

NDIA

National Defense Industrial Association

Promoting National Security Since 1919

13th Annual Systems Engineering Conference
“Achieving Acquisition Excellence via Effective Systems Engineering.”
San Diego, CA
October 27th, 2009

“Unmanned Ground Vehicle Integrated Diagnostics”

Larry Osentoski, President & CEO
DRIVE Developments, Inc.
7314 Nineteen Mile Road
Sterling Heights, MI 48314

Corporate Overview

DRIVE Developments, Inc. is a high quality engineering solution provider. Our experience is strongly rooted in vehicular diagnostics and prognostics. This is evidenced in our **DIME (Diagnostic Information Management Environment)** product line which combines over 50 years of staff experience with hardware and software development within test facilities, **remote diagnostics and fleet management.**

The breadth of our capabilities also extend into other areas of vehicular engineering to include scientific test cell development, internet applications and plant monitoring systems.

We truly believe in the philosophy of “Lead, Follow or Get Out of the Way”

Business Highlights

- Michigan Small Business incorporated in July 2007
- Focused on Military and Commercial vehicle work
- Featured on The Economic Report with Greg Gumbel in Fall 08'
- Selected as one of "Michigan's 50 Businesses To Watch for 2009"
- Selected as Prime on \$500M / 5 year TARDEC OMNIBUS
- Selected as Crain's Top 25 Defense Companies to Watch 2010

Overview :

This presentation will present an example of successful integration of diagnostics within a UGV platform that was delivered to US Forces Special Operations Command by DRIVE Developments, Inc. for use in riverine drug interdiction operations OCONUS.

The UGV, named **ARK**, is an Amphibious Robot that can travel at speeds up to 22 mph on land and up to 5mph in waterways. The vehicle is remote controlled and is interoperable with all Ethernet based military communications including but not limited to Wave Relay equipment.

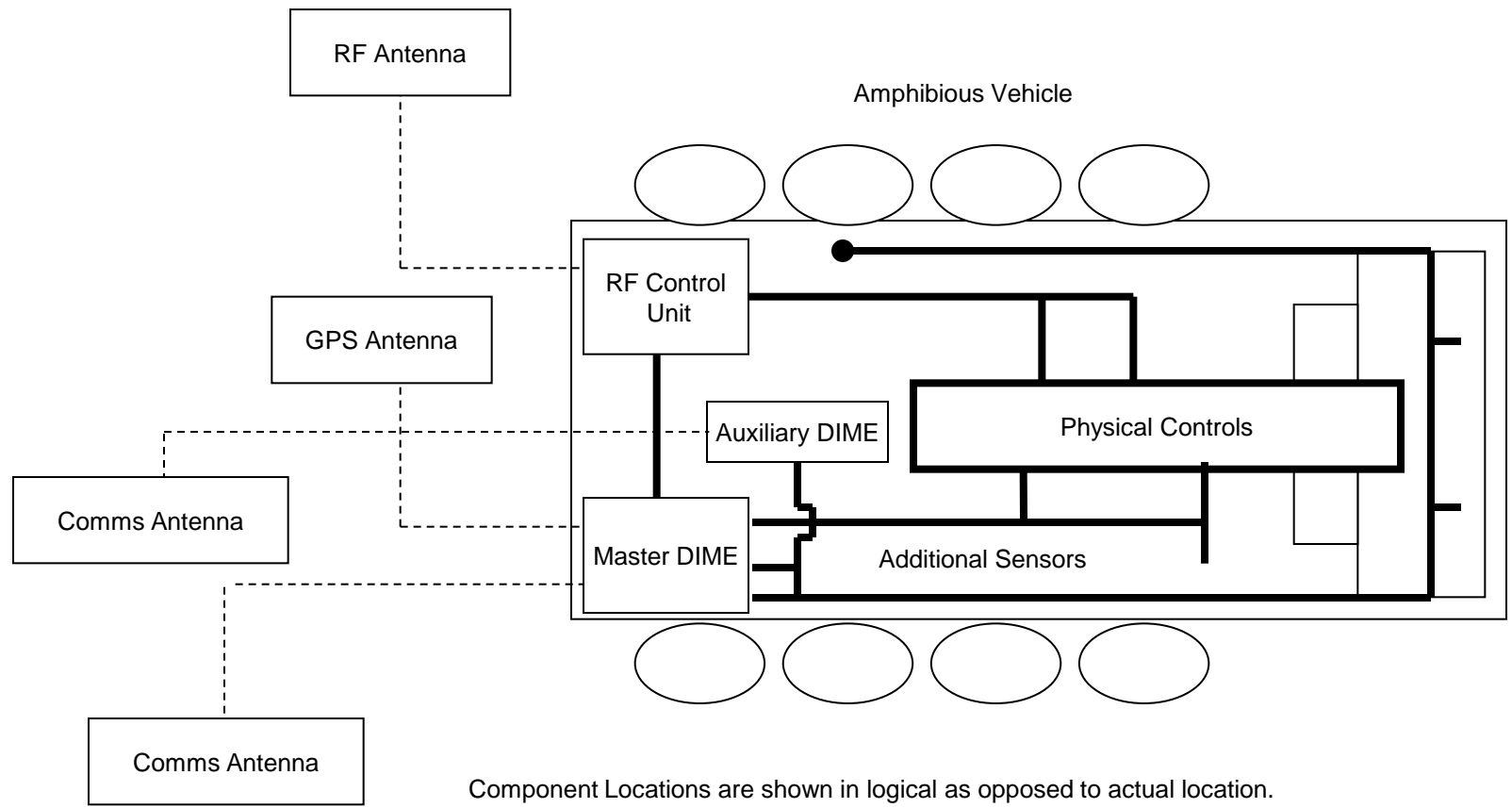
ARK – Amphibious Remote Controlled Robot



Features of ARK

- Resident CAN data bus which records vehicle activity and alerts operators and commanders of pending and current fault conditions
- GPS tracking
- Extensive on-board instrumentation and controls that provide a real time view into the current operation and long term duty cycle of the vehicle

ARK System Hardware : *Logical System Block Diagram*



Component Locations are shown in logical as opposed to actual location.

SIDE VIEW ARK



Onboard driver T-handle controls to override remote control system. Actuators free follow when driver overrides.

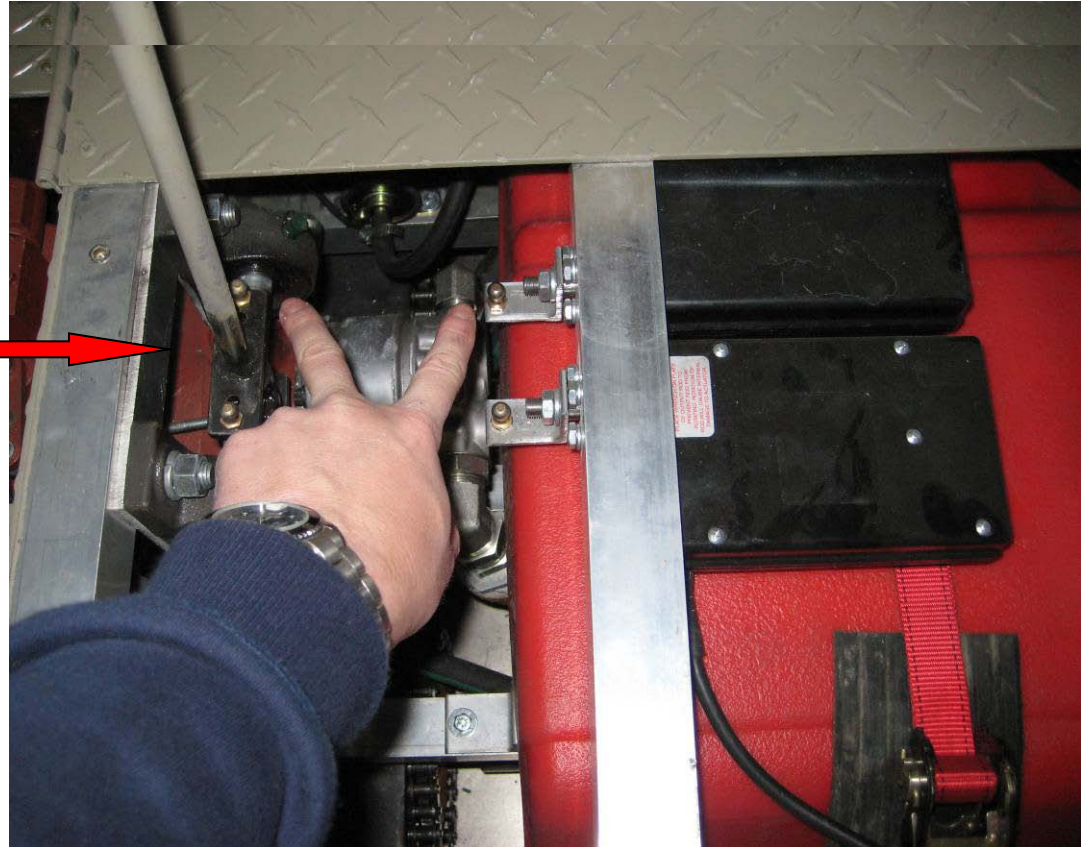


Onboard driver T-handle controls to override remote control system. Actuators free follow when driver overrides.



Onboard driver T-handle controls to override remote control system. Actuators free follow when driver overrides.

