use the Auto-APN feature. In practise, most units will be using the default server and Auto-APN, and will not require any of the five tabs shown to be supplied.

10. TRACKING SETTINGS

1. Overview

The Dart's tracking centres on the concept of a trip.

When not in a trip and otherwise idle it sleep and generate **heartbeats**. These are regular health checks that log a telemetry record and do an upload. The default period is 1 hour.

There are a number of different trip types:

1. Movement based trip: also known as emulated ignition. If the device detects GPS movement beyond a configurable threshold (150m by default), it will begin tracking a trip. The trip is typically ended when it has not moved for a configurable period (4 min by default).
2. Ignition based trip: this trip type is started and stopped according to the status of the ignition (white) wire.
3. Run detect trip: run detect is a scheme that uses the external voltage level to start and stop trips. This is based on the assumption that the battery voltage of a vehicle will rise when the engine is running and the battery is being charged by the alternator

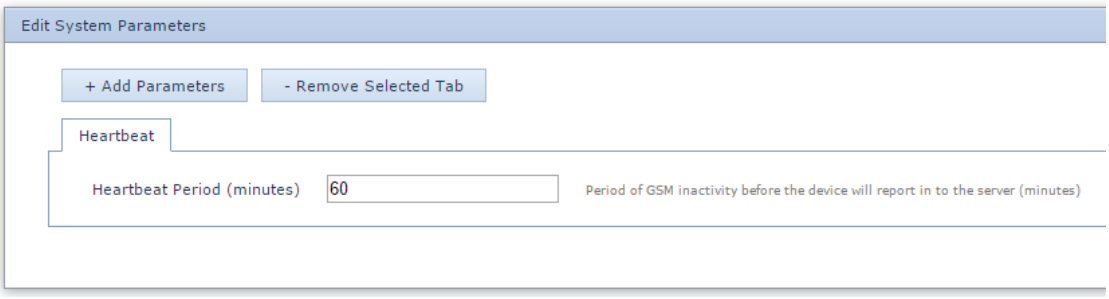
In a trip the device will keep the GPS on. It will try to maintain a connection with the server to provide live updates.

2. Heartbeat

When the Dart is not tracking a trip and otherwise idle, it will sleep. It will schedule a regular wakeup on the heartbeat period. On the heartbeat period it will:

1. Log a heartbeat record, which will include GPS, analogue and digital data. This telemetry forms a health check. The GPS data is likely to be the last logged point, unless it has moved since it was logged.
2. The Dart will then do an upload. It will connect to the server and attempt to upload the heartbeat and any other records that have been logged. The server will notify the Dart if it needs to update any of its slots. The Dart will check the age of its offline GPS Assist data. If older than 5 days, it will connect to the u-Blox servers and download an update.
3. The Dart will turn on the GPS to refresh the module's ephemeris data. This improves the quality of subsequent fixes.

1. Configuration



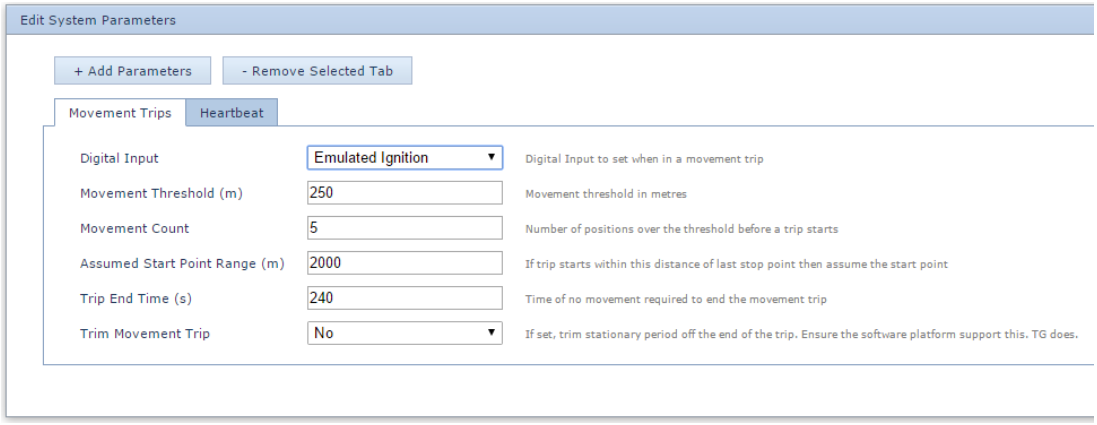
The *Heartbeat Period* is the maximum time between upload attempts in minutes.

3. Movement Trips

Movement based trips, or emulated ignition, use GPS movement to start and stop trips.

1. Generally a device will be woken by the accelerometer reporting vibration.
2. It will turn on its GPS and monitor the distance from its resting point.
3. If it exceeds the *Movement Threshold*, is moving faster than 15 km/h, and the GPS fix is of sufficient quality, it will start a movement based trip.
4. It will log telemetry according to the tracking setup.
5. If the device is stationary for *Trip End Time* it will end the trip. Stationary means that it has not moved by *Movement Threshold* and the speed is less than 15 km/h.
6. If the device cannot obtain a GPS fix for more than *Trip End Time*, it will end the trip.
7. If the device does not have external power and the internal battery is low, it will end the trip.

1. Configuration



Digital Input determines which digital input to set when in a movement trip. Select *Emulated Ignition* to use Emulated Ignition, which sets input 0 (Ignition).

Movement Threshold (m) is the distance used to start and stop movement based trips.

Movement Count is how many GPS fixes beyond the threshold are required before a trip is started. This helps to disregard false GPS data. Increase this if false trip starts are occurring.

Assumed Start Point Range (m): if a movement trip start is detected, log an assumed start point if the device is still within this radius of the start point. If within the assumed start point range, the trip start will be logged at the rest position, and a distance travelled point will be logged at the point when the device crossed the threshold. If not within this assumed start point range, the trip start is logged at the point where the device decided it was in trip.

Trip End Time (s) is the amount of time, in seconds, that the device should be stationary or without a GPS fix before ending a movement based trip.

