RaceGrade

LTE GATEWAY PRO-V3

Contents

Introduction

This manual details the setup and installation of the RaceGrade 4G LTE Cellular Gateway telemetry system. The system provides real time telemetry data from a vehicle to the base station. It uses Verizon's 4G LTE cellular network to provide data coverage at any venue with cellular coverage. International venues are supported with an alternate SIM card that supports other networks. The gateway supplies fast update rates to allow accurate data while simplifying trackside setup by utilizing smaller antennas and eliminating the necessity of repeaters. The gateways come preconfigured to work seamlessly upon power up.

Custom configurations can be implemented with an upgrade. The gateway connections are all on the top surface to improve flexibility in mounting arrangement. The case is water resistant and features 3 antenna connections and an Autosport connector for signals and supplies. Continuous device uptime during transient voltage operation, such as power cycling or starting the vehicle, is achieved via an internal super-capacitor system.

The gateways support serial data rates of 115.2 kbps found in all MoTeC's Dash logger products and other brands of data loggers. The gateways are capable of higher data rates for future radio upgrades.

Cellular Service

The Verizon Wireless network has been chosen due to its prime coverage at venues across the United States. MoTeC Systems USA provides data plans from Verizon for a service fee, and the customer is responsible for making sure this is paid and up to date. The standard service will not function properly outside the United States. Please contact MoTeC Systems USA if your application requires running the RaceGrade LTE Cellular Gateway outside the United States.

The gateway transmits telemetry data by connecting to the internet. This detail is important to remember, as the gateways DO NOT connect to each other in a point-to-point system commonly found with 900MHz telemetry systems.

Super Capacitor Supply Holdup System

Due to the long boot times of the RaceGrade 4G LTE Cellular Gateway, the gateways come with a supply power holdup system installed. This system is based on super capacitors and requires no user maintenance. The gateway automatically switches between input power and internal power modes such that the gateway remains live for as long as possible. When the input voltage falls below 7V, the gateway switches to internal voltage. The capacitor will hold the gateway live typically between 10 seconds and 40 seconds depending on gateway data usage. In real world tests transmitting vehicle telemetry only, the holdup system typically kept the gateway live for 25 seconds.

After the gateway is completely powered down (internal supply depleted), the first power up will take approximately 120 seconds until telemetry data is transmitted, while charge time of the internal supply takes less than 60 seconds. After the initial boot, the telemetry system will stay live unless the input supply is disconnected or shut off for lengthy (above 25 seconds) periods of time.

Radio Reset Procedures

If the radio becomes unresponsive for an unknown reason, it can be reset via conditions set by the user. The first of which can be done by a CAN message sent directly to the Radio. This would be done in an application such as a driver reset button. Once depressing this button, the CAN message 0x737, offset 0, length 8, message 0x01 can be sent to shutdown the radio. A standard CAN Transmit Message can be seen below. To turn the radio back on, the message 0x00 must be sent back to the radio.
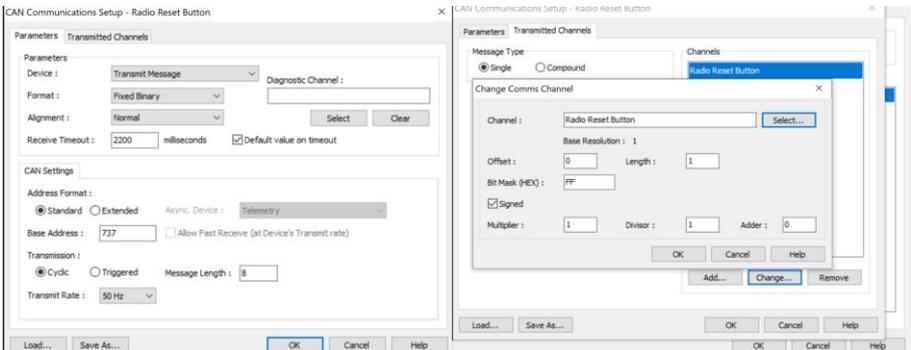

Figure 1

Note that when the CAN Reset message has been sent, this will shutdown* the radio and power up the radio as soon as the reset button as been released. If the Button is to be used as an On/Off switch as well as a Reset button, using a counter function is recommened.