Two independent linkages manipulate all remote control motion via the two on board actuators



Hydrostatic driven outboard water propulsion



INSIDE CHASSIS VIEW



OUTSIDE CHASSIS VIEW

Upgraded Instrument panel

EStop Button

Fuel level gage



Remote enable switch

Instrument panel



The gauge is wired into the vehicles CAN network. The AUX DIME reads the gauge input and broadcasts the corresponding fuel level message. The MASTER DIME logs and reports the fuel level information to the portal system.

**Fuel Level Gage controlled by DIME AUX
Smart ECU on J1939 over CAN**

Instrument panel



The E-stop is wired into the vehicle's control panel. When depressed all vehicle functions are cut off and power is removed from the system.

On board E-stop manually controlled by the operator.

Instrument panel



The switch is wired to the vehicle control systems and supplies power to the remote control unit. As a safety precaution changing modes during operation kills the engine. This prevents unwanted behavior when the actuators either take over or relinquish control.

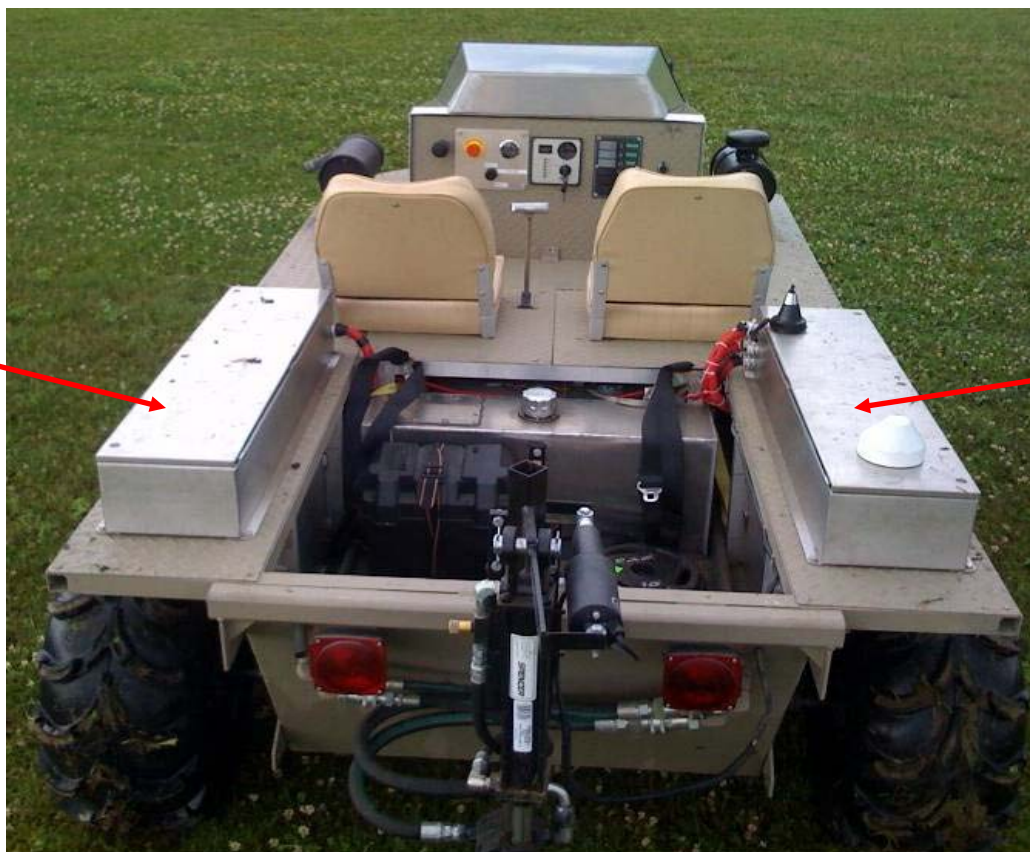
Operator controlled remote control enable switch.

Hand Held Remote Control



Master and AUX DIME mounting: The DIME units and the remote control receiver electronics are mounted in NEMA enclosures as shown below.

AUX unit location.



DIME Master
and Omnex
Receiver location.

Situational Awareness : DIME Antenna

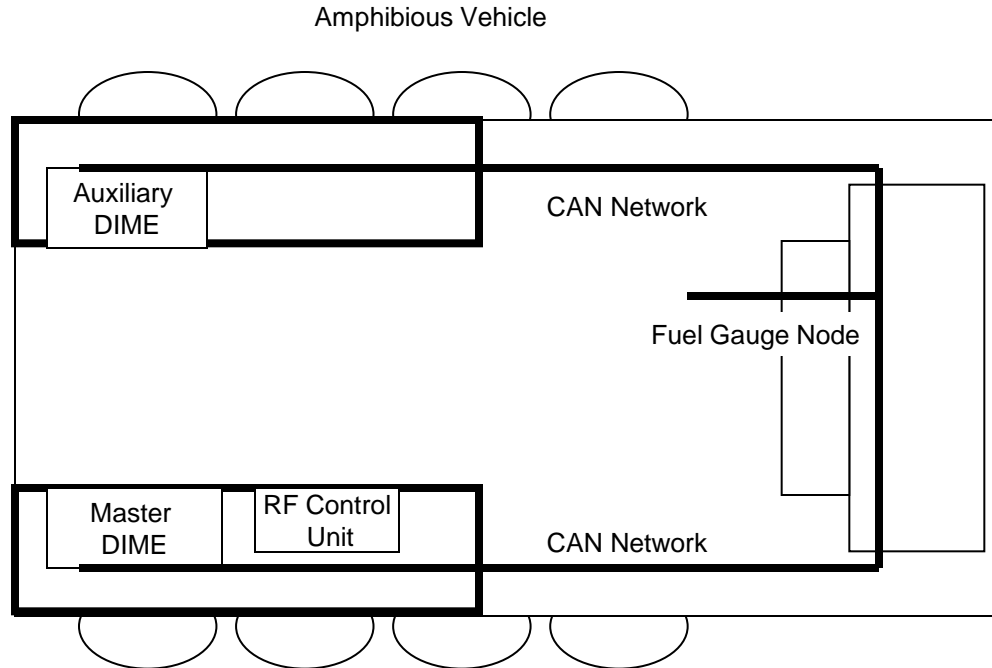
- a) Dual WiFi / GPS antenna.
- b) GPS antenna has active gain.
- c) 2.4GHz Comms frequency supporting both 802.11b/g
- d) Currently mounted on the hood of the vehicle to provide clear path to the sky for GPS.



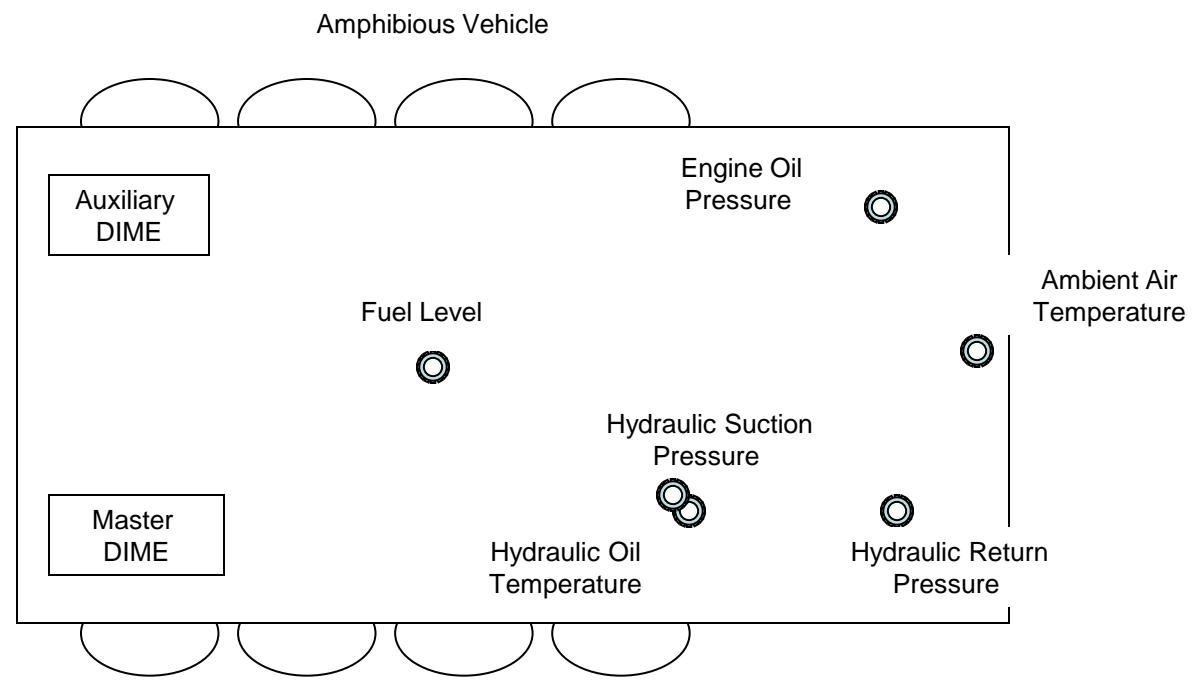
CAN J1939 Network

- a) MASTER and AUX DIME CAN Controllers
- b) AUX unit interfaces sensors and broadcasts CAN data providing network data.
- c) MASTER unit collects data and reports to portal.
- d) CAN J1939 Fuel gauge connects directly to the CAN network and receives messages.
- e) The Network runs around the vehicle in a horseshoe pattern and allows for future connections and nodes.

