



## Overview:

The GFX sensor is a high-performance GPS and dynamic motion sensor for use in on/off-highway vehicle applications. The unit features an embedded GPS receiver and inertial measurement unit (IMU) sensor with configurable outputs to meet the needs of a variety of demanding applications.

**Model Part No. 6044572-001**

## Key features:

- GPS receiver provides positioning and velocity estimates at 5Hz
- NMEA 2000 (CAN) and NMEA 0183 (RS232) output messaging
- Provides ISOBUS ground speed message
- Available true ground speed PWM output (available on request)
- IMU provides 3-axis: linear acceleration, angular rate and magnetic field
- Low current consumption (up to 120mA)
- Wide operating temperature range (-40°C to 85°C)
- Dustproof and waterproof design, suitable for open-cab environments
- Compact and rugged package allows for flexible vehicle mounting
- Easy to install and use

## Key acronyms and abbreviations:

CAN	Controller Area Network
EMC	Electromagnetic Compatibility
FCC	Federal Communications Commission
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IMU	Inertial Measurement Unit
IP	Ingress Protection
NMEA	National Marine Electronics Association
RED	Radio Equipment Directive
SAE	Society of Automotive Engineers
PWM	Pulse Width Modulation

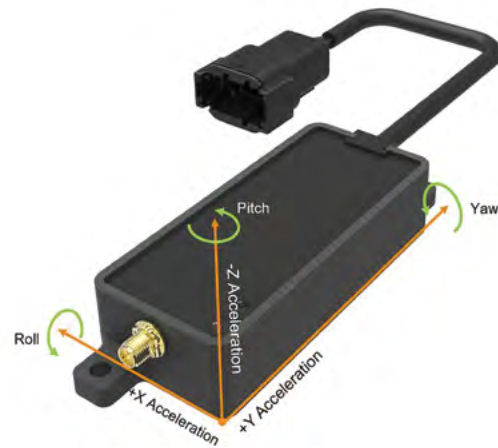
## Technical specifications:

Mechanical		
Size	L 125mm x W 43mm x H 22.25mm (Length x Width x Height)	
Weight	160 gram	
Mounting torque	1.8Nm±0.2Nm	
Mounting size	5.35mm hole	2 locations
Color	RAL 9005 Jet black	Potted assembly

Operating voltage & input current		
Operating voltage	5VDC to 36VDC	Vehicle battery operated
Nominal voltage	12VDC and 24VDC	
Input current	Up to 120mA	At full operating voltage range

GPS specification		
GPS L1 frequency	1575.42 MHz	
Accuracy	4.77m CEP	Circular Error Probability (radius of a circle centered on the true value)
Acquisition time	Hot start	4 Sec
	Warm start	38 Sec
	Cold start	60 Sec
Sensitivity	Tracking	-160dBm
	Acquisition	-145dBm
GPS data update rate	5Hz	

IMU specification	
Linear acceleration	±4 g
Angular rate	±245 dps
Magnetic field	±4 gauss
IMU data update rate	50Hz



**X, Y & Z axis**  
**Direction of detectable accelerations**  
**Direction of detectable angular rates**  
**Circular arrow direction indicates positive angular rate**

Digital speed output		
Signal format	PWM	Duty cycle: 77%
PWM frequency	36Hz to 1.85KHz for 1kph to 50kph speed	Linearly varying
Signal amplitude	Equal to supply input	
Accuracy	± 5%	
Source impedance	100Ω ± 10Ω	
Load impedance	>3kΩ	

**Note:** 1. Digital speed output is disabled at speed less than 1Kph  
 2. When digital speed output is disabled, output will be equal to supply input (100% duty cycle).

**Caution:** Pay attention to Digital Output Pin Wiring. This pin should not be short circuit with ground terminal.

**Electrical specifications**

Short circuit protection	Yes	Short condition: output to battery & input to GND CANH & CANL pins: Up to 36V TX & RX pins: Up to 32V
Reverse polarity	Yes	Up to -36V
Hot plug	Yes	Live connection and disconnection to power supply

**Connector**

Supply and I/O connector	Deutsch DTM04-08PA	Male type (8 pin)
Mating connector	Deutsch DTM06-08SA	Female type (8 pin)
GPS antenna connector	SMA Female Board/ bulkhead mount connector	Female type