The second reset condition can come from the reset switch under the ignition pin. By using the ignition pin for a reset switch, it will allow the user to turn the radio on or off. When the switch pulls the voltage high (battery voltage) the radio will shut down*. When release to open circuit, the radio will power back up.

Note: The power down cycle takes around 10 seconds

CAN Messaging

Radio information including, but not limited to radio temperature, voltage, signal strength, bands used, data used, and number of dropped packets available over CAN, contact MoTeC USA for DBC File.

MoTeC Dash Requirements

To send real time telemetry, the vehicle dash must have a serial output with vehicle data, e.g., MoTeC's C185, ACL, ADL3 or C187 with a T2 or Telemetry Monitor enable. Options currently enabled can be viewed by going to the menu (in the Dash Manager software) '*Online > Enable Dash Options'.* The dash must be connected to the computer and powered when doing this.

Alternate Hardware Requirements

Other brands of data loggers and other devices are compatible with the gateways provided, there is a serial output to send out the data stream. Please consult your equipment documentation for more information.

Computer Requirements

The PC for receiving telemetry data from the vehicle must have a serial port to work with the base station gateway. Physical RS-232 ports built into the laptop and USB-to-Serial adapters both work as well. Refer to the MoTeC T2 or MoTeC Telemetry Monitor Release Notes for the applicable system requirements to run the software.

Power Supply Requirements

All gateways are recommended to be wired to a 12VDC supply with a minimum current rating of 3 amps. The gateway functions between 9-30VDC.

4G LTE Cellular Telemetry Service (Linked Pair)

The Gateways are sold as a linked pair. This is configured at MoTeC Systems USA prior to shipping and can only be changed by MoTeC Systems USA staff. These gateways do not allow internet access by default; however, the base gateway can be configured to allow standard internet access for computers and other internet devices. **Doing this WILL use a significant amount of data**. More data can be added to the plan for the gateways. Access to advanced setups and features will require an unlock option. Due to the potential complexity of custom configurations, unlocking radios will impose a support fee.

4G LTE Gateway Installation

Diversity

The RaceGrade 4G LTE Cellular Gateways support dual cellular antennas. The added antenna improves reception in low signal quality situations as well as congested signal areas. MoTeC Systems USA has found a marked improvement in telemetry quality while running dual antennas. It is highly recommended that any setup fitted with the system run dual antennas in both the vehicle and base station. The antennas should be mounted at least 8 inches away from each other and 12 inches from any other antennas.

Installation

Vehicle

A mobile style antenna(s) must be fitted to the vehicle. To improve reception, please follow these recommendations:

The antenna(s) should be:

- Outside of the vehicle
- Placed on the highest surface of the vehicle
- Placed on a large flat surface
- Kept 12 inches away from all other antennas but the 'Diversity' antenna
- Be run in conjunction with another antenna, one wired to the 'Main' SMA connector on the gateway and the other wired to the 'Div" SMA connector on the gateway.

It is recommended that the vehicle uses the MoTeC Systems USA recommended antenna kit for optimal performance. The radio settings and antennas have been optimized to work together. These antennas greatly improve reception in weak or congested signal areas.

Pictured right in Figure 1 is vehicle antenna, ground plane and mount. The antenna is ~4 in (10.1 cm) tall and the ground plane is 8 in (20.3 cm) in diameter. This is mounted to a NMO thick wall (up to ¾ in) mount to supply a robust solution that works in any vehicle. The mount comes pre-wired with RG-58 cable and

Figure 2

terminated with an SMA connector. The standard coax cable length is 7 feet, but custom lengths can be ordered.

Below, in Figure 2, the three pieces to each car antenna are laid out in their independent forms. On the left is the antenna and the right is the mount. The piece underneath is the ground plane. Installation requires a 0.75 in diameter hole needs to be drilled in the roof of the vehicle per antenna. If a 2nd antenna for diversity is used, then it must be spaced more than 8 inches (20.3 cm) from the first hole (and any other antennas on the roof). Pieces should be assembled such that the ground plane is underneath the roof (sandwiched by the bottom keeping the ring on the mount and the bottom of the roof). Then, the antenna can be threaded on after.