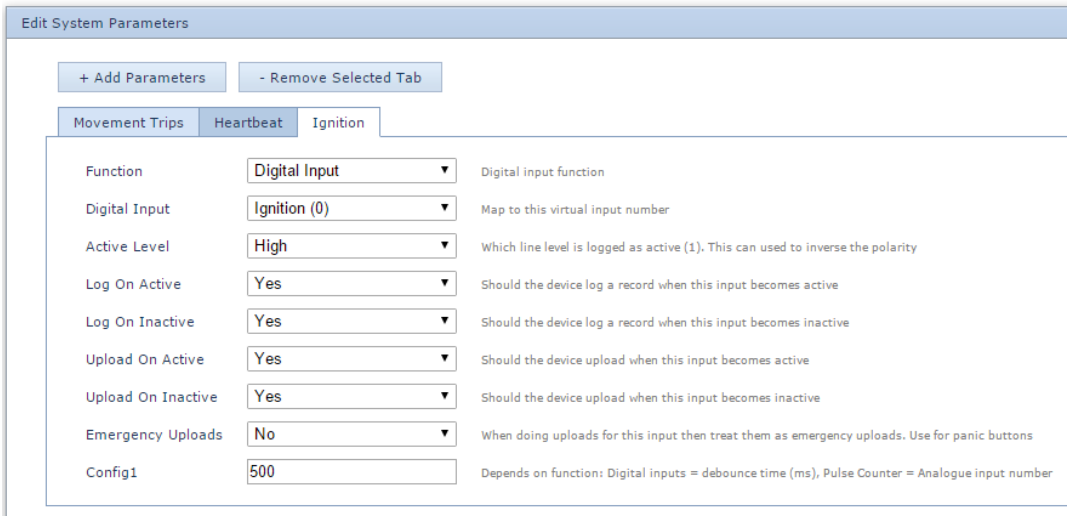
Trim Movement Trip can be set to *Yes* if the device should log a trim trimming record. The trimming record indicates the trip type and the stationary period. If understood by the

software frontend platform, it can be used to trim the stationary time off the end of a movement trip. The default is *No*, or do not log a trimming record.

4. Ignition

Ignition based trips are started and stopped according to the status of the ignition wire. The ignition wire is the white wire in the 12 wire harness. The ignition wire does not have a configurable bias (pull up/down) as it is always pulled down in hardware.

1. Configuration



Function sets the function of the digital input. To use wired ignition select *Digital Input.*

Digital Input is the logical digital input to map the function to. To use wired ignition, select *Ignition (0).* The input can be mapped to other inputs – for example if setup to use emulated ignition, this input can be mapped to digital input 3.

Active Level determines the polarity of the input. *High* means the input is on when the physical wire is pulled to a high voltage. *Low* means the input is on when the physical wire is pulled to a low voltage.

Log On Active determines whether a Digital Input Change record should be logged on a change from inactive (off) to active (on).

Log On Inactive determines whether a Digital Input Change record should be logged on a change from active (on) to inactive (off).

Upload On Active determines whether an upload should be requested on a change from inactive (off) to active (on).

Upload On Inactive determines whether an upload should be requested on a change from active (on) to inactive (off).

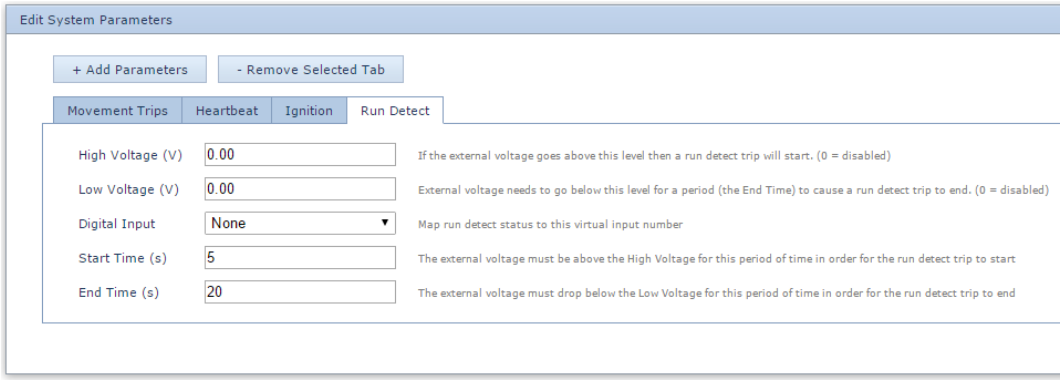
Emergency Uploads determines whether the upload should treated as an emergency (essential upload) or not. Emergency uploads will not time out. This is useful for a panic button for example.

Config1 holds the debounce period in milliseconds.

5. Run Detect

Run detect is a scheme that uses the external voltage level to start and stop trips. This is based on the assumption that the battery voltage of a vehicle will rise when the engine is running and the battery is being charged by the alternator.

1. Configuration



Two voltage levels are used to start and stop trips. The external voltage must exceed the *High Voltage (V)* for *Start Time (s)* to start a trip. When this occurs, the *Digital Input* will be set. If set to *Ignition (0)* this will start a trip. Other input mappings can also be used.

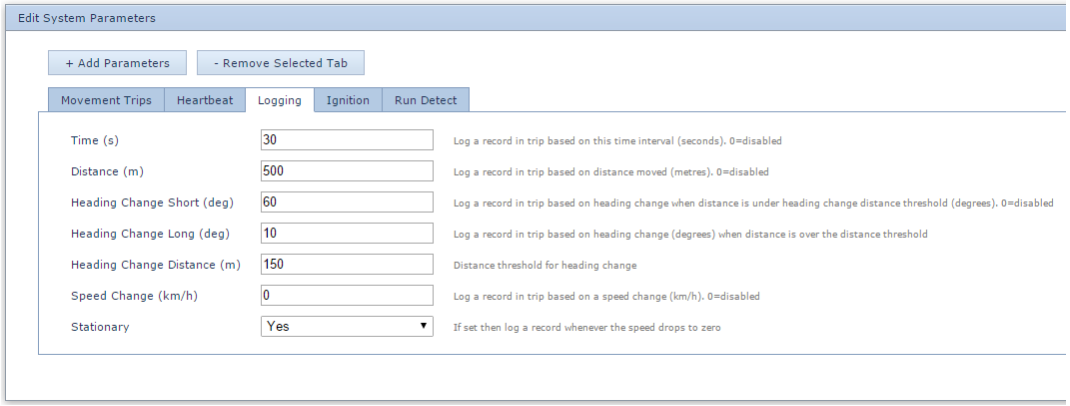
If the external voltage is lower than *Low Voltage (V)* for *End Time (s)* the *Digital Input* will be cleared. If set to *Ignition (0)* the trip will end.

The difference between *High Voltage (V)* and *Low Voltage (V) can* provide some hysteresis, but is commonly set to the same value. For example this could be set to 13.2V to work with a normal 12V vehicle.

6. Logging

Once a trip has started, the logging behaviour is determined by the settings in this section. The goal of this tracking algorithm is to provide an accurate and customisable representation of the trip with the minimum number of records.

1. Configuration



Note: set any of the following parameters to zero to disable their function.

If more than *Time (s)* seconds have passed since the last data point was logged, then log a new point with the log reason “elapsed time”.