Situational Awareness : CAN J1939 Network



Situational Awareness : Sensor Locations



Situational Awareness : Integration

- a) NEMA electronics enclosures mounted on each side of the vehicle.
- b) DIME units and remote control receiving unit mounted within NEMA enclosures.
- c) Power, ground and communications lines integrated.
- d) Remote control integration complete with all functional testing passed.
- e) CAN Network completed
- f) Sensors wired to appropriate DIME units.
- g) Communications/GPS antenna mounted.

Vehicle Health & Situational Awareness

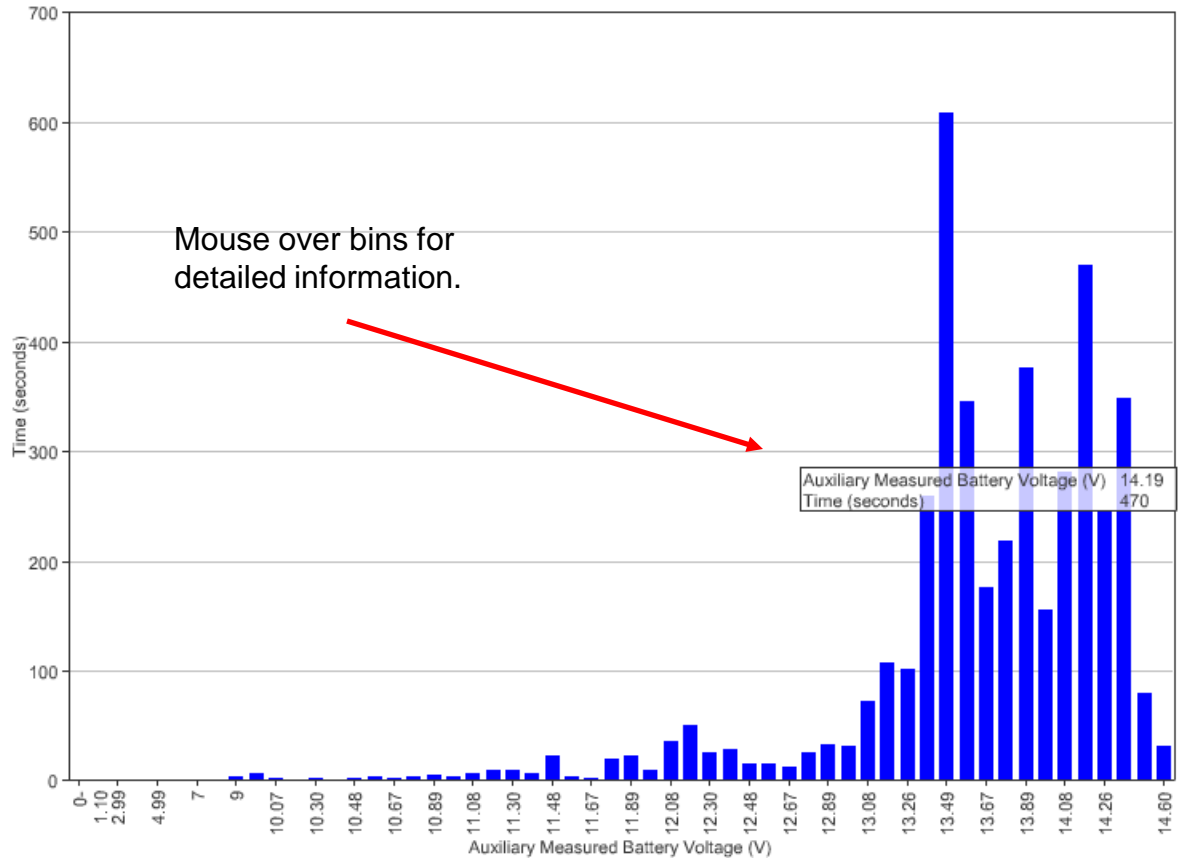
1. Application management features
 - a. Remote firmware flash (MINT file)
 - b. Remote Application flash (REED file)
2. Data Collection Types
(Histograms, Time in State, Event Counters, Situation Awareness files, Event Window Files)
3. Data Collection Speed
 - a. Bus speed for triggered or fault events
 - b. 10 Hz (100ms) for non-time correlated data
4. Remote configuration - Proprietary data compression techniques enabling performance in low bandwidth Military environments.
5. System processing of data from multiple data bus sources (CAN, J1708, RS485) simultaneously.
6. Capable of storing data in emergency power loss situations.
7. BIST (Built In Self Test)

Auxiliary Measured Battery Voltage Histogram

- Vehicles >
- Trouble Codes >
- Histograms >
- Locations >
- Events >
- State Monitoring >

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

Parameter: Auxiliary Measured Battery Voltage View: Time (seconds)



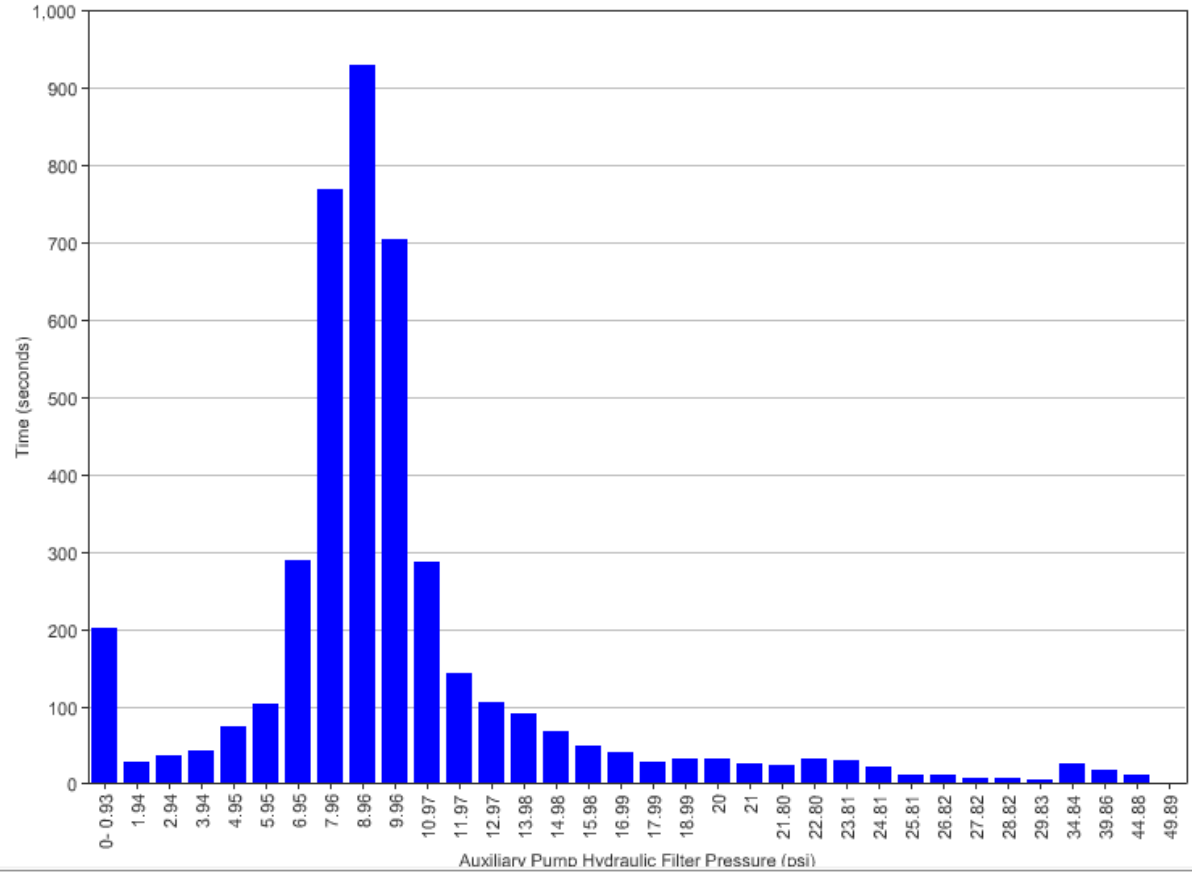
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Auxiliary Pump Hydraulic Filter Pressure