Figure 3

Please note that there is a gold contact **"dot"** integral to the mount that can fall out very easily during installation. THIS PIECE MUST BE IN THE MOUNT FOR THE ANTENNA TO OPERATE CORRECTLY. The mount is shipped with a piece of tape over the contact dot to prevent the piece from falling out.
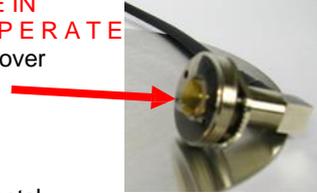
Base Station

The base antennas should be placed away from any metal objects and more than 8" away from each other. Since these antennas are not mobile, installation is less critical. Ensure that they are mounted such that the signal and network status LEDs are green. Our experience has shown that the antennas can be mounted to a tripod or mounted to the top of the base station without issue. A mast is not needed.

The antennas in Figure 3 are supplied with mounts for attachment to a pole and coax, pre-terminated with an SMA and Type-N connector. The coax cable length is 7 ft.

Please see the Specifications Appendix for more information.

Figure 4

Gateway

The gateway itself can be mounted anywhere inside the vehicle or base station cart but should be soft mounted (such as soft Velcro) and kept from heat as much as possible. The cables from the gateway should be kept away from any high amperage chassis wires. If it is necessary to cross a harness carrying high loads, please cross the wires with 90-degree intersections, do not run the cables in parallel with each other.

MoTeC Software Setup

For new installations, please refer to the T2 Telemetry Quick Start Guide for dash setup and T2 Server setup instructions. It is available at **www.motec.com** in the "Downloads" section.

For applications already running Telemetry Monitor or T2, the setup will function exactly as it currently does, no changes are required.

Please refer to Base Parameters Appendix on page 13 for the base programming parameters that come standard with this system.

