Micronet SmartHub LTE Underdash

On Board Computer

Hardware Guide

Revision 1, July 2018

powered by

ANDROID

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Revision History

Revision	Date	Change
1	July 2018	Document created

Safety Precautions

Read the following safety precautions before installation or operation.

WARNING!

Abnormal Conditions

Should the SmartHub Underdash become hot, start to emit smoke or a strange odor, immediately turn off the power and contact your original dealer or authorized service provider. Continued usage is dangerous and may result in fire or electric shock.

WARNING!

Foreign Objects

Avoid having foreign matter or objects enter into any opening of the SmartHub Underdash. This could result in fire or electric shock. Immediately turn off the power and contact your original dealer or an authorized service provider.

WARNING!

Location and Physical Damage

If the SmartHub Underdash falls and is damaged, turn off the power immediately and contact the original dealer or authorized service provider. Continuing to use the device in this state or locating the device in extremely humid or dusty areas is dangerous and may result in fire or electric shock.

WARNING!

Liquids

Keep the device away from water, other liquids and liquid containers. Liquid entering into the device can cause fire and electric shock.

CAUTION

Power Supply

Do not use the SmartHub Underdash with any voltage other than that specified. Avoid situations that can cause damage to the power cable. Do not place heavy objects on the power cable and keep it away from sources of heat. Never twist, sharply bend, or pull the power cable. If the power cable is damaged (exposing or breaking wires), contact your original dealer or service provider about repair or replacement. Damage to the electrical cable may result in fire or electrical shock.

1. Introduction

Micronet SmartHub-U Platform Overview

Micronet SmartHub Underdash is a rugged, next generation Android On-Board Telematics Computer. It provides a rugged and versatile vehicle-centric mobile-computing platform for a variety of in-cab mobility applications and solutions.

With integrated GPS, Cellular Communication, Wi-Fi, BT, cameras and various sensors and with support for a suite of vehicle and peripheral interfaces - SmartHub Underdash enables a host of advanced mobility solutions such as: Fleet Management, ELD BYOD HOS, Driver Behavior, ADAS, Video Analytics, Driver Distraction Alerts, Routing and Dispatch, Fuel Efficiency, Speed by Street, Navigation, Fleet Tracking, Driver Interaction and more.

Designed to operate in a rough commercial automotive environment, including a wide range of temperatures, vibrations and shocks, the Micronet SmartHub Underdash provides Enhanced Solution Life Cycle.

The SmartHub Underdash platform supports the Google Android™ 5.1.1 operating system.

Micronet SmartHub-U Model

Micronet implemented the SmartHub Underdash installation, mounted under the dashboard or another hidden place on the vehicle. Include internal Cellular antennas and GPS SMA connector for external active antenna. The SmartHub Underdash provides the key feature set, described in configuration chapter below.

In addition, optional features, accessories and OEM features are available as follows:

- **Platform accessories** - provides accessory features such as mounting cradle.
- **OEM optional features** - provides OEM optional features such as branding and labeling

Addition information on Micronet SmartHub Underdash can be viewed in Micronet's web site http://www.micronet-inc.com/products/smarthub/.

Physical Interfaces

The Micronet SmartHub Underdash provides the following physical interfaces:

- USB Client and Host
- Serial RS232
- Interfaces for vehicle such as CANBus and J1708

- A2D and Digital input signals for ignition switch control and other I/Os
- Digital control output signals

Wireless Module

The Micronet SmartHub Underdash supports 3.5G and 4G LTE cellular communication and GPS.

GSD™ Software Services

Micronet's GSD™ (Guardian System Design) is a cloud-based SaaS platform for managing mobile devices in the field.

GSD™ enables remote, delta-based, Over-The-Air Firmware and Application Updates, allowing customers to keep devices relevant anywhere, anytime. It features Mobile Device Management functionality, Remote Control and Self-Diagnostic.

Administrators can proactively monitor and manage connected devices with a flexible web interface.

GSD® Software Services

Introducing; GSD® - Advanced software tools to manage and support mobile devices in the field.

Micronet's new comprehensive software framework called GSD® - Guardian System Design - is a cloud-based Software-as-a-Service platform that provides advanced software tools to manage and support applications and system firmware upgrades on Micronet and third party devices installed in the field. The GSD® enables remote, over-the-air, access and control of Android based mobile devices, to conduct individual, or group diagnostics, support and training activity.

GSD® a fully integrated software framework enabling new levels of control, support and corporate policy compliance

GSD® is offered on Micronet's SmartHub Underdash series of rugged, automotive-grade, MDTs. It enables both firmware and application software to be remotely managed, and simplifies maintenance, trouble-shooting and remote training, significantly reducing operational costs over the life time of the product, and substantially improving user experience and customer satisfaction.

GSD® features white-label cloud-based software as a service solutions, offered as two key services:

- Mobile Device Management and remote control
- Fail-safe firmware and application over-the-air updates (FOTA/OTA)

Development Tool Kit

Micronet's SmartHub Underdash Development Package provides all the tools required for product evaluation, application development quick-start, and product testing. The Developers Package contains all essential hardware and software components as described in the following sections.

Hardware

- Micronet SmartHub Underdash OBC
- Wall power supply
- Mechanical and interface connection accessories
- Main cable harness
- Mounting accessories

Software

- Software Development Kit (SDK) provides a set of software tools and API documentation.
- Android demo samples for some device features including the source code.

Documentation

- Micronet SmartHub-U Hardware guide
- Micronet SmartHub-U Getting Started guide
- Micronet SmartHub-U OS Update guide
- Micronet SmartHub-U Remote Control and Display guide

2. Micronet SmartHub-U Views

This chapter describes the SmartHub Underdash views and the functionalities on each view.

Micronet SmartHub-U Front View

Figure 1: Micronet SmartHub Underdash Front Panel View

For more information about the Micronet SmartHub Underdash front panel view, see:

- Customized Logo, on page 14

Micronet SmartHub-U Rear View

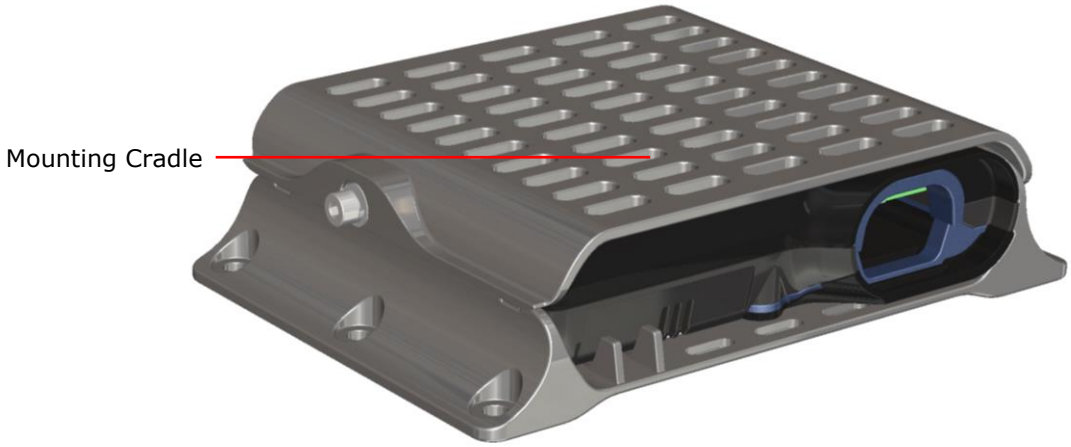

Figure 2: Micronet SmartHub Underdash Rear Panel View

For more information about the Micronet SmartHub Underdash rear panel view, see:

- Mounting Cradle, on page 11

Micronet SmartHub-U Bottom View

Figure 3: Micronet SmartHub Underdash Front Panel View

For more information about the Micronet SmartHub Underdash bottom panel view, see:

- LED Indicator, on page 14
- Reset Button, if needed, a reset button resets the SmartHub Underdash and reboots depends on the ignition switch input state.

Micronet SmartHub-U TOP View

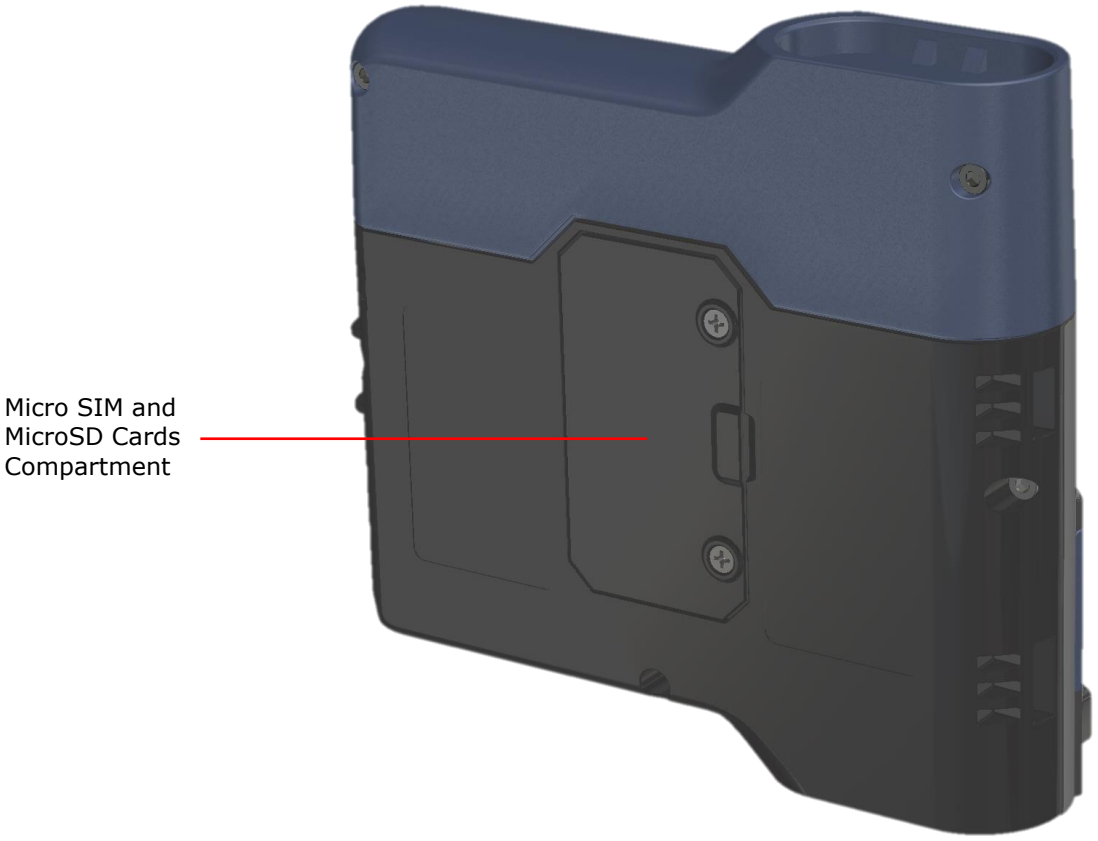

Figure 4: Micronet SmartHub Underdash Top Panel View

For more information about the SmartHub Underdash top panel component, see:

- MicroSD Memory Card Slot, on page 14
- MicroSIM card slot, on page 18

Micronet SmartHub-U Mounting Cradle

Mounting Cradle

The SmartHub Underdash mounting cradle is used for mounting the OBC under the vehicle dashboard or any place in the vehicle cabin.

The cradle consists of two parts, base and cover, with ventilation holes for Effective heat dissipation of the SmartHub Underdash OBC device.

Hooks on one side of the cradle and a screw are used to mount the device inside the cradle. Before hooking the OBC, the MicroSIM and optionally MicroSD card should be insert on the dedicated compartment on the top side of the device.

The cradle has six holes to assemble under the dashboard of to another place.

Figure 5: Micronet SmartHub Underdash Mounting Cradle Right View

Figure 6: Micronet SmartHub Underdash Mounting Cradle Left View

3. Functional Details

Platform Core

Operating System

The SmartHub Underdash OBC is powered by Google Android™ 5.1.1 Lollipop.

ELD Compliance

The Micronet SmartHub Underdash system boot time is ~40 seconds. The ELD requirement is up to 1 minute.

Application Development Environment

The SmartHub Underdash OBC supports any open source IDE. Micronet recommends using the Android Studio IDE.

Micronet's Development Toolkit (DTK) includes the following components:

- Full Micronet SDK
- Application sample demonstrates the Micronet's proprietary API
- Device management and upload tools
- Development accessories
- Documentation

For more details about the development infrastructure, product tools, and DTK contents, please refer to the "Micronet SmartHub Underdash OBC Getting Started" Guide.

Processor

- Qualcomm Snapdragon 410 - 1.2GHz Quad Core
- High-performance Superscalar 4x ARM® Cortex™ A53

Co-Processor

- Freescale K20_120
- MQX RTOS

RAM

1GB LPDDR3 RAM memory

Flash Memory

8GB eMMC

MicroSD Memory Card Slot

The MicroSD card slot is located on the Micronet SmartHub Underdash top panel cards compartment.

Watchdog

To monitor mission-critical processes, the platform provides an intelligent watchdog mechanism. This mechanism provides various capabilities for guard and restarts the OBC if the system hangs.

The Android provides a level of watchdog mechanism by the "Applications Manage" to control application stability.

User Interface

LED Indicator

The SmartHub Underdash OBC includes one LED on the front panel, controlled by the OS.

Customized Logo

Micronet provides the option to attach a customized logo based on your specifications. To enable rebranding the product, Micronet will provide graphic files and size specifications. This is subject to an additional charge per unit and MOQ.

Figure 7: Customized Logo

Sound

Speakers

The SmartHub Underdash OBC provides external speaker connection through the main cable harness.

Microphone

The SmartHub Underdash OBC provides external speaker connection through the main cable harness.

Communication Interfaces

Serial Communication

The SmartHub Underdash OBC supports 4 serial communication ports for external devices and peripheral connections and a debug port connected to the Co-Processor. These ports support various hardware and software flow control functions.

Serial Port 1 (COM1)

The SmartHub Underdash OBC supports an EIA-RS232 level serial communication port. The port supports a baud rate of 300 to 115,200bps, and provides one pair of communication-control handshake signals (CTS / RTS).

Serial Ports 2-4 (COM2-4)

The SmartHub Underdash OBC supports EIA-RS232 level serial communication ports 2-4. The ports support a baud rate of 300 to 115,200bps, and provide the TX and RX signals only.

Debug Serial Port (COM7)

The SmartHub Underdash OBC supports EIA-RS232 level serial communication port for Co-Processor debugging purposes. The port supports a baud rate of 300 to 115,200bps, and provides the TX and RX signals only.

USB Communication

The SmartHub Underdash OBC supports two USB ports (Universal Serial Bus), one USB Host port for external device/peripheral connections, the second USB is a USB Client.

USB Host

The USB Host Port connects to the main device connector. This port supports the USB2.0 low, full, and high-speed communications standards.

NOTE:

The USB Host port provides up to 500 mA of power consumption for non-self-powered client devices.

The USB Host interface supports the following profiles:

- USB Standard HID
- USB Printer (PCL)
- USB Storage

For more information about these interface signals please see the USB Host 1 signal map on page 26.

USB Client

The USB Client interface supports Android ADB for application development, device configuration and management, and for application debugging.

Peripheral Controls

Analog and Digital Input lines

The SmartHub Underdash OBC provides seven automotive input lines (0-32V). The input lines can be configured as digital or analog lines.

IGN (automotive voltage level) is for monitoring the ignition switch signal. The other inputs can be used for any purpose, like sensing door opening, sensing bus amber lights, etc.

The input signals are provided on the main 44 pins connector and on the DVI connector.

NOTE:

INP1 is also used to power on the device from shutdown state. For proper power management implementation, the input should be connected to the vehicle's ignition switch.

Open Collector Outputs

The SmartHub Underdash OBC provides four O.C output lines for external peripheral control.

Wireless Communication

Wireless LAN

Overview

The SmartHub Underdash OBC provides a Wireless Local Area Network (IEEE 802.11) module.

Wireless LAN communication is especially suited for high-speed data transfer over the air, when a Wireless LAN hotspot infrastructure exists. For applications that require large data transactions, Wireless LAN is the most economical way to implement the solution.

Bluetooth communication is used for Bluetooth-enabled connections with peripherals such as an audio headset and printer.

Wireless LAN Operation

The WLAN module is compliant with the IEEE 802.11 b/g/n standard and uses DSSS (Direct Sequence Spread Spectrum), OFDM (Orthogonal Frequency Division Multiplexing), DBPSK, DQPSK, CCK, and QAM baseband modulation technologies.

In addition to supporting WPA / WPA2, WEP 64-bit, and 128-bit encryption, this module supports the following:

- IEEE's 802.11i security standard through the implementation of AES (Advanced Encryption Standard), CCMP (Counter Mode CBC-MAC Protocol), and WEP with TKIP security mechanisms.
- IPsec with DES / 3DES / ASE encryption and MD5 / SHA-1 authentication
- (the AW-GH381 supports) 802.11e QoS (Quality of Service) for voice applications

Bluetooth 4.1

The SmartHub Underdash OBC provides a Bluetooth 4.1 BLE module.

Cellular Modem

The Micronet SmartHub Underdash OBC provides cellular modem with the following bands:

- 3.5G GSM for Europe - B8/900 and B3/1800, DC-HSPA+ B1/2100 and B8/900 bands.
- 4G AT&T LTE for NA - AT&T and T-Mobile B2 1900MHz, B4 AWS1700MHz, B5 850MHz, B12/B13 700MHz; 3G B2 1900MHz, B5 850MHz

MicroSIM card slot

The GSM modem requires a MicroSIM card connection. The MicroSIM card slot is located on the top panel compartment of the OBC.

Cellular Antenna

The Micronet SmartHub Underdash has two Main and Diversity internal integrated antennas.

GPS Receiver

The Micronet SmartHub Underdash OBC provides a high sensitive GPS receiver support 50 channels, NMEA0183 standard sentences, AGPS, GPS and GLONASS satellites.

GPS Antenna

The Micronet SmartHub Underdash OBC has an SMA connector for external **ACTIVE** antenna.

Accelerometer

The Micronet SmartHub Underdash OBC provides an Accelerometer, Compass and Gyroscope module. The accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations.

Acceleration is the measurement of the change in velocity or speed divided by time. For example, a car accelerating from a standstill to 60 mph in six seconds is determined to have an acceleration of 10 mph per second (60 divided by 6).

Wiggle Sensor

The Micronet SmartHub Underdash OBC provides automatic Power-up trigger to turn on the device when sensing movement of the vehicle or closing the vehicle door.

SAE J1939 CANBus

The SmartHub Underdash OBC provides two SAE J1939 CANBus ports that enable the connection of a variety of vehicle peripherals, such as the vehicle's computer, vehicle's sensors and so on.

Single Wire CANBus

The Micronet SmartHub Underdash provides a single wire CANBus port through its main cable.

SAE J1708

The SmartHub Underdash OBC provides SAE J1708 port. The SAE J1708 is a standard used for serial communications between ECUs on a heavy-duty vehicle and between a computer and the vehicle. With respect to Open System Interconnection model (OSI), J1708 defines the physical layer.

4. Main Cable Harness

Every customer designs its main cable according the main connectors on the SmartHub Underdash PCBA describes in Interface Connectors section below.

In addition, Micronet provides engineering cable design for its customers if necessary, the customers can manufacture the cable according Micronet's scheme or according to their design.

Figure 8: SmartHub Underdash OBC Interface connectors

5. Connector Signals Map

Overview

This chapter describes the SmartHub Underdash OBC interface connectors and signals found on the main and secondary connectors.

The following abbreviations are used:

- I - Input signal
- O - Output signal
- B - Bus signal
- V - Voltage signal
- G – Ground
- P – Positive
- N – Negative

Interface Connectors

The SmartHub Underdash OBC interface contains Molex Pico-Clasp™ Wire-to-Board Header 1.00 mm pitch 20 and 50 pin connectors. All pins are ESD protected (against electrostatic discharge). The Main Connector Pinout and Secondary Connector Pinout tables below describe the pinout of each connector.

Figure 9: SmartHub Underdash OBC Interface connectors

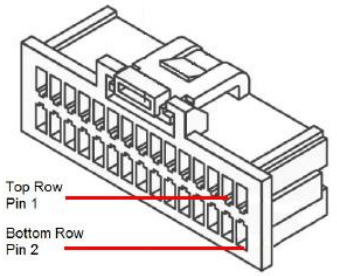

Figure 10: Main 20 pin connector

Main Connector Pinout

The following table lists the main 20 pin connector signals by pin number.

Table 1: Main Connector Signal Map (by Pin Number)

Pin	Signal	Type	Function	Specifications
1	+VIN	V	Input Power 12V/24V	Typical – 12V/24V - Minimum continues – 6V (5V for up to 40ms according to ISO7637) - Maximum continues – 32V
2	+VIN	V		
3	VIN_GND	G	Ground	
4	VIN_GND	G		
5	Ignition Input	A	A2D Input Ignition switch	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +32V
6	CAN1 H	I/O	CAN High Signal	
7	N/A			
8	CAN1 L	I/O	CAN Low Signal	
9	N/A			
10	CAN2 H	I/O	CAN High Signal	
11	GND	G	Ground	
12	CAN2 L	I/O	CAN Low Signal	
13	USB Host +5V	V	USB Host Port VBUS	USB 2.0
14	J1708 P	P	J1708 Positive Signal	

Pin	Signal	Type	Function	Specifications
15	USB Host 1 D-	B	USB Host Port1 Data-	USB 2.0
16	J1708 N	N	J1708 Negative Signal	
17	USB Host 1 D+	B	USB Host Port1 Data+	USB 2.0
18	SWC	I/O	CAN	Single wire CAN
19	USB Host 1 GND	G	Ground	USB 2.0
20	GND	G	Ground	

Pinout by Functionality

The following table lists the 20 pin connector signals by functionality.

Table 2: Main Connector Signal Map (by functionality)

Pin	Signal	Type	Function	Specifications
1	VIN_GND	G	MDT Power supply Ground	
2	VIN_GND	G		
3	+VIN	V	Input Power 12V/24V	Typical – 12V/24V - Minimum continues – 8V - Maximum continues – 32V
4	+VIN	V		
5	Ignition Input	A	A2D Input Ignition switch	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
6	CAN1 H	I/O	CAN High Signal	
8	CAN1 L	I/O	CAN Low Signal	
10	CAN2 H	I/O	CAN High Signal	
12	CAN2 L	I/O	CAN Low Signal	
18	SWC	I/O	CAN	Single wire CAN
14	J1708 P	P	J1708 Positive Signal	
16	J1708 N	N	J1708 Negative Signal	
13	USB Host +5V	V	USB Host Port VBUS	USB 2.0
15	USB Host 1 D-	B	USB Host Port1 Data-	USB 2.0
17	USB Host 1 D+	B	USB Host Port1 Data+	USB 2.0
19	USB Host 1 GND	G	Ground	USB 2.0

Pin	Signal	Type	Function	Specifications
11	GND	G	Ground	
20	GND	G	Ground	

Secondary Connector Pinout

Pinout by Pin Number

The following table lists the 50 pin connector signals by pin number.

Table 3: Secondary Connector Signal Map (by Pin Number)

Pin	Signal	Type	Function	Specifications
1	Automotive Input	I	Digital Input 1	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V 0V-30V max, 12k OHM
2	N/A			
3	Automotive Input	I	Digital Input 2	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
4	N/A			
5	Automotive Input	I	Digital Input 3	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
6	N/A			
7	Automotive Input	I	Digital Input 4	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
8	N/A			
9	Automotive Input	I	Digital Input 5	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
10	GND	G	Ground	
11	Automotive Input	I	Digital Input 6	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
12	N/A			

Pin	Signal	Type	Function	Specifications
13	Automotive Input	I	Digital Input 7	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
14	N/A			
15	GND	G	Ground	
16-19	N/A			
20	GND	G	Ground	
21	GND	G	Ground	
22	N/A			
23	GND	G	Ground	
24-40	N/A			
41	USB OTG +5V	V	USB OTG VBUS	USB 2.0
42	GND	G	Ground	
43	USB OTG D-	B	USB OTG Data-	USB 2.0
44	GND	G	Ground	
45	USB OTG D+	B	USB OTG Data+	USB 2.0
46	GND	G	Ground	
47	USB OTG ID	B	USB OTG Identifier	USB 2.0
48	GND	G	Ground	
49	USB OTG GND	G	Ground	USB 2.0
50	GND	G	Ground	

Pinout by Functionality

The following table lists the 50 pin connector signals by functionality.

Table 4: Secondary Connector Signal Map (by Functionality)

Pin	Signal	Type	Function	Specifications
1	Automotive Input	I	Digital Input 1	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V 0V-30V max, 12k OHM

Pin	Signal	Type	Function	Specifications
3	Automotive Input	I	Digital Input 2	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
5	Automotive Input	I	Digital Input 3	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
7	Automotive Input	I	Digital Input 4	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
9	Automotive Input	I	Digital Input 5	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
11	Automotive Input	I	Digital Input 6	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
13	Automotive Input	I	Digital Input 7	**Typical Min Max** Input Low: VIL 0V -30V 6V Input High: VIH 12V-24V +8V +30V
41	USB OTG +5V	V	USB OTG VBUS	USB 2.0
43	USB OTG D-	B	USB OTG Data-	USB 2.0
45	USB OTG D+	B	USB OTG Data+	USB 2.0
47	USB OTG ID	B	USB OTG Identifier	USB 2.0
49	USB OTG GND	G	Ground	USB 2.0
10	GND	G	Ground	
15	GND	G	Ground	
20	GND	G	Ground	
21	GND	G	Ground	
23	GND	G	Ground	
42	GND	G	Ground	
44	GND	G	Ground	
46	GND	G	Ground	
48/50	GND	G	Ground	

6. Platform Power

Overview

The SmartHub Underdash power comes directly from the vehicle's 12V/24V DC battery and provides intelligent power management options that reduce drain on the vehicle’s battery.

Super Capacitors

The SmartHub Underdash has a super capacitor inside to:

- Provide power backup if the main power source is disconnected.
- Provide power backup during an ignition event (vehicle start up).

The SmartHub Underdash automatically manages power and super capacitor charging. The operation time of the SmartHub Underdash while powered by the internal super capacitor is dependent on the peripherals and applications being used. Nevertheless, the estimated time of continued operation for standard applications is ~20 seconds.

The super capacitor will take approximately 20 minutes to charge when the device is first powered on by the battery. After 20 minutes, the super capacitor should be fully charged and will provide up to 20 seconds of backup power to the device.

When power is initially connected to the SmartHub Underdash, charging on the super capacitor starts. The SmartHub Underdash may not power up immediate as the systems is waiting for the super capacitor to reach a predetermined value. This initial charging could take up to 1min before the power LED turns on. Power may be connected to the SmartHub Underdash at any time.

Device Power Consumption

Table 5: SmartHub Underdash Current Consumption

SmartHub Underdash Current Consumption			
Power OFF		***Operational mode***	
12V	***24V***		
~10mA	~7mA	250mA	130mA

Electrical Installation Procedure

1. Prepare the wiring for power and all other required peripherals in the vehicle, for connection to the SmartHub Underdash main harness cable.
2. Connect the main harness cable 20 pins and 50 pins Molex connectors to the SmartHub Underdash connectors inside the cable compartment.
3. The power signals from the main harness cable should be connect to the vehicle's power line protected by a 10A fuse. An inline 3A "Slow Blow" fuse (with fuse holder for HHC/HHD blade-type fuses) should be add to the main power cable.
4. To power on the SmartHub Underdash turn on the ignition switch or to hit the SmartHub Underdash, the wiggle sensor will turn on the device.

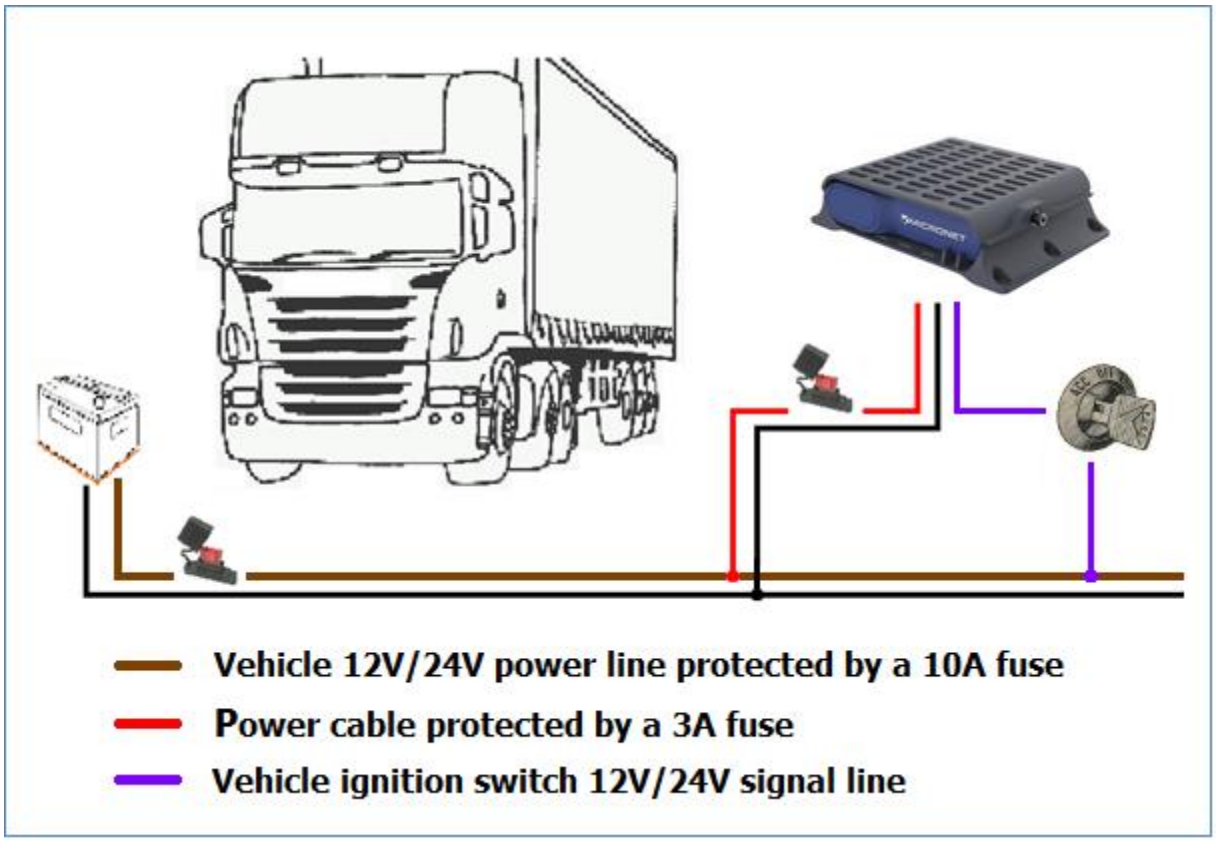

Figure 11: Electrical Installation Scheme

FCC Statement

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio/TV technician for help

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions (1)this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.