- Vehicles
- Trouble Codes
- Histograms
- Locations
- Events
- State Monitoring

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

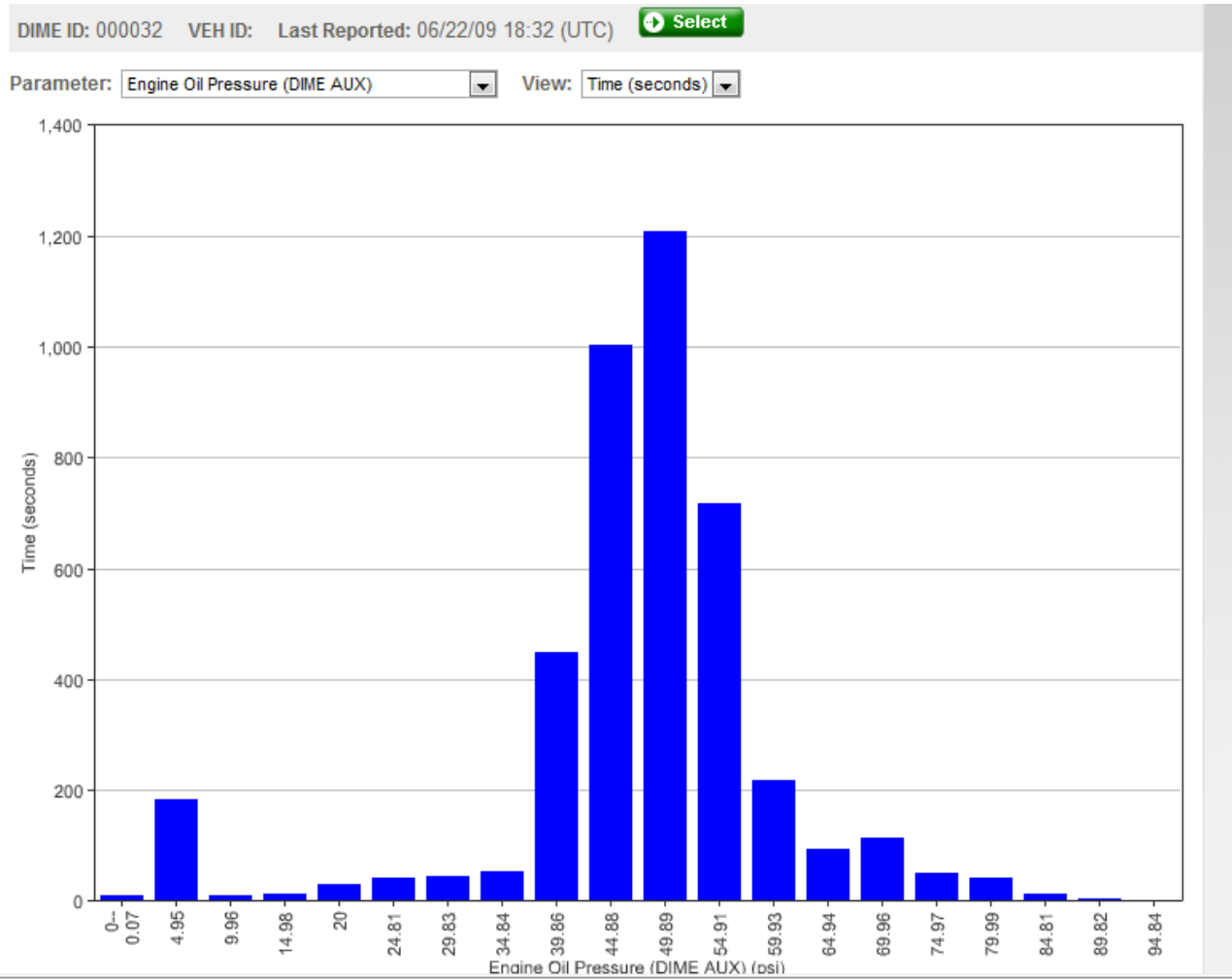
Parameter: Auxiliary Pump Hydraulic Filter Pressure View: Time (seconds)



DRIVE Developments, Inc.

Engine Oil Pressure

- Vehicles >
- Trouble Codes >
- Histograms >**
- Locations >
- Events >
- State Monitoring >

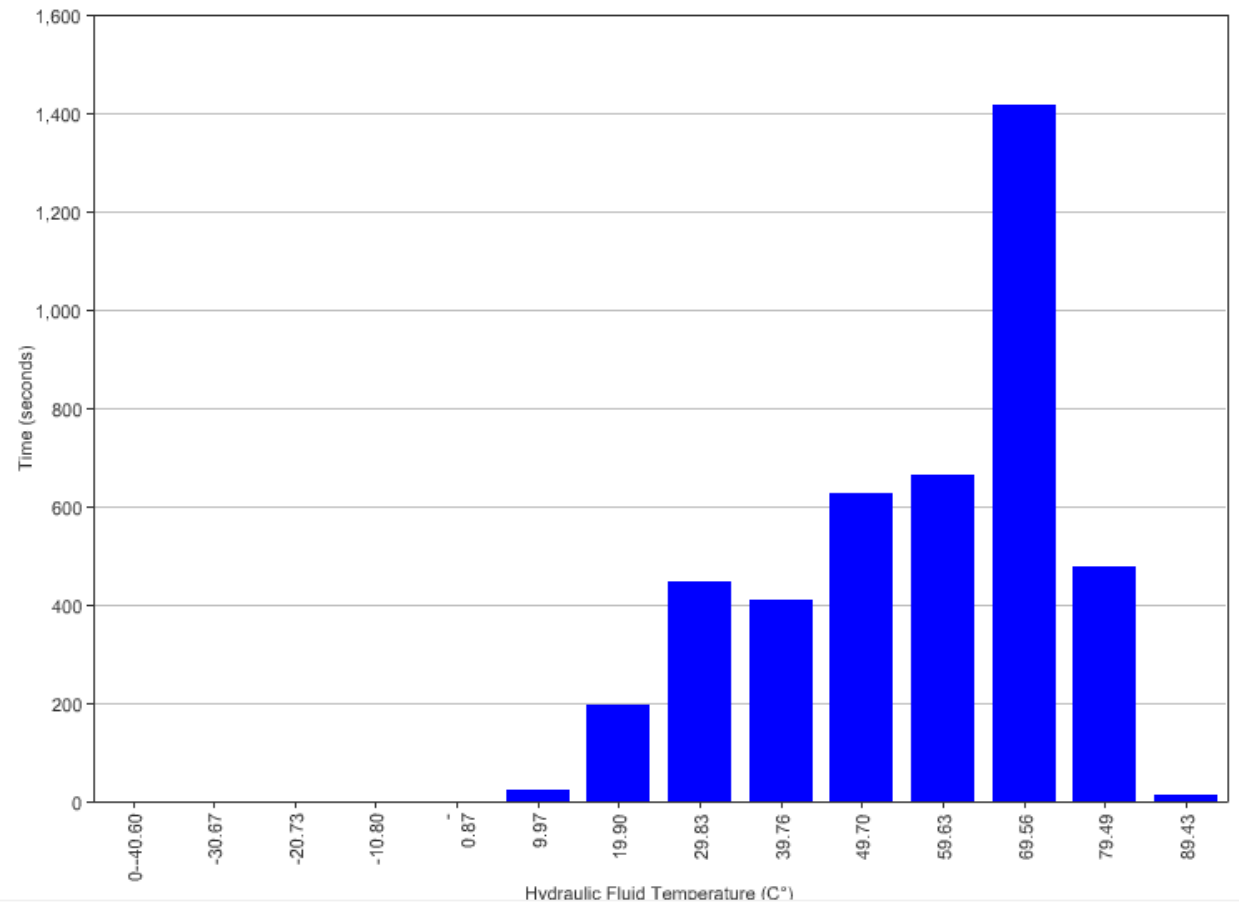


Hydraulic Fluid Temperature

- Vehicles
- Trouble Codes
- Histograms
- Locations
- Events
- State Monitoring

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) [Select](#)

Parameter: Hydraulic Fluid Temperature View: Time (seconds)



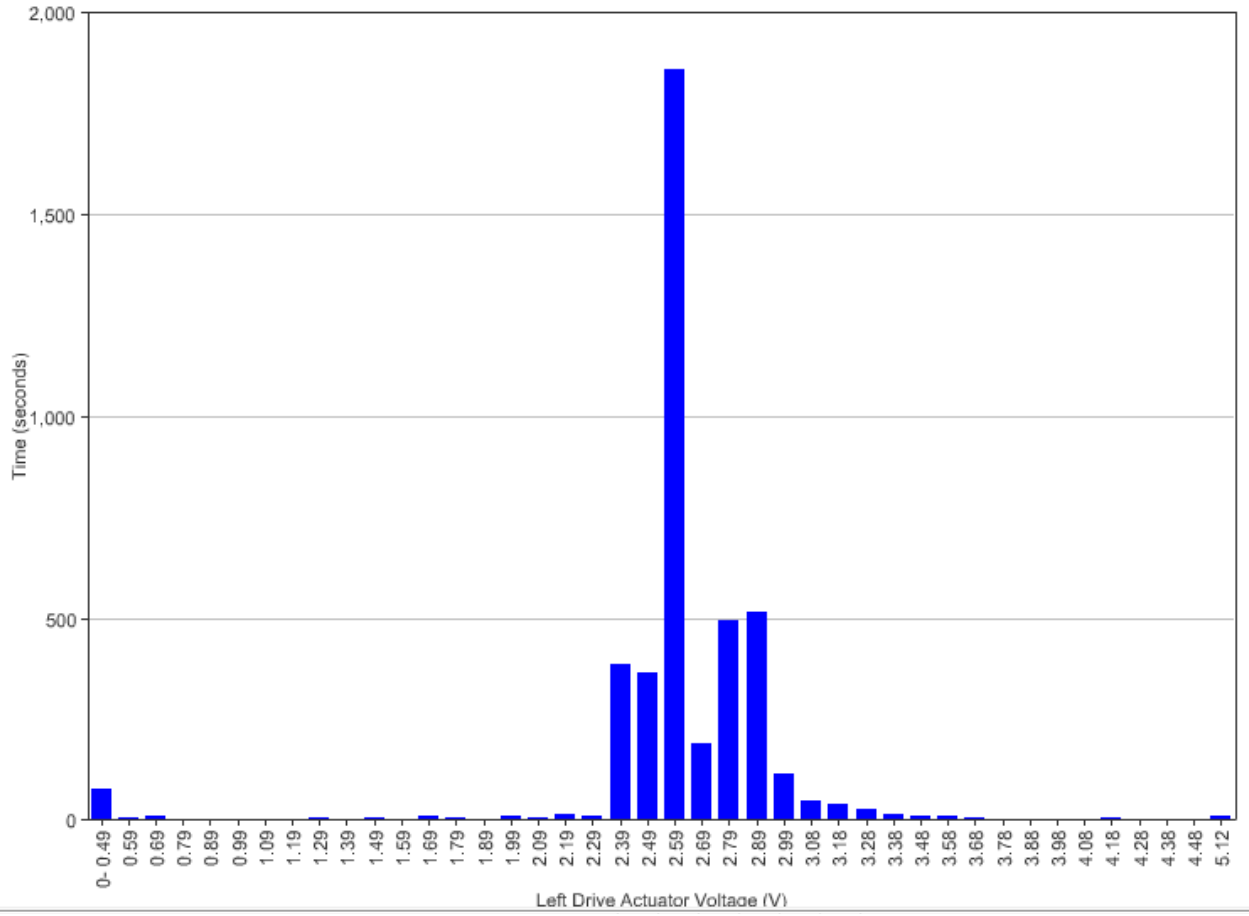
DRIVE Developments, Inc.