If the distance between the last logged point and the current position exceeds *Distance (m),* then log a new point with log reason “distance”.

Heading change logs are split into short and long heading changes to minimise points in large heading changes in a small distance. If the distance since the last logged point is less than *Heading Change Distance (m)* log a point if the heading changes by more than *Heading Change Short (deg).* If the distance since the last logged point is more than the *Heading Change Distance (m)* log a point if the heading changes by more than *Heading Change Log (deg).* Heading change records use the log reason “heading change”.

The heading change setup allows accurate reproduction of corners and bends without excessive data use.

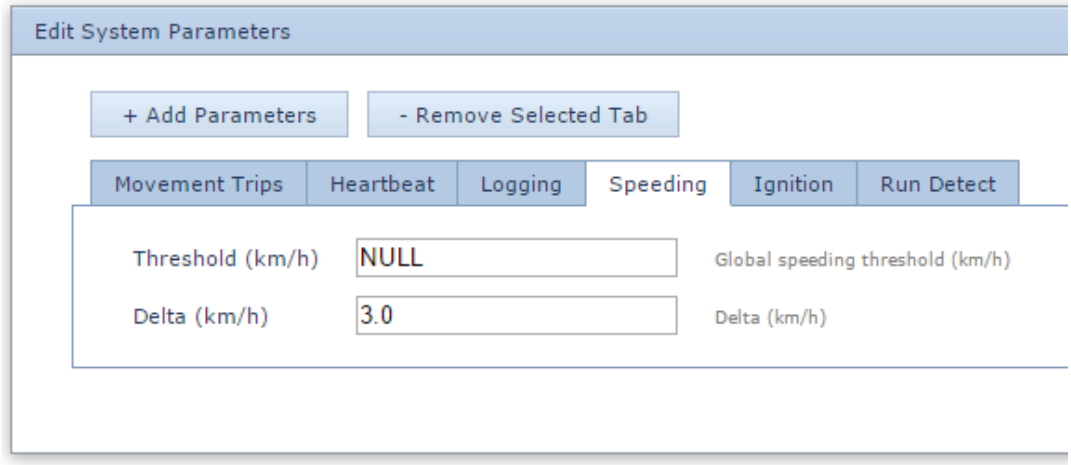
If the speed of the device changes by *Speed Change (km/h)* since the last logged point, log a new point with log reason “speed change”.

Set *Stationary* to *Yes* to log a point when the speed reaches 0 km/h. This results in a “stationary” log reason.

7. Speeding

A global speed limit can be set on the device to activate a buzzer. Depending on the configuration and device build, it could be an internal buzzer and/or external buzzer on a switched ground output.

1. Configuration



Threshold (km/h) determines the speed at which the buzzer is turned on. *Delta (km/h)* is the speed below the *Threshold (km/h)* at which the buzzer will be turned off.

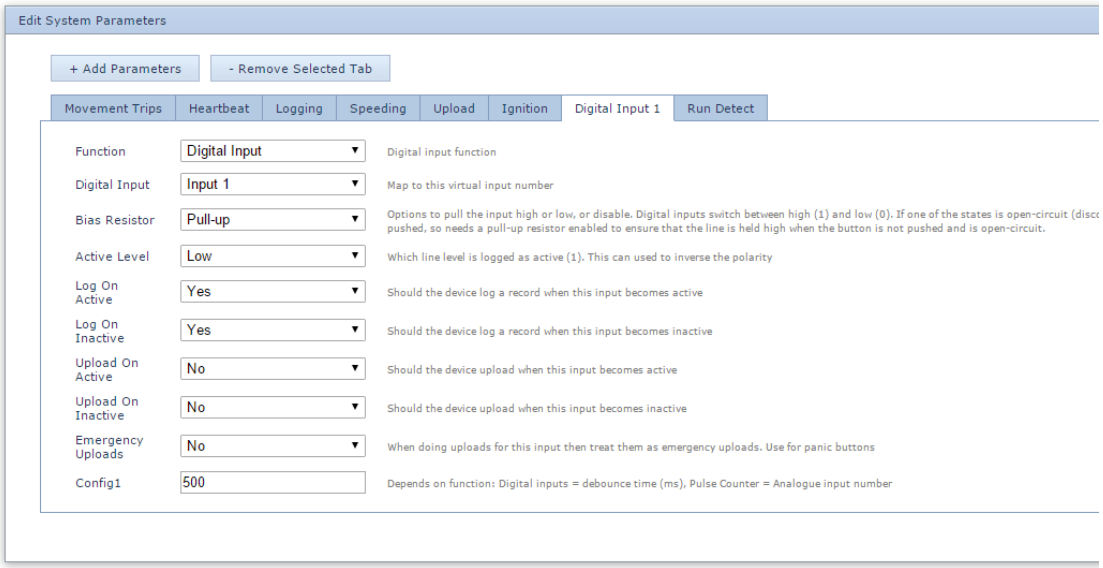
11. INPUT AND OUTPUT SETTINGS

1. Digital Inputs

The device has 2 digital inputs. The ignition input is discussed in section 10.4 in relation to the tracking. Both digital inputs have configurable biasing (pull up/down). Input 1 is the pink wire in the harness and Input 2 is the blue wire.

The default configuration for both input 1 and 2 is pulled up, active low. This can easily be used with a pull to ground switch.

1. Configuration



There is one tab for Digital Input 1 and another tab for Digital Input 2. The parameters have the same functions for their respective inputs.

Function sets the function of the digital input. To use the inputs as standard digital inputs, select *Digital Input.*

Digital Input is the logical digital input to map the function to. By default input 1 maps to *Input 1* and input 2 maps to *Input 2.*

Bias Resistor gives the option to internally pull the input high, low or disable the bias. Digital inputs switch between high (1) and low (0). If one of the states is open-circuit (disconnected) then you will need to enable a bias resistor setting, opposite to the level the input is being switched to. For example, if a panic button connects the line to ground when pushed, it needs a *pull-up* resistor enabled to ensure that the line is held high when the button is not pushed and is open-circuit.

Active Level determines the polarity of the input. *High* means the input is on when the physical wire is pulled to a high voltage. *Low* means the input is on when the physical wire is pulled to a low voltage.

Log On Active determines whether a Digital Input Change record should be logged on a change from inactive (off) to active (on).

Log On Inactive determines whether a Digital Input Change record should be logged on a change from active (on) to inactive (off).

Upload On Active determines whether an upload should be requested on a change from inactive (off) to active (on).

Upload On Inactive determines whether an upload should be requested on a change from active (on) to inactive (off).