**Environmental specifications**

Operating temperature	-40°C to +85°C	
Storage temperature	-40°C to +85°C	
Humidity	90% RH	
Altitude	40000 ft	Air shipment , Device off state
Mechanical shock	50Grms, 11mSec	6 pulses at each axis, Total: 36 pulses
	30Grms, 18mSec	10 pulses at each axis, Total: 60 pulses
Ingress protection	IP67	ISO 20653 (Road vehicles - Degrees of protection (IP code) Protection of electrical equipment against foreign objects, water and access
Salt spray	96 hrs. in salt fog atmosphere	
Chemical resistance	Cab mounting	Alcohol, Detergents, Diesel fuel, Waxes, Spray paint, Hydraulic fluid etc.
Free fall	<1m	
Vibration		
Sine sweep	10Hz to 2000Hz, 3.5Grms	
Random vibration	10Hz to 2000Hz, 2.18Grms	

**Communication protocols**

CAN	SAE J1939	Baud rate 250Kbps
Serial	RS232	Default : 115200 bps  Configurable baud rate 9600/19200/38400/57600/115200 bps

**LED indication**

Power ON / OFF	Green	Continuous ON when powered up
Diagnostic / health monitoring	Red	Continuous ON when faults persist <ul style="list-style-type: none"> <li>• Overvoltage (&gt;36V) &amp; under voltage (&lt;5V)</li> <li>• GPS antenna open &amp; short</li> <li>• Over temperature fault (95°C)</li> <li>• GPS and IMU fault</li> </ul>

**European Commission Directives**

**Electromagnetic Compatibility (EMC) Directive 2014/30/EU**  
EN ISO 14982:2009

Agriculture and Forestry machinery			
Conducted Electrical Transient Pulses	ISO7637:2004	Level: IV for 12V & 24V (all pulses)	
Radiated Emission	CISPR 25:2016	30MHz to 1000MHz	
Bulk Current Injection	ISO11452-4:2011	Functional Class A 20MHZ-200MHZ, 60mA	
Radiated Immunity	ISO11452-2:2004	Functional Class A 200MHZ to 1GHZ, 30V/m	
ESD	ISO 10605:2008	Functional Class A - Contact & Air discharge (Powered and Unpowered)  Direct discharge (3 pulses with > 1s interval) Contact: ±4kV Air: ±4kV  Indirect Discharge: (50 pulses with > 50ms interval) ±4kV	

**Radio Equipment Directive (RED) 2014/53/EU**

ETSI EN 301 489-19 V2.1.0:2017

EMC for Radio Equipment and Services

Conducted Electrical Transient Pulses	ISO7637:2004	Level: IV for 12V & 24V (all pulses)	
Conducted Immunity	IEC 61000 4-6:2013	Functional Class A 150KHZ-80MHZ, 3Vrms	
Conducted Emission	Reference Clause 8.3 CISPR 32:2015 / EN 55032:2015	Quasi-peak: Product Class A 0.15-0.5MHZ: 79dB(uV) 0.5-30MHZ: 73dB(uV) Average: Product Class A 0.15-0.5MHZ: 66dB(uV) 0.5-30MHZ: 60dB(uV)	
Radiated Immunity	IEC 61000 4-3:2006	80MHZ to 6GHZ, 3V/m, Class A	
Radiated Emission	EN 55032	30MHz to 6GHZ	

ETSI EN 303 413 V1.1.1 (2017-06)

Harmonised EU standard for GNSS essential requirement

Spurious Emission	Reference: Clause No 4.2.2	30MHz-8.3GHz (Radiated & Conducted Method)	
Adjacent Frequency band	Reference: Clause No 4.2.1	Δ C/NO ≤ 1 dB Conducted Method	

**Low Voltage (LVD) Directive 2014/35/EU/2014/53/EU**

IEC 62368-1:2014 Safety: Audio/video, information and communication technology equipment - Part 1: Safety requirements (Hazard Based Safety Standard)

EN 62479:2010 Health: Assessment of the compliance of low-power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz)

**RoHS 2 Directive 2011/65/EU**

Restriction of the Use of Certain Hazardous Substances in Electronic and Electrical Equipment

**Other directives**

FCC SDoC (Suppliers Declaration of Conformity)	FCC part 15B	Part 15-Low Power Unlicensed Devices Radiated Emissions Section 15.109 (30MHz to 1GHz)
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### CAN output messages

GFX provides GPS, IMU, ISO bus PGN 65097 and proprietary PGN 65281 on CAN bus. Default source address of CAN message is 75 (0x4B). CAN message data switches between unsigned integer (UINT) and signed integer (INT) based on the parameter.