Left Drive Actuator Voltage

- Vehicles >
- Trouble Codes >
- Histograms >
- Locations >
- Events >
- State Monitoring >

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

Parameter: Left Drive Actuator Voltage View: Time (seconds)



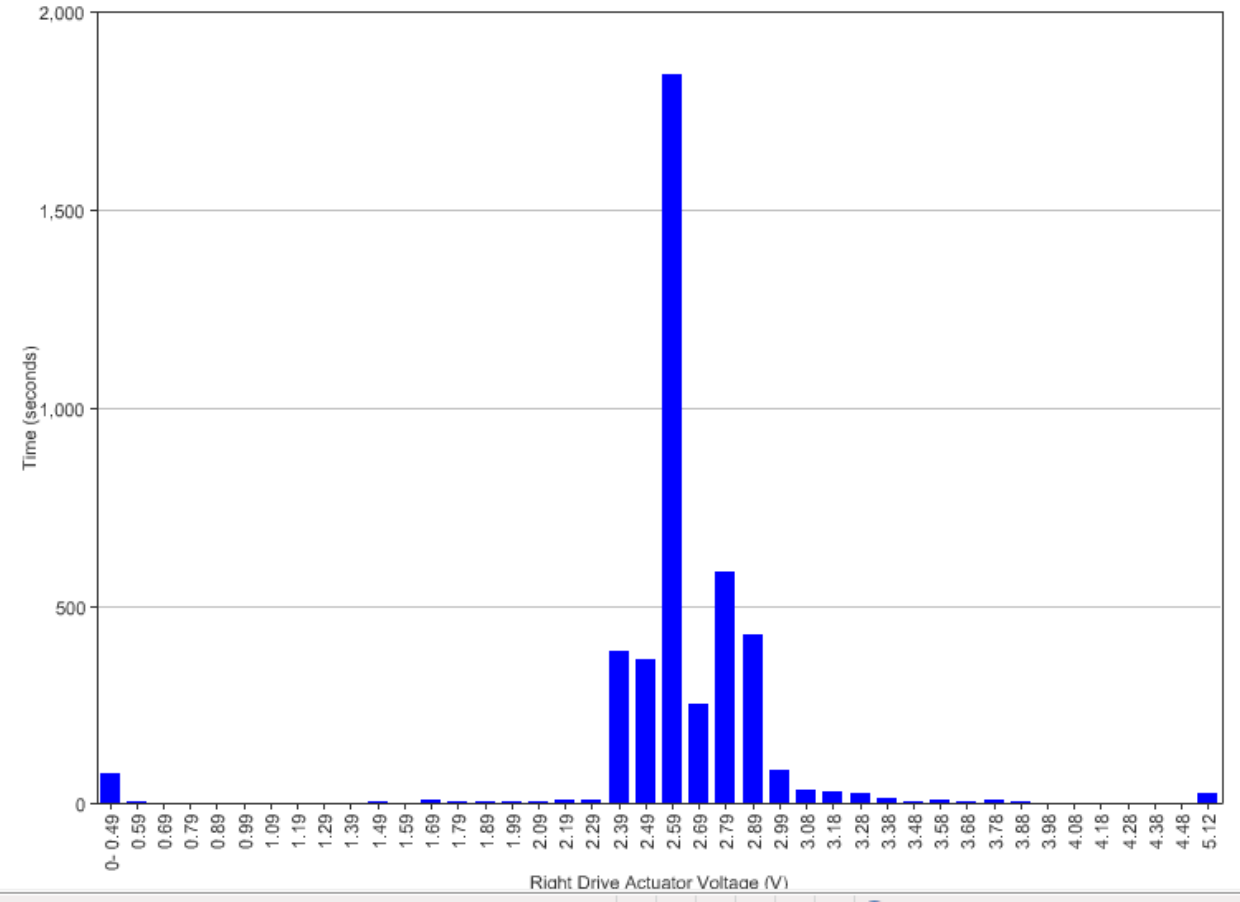
DRIVE Developments, Inc.

Right Drive Actuator Voltage

- Vehicles >
- Trouble Codes >
- Histograms >
- Locations >
- Events >
- State Monitoring >

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

Parameter: Right Drive Actuator Voltage View: Time (seconds)

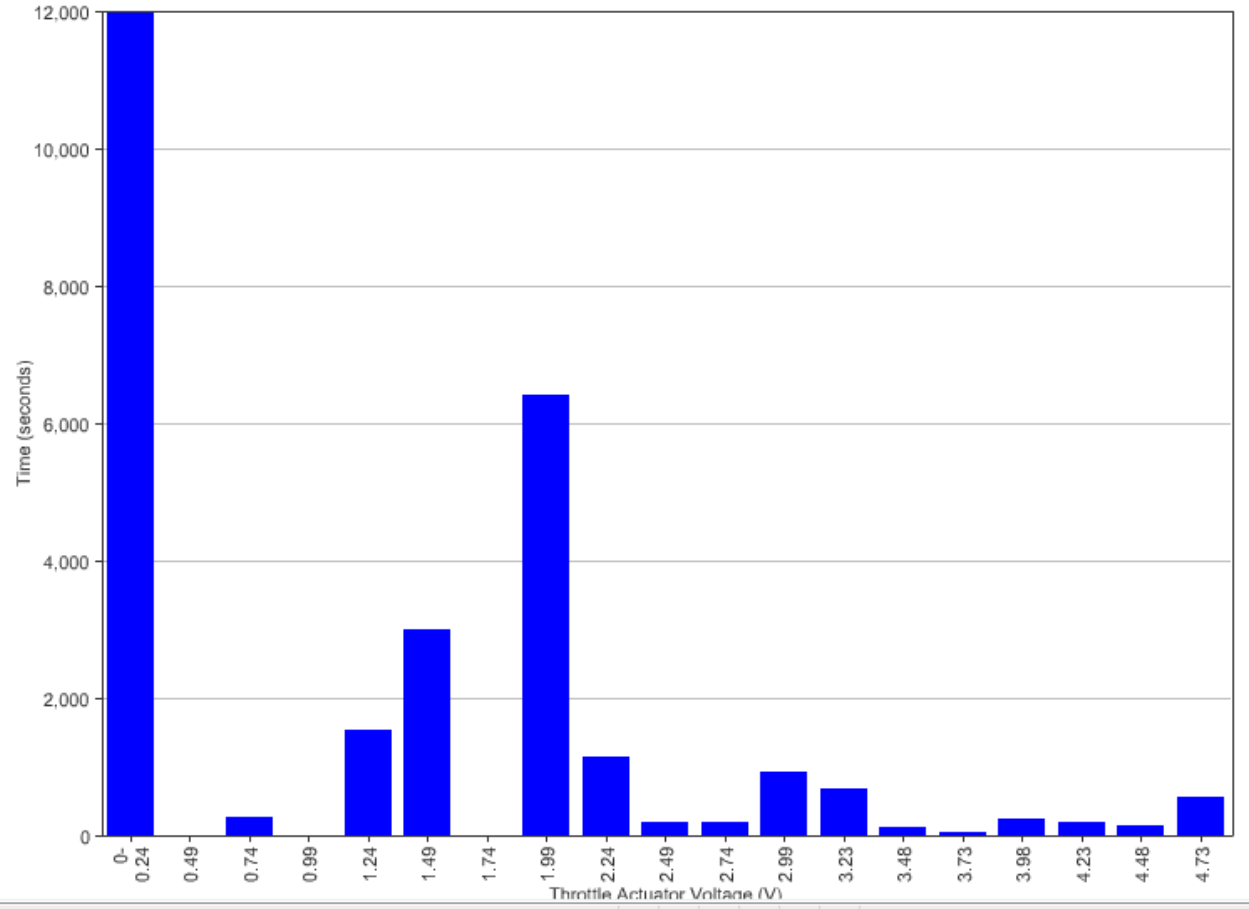


Throttle Actuator Voltage

- Vehicles
- Trouble Codes
- Histograms**
- Locations
- Events
- State Monitoring