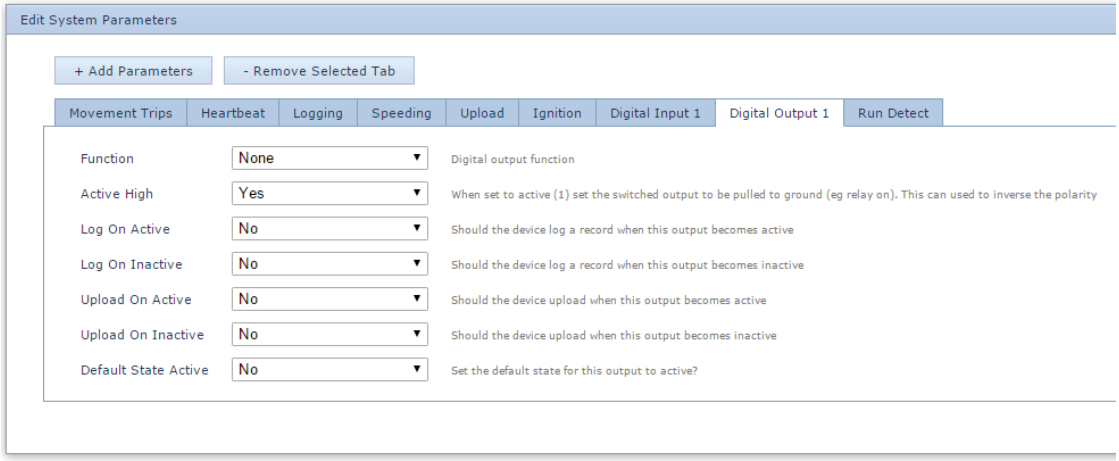
Emergency Uploads determines whether the upload should treated as an emergency (essential upload) or not. Emergency uploads will not time out. This is useful for a panic button for example.

Config1 holds the debounce period in milliseconds.

2. Digital Output

The Dart has a single switched ground output. This can be used as a low side switch. When on, the line is grounded. When off, the line is floating or high impedance. This is commonly used for a buzzer, relay or LED. Switched ground 1 is the yellow wire in the harness.

1. Configuration



Function determines what the output is used for. Options include *None, Digital Output, Buzzer, Immobiliser* and *LED.*

Active High determines the polarity of the output. If the line should be grounded when On, choose *Yes.* If the line should be grounded when off, choose *No.* For example, an immobiliser is “on” when the relay is not energised and “off” when the relay is energised, so the output should be *Active High = No* so that the relay is given ground when the immobiliser is off. Buzzers and LED’s are generally *Active High = Yes.* Immobilisers are generally *Active High = No,* but it depends on how the relay is wired in.

Log On Active determines whether a Digital Output Change record should be logged on a change from inactive (off) to active (on).

Log On Inactive determines whether a Digital Output Change record should be logged on a change from active (on) to inactive (off).

Upload On Active determines whether an upload should be requested on a change from inactive (off) to active (on).

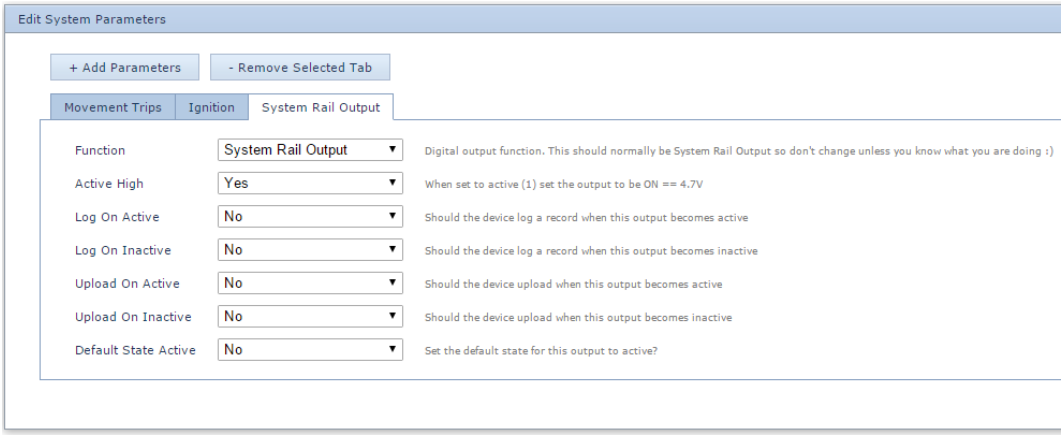
Upload On Inactive determines whether an upload should be requested on a change from active (on) to inactive (off).

Default State Active determines the state of the output if there has been no control action taken – for example for the first time it is setup.

3. System Rail Output

The system rail output is available in the harness as the purple wire. It is normally part of the 4 way Molex for connecting to peripherals. It is used to power peripherals. It is treated as an output by the firmware. The output is approximately 4.7V.

1. Configuration



Most users should not change the defaults. The field descriptions correspond to those of the Digital Output in section 11.2, except the output is 4.7V and not a switched ground.

12. OTHER SETTINGS

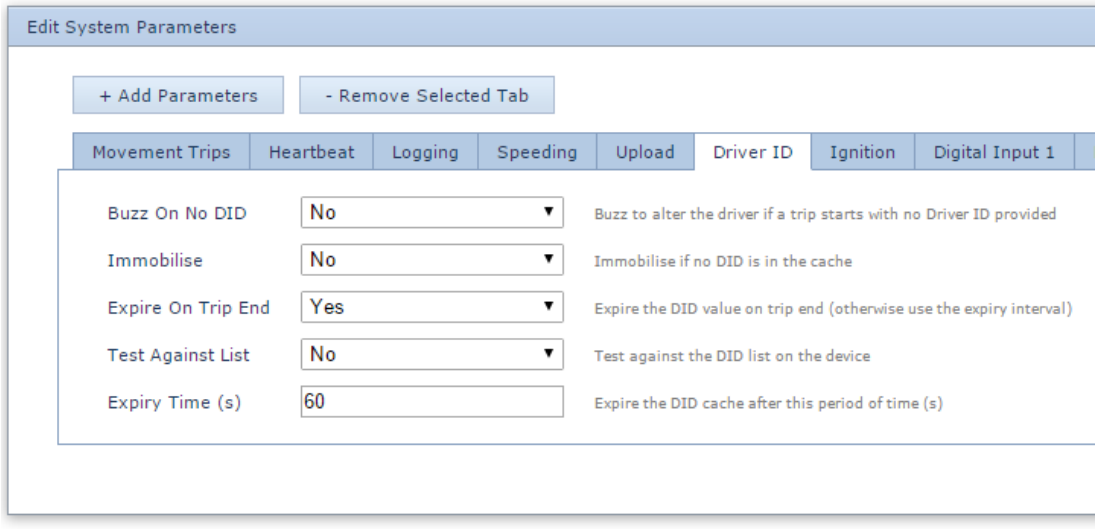
1. Driver ID

Note: The Driver ID module is not complete on the Dart.