#### 1. GPS message information

GFX provides following NMEA 2000 PGNs at 5Hz transmission rate over CAN bus.

##### **PGN 126992**

This PGN provides a regular transmission of UTC time and date.

##### **PGN 129025**

This PGN provides latitude and longitude referenced to WGS84.

##### **PGN 129033**

This PGN provides time, date and local offset time information.

##### **PGN 129026**

This PGN provides Course Over Ground (COG) and Speed Over Ground (SOG).

##### **PGN 127250**

This PGN provides Heading sensor angle, Deviation, Variation information.

##### **PGN 127258**

This PGN provides Age of service, Variation information.

##### **PGN 129539**

This PGN provides GNSS status and dilution of precision components (DOP).

##### **PGN 129029**

This PGN conveys a comprehensive set of Global Navigation Satellite System (GNSS) parameters, including position information.

**Note:** The PGN 129029 transmits more than 8 bytes of data. So, to transmit this PGN NMEA 2000 Fast Packet protocol is used.

## 2. IMU message information

GFX transmits IMU data over CAN bus at 50Hz transmission rate in below defined format.

### PGN 65429

This PGN provides IMU X, Y and Z Axis Acceleration data.

PGN 65429 (0xCFF954B) - Acceleration Data																
Byte	Byte 0		Byte 1		Byte 2		Byte 3		Byte 4		Byte 5		Byte 6		Byte 7	
Field	Acceleration X				Acceleration Y				Acceleration Z				Accl and Gyro Who I AM Reg		Accl and Gyro Status reg	
Datatype	Int 16				Int 16				Int 16				Unit 8		Uint 8	
Resolution	0.001				0.001				0.001				-		-	
Unit	g				g				g				NA		NA	
Byte Sequence	Accl Byte 0		Accl Byte 1		Accl Byte 0		Accl Byte 1		Accl Byte 0		Accl Byte 1					
Bit Sequence	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8				

Default value of Who I AM register of Acceleration and Gyroscope is 0x68, it indicates Accelerometer and Gyroscope are responding.

### PGN 65430

This PGN provides IMU X, Y and Z Axis Gyroscope data.

PGN 65430 (0xCFF964B) - Acceleration Data																
Byte	Byte 0		Byte 1		Byte 2		Byte 3		Byte 4		Byte 5		Byte 6		Byte 7	
Field	Angular Rate X				Angular Rate Y				Angular Rate Z				Accl and Gyro Who I AM Reg		Accl and Gyro Status reg	
Datatype	Int 16				Int 16				Int 16				Unit 8		Uint 8	
Resolution	0.01				0.01				0.01				-		-	
Unit	dps				dps				dps				NA		NA	
Byte Sequence	Gyro Byte 0		Gyro Byte 1		Gyro Byte 0		Gyro Byte 1		Gyro Byte 0		Gyro Byte 1					
Bit Sequence	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8				

Default value of Who I AM register of Acceleration and Gyroscope is 0x68, it indicates Accelerometer and Gyroscope are responding.

### PGN 65431

This PGN provides IMU X, Y and Z Axis Magnetometer data.

PGN 65431 (0xCFF974B) - Acceleration Data																
Byte	Byte 0		Byte 1		Byte 2		Byte 3		Byte 4		Byte 5		Byte 6		Byte 7	
Field	Magnetic Field X				Magnetic Field Y				Magnetic Field Z				Mag sensor Who I AM Reg		Mag sensor Status reg	
Datatype	Int 16				Int 16				Int 16				Unit 8		Uint 8	
Resolution	0.001				0.001				0.001				-		-	
Unit	gauss				gauss				gauss				NA		NA	
Byte Sequence	Mag Byte 0		Mag Byte 1		Mag Byte 0		Mag Byte 1		Mag Byte 0		Mag Byte 1					
Bit Sequence	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8				

Default value of Who I AM register of Magnetometer is 0x3D, it indicates Magnetometer is responding.

### 3. ISO Bus PGN 65097 message information

This PGNs provides speed over ground at transmission rate of 10Hz over CAN bus.

PGN 65097 (0x0CFE494B)									
Bytes	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7 (bit 7 to 5)	Byte 7 (bit 1,0)
Parameter	Speed Over Gnd		Ground Based Machine Distance				Reserved	Reserved	Ground Based Machine Direction
Datatype	Uint 16								
Resolution	0.001								
Unit	mps		NA				NA	NA	NA
Byte Sequence	SoG Byte 0		SoG Byte 1						
Bit Sequence	Bit 7	Bit 0	Bit 15	Bit 8					

### 4. PGN 65281 information

This PGN provides supply voltage, temperature, status code.