MoTeC Logger Telemtry

Please note that while the gateways will support the fastest data rate available through MoTeC's current product line (115.2 kbps), the system will not function correctly at a data rate transmission higher than 85% bandwidth as setup in the Dash Manager Software. The baud rate selected should be 115.2 kbps (red circle in 6). Channels and transmission rates can be added until 85% is reached, such as the example in Figure 5. To reach the Telemetry function within the Digital Dashboard, open the manager and click 'Functions > Telemetry'. Make sure the Server is on 'MoTeC T2' and add the channel(s) that need to be streamed.
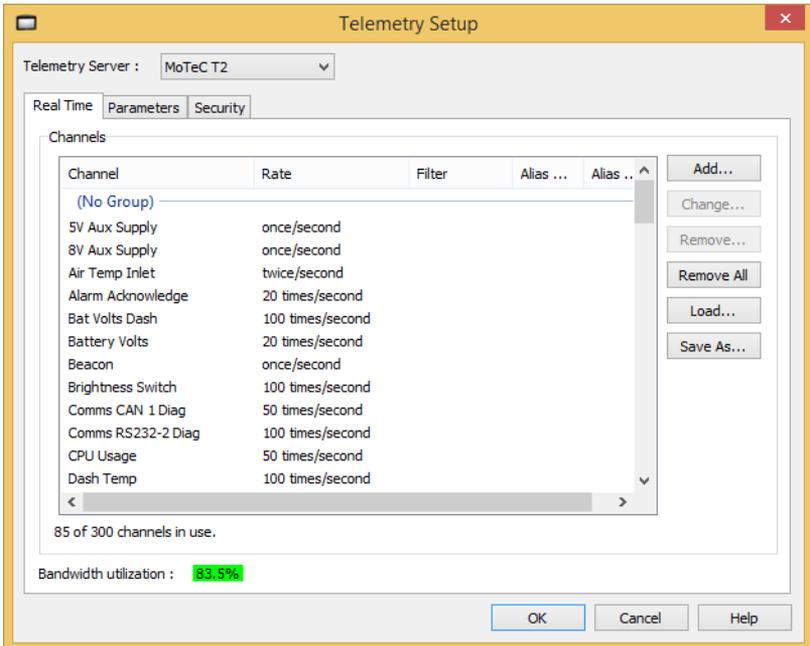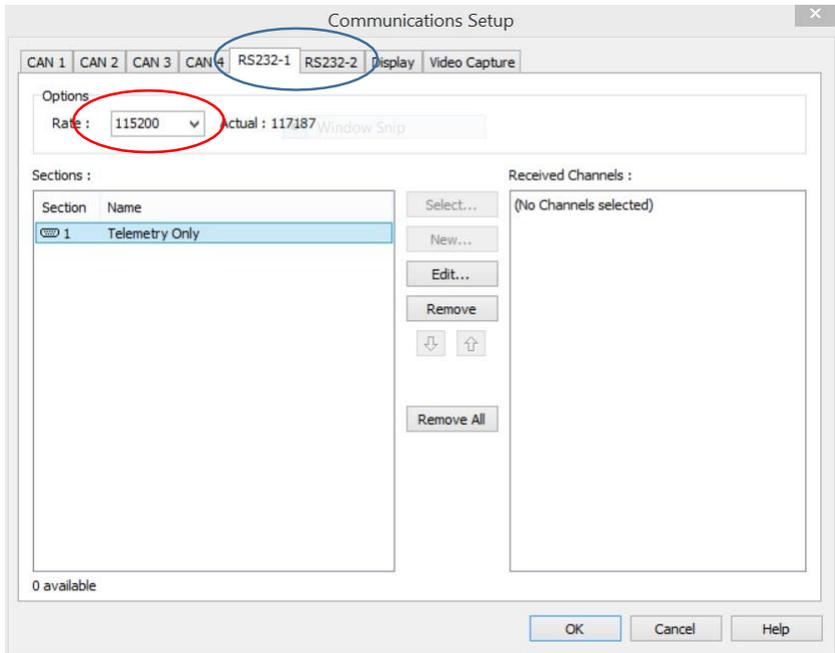

Figure 5

The serial connection should be wired so that the TX of the serial output of the logger is wired to the RX of the RG Gateway. Refer to the Wiring Appendix on page 13 for a wiring schematic. When wiring the car, please note which serial output is used, the information is needed when setting up the logger.

Next, the serial communications setup needs to be completed under 'Connections > Communications' and under RS232-1 Tab. If, the RS232-1 tab is not filled out, select the 'Select' button, and search for 'Telemetry Only' Template. Click the template and adjust the Rate to 115200 as shown below.

Figure 6

Shown in Figure 6 is a screen capture from the C185 dash manager. There are two RS232 inputs available, ensure that the correct one is used (blue circle in Figure 5). Either will work correctly. Ensure your software setup matches your wiring.

Make sure that the pit side radio is connected via USB to serial to your PC. This will allow the connection for the T2 Server to communicate with the second radio.

Under the T2 Server Page, double click Inputs to have this page come up for the 'Input Stream'. A basic serial port settings can be shown.
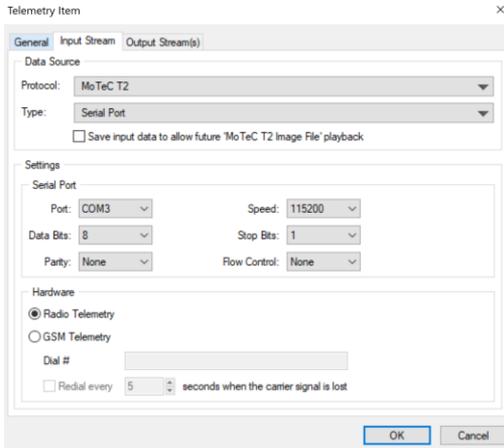

Figure 7

The COM Port may need to be adjusted for where the serial is connected into the computer. Next the outputs need to be setup within the T2 Server. Double click the inputs and select the 'Output Stream' tab. Click the 'add' button and this will open the output streams settings. Select the T2 Server under settings and select 'All Interface'. A basic Output Stream can be seen below.

Figure 8

Once the output stream has been setup, the data can be viewed in i2 Pro. Open i2 Pro and go to 'File > Telemetry > Enable Telemetry > Add > 'Laptop''. The data from the radio should be coming it. You just need to add the channels to see the stream.

MoTeC T2 UDP

This requires the radios to be setup by MoTeC USA for a UDP connection. The default setup for these radios is Serial, a conversion to UDP will need to be requested. Please contact MoTeC USA to have a radio set converted or if there is uncertainty how the radios are setup to communicate.
When setting up the UDP, you need to follow the same process for setting up the T2 program. When the input has been setup, select 'Network' under type. The settings will which and you will be able to select UDP. Then the listening interfaces can be selected. The network interface should be set to All Interfaces. Unless a different configuration has been requested for the radio pair, the default Port will be 21234. If multiple cars are being used with the same base radio, this number will increment for each car (i.e., car 1 is 21234, car 2 is 21235).

Figure 9

Next the outputs need to be setup within the T2 Server. Double click the inputs and select the 'Output Stream' tab. Click the 'add' button and this will open the output streams settings. Select the T2 Server under settings and select 'All Interface'. A basic Output Stream can be seen below.
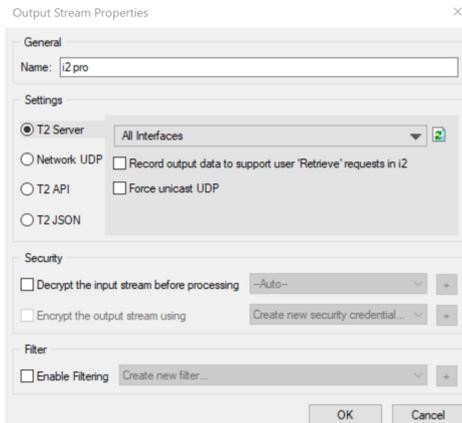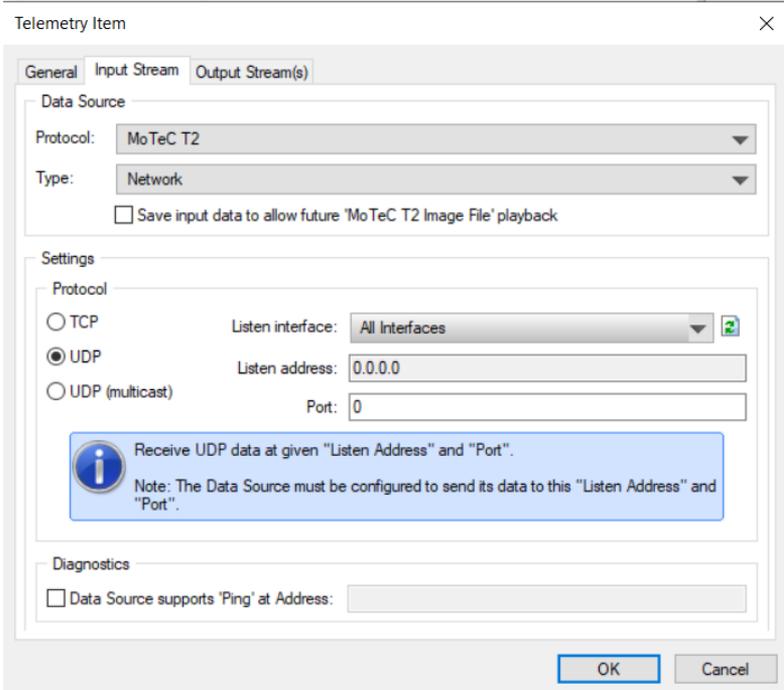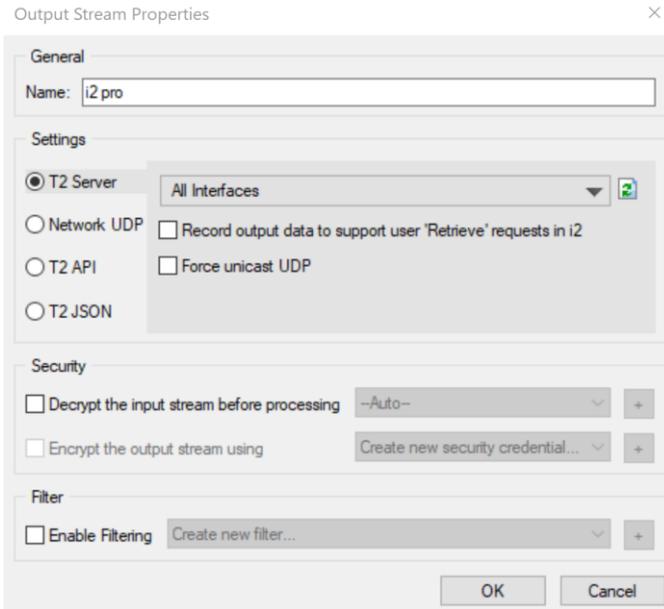

Figure 10

Once the output stream has been setup, the data can be viewed in i2 Pro. Open i2 Pro and go to 'File > Telemetry > Enable Telemetry > Add > 'Laptop''. The data from the radio should be coming it. You just need to add the channels to see the stream.

Diagnostics

The gateways are primarily a 'functioning' or 'not functioning' device. If the data received is intermittent data, such as jerky or hesitant data every few seconds, there is most likely a setup issue in the dash manager. If the telemetry data quits for minutes, then comes back, that is most likely a gateway issue. Please refer to the LED status for diagnosis.

Before beginning to troubleshoot the system, please ensure that enough time was given for the device(s) to start. Boot time is approximately two minutes.

LED Status

The RaceGrade Cellular Gateway LED light status functions as detailed in Figure 6.

Led	Color/Pattern	Descriptions
Power	Off	No Power
	Solid Green	Nominal Power
	Solid Yellow	Low Power Mode
	Solid Red	Device not operational
Signal	Solid Green	Good Signal
	Solid Yellow	Marginal Signal
	Solid Red	Poor Signal
	Flashing Red	No Signal
Network	Solid Green	Network Ready
	Flashing Yellow/Green	Network Ready, No LTE
	Flashing Yellow	No Service
	Solid Yellow	Connecting
	Flashing Red	Negotiation Failed
	Solid Red	Link Down
Activity	Off	Normal Operation
	Flashing Green	WAN Traffic RX/TX
	Flashing Red	Serial Traffic RX/TX

Figure 11

Trouble Shooting

Ensure that both the base station and vehicle gateways LEDs are solid green, with exception of the Activity Light.

1. If there is no flashing red 'Activity' light on the car side:
   a. Check vehicle logger setup, refer to Base Parameters Appendix
   b. Check Wiring (The TX of the gateway should go to RX of logger)
2. If there is no flashing red 'Activity' light on the base station side but the car side shows serial activity
   a. Make sure that the correct base station gateway that coincides with the car gateway is powered on.
   b. Call MoTeC Systems USA

Appendix

Part Numbers and Kits

RG.DV.0180.02　　　　　　Race Grade Cellular Gateway
M TEL 4G CAR ANT KIT　　4G Car Side Antenna Kit
RG.KT.0284.01　　　　　　4G Pit Side Antenna Kit

NOTE:　The data plans are created and maintained by the end user.
　　　　　The data plans can be found by the following link:

　https://www.milspecwiring.com/4G-LTE-Telemetry-Service_p_2952.html

Specifications

RaceGrade Cellular Gateway:

- Dimensions: 4.91"x 4.17" x 1.15" (12.5 cm x 10.6 cm x 3.0 cm)
- Weight: .93 lbs or 411 grams
- Main Connector:AS010-35PN (Mating Connector: AS610-35PN)
- Ethernet Connector:ASL006-05PA-HE (Mating Connector: AS606-35SA)
- Diversity Cellular Connectors: Female SMA
- Antenna Connector: Female SMA
- Status LEDs for Power, Signal, Network and Activity
- Water Resistant Enclosure
- Ethernet Interface
- Current Use: <1 Amp Maximum during normal use, <3 Amps Maximum during internal supply charging (60 seconds maximum charge time)
- Voltage Range: 9V -30V
- Super-Capacitor Hold Up Time: 10 seconds w/ gateway loaded; 40 seconds w/ gateway idle
- Peak D/L: Up to 600 Mbps
- Peak U/L: Up to 150 Mbps
- 4G LTE Frequency Bands:
    - B1, B2, B3, B4, B5, B7, B8, B9, B12, B13, B18, B19, B20, B26, B28, B29, B30, B32, B41, B42, B43, B46, B48, B66
- 3G Frequency Bands: B1, B2, B4, B5, B6, B8, B9, B19

RaceGrade Base Antenna

- ~4dB gain
- 9.8 in (24.8 cm) tall
- 1 in (2.54 cm) wide
- Ground Plane Required
- 50-ohm impedance
- Omnidirectional

RaceGrade Vehicle Antenna~3dB gain

- 3.3 (8.3 cm) in tall
- 1.44 in (3.6 cm) wide
- Ground Plane Required
- 50-ohm impedance
- Omnidirectional

Base Parameters

- Baud: 115.2kbaud
- Serial Protocol: 8 bits, No Start Bits, 1 stop bit
- Verizon Wireless 4G Network, fallback to 3G
- 85% Max Utilization Rate in T2 or Telemetry Monitor

Wiring

Connector Pinouts

Main: AS610-35SN Mating Connector
- Pin 1- Reserved
- Pin 2- RS 232 TX1
- Pin 3- RS 232 RX1
- Pin 4- Reserved
- Pin 5- Ground
- Pin 6- Reserved
- Pin 7- CAN Low N/C
- Pin 8- CAN High N/C
- Pin 9- Ground
- Pin 10- Reserved
- Pin 11- Reserved
- Pin 12- IGN N/C
- Pin 13- Power

Ethernet (Eth): ASL606-05HE Mating Connector
- Pin 1- Ethernet RX (+)
- Pin 2- Ethernet RX (-)
- Pin 3- Reserved
- Pin 4- Ethernet TX (+)
- Pin 5- Ethernet TX (-)

Serial Pinout

1. C185 RS232 TX Pin 70 or RS232 2 TX Pin 15 to RaceGrade Cellular Gateway Main Connector Pin 4
2. Ensure ground of the C185 is grounded to the same point as the RaceGrade Cellular Gateway

Ethernet

If Ethernet is used, please use the straight through wiring method. The wires must be twisted pairs per the IEEE 802.3 spec.
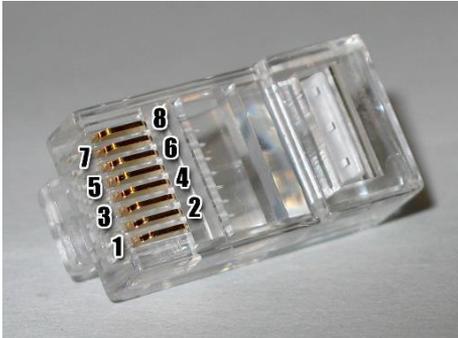
Straight through each pin of the Ethernet port is connected to the corresponding pin in the other connector.

Cross over: the RX and TX pairs of wire are cross over or swapped in one connector.

The pinout for a straight through connection (T568A) and cross over connection (T568B) is as follows in Figure 7.

Pin	T568A			T568B		
	Signal	Pair	Color	Signal	Pair	Color
1	TX+	3	White/Green	RX+	2	White/Orange
2	TX-	3	Green	RX-	2	Orange
3	RX+	2	White/Orange	TX+	3	White/Green
4		1	Blue		1	Blue
5		1	White/Blue		1	White/Blue
6	RX-	2	Orange	TX-	3	Green
7		4	White/Brown		4	White/Brown
8		4	Brown		4	Brown
Pins on Male RJ45 Jack						

Figure 12