The Driver ID module allows the device to work with an RFID reader to collect driver identification data. The device can store a Driver List in its non-volatile memory. It is possible to enable/disable a vehicle using a buzzer or relay until a valid driver is identified.

Note that Telematics Guru is the only software platform that supports Driver Lists.

1. Configuration



Buzz On No DID can be set to *Yes* to sound an internal or external buzzer if a trip starts with no valid driver identified.

Immobilise can be set to *Yes* to turn an immobiliser on when a driver is not identified. When identified, the immobiliser is disabled. See notes on digital outputs for using immobilisers.

Expire On Trip End controls how the ID is cached after a trip ends. If *Yes,* it is removed from the cache immediately. If *No,* it is kept in the cache for *Expiry Time (s).*

Expiry Time (s) also controls how long the ID is cached for after a scan. If a trip starts within that time, the ID is valid for that trip, unless another ID is scanned.

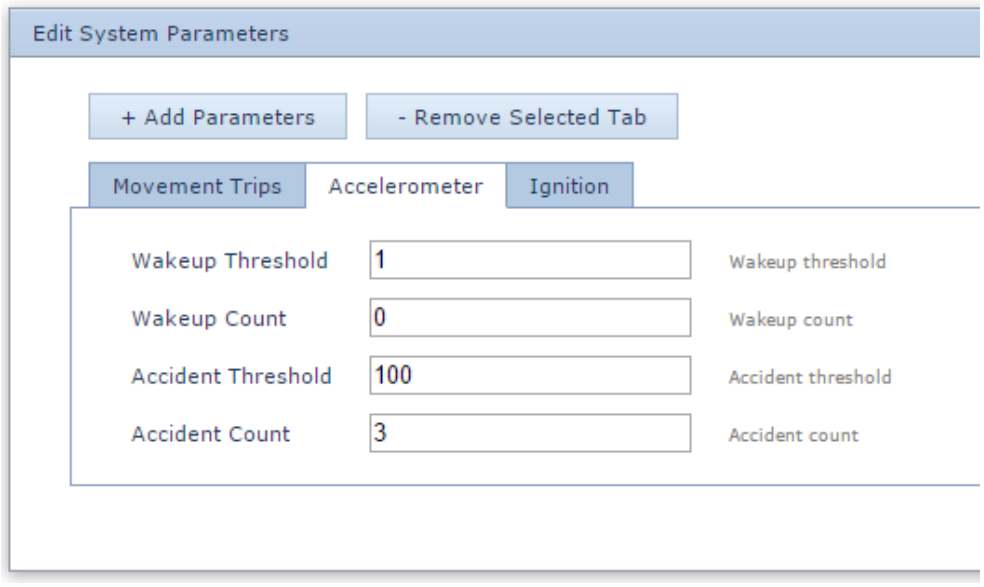
Test Against List controls whether the ID should be compare against the on board Driver List to check if the ID is valid. If set to *No* any ID will be valid. If set to *Yes* the ID must be present and allowed to drive.

2. Accelerometer

The accelerometer is used to wake the device from sleep when there are movements. The device will then power the GPS module and check for significant movement from the resting point.

The accelerometer is also use for accident detection. The implementation uses a simple acceleration threshold and count for samples above the threshold in order to trigger an accident. Accidents are records with the “accident” log reason.

1. Configuration



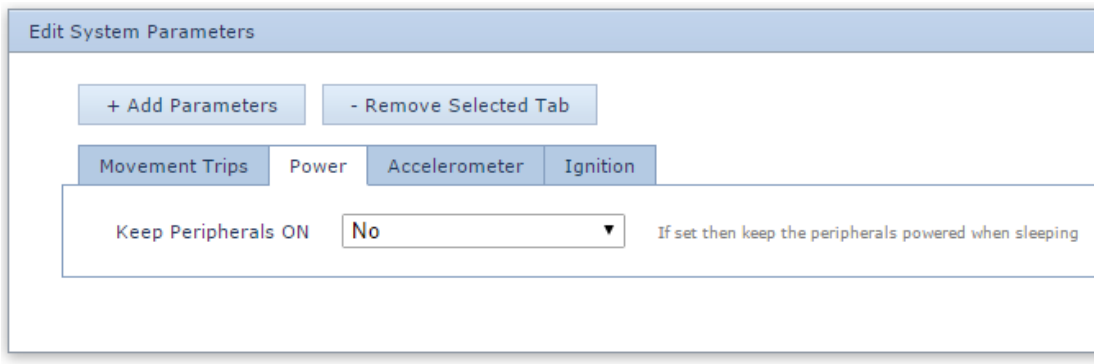
Wakeup Threshold configures how sensitive the accelerometer is to accelerations that will wake the unit from sleep. The default is 1, which is the most sensitive setting. Units are 0.063G. *Wakeup Count* configures the number of samples exceeding the threshold required to wake the unit. Sample period is typically 20 ms.

Accident Threshold is the magnitude of the acceleration threshold for triggering an accident. The units are $100G^2$. The default is 100, which is 3.16G. The *Accident Count* is the number of samples required above *Accident Threshold* before an accident is logged. The sample period is typically 20 ms.

3. Power

This section simply controls the power to peripherals when the device sleeps.

1. Configuration

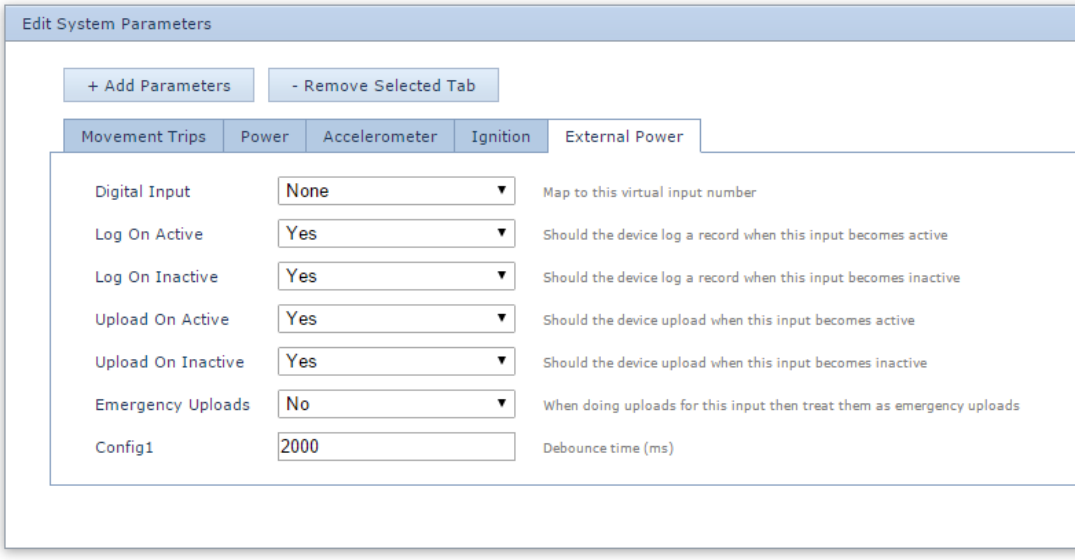


Keep Peripherals ON should be *Yes* if the System Rail Output (purple wire) in the 4 way Molex connector should be left on when the device sleeps.