DIME ID: 000032 VEH ID: Last Reported: 08/04/09 20:40:02 (UTC) [Select](#)

Parameter: Throttle Actuator Voltage View: Time (seconds)



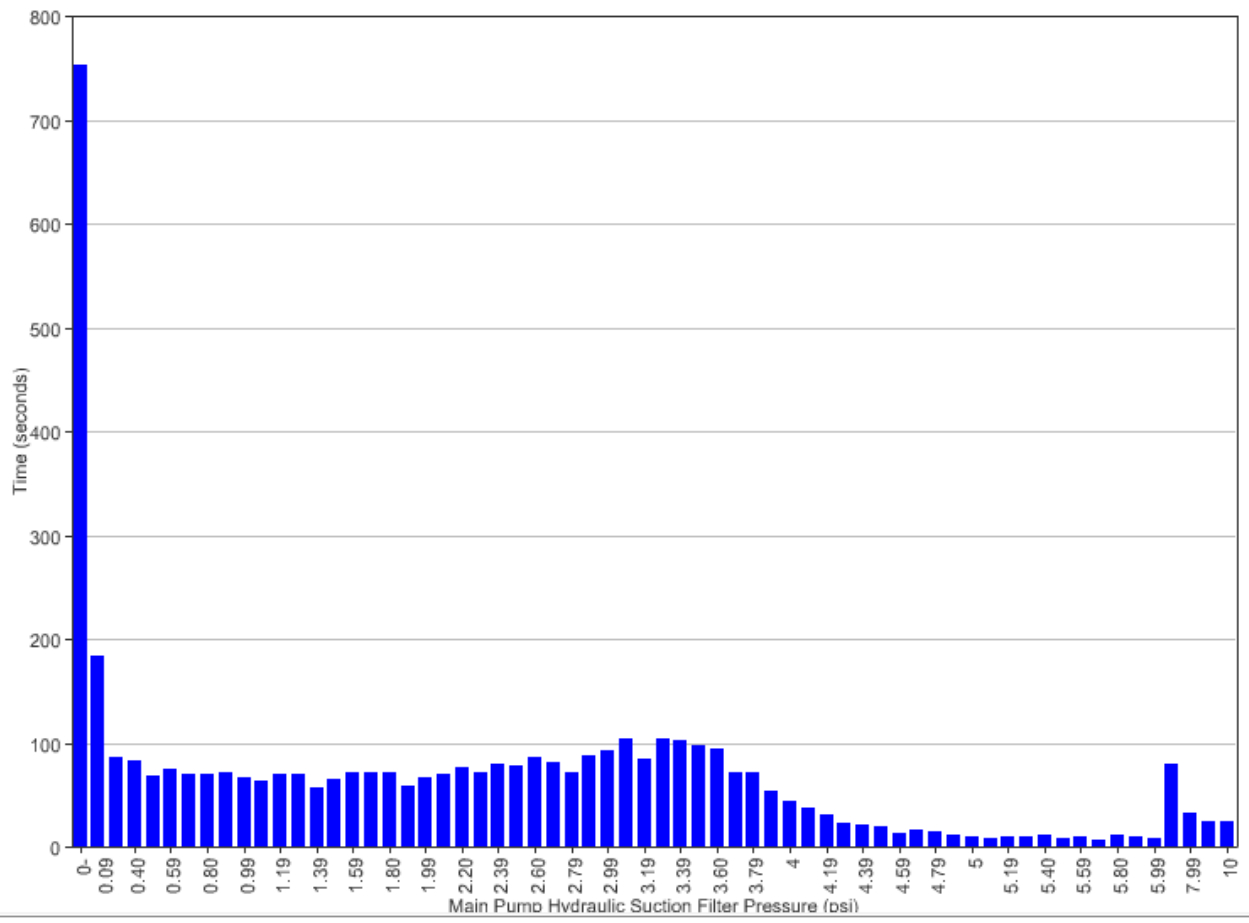
DRIVE Developments, Inc.

Main Pump Hydraulic Suction Filter Pressure

- Vehicles >
- Trouble Codes >
- Histograms >
- Locations >
- Events >
- State Monitoring >

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

Parameter: Main Pump Hydraulic Suction Filter Pressure View: Time (seconds)



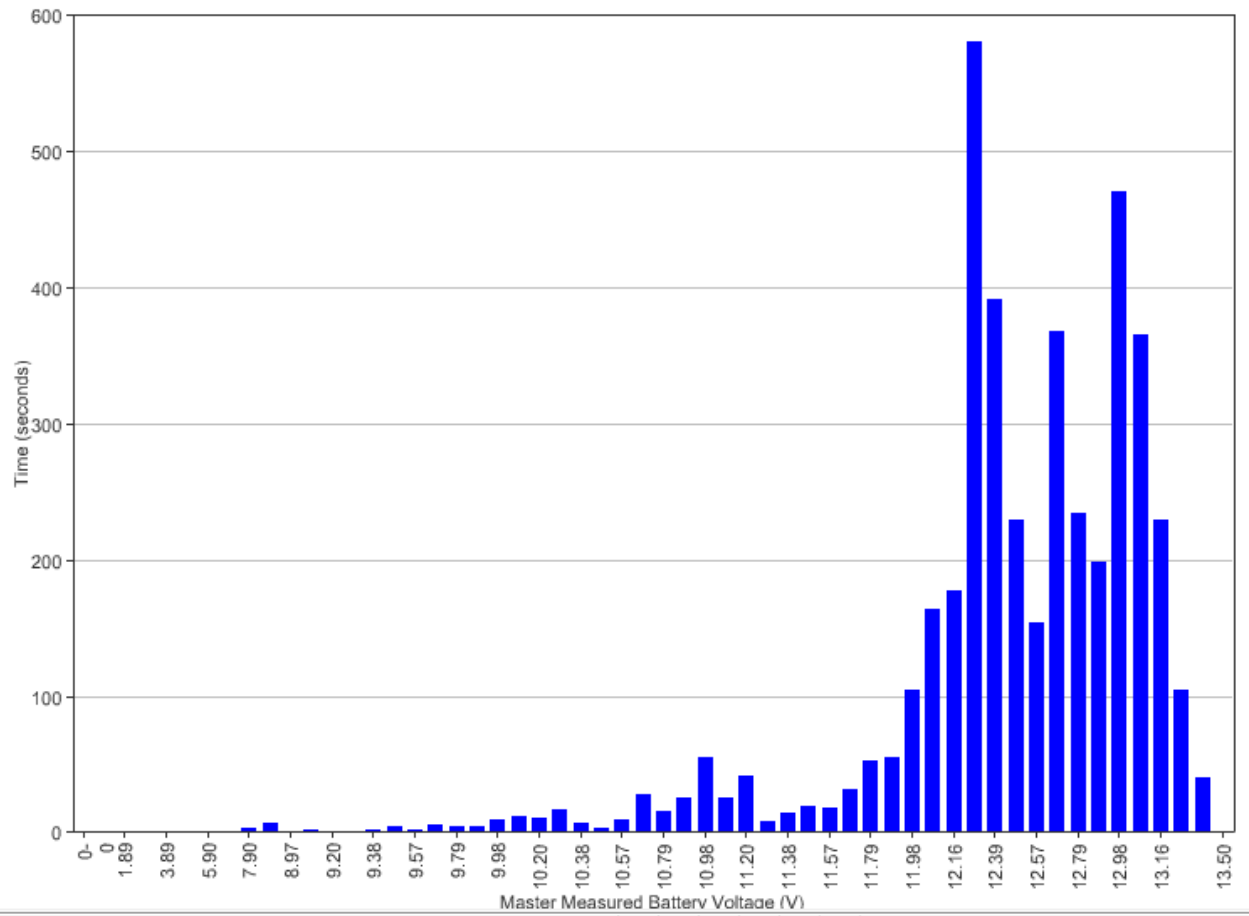
DRIVE Developments, Inc.