PGN 65281 (0x18FF014B)												
Bytes	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8			
Parameter	Unused	Unused	Temperature		Supply Volt		Unused	Status Word				
Datatype	NA	NA	Int 16		Uint 16		NA	Uint 8				
Resolution	NA	NA	0.01		0.01		-	-				
Unit	NA	NA	°C		Volts		NA	NA				
Byte Sequence	NA	NA	Temp Byte 0	Temp Byte 0	Voltage Byte 0	Voltage Byte 0						
Bit Sequence	NA	NA	Bit 7	Bit 0	Bit 15	Bit 8	Bit 7	Bit 0	Bit 15	Bit 8	NA	NA

#### Status code (Byte 7 in PGN 65281)

Status word indicate various fault conditions, supply voltage fault, over temperate fault, GPS Antenna fault, GPS message not received fault, IMU acceleration and magnetometer fault.

Sr. No	Status word bit	Fault	Hex value	Description
1	0	Supply voltage fault	0x01	Indicate under voltage (<4.5V) and over voltage (>36V ) Fault
2	1	Over temp fault	0x02	Temperature > 100 deg c
3	2	GPS Antenna Open	0x04	GPS Antenna not connected
4	3	GPS Antenna Short	0x08	Antenna Short
5	4	GPS message not received	0x10	Not receiving any message from GPS module
6	5	All Axis data of Accl are zero	0x20	Value of all Axis of Acceleration are zero
7	6	Reserved	-	
8	7	All Axis data of Mag are zero	0x80	Values of all Axis of Magnetometer are zero

### NMEA 0183 configuration messages

GFX NMEA0183 output can be enabled or disabled using PMTK\_SLEEP\_CLT serial command. NMEA0183 output is enabled by default.

Baudrate of NMEA0183 messages can be configured using PMTK\_SET\_NMEA\_BAUDRATE serial command. Default baud rate is 115200 bps

<b>PMTK_SLEEP_CTL</b>		<b>Receiver Sleep Control</b>
Controls the Sleep mode of the receiver.		
Field	Description	
0	Message ID \$PMTK161	
1	0 - Sleep (Disable NMEA 0183 output) 1 - Wake (Enable NMEA 0183 output)	

<b>PMTK_SET_NMEA_BAUDRATE</b>		<b>NMEA Baudrate</b>
Set NMEA port baud rate		
Field	Description	
0	Message ID \$PMTK251	
1	"Baudrate setting: 9600 19200 38400 57600 115200"	

### NMEA 0183 output messages

<b>GGA</b>		<b>GPS Fix Data</b>
The GGA message includes time, position, and fix related data for the GPS receiver at 5 Hz update rate.		
Field	Description	
0	Message ID \$GPGGA	
1	UTC of position fix	
2, 3	Direction of latitude, N (North) or S (South)	
4, 5	Direction of longitude, E (East) or W (West)	
6	GPS Quality indicator: 0 - Fix not valid, 1 - GPS fix, 2 - Differential GPS fix	
7	Number of satellites in use, range from 00 through to 24+	
8	Horizontal Dilution of Precision (HDOP)	
9, 10	Antenna altitude in Meters (MSL reference) , M = Meters	
11, 12	"Geoidal Separation in Meters, M=Meters. Geoidal separation is the difference between the WGS-84 earth ellipsoid and mean-sea-level."	
13	Age of differential GPS data record. Time in seconds since last Type 1 or Type 9 update. Null field when DGPS is not used.	
14	Reference station ID, range 0000-4095. A null field when any reference station ID is selected and no corrections are received.	
hh	The checksum data, always begins with *	

<b>ZDA</b>		<b>UTC day, month, and year, and local time zone offset</b>
The ZDA message contains Time of Day in UTC: the day, the month, the year and the local time zone at 1 Hz update rate.		
Field	Description	
0	Message ID \$GPZDA	
1	UTC (When UTC offset has been decoded by the receiver)	
2	Day, ranging between 01 and 31	
3	Month, ranging between 01 and 12	
4	Year	
5	Local time zone offset from GMT, ranging from 00 through ±13 hours	
6	Local time zone offset from GMT, ranging from 00 through 59 minutes	
hh	The checksum data, always begins with *	

<b>GSA GPS DOP and active satellites</b>	
The GSA messages indicates the GPS receiver's operating mode and lists the satellites used for navigation and the DOP values of the position solution at 1 hz update rate.	
Field	Description
0	Message ID \$GPGSA
1	"Mode: M = Manual, A = Automatic. In manual mode, the receiver is forced to operate in either 2D or 3D mode. In automatic mode, the receiver is allowed to switch between 2D and 3D modes subject to the PDOP and satellite masks."
2	Mode 2, Fix type, 1 = not available, 2 = 2D, 3 = 3D
3 - 14	"PRN numbers of the satellites used in the position solution. When less than 12 satellites are used, the unused fields are null"
15	Position dilution of precision: 0.5 through 99.9
16	Horizontal dilution of precision: 0.5 through 99.9
17	Vertical dilution of precision: 0.5 through 99.9
hh	The checksum data, always begins with *

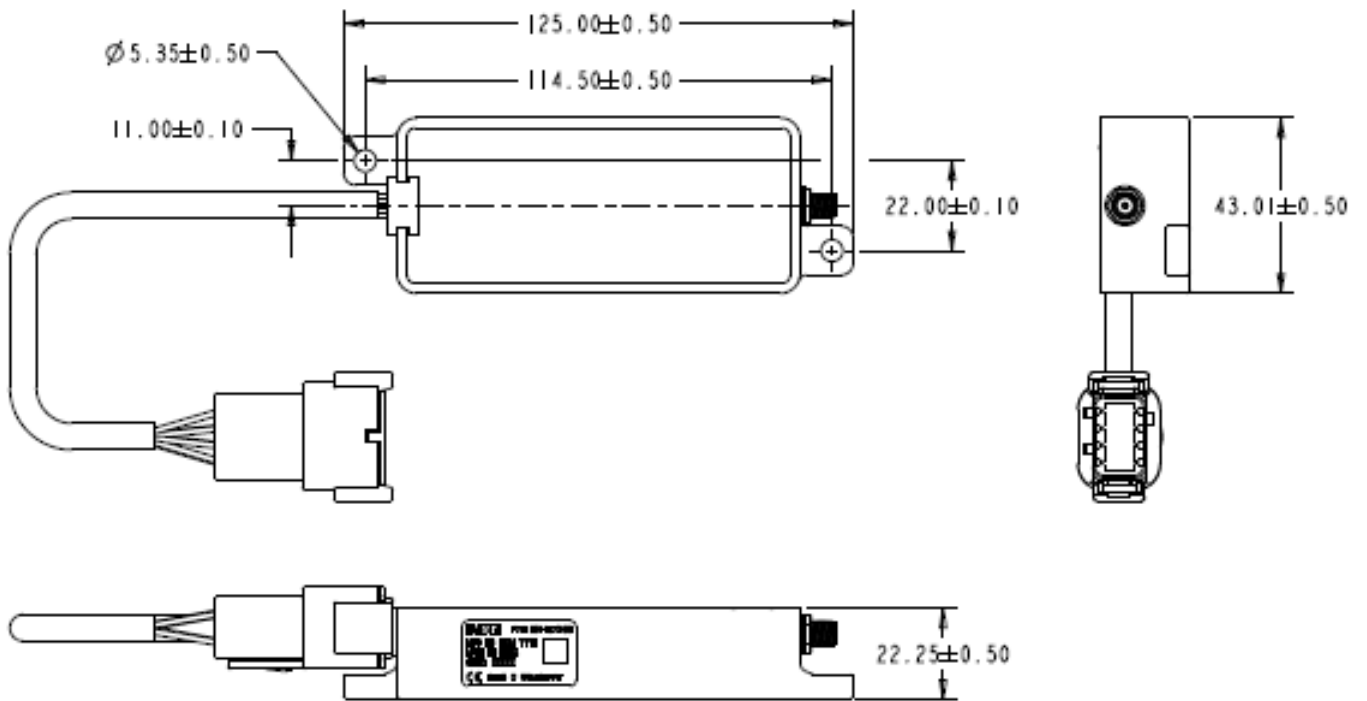
<b>VTG Track made good and speed over ground</b>	
The VTG message conveys the actual track made good (COG) and the speed relative to the ground (SOG) at 1 hz update rate.	
Field	Description
0	Message ID \$GPVTG
1, 2	Track made good relative to true north
3, 4	Track made good relative to magnetic north
5, 6	Speed over ground (SOG) in knots
7, 8	Speed over ground in kilometers/hour (kph)
9	Mode indicator: A=Autonomous mode D=Differential mode E=Estimated (dead reckoning) mode M=Manual input mode S=Simulated mode N=Data not valid
hh	The checksum data, always begins with *

<b>RMC Position, velocity, and time</b>	
The RMC message contains the time, date, position, course, and speed data provided by the GPS navigation receiver at 1 hz update rate. A checksum is mandatory for this message and the transmission interval may not exceed 2 seconds. All data fields must be provided unless the data is temporarily unavailable. Null fields may be used when data is temporarily unavailable.	
Field	Description
0	Message ID \$GPRMC
1	UTC of Position Fix (when UTC offset has been decoded by the receiver).
2	Status: A - Valid V - Navigation receiver warning
3, 4	Latitude, N (North) or S (South).
5, 6	Longitude, E (East) or W (West).
7	Speed over the ground (SOG) in knots
8	Track angle in degrees true
9	Date: dd/mm/yy
10, 11	Magnetic variation in degrees, E = East / W= West
12	"Position System Mode Indicator: A = Autonomous D = Differential E = Estimated M = Manual input S = Simulation mode N = Data not valid"
hh	The checksum data, always begins with *



PMTKANT	Antenna Status
Antenna status at 5 hz update rate	
Example: \$PMTKANT,0	
Field	Description
0	Message ID \$PMTKANT
1	"N (antenna status) 0 = Open 1 = Normal 2 = Short"

**Product dimensions**



ALL DIMENSIONS ARE IN MM

**Pin out details**

Pin No.	Pin name
1	Supply Input
2	CAN High
3	RS232 RX
4	Digital Out- Speed signal
5	Not used
6	RS232 TX
7	CAN Low
8	Ground

**Note:** Use supply ground for RS232 GND.

## Installing the GFX

### Mounting considerations

- The GFX shall be fixed using two mounting holes provided diagonally across the enclosed assembly.
- Use the standard threaded M5 size screws to affix the GFX. (Note: Customer shall choose length of the screws as per mounting base)
- Mounting torque shall be  $1.8 \pm 0.2 \text{ Nm}$ .

### Mating antenna details

Use 3V external Active Antenna

Recommended Active Antenna

Part Number: 66800-52, Manufacturer: Trimble Inc.

**Note:** Antenna interface SMA connector recommended mating torque - 4-5 inch-pounds.

Antenna interface SMA connector durability- 500 Cycles.

**Caution:** Supply voltage provision is 3V for external active antenna. Ensure appropriate antenna is chosen for functioning of GPS.

### Recommended wiring practices

- Confirm the CAN cable is properly terminated using 120 ohm resistor.
- Use twisted or twisted shielded pair cable for CAN as per the applicable standard.
- Verify that the harness is constructed to meet the needs of the application environment (e.g. shock, vibration, moisture, temperature, chemicals, and impact).
- Ensure that the harness is designed and constructed to minimize induced interference resulting from EMI coupling between signal wires.
- Separate power circuits from low-level signals.
- Provide sufficient clearance from moving parts.
- Wires routed through holes in the vehicle body/chassis should use grommets.
- Avoid sharp metal edges, fasteners, and other abrasive surfaces or use protective shielding when routing harness assembly.
- Route wires to avoid exhaust system components or other high temperature areas, use appropriate heat shielding or other insulation where routing is a problem.
- Avoid routing near wheel wells or provide adequate mechanical protection to the assembly
- Use a protective fuse sized appropriately for the GFX supply current.

## Device troubleshooting

The following is a check list, if there is any problem in the device.

- Make sure the Power indication Green LED is ON

If Red LED is ON, check the following:

- Power input is within 5-36V.
- External Antenna interface- Antenna is not properly connected or antenna is shorted. Short alert is triggered if external active antenna draws approximately more than 19mA.
- Operating temperature is not exceeding  $>85$  Degrees Celsius.
- GPS information is not available in corresponding PGNs.
- IMU Accelerometer and Magnetometer three axis information is not available in corresponding PGNs.

## Warnings

When installing this component, all requirements of the outlined standard must be fulfilled.

- This component is designed to be affixed in the application, and a suitable enclosure should be provided in the end system.

## Declaration of conformity

Hereby, Eaton Corp. declares that this GFX is in compliance with the essential requirements and other relevant provisions of the following directives:

1. Electromagnetic Compatibility (EMC) Directive 2014/30/EU
2. Radio Equipment Directive (RED) 2014/53/EU
3. Low Voltage (LVD) Directive 2014/35/EU
4. RoHS 2 Directive 2011/65/EU

## Manufacturer Details

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April 2020

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