4. External Power

This parameter block configures the reaction to external power changes. External power is considered good if the input switcher is running, able to charge the internal battery and run the processor. This threshold is 6 V.

1. Configuration



Digital Input allows the mapping of the external power status (good/on or not good/off) to a digital input. The status is always mapped to one of the status bits (section 13.3), so this is an additional mapping.

Log On Active determines whether a Digital Input Change record should be logged on a change from inactive (off) to active (on).

Log On Inactive determines whether a Digital Input Change record should be logged on a change from active (on) to inactive (off).

Upload On Active determines whether an upload should be requested on a change from inactive (off) to active (on).

Upload On Inactive determines whether an upload should be requested on a change from active (on) to inactive (off).

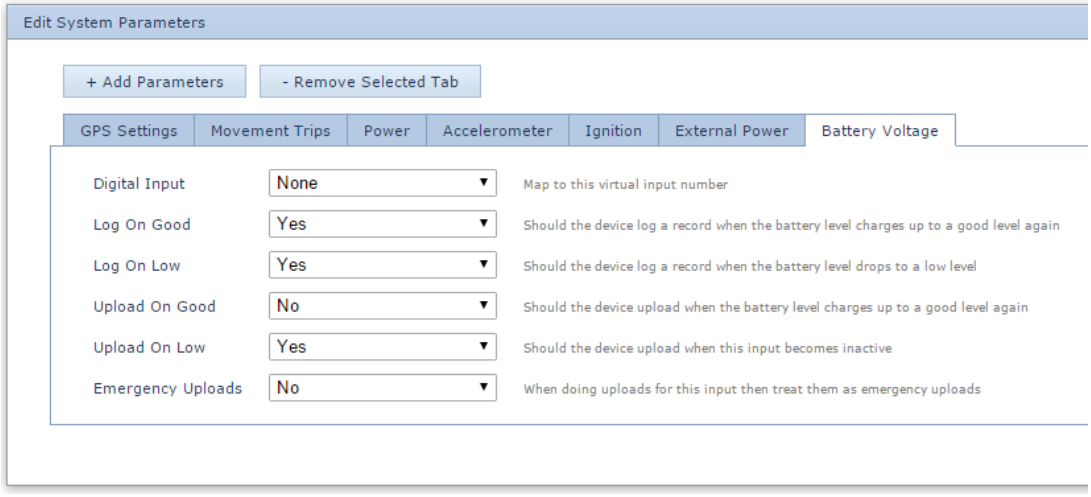
Emergency Uploads determines whether the upload should treated as an emergency (essential upload) or not. Emergency uploads will not time out.

Config1 holds the debounce period in milliseconds. This can be useful in masking short term power glitches. Set the period to be longer than the glitch.

5. Battery Voltage

This parameter block configures the reaction to internal battery levels. The internal battery is considered good above 3.5 V. The device will operate down to about 3.3V.

1. Configuration



Digital Input allows the mapping of the battery good status (good or not good) to a digital input. The status is always mapped to one of the status bits (section 13.3), so this is an additional mapping.

Log On Active determines whether a Digital Input Change record should be logged on a change from inactive (off) to active (on).

Log On Inactive determines whether a Digital Input Change record should be logged on a change from active (on) to inactive (off).

Upload On Active determines whether an upload should be requested on a change from inactive (off) to active (on).

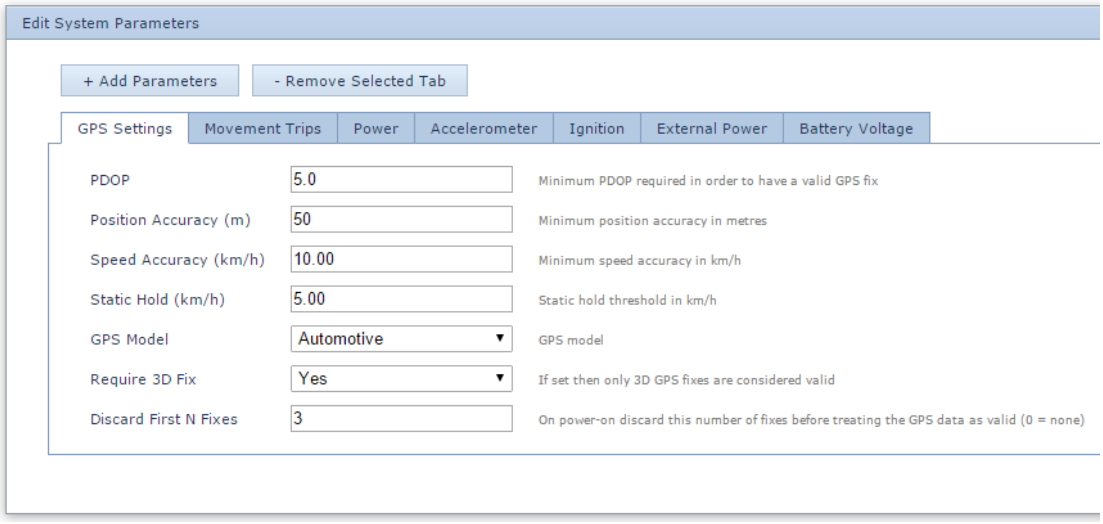
Upload On Inactive determines whether an upload should be requested on a change from active (on) to inactive (off).

Emergency Uploads determines whether the upload should treated as an emergency (essential upload) or not. Emergency uploads will not time out.

6. GPS Settings

The u-Blox GPS module has a host of settings, most of which need no configuration. A few of these settings are exposed to allow the GPS accuracy to be fine-tuned. Most users will not need to configure the GPS.

1. Configuration



The *PDOP*, *Position Accuracy*, and *Speed Accuracy* settings allow you to configure the minimum accuracy required before the GPS is considered fixed. Lowering these values will lead to increased accuracy, at the cost of extended fix times.