Master Measured Battery Voltage

- Vehicles >
- Trouble Codes >
- Histograms >
- Locations >
- Events >
- State Monitoring >

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

Parameter: Master Measured Battery Voltage View: Time (seconds)



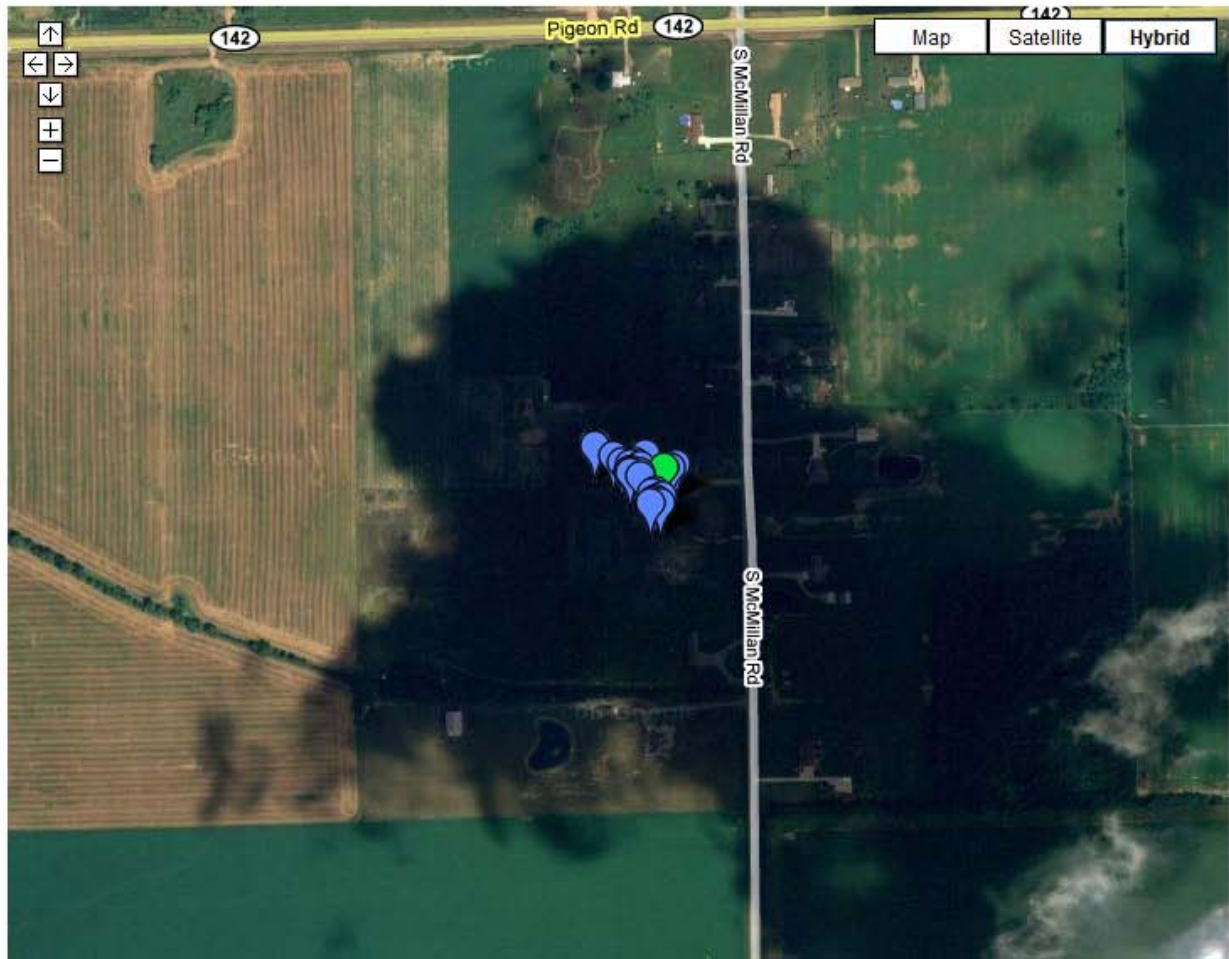
DRIVE Developments, Inc.

Situational Awareness View

DRIVE Developments, Inc.

- Vehicles
- Trouble Codes
- Histograms
- Locations
- Events
- State Monitoring

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) [Select](#)



Situational Awareness View

- Vehicles
- Trouble Codes
- Histograms
- Locations
- Events
- State Monitoring

DIME ID: 000032 VEH ID: Last Reported: 06/22/09 18:32 (UTC) Select

Map Satellite Hybrid

Date/Time: 06/22/09 06:27:28 PM
Latitude: 43.817701
Longitude: -83.062438
Ambient Air Temperature (DIME AUX): 88.79 F
Left Drive Actuator Voltage: 2.77 V
Right Drive Actuator Voltage: 2.76 V
Throttle Actuator Voltage: 0.00 V
ARK Control Mode: 0.00 V
Auxiliary Measured Battery Voltage: 14.01 V
Auxiliary Pump Hydraulic Filter Pressure: 5.75 psi
DIME Internal Temperature: 42.18 C°
DIME measured battery input voltage: 2.82 V
Engine Oil Pressure (DIME AUX): 36.25 psi
Fuel Level (DIME AUX): 97.23 %
Hydraulic Fluid Temperature: 63.24 C°
Main Pump Hydraulic Suction Filter Pressure: 0.72 psi

Situational Awareness View: Reported Faults

DRIVE Developments, Inc.

Vehicles ▶

Trouble Codes ▶

Histograms ▶

Locations ▶

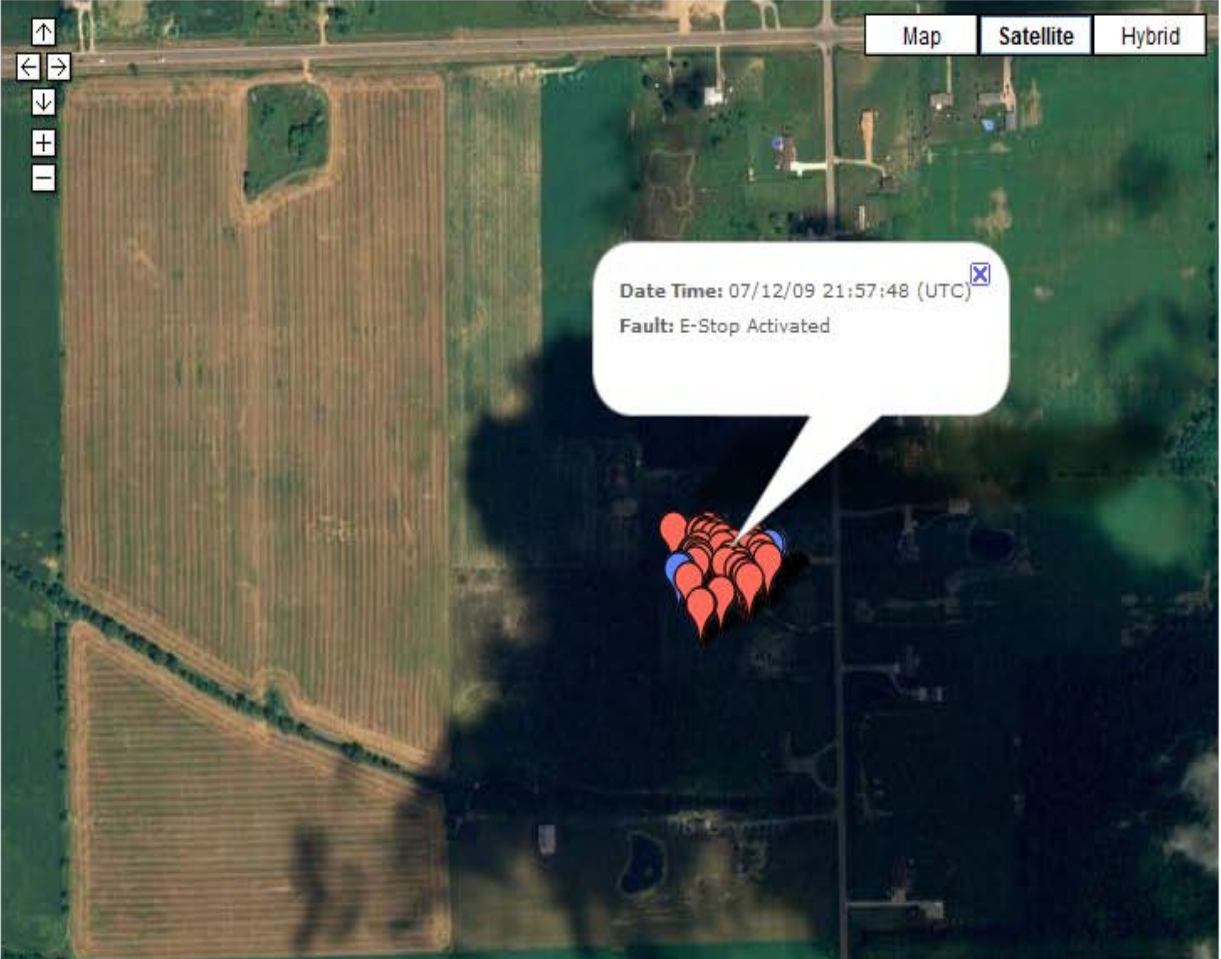
Events ▶

State Monitoring ▶

DIME ID: 000032 VEH ID: Last Reported: 08/04/09 20:40:02 (UTC) **Select**

Map Satellite Hybrid

Date Time: 07/12/09 21:57:48 (UTC) ✕
Fault: E-Stop Activated



Reported Faults

Vehicles >

Trouble Codes >

Histograms >

Locations >

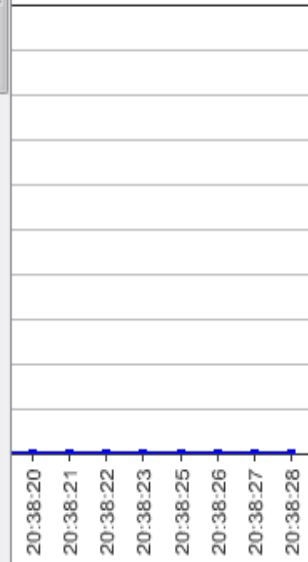
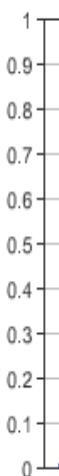
Events >

State Monitoring >

DIME ID: 000032 VEH ID: Last Reported: 08/04/09 20:40:02 (UTC) Select

Fault:	Param
DIME - Throttle Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)	DIME - Throttle Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)
DIME - E-Stop Activated - 08/04/09 20:38:01 (UTC)	DIME - Left Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)
DIME - Left Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)	DIME - Right Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)
DIME - Right Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)	DIME - Left Actuator Out of Range Low - 08/04/09 20:18:15 (UTC)
DIME - Left Actuator Out of Range Low - 08/04/09 20:18:15 (UTC)	DIME - Right Actuator Out of Range Low - 08/04/09 20:18:15 (UTC)
DIME - Right Actuator Out of Range Low - 08/04/09 20:18:15 (UTC)	DIME - Throttle Actuator Out of Range Low - 08/04/09 20:18:15 (UTC)
DIME - Throttle Actuator Out of Range Low - 08/04/09 20:18:15 (UTC)	DIME - E-Stop Activated - 08/04/09 20:18:15 (UTC)
DIME - E-Stop Activated - 08/04/09 20:18:15 (UTC)	DIME - Left Actuator Out of Range Low - 08/01/09 20:39:13 (UTC)
DIME - Left Actuator Out of Range Low - 08/01/09 20:39:13 (UTC)	DIME - Right Actuator Out of Range Low - 08/01/09 20:39:13 (UTC)
DIME - Right Actuator Out of Range Low - 08/01/09 20:39:13 (UTC)	DIME - Throttle Actuator Out of Range Low - 08/01/09 20:39:13 (UTC)
DIME - Throttle Actuator Out of Range Low - 08/01/09 20:39:13 (UTC)	DIME - E-Stop Activated - 08/01/09 20:39:13 (UTC)
DIME - E-Stop Activated - 08/01/09 20:39:13 (UTC)	DIME - E-Stop Activated - 07/26/09 22:34:22 (UTC)
DIME - E-Stop Activated - 07/26/09 22:34:22 (UTC)	DIME - E-Stop Activated - 07/26/09 22:34:05 (UTC)
DIME - E-Stop Activated - 07/26/09 22:34:05 (UTC)	DIME - E-Stop Activated - 07/26/09 21:54:43 (UTC)
DIME - E-Stop Activated - 07/26/09 21:54:43 (UTC)	DIME - E-Stop Activated - 07/26/09 21:54:40 (UTC)
DIME - E-Stop Activated - 07/26/09 21:54:40 (UTC)	DIME - Left Actuator Out of Range Low - 07/26/09 21:50:25 (UTC)
DIME - Left Actuator Out of Range Low - 07/26/09 21:50:25 (UTC)	DIME - Right Actuator Out of Range Low - 07/26/09 21:50:25 (UTC)
DIME - Right Actuator Out of Range Low - 07/26/09 21:50:25 (UTC)	DIME - Throttle Actuator Out of Range Low - 07/26/09 21:50:25 (UTC)
DIME - Throttle Actuator Out of Range Low - 07/26/09 21:50:25 (UTC)	DIME - E-Stop Activated - 07/26/09 21:50:25 (UTC)
DIME - E-Stop Activated - 07/26/09 21:50:25 (UTC)	DIME - Left Actuator Out of Range Low - 07/26/09 00:37:23 (UTC)
DIME - Left Actuator Out of Range Low - 07/26/09 00:37:23 (UTC)	DIME - Right Actuator Out of Range Low - 07/26/09 00:37:23 (UTC)
DIME - Right Actuator Out of Range Low - 07/26/09 00:37:23 (UTC)	DIME - Left Actuator Out of Range Low - 07/26/09 00:37:02 (UTC)
DIME - Left Actuator Out of Range Low - 07/26/09 00:37:02 (UTC)	DIME - Right Actuator Out of Range Low - 07/26/09 00:37:02 (UTC)
DIME - Right Actuator Out of Range Low - 07/26/09 00:37:02 (UTC)	DIME - E-Stop Activated - 07/26/09 00:30:48 (UTC)
DIME - E-Stop Activated - 07/26/09 00:30:48 (UTC)	DIME - Left Actuator Out of Range Low - 07/26/09 00:30:48 (UTC)
DIME - Left Actuator Out of Range Low - 07/26/09 00:30:48 (UTC)	

to display additional information.



Reported Faults Detailed Graph

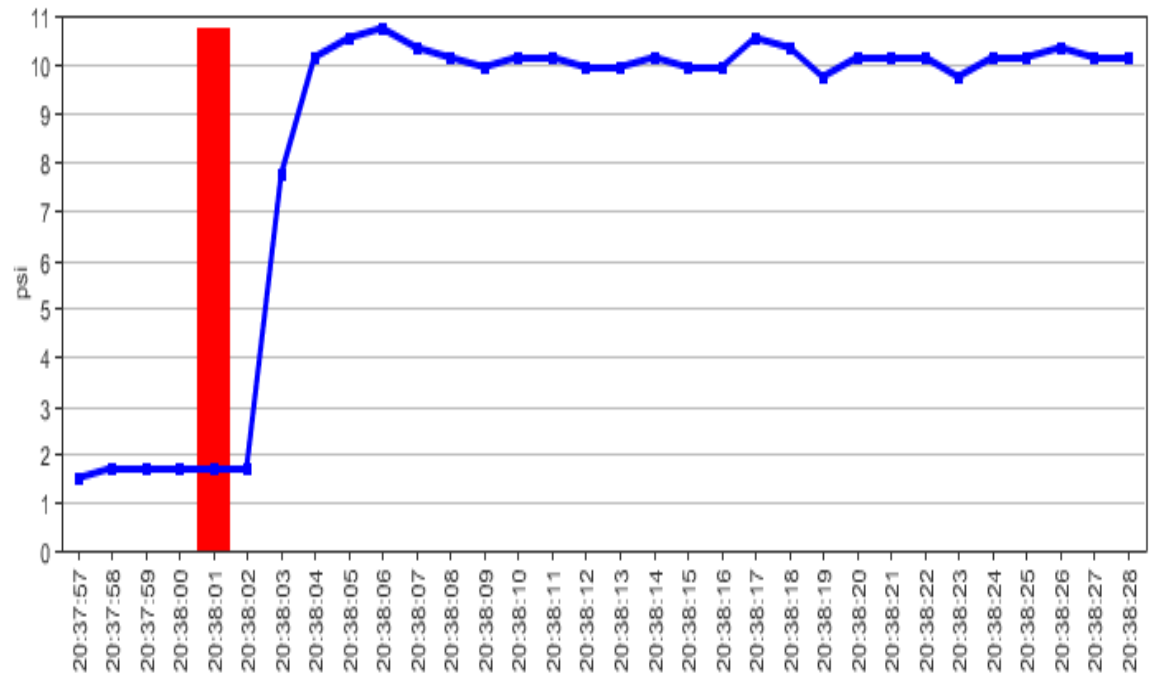
- Vehicles
- Trouble Codes
- Histograms
- Locations
- Events
- State Monitoring

DIME ID: 000032 VEH ID: Last Reported: 08/04/09 20:40:02 (UTC) [Select](#)

Fault: DIME - Throttle Actuator Out of Range Low - 08/04/09 20:38:01 (UTC)

Parameter: Auxiliary Pump Hydraulic Filter Pressure

The red line indicates a fault. Click on the fault to display additional information.



Next Generation of the ARK :

The initial ARK vehicle has been tested at Avon Park, FL test facility with US Special Forces. DRIVE is currently developing the next generation of this vehicle that will include 360 degree real time day/night vision in addition to the integration of our new NICKEL product for diagnostic data bus monitoring within a wireless controller solution.

Our Family of DIME Products

Diagnostic Information Management Environment (DIME)



What is the DIME?

The DIME (**D**iagnostic **I**nformation **M**anagement **E**nvironment) is a **TRL 8** end-to-end **Lifecycle and Vehicle Health Management System** complete with on-board storage, GPS tracking, wired and wireless communication interfaces. DIME enables *Connected Vehicle* applications.

The system is capable of remotely updating and upgrading the system firmware and application code within seconds even in low communication bandwidth environments. This is accomplished via the DIME Data Management Center where data is stored, analyzed, distributed and displayed.

What is the DIME?

HARDWARE Features:

- Technical Readiness Level (TRL) 8
- **Ultra low power consumption (<25mW) in sleep mode with optional ZERO power draw configuration.**
- Low space and weight claim (approx 1.5 lbs)
- **Capable of start up and recording in less than 50ms**
- 802.11 b/g wireless interface
- 2 CAN channels capable of 1Mbps communications
- Ultra low cost hardware investment
- RS485 / RS422
- Capable of waking up from up to eight unique input sources (CAN Bias, CAN Activity, Ignition, J1708, RS232, RS422/RS485, External input, Real Time Clock)

What is the DIME?

HARDWARE Features continued:

- RS232
- Ethernet
- **GPS (Global Positioning System)**
- **Sensor interfaces (Analog and Digital)**
- Remote management / disablement of GPS/Wireless comms
- Wave Relay, Fortress, and CAISI compliant via Ethernet connection
- Forms the foundation for any diagnostic system for any vehicle platform.
- Compatible interface with mounted and mobile vehicle display systems.
- Disposable technology, low logistics footprint

What is the DIME?

Embedded Software Features:

- **Remote configuration**
- Data compression techniques enabling performance in low bandwidth Military environments.
- **System processing of data from multiple data bus sources (CAN, J1708, RS485) simultaneously.**
- Capable of storing data in emergency power loss situations.
- **BIST (Built In Self Test)**

THANK YOU

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