



GPS-RT RATE TABLE REFERENCE GUIDE

GPS Creations' Model GPS-RT, single-axis motion simulation rate table

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Introduction

A single-axis positioning rate table is a device used to test and make measurements on equipment such as a GPS receiver which has built-in ability to detect turns. Many GPS receivers today include electronic gyroscopes* as an integral part of their design which aid in determining position or location. This technique is commonly called “Dead Reckoning” permitting the GPS receiver to be used in the absence of available GPS signals for short time periods. Various other sensor inputs are also used as aids to this process. Those are shown in the diagram below.

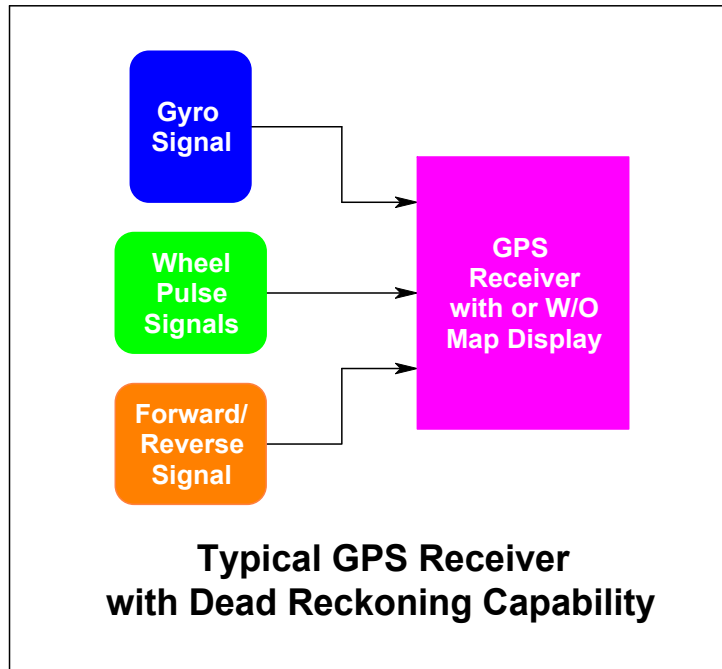


Figure 1 – Typical Block Diagram of a GPS receiver with Dead Reckoning Capability

Figure 1 shows the major components of a Dead Reckoning system. The gyro (usually a piezo electric device) may or may not actually be designed into the GPS receiver. If it is, then the mechanical mounting of the receiver is critical to its successful operation of the gyro. More on this later in the *Test Procedure* section. The other two inputs are wheel pulses and the forward/reverse signal. Both of these inputs are typically provided by the vehicles' electrical system.

The purpose of the rate table is to simulate turns that the vehicle makes as it travels down a road or highway. With the GPS receiver and its gyro mechanism attached to the top of the rotating table, a GPS simulator may be used to drive the rate table and simulate the conditions that would normally be experienced real-time on highways. Being able to continuously repeat the test scenario makes it easier to experiment with possible improvements or correct for errors in the GPS receiver operation and performance. The GPS-RT is designed to work with any GPS simulator

*Micro Electro-Mechanical Systems (MEMS) Devices

capable of generating an analog signal for this purpose. The GPS Creations GPSSIM-14 with the automotive card option will work with the GPS-RT. Also, the Navigation Laboratories LabMate and LabPro model GPS Simulators with the automotive option have this capability (see www.navlabs.com for more information).

The GPS Creations model GPS-RT single axis rate table is shown in figure 2. A standard vehicular GPS receiver with a highway map display is shown mounted on the rate table top mechanism.



Figure 2 - GPS-RT w/GPS Receiver for Testing

Installation and Setup

Remove the seal from the GPS-RT shipping drum, open the drum clamp and remove its top. Remove literature, cables, hardware and cushioning from the top of the container. There are two electrical cables, one being the standard A.C. power cord, the other being the interface cable to the GPS simulator. Set these aside for later use. Grasp the top of the fabric bag containing the GPS-RT and remove the rate table from the drum by pulling straight up. This container has been designed to protect the rate table when being transported through standard shipping channels. If the rate table is

going to be shipped to different locations during its future use, it is advisable to save this container for such purposes.

Sit the package on a level surface and examine it for visible evidence of physical damage. Contact your carrier if there is obvious damage in order to file a claim as the rate table is shipped with insurance. Contact GPS Creations if you feel repairs are going to be necessary. Clip the cable tie closure of the GPS-RT bag and remove the bag surrounding the GPS-RT.

Next, place the rate table on a smooth level surface where the three leveling screws on the base may be adjusted as desired to level the top surface. The leveling screws should never be removed from the GPS-RT as these elevate the table above condensates that may subsequently form in any chilled environmental chamber to which the table may be subjected.

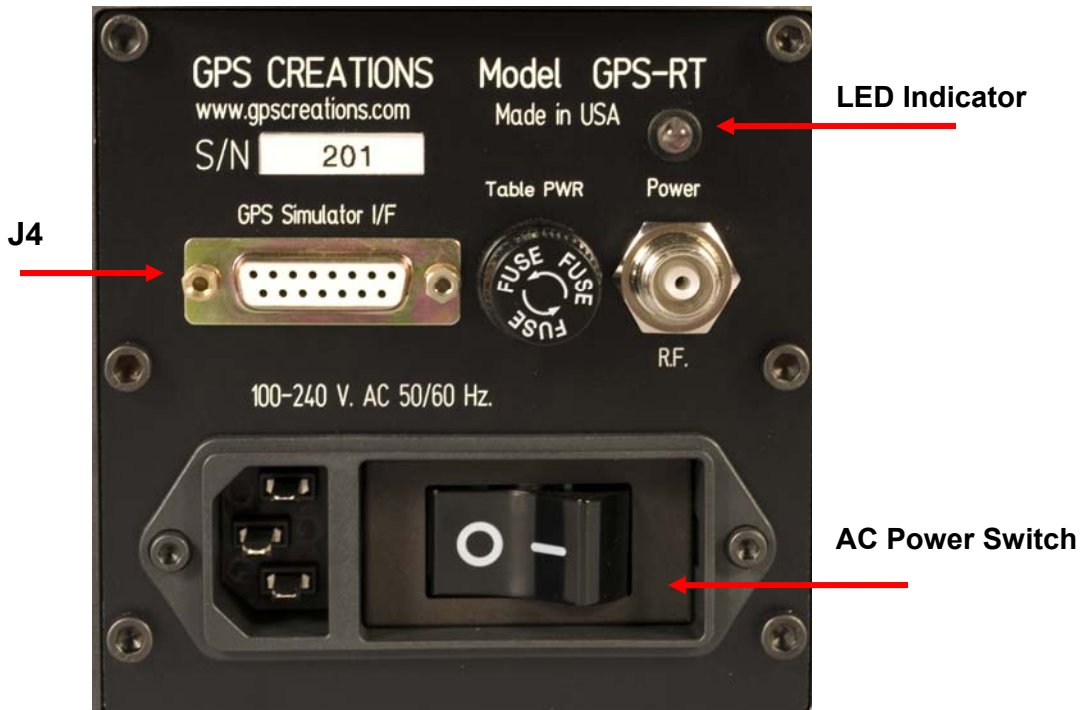


Figure 3 – Nameplate/Control Panel

Refer to the picture of the nameplate in figure 3 for the following steps:

► **Step 1.** Remove the three table locking screws used for shipping purposes. Save these for future use if the unit is to be shipped to another location. The locking screws are provided to protect the table's bearings from potential damage during shipment.

► **Step 2.** Connect the AC power cord to the rate table breaker switch on the nameplate assembly. The GPS-RT can be used with 110-120 or 220-240 volts AC (NOTE: an adapter may be required for 220 volt operation). The rate table is already configured to operate from either voltage. Plug the other end of the power cord into a convenient wall outlet.

► **Step 3.** With no other connections hooked up, switch on the rate table. The power LED should illuminate immediately and stay illuminated. After approximately 5 to 10 seconds, the table should begin to rotate. It will rotate 360° clock-wise at one speed and then stop. After the CW rotation, the table will rotate CCW at a different speed to the point at which the table was positioned when rotation started.

► **Step 4.** The table should rotate smoothly, uniform and without wobble. The table top will perform five rotations as described in the Step 3, then stop with the power LED still illuminated.

► **Step 5.** Note the sound of the rate table when it is rotating as well as when it comes to a stop. There should not be any rattling or grinding noises indicating loose, binding or damaged internal components. If the table fails to rotate as anticipated, no attempt should be made at any time to manually force rotation. Trying to manually rotate the table may damage internal components of the GPS-RT.

► **Step 6.** Turn the rate table **OFF** and connect both the GPS simulator interface cable and power cord to the rate table.

► **Step 7.** Switch **on** the rate table again. This time, note the condition of the power LED. Since the other end of the cable is not connected to the GPS simulator, the LED should blink about one second pulse.

Note: if the rate table does not operate as noted in any of the above steps, contact GPS Creations for advice or possible solution.

► **Step 8.** Connect the other end of the interface cable to the GPS simulator. The rate table is now ready for accepting commands from the GPS simulator. Go to the section called “**Operating Instructions**” for further reading.

Hardware Description

The GPS-RT consists of two major parts, 1) the rotating table-top assembly and 2) the base assembly which houses the electronic circuits and the motor drive/reduction gear mechanism. See figures 4 & 5 cross-section views of the GPS-RT for the basic construction technique that's used.

The table top has two sets of electrical terminal blocks with 5 connections each. These electrical connections are provided through a slip ring assembly mounted on the table drive shaft and eventually coupled to the 15 pin connector at the name plate assembly. See table 1 for the electrical connections and pin-out description. The table top has six each ¼ inch threaded holes for securing the equipment to be tested. Three of these mounting holes had nylon screws in them for securing the table for shipping purposes. Those nylon screws should be removed before any attempt is made to operate the table.

The GPS-RT table and base is all aluminum construction with black anodized finish for appearance and durability.

TABLE 1 – GPS-RT TABLE ELECTRICAL CONNECTIONS			
Terminal Block # 1		Terminal Block # 2	
Terminal	Function	Terminal	Function
1	RF Signal	6	Forward/Reverse Signal
2	RF Ground	7	Wheel Pulse Left Front
3	12 Volts DC Positive (Fused)	8	Wheel Pulse Left Rear
4	12 Volts DC Neg. (Ground)	9	Wheel Pulse Right Front
5	Spare – connected to J4-10	10	Wheel Pulse Right Rear

Table rotation is driven by a stepping motor through a 20:1 gear reducer. The motor is driven by a microprocessor based electronic control system. The table is direct-coupled mechanically to the reduction gear assembly providing for years of trouble free rotation. No drive belts are used on the GPS-RT.

Electrical connections to the unit being tested are provided through a 15 pin connector on the front of the rate table base assembly. These connections are routed through slip rings permitting the table to rotate and still provide electrical connections to the terminal blocks on the table's top plate.

12 volts DC is available on terminal block # 1, pins 3 and 4, and comes from the main power supply in the rate table base. This voltage is present any time the main breaker is turned on. A 3.0 ampere fast-blow fuse is located on the front panel for protection of this circuit. This fuse is only for the 12 volt DC supply present on terminal block # 1, the electronic circuits in the base are independent of this circuit. This circuit will normally be used to power the device being tested. The 3 ampere rating is limited by the slip ring assembly. CAUTION: Use of a larger value fuse may cause permanent damage to the slip rings.

Table 2 – J4 Electrical Connections (Red denotes from GPS Simulator)			
Pin #	Description	Pin #	Description
1	Ground	9	No Connect
2	Serial Data/USB	10	Spare – connects to TB1-5
3	Serial Data/USB	11	Forward/Reverse Signal
4	USB +5	12	Wheel Pulse L.F.
5	Gyro (YAW) Signal	13	Wheel Pulse L.R.
6	Jumper to pin # 7	14	Wheel Pulse R.F.
7	Jumper to pin # 6	15	Wheel Pulse R.R.
8	No Connect	Shell	Ground

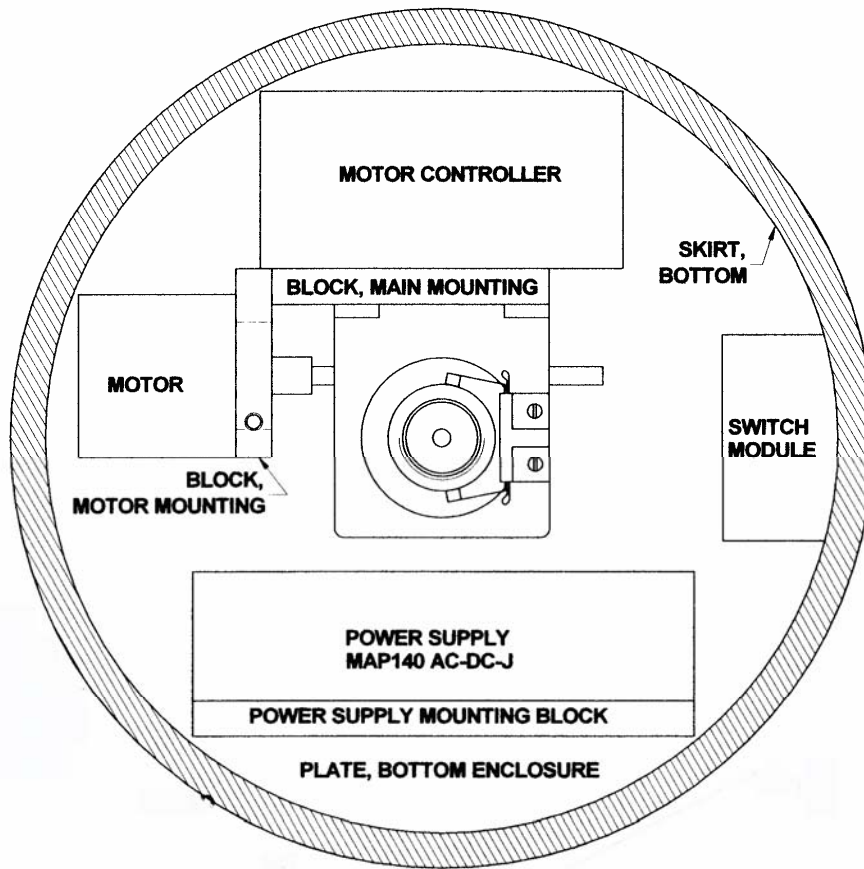


Figure 4 – View from the top of the Interior Motor Drive Mechanism

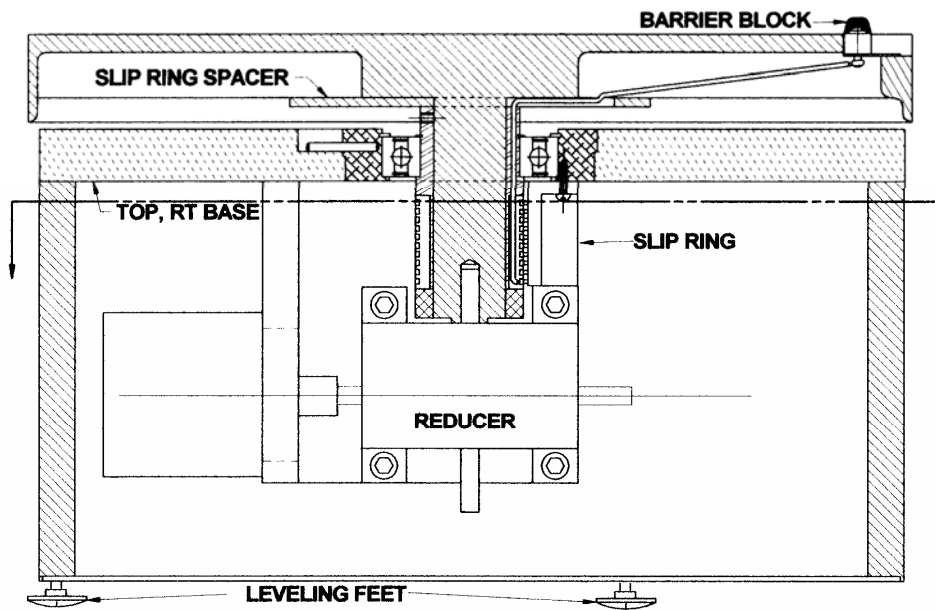


Figure 5 – Side View of Interior Motor Drive Mechanism

Operating Instructions

The GPS-RT is a microprocessor-based rate table design. When the interface cable to the GPS simulator is not connected to the rate table, the GPS-RT will perform a diagnostic table rotation procedure upon application of A.C. power. This is a field diagnostic procedure used to verify that the electronic controls in the rate table are functioning properly. To test this feature, simply remove the interface cable from the 15 pin connector and turn on the power switch on the front of the rate table. After about 10 seconds, the table should rotate 360 degrees clockwise, stop and then turn 360 degrees counter-clockwise. It will repeat this rotation process for five cycles. When the interface cable is connected, the rate table will detect this and wait for commands from the GPS simulator.

Power Indicator – (Light Emitting Diode - LED) functions: The red power LED located on the front name plate is normally illuminated continuously anytime the AC power is applied and the breaker is switched on. However, the LED will blink on and off at a very slow rate if the GPS simulator is not set up to send gyro (yaw or turn) signals to the rate table. Additionally, the LED will blink on and off at a very fast rate if the GPS simulator sends a command that is beyond the turning rate capacity of the GPS-RT (i.e., a command to turn faster than 1 revolution/second). Table 3 has more information on this function.

Table 3 - POWER LED INDICATOR	
Light Condition	Function Description
Extinguished	GPS-RT A.C. Main Power is Switched OFF
Illuminated Solid	GPS-RT A.C. Power is Switched On and Operation is Normal
Blinks 1 second ON and 1 Second OFF	Slow Blink - GPS Simulator is not sending the proper analog signal to the GPS-RT. This may be due to the GPS simulator not being connected, not active or not in the "run" mode.
Blinks ½ Second ON and ½ Second OFF	Fast Blink - GPS Simulator has sent a command that the GPS-RT can not perform. Requires power cycling the GPS-RT to recover.

If the "fast blink" condition occurs during an actual test, this indicates the rate table has been commanded to turn faster than it is capable of turning. The rate table will have to be power cycled in order to clear this condition. To prevent this from re-occurring, the scenario on the GPS simulator will need modification. There is no harm to the rate table when this event occurs, but since the rate table can not complete the command, a visual signal of this condition is given to the user. Also, the rate table will stop any further movement when this condition exists.

Test Procedure

As mentioned earlier in this document, the gyro must be mounted such that it is capable of detecting turns. When the gyro is internal to the device being tested and not visible on the outside, caution must be exercised to be sure that the unit is installed in

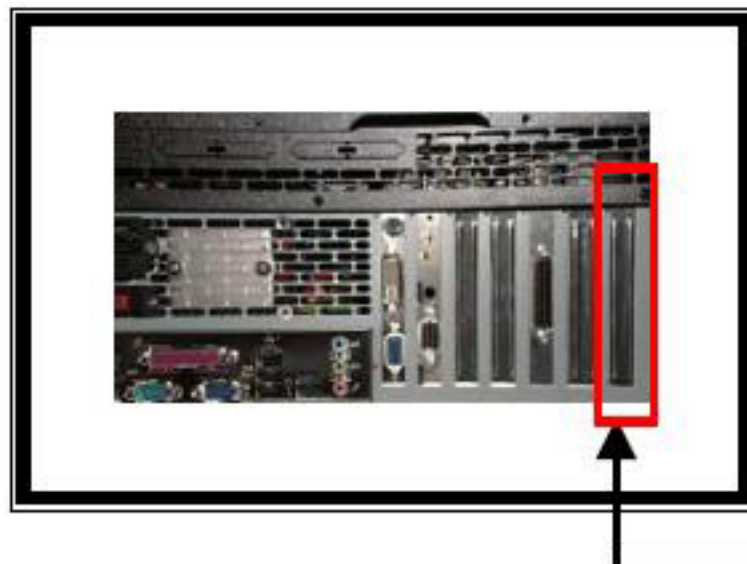
the “normally used” configuration. Typically, the gyro must be mounted where it is vertical or perpendicular to the rate table.

For testing a GPS receiver with a gyro or other device with a turn detection system, place the device to be tested on the table and make it mechanically secure using the ¼ inch threaded holes provided on the top. Be sure that the ¼ inch bolts do not protrude beyond the bottom of the top plate.

Be sure to observe the polarity for the 12 volt DC power for the unit being tested. If the operating voltage is something other than 12 volts, there is a spare pin which has been brought out and available for such. See table 2 for more information. If available, attach the wheel and forward/reverse signal leads to the appropriate connections on terminal block # 2. Also, if the RF connection can be made through the rate table, make sure that the ground and center pin connection are as shown in table 1.

The gyro signal sent by the GPS simulator should start off by simulating the vehicle going in a straight line for a minimum of 10 seconds. This will permit the GPS-RT to synchronize with the GPS simulator. Once the scenario being run starts a turn, the rate table should follow the movement being simulated. The gyro signal will be positive going for the table to make clockwise turns (vehicle making a turn to the right) and negative going for counter-clockwise turns (vehicle turning to the left).

The interface cable from the GPS-RT is connected to the GPSSIM-14 simulator 25-pin connector where shown in figure 6 below. NOTE: there are two identical connectors on the GPS simulator. The cable to the rate table is connected to the one nearest the edge of the case.



This 25 Pin Connector

Figure 6 – Interface Cable Connection to the GPS Simulator

The GPS-RT should now be ready to operate with the GPS simulator.

A GPS simulator test scenario program for exercising the rate table is supplied on the CD which comes with the rate table. This program will run on the GPSSIM-14 or any of the Navigation Laboratories simulators. This program may be used as a model for other scenarios to be generated if desired. Be sure to modify the scenario's file parameters from "Read Only" when this program is copied from the CD on to the hard drive of the GPS simulator. Place this program in the C:\Voyager\Runs folder.

Warranty and Repairs

The GPS-RT carries a one-year parts and labor warranty beginning at time of shipment. If the rate table has a failure, it must be returned F.O.B. to GPS Creations for repairs. If repair is from a routine failure, repair will be performed at no cost. If repair is required due to improper handling (to be determined by GPS Creations), repair charges may be the responsibility of the customer. Repairs will not be made without first contacting and quoting actual charges to customer. If repair is necessary after expiration of the warranty period, contact GPS Creations for a quote and to obtain a Return Material Authorization (RMA) number.

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Firmware Upgrades

The GPS-RT contains a microprocessor based electronics control system. The firmware for operation of the rate table is stored in what is called a "flash memory circuit" which means that future improvements and enhancements can be loaded into rate tables already out in the field and in service. The firmware is loaded into the rate table using a standard PC and either a serial RS-232 or USB connection. Contact GPS Creations for more information on current firmware releases and upgrade procedure.

GPS Creations follows a policy of continuous product improvement; specifications and descriptions are therefore subject to change without notice. Please contact GPS Creations for the latest product information.

APPENDIX A

GPS-RT to GPSSIM-14 GPS Simulator Interface cable



Figure A1 – GPS-RT to GPSSIM-14 Interface Cable

When the GPS-RT is to be used with a GPS Creations or Navigation Laboratories GPS simulator, the cable shown above is supplied with the rate table. The standard length of this cable is 10 feet. If a longer cable is needed, a standard PC parallel cable may work as long as the cable has all 25 conductors. If such extension cable can not be found locally, contact GPS Creations for a special length cable.

If the GPS-RT is to be used with a different manufacturer's simulator or if the rate table is to be used in some other application, the terminal identification is given in table 2 for making up your own cable. Contact GPS Creations for a quote on construction of a special purpose interface cable, if desired.

The following section describes monitoring operational status of the GPS-RT with a PC if desired.

Using Hyper Terminal® to monitor data on either the RS232 or USB port

The GPSRT constantly outputs data on its serial port for the purpose of monitoring current actions and status. It is not necessary to hook-up this connection but it is

available for anyone desiring to utilize it. A computer program such as Hyper Terminal® may be used for this purpose. The communications parameters are 19,200 BPS, No parity, 8 data bits and 1 stop bit and without any flow control. Note that the GPSRT also uses this serial port for the purpose of installing firmware upgrades.

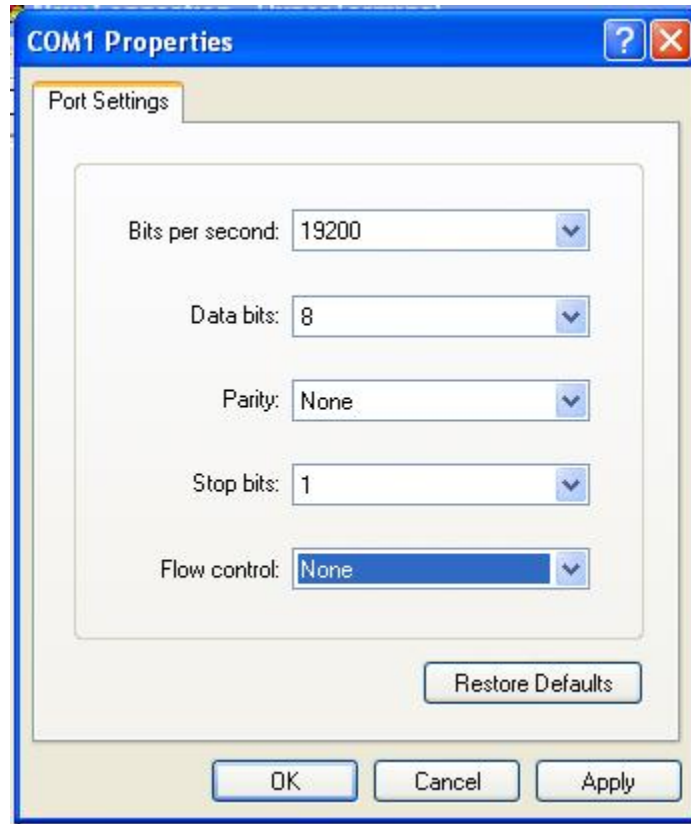


Figure A2 – Communications Parameters Settings

The GPSRT requires a special communications protocol to send commands from a computer to the motor control electronics, so inadvertently pressing keyboard keys or commands does not get acknowledged and will not affect normal operations. However, this sort of activity should be minimized for best performance of the GPSRT.

® Hyper Terminal is a registered trademark of Microsoft

Figure A2 shows a typical Hyper Terminal screen of data when the interface cable is not connected and the GPSRT is powered on and has gone into its diagnostic table rotation process.