The *Static Hold* threshold is the speed below which the GPS module will filter out small movements. Slow moving vehicles may need to reduce this.

The *GPS Model* selects a statistical module used by the GPS hardware when filtering out noise during GPS fixes. Generally choose *Automotive.*

The *Require 3D Fix* option requires a 3D fix before the GPS is considered fixed. This is highly recommended, as 2D fixes use fewer satellites, and can be unreliable. However, if signal levels are very poor, disabling this option may improve the chance of a successful fix.

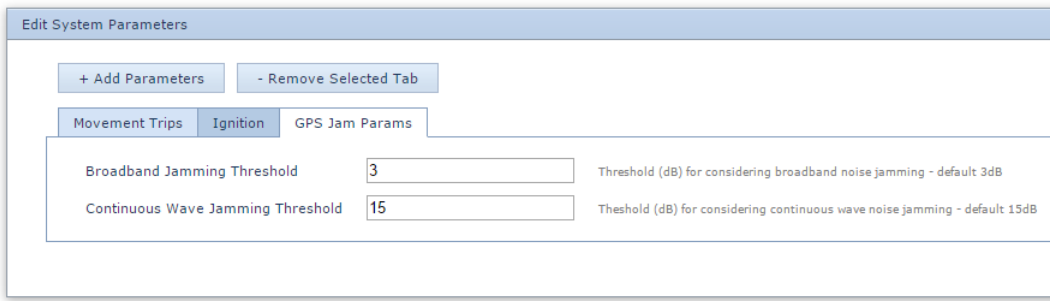
The *Discard First N Fixes* option discards a configurable number of points from the GPS if the PDOP is above 2.3. This gives the GPS some time to improve its accuracy, and lowers the chance of outlying GPS fixes slipping through the filters.

7. GPS Jamming

The GPS module reports whether jamming has been detected or suspected by the receiver. The jamming status sets a configurable digital input. The detector monitors background noise and looks for significant changes, which may indicate jamming.

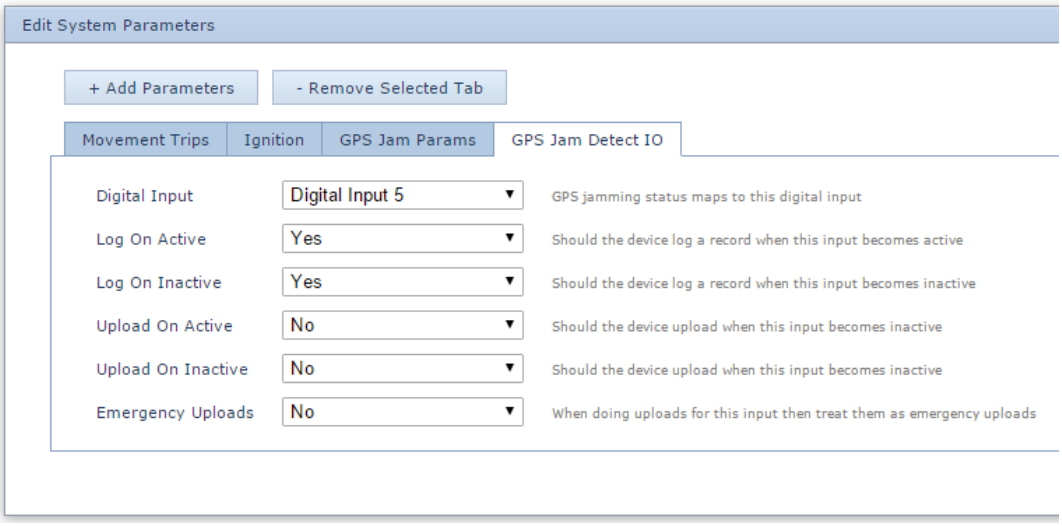
Two types of jamming can be detected: continuous wave and broadband. Continuous wave refers to a constant jamming signal at a specific frequency. Broadband is a broad spectrum jamming signal.

1. Configuration of Jamming Parameters



Broadband Jamming Threshold and *Continuous Wave Jamming Threshold* allow the jamming thresholds to be specified. These thresholds are dB level above 'normal'. The GPS receiver requires a previous good fix to establish normal levels.

2. *Configuration of Jamming Detect IO*



Once jamming is detected, a digital input can be set. This section configures which input to set and how to respond to the changes.

13. ANALOG AND DIGITAL INPUT MAPPINGS

The device provides a set of virtual analogue and digital inputs to which various signals can be mapped. Signal sources include physical signals, such as battery voltage, and status flags, such as trip status.

In addition, a separate set of fixed function digital status flags is provided.

1. Analogue Inputs

The first ten analogue inputs are signed 16 bit values. Analogue inputs following the first 10 are signed 32 bit values. Four fixed mappings have been defined, and the fifth is reserved:

#	Mapping	Unit	Notes
1	Internal Battery Voltage	mV	
2	External Voltage	mV x 10	E.g. 1200 = 12’000mV = 12V
3	Temperature	°C x 100	E.g.: 2400 = 24°C
4	GSM Signal Strength	(dBm + 113) x 0.5	Practically, a scale of 0-31 0 = -113 dBm (min) 31 = -51 dBm (max)
5	Reserved		

2. Digital Inputs

There are 32 digital inputs. No fixed mappings have been defined, but there are a number of useful defaults. For example, digital input 0 is generally ignition (wired or emulated). The default (configurable) mappings are:

#	Mapping	Notes
0	Ignition	Indicates a trip has started due to the ignition wire (wired ignition) or GPS movement (emulated ignition).
1	Dig In 1	Physical digital input 1 is mapped here by default, but could be remapped elsewhere
2	Dig In 2	Physical digital input 2 is mapped here by default, but could be remapped elsewhere

Mappings are configured individually in the System Parameters (section 10, 11, and 12).

3. Digital Status Flags

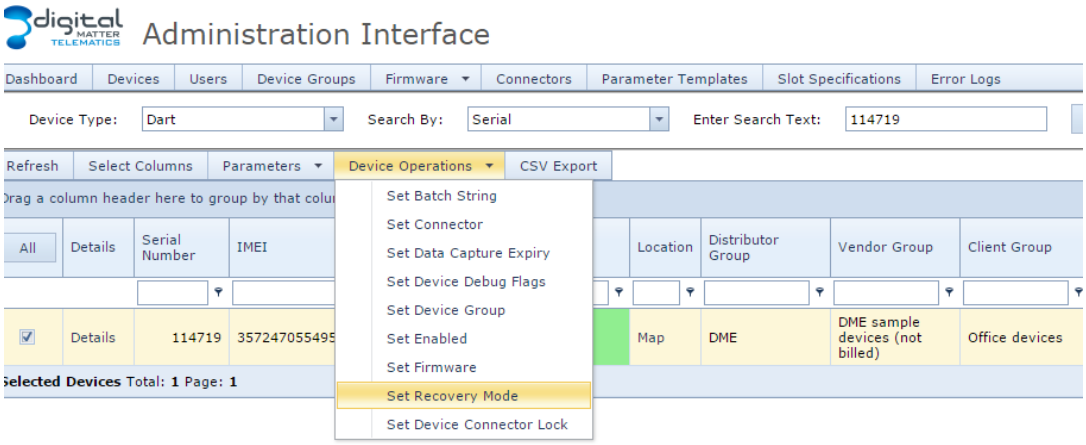
The digital status flags are a separate set of fixed function digital flags that accompany the analogue and digital inputs.

#	Name	Notes
0	In Trip	Indicates a trip has started for any reason.
1	Battery Good	Set when the internal battery level is above 3.5V
2	External Voltage Good	Set when the external voltage is sufficient to run the device and charge the battery – above 6V.
3	Connected to Server	Set if the device is connected at the time the record is logged.

14. RECOVERY MODE

Recovery mode is an always-on, always-connected tracking mode intended for stolen vehicle recovery. It attempts to provide a continuous live position. If GPS or GSM jamming occurs, the continuous network activity improves an “LBS lookup” on the GSM network.

Recovery mode is configured through the OEM Server web management interface. It can be set or cleared in the Device Operations dropdown of the Devices screen:



Setting or clearing Recovery Mode queues an Asynchronous Message for the Dart, which instructs it to change modes. The Dart receives Asynchronous Messages on each upload, or immediately when connected in a trip or in Recovery Mode, and will remember the setting across reboots and battery changes.

In Recovery Mode, the Dart will attempt to maintain a constant connection to the server, and a constant GPS fix. A trip will be started and updates are sent every 10 seconds.

The tracking performance in Recovery Mode is excellent, but if there is no external power the battery will run down quickly in this mode. Users should also beware of the possibility of overrunning their mobile data limits while attempting to track a vehicle due to the higher than usual data volumes.

15. TROUBLESHOOTING

1. No Connection on Power Up

If a device is not connecting, it is usually power or SIM related.

Check that the device is powered:

- If using an internal battery, it should be above 3.5V for a reliable connection.
- If using external power, the device should receive 7 – 35V on the red wire on the harness, and ground on the black wire. If using a different harness, ensure the polarity is correct. It should draw 20 – 100 mA on power up.
- The LED on the PCB should illuminate. If it switches on briefly and goes off, it may indicate that the power is not sufficient for the device to boot. It will wait until either external power is above 7V or the internal battery is above 3.5V. If either condition is true, the LED will start to flash slowly.

Check that the SIM is in order:

- The SIM is installed with the correct orientation, and the holder is properly latched.
- The SIM PIN is either not set, or is set to the Dart's PIN. The PIN can be retrieved from the OEM Server web interface.
- The SIM has credit / airtime.
- The APN is set correctly: a new Dart will be set to Auto-APN unless your distributor has made special arrangements. An in-service Dart may have been configured with a specific APN in the past. To be certain, you can SMS the APN settings (see section 8.3).
- The LED will flash slowly until it connects to the server. Once connected it will flash fast. If data is sent, it will got solid briefly and revert to flashing fast.

2. Forcing a Connection

There is no way to initiate a connection remotely because when the device sleeps, it switches off its modem. You will need to wait for the next scheduled connection – either a heartbeat, trip start or input change.

If you have the unit in your hands, you can force a connection by toggling external power. An external power change triggers an upload. Ensure the change is long enough to trigger the external power debounce period – 2 seconds by default.

You can also change any of the inputs set to trigger an upload. Usually ignition will trigger an upload. This depends on the system parameter configuration.

3. Debugging with OEM

The OEM Admin Interface is a powerful tool for understanding what your device is doing. See the OEM guide for detailed instructions. The following notes may help:

- Check when it last connected and if it committed records successfully.
- Check external power and internal battery level.

- Enable the log capture. Normally the OEM server forwards logs to the 3rd party software platform. Enable the capture of logs by selecting the device; going to Device Operations->Set Data Capture Expiry; select a date in the future when the server should stop the capture; click OK. View the logs in the Device Details->Logs tab.
- Enable debugging for a module. Do this by selecting the device; going to Device Operations -> Set Device Debug Flags; set the module of interest to the required logging level; select an expiry date when the debugging should end; click OK. View the logs in the Device Details->Logs tab

4. GPS troubleshooting

For detailed GPS troubleshooting, GPS debug message can be enabled on OEM Server. When the debug level is set to Info, GPS debug messages will appear in the log. In addition to individual fix times, signal level diagnostics whenever a fix takes longer than 36 seconds, or the GPS decides to stay awake after a fix to collect more satellite information. Please note that while debug messages are enabled, uploads will use extra data.

The GPS debugging can be enabled on the OEM Admin Interface by selecting the device; going to Device Operations->Set Device Debug Flags; set GPS to Info; select an expiry date when the debugging should end; click OK.

The diagnostics will be available on the OEM Admin interface. Click device details and go to the logs tab. Uploaded debug messages will look like this:

Example	Description
Debug[GPS][Info]: TTFT=0s	Time taken for GPS to determine the time. Usually 0 or 1 seconds.
Debug[GPS][Info]: TTFF=3s PDOP(x10)=23 3Dfix=1	Time taken for a basic GPS fix. Usually between 1 and 36 seconds.
Debug[GPS][Info]: Valid=3s PDOP(x10)=23 3Dfix=1	Time taken before a GPS fix passes additional validity filters. Usually TTFF + 0 to 3 seconds.
Debug[GPS][Info]: ORB 54,4,10	Known orbitals. In this example, of 54 possible orbitals, 4 are known in detail, and the knowledge is useable for the next 10 x 15 minutes. Detailed orbital knowledge is not required for a fix, but can speed up the process.
Debug[GPS][Info]: SAT22 43402,43723,40663 …	Tracked satellites. In this example, 22 simultaneous channels are active (locked or searching). The best ten satellites are listed, with the first two digits of each number being the signal to noise ratio – 43, 43, and 40 dB Strengths above 25 are useable, above 35 are good, and above 45 are excellent.

5. Poor Movement Trip Start Performance

If movement trip (emulated ignition) starts are poorer than expected, check the following:

- What is the movement threshold? The default is 150m. Reducing this may result in false trip starts.
- The GPS may have taken a long time to lock, due to poor signal or a fault. See GPS Troubleshooting above. Check the quality of the fix and the time to first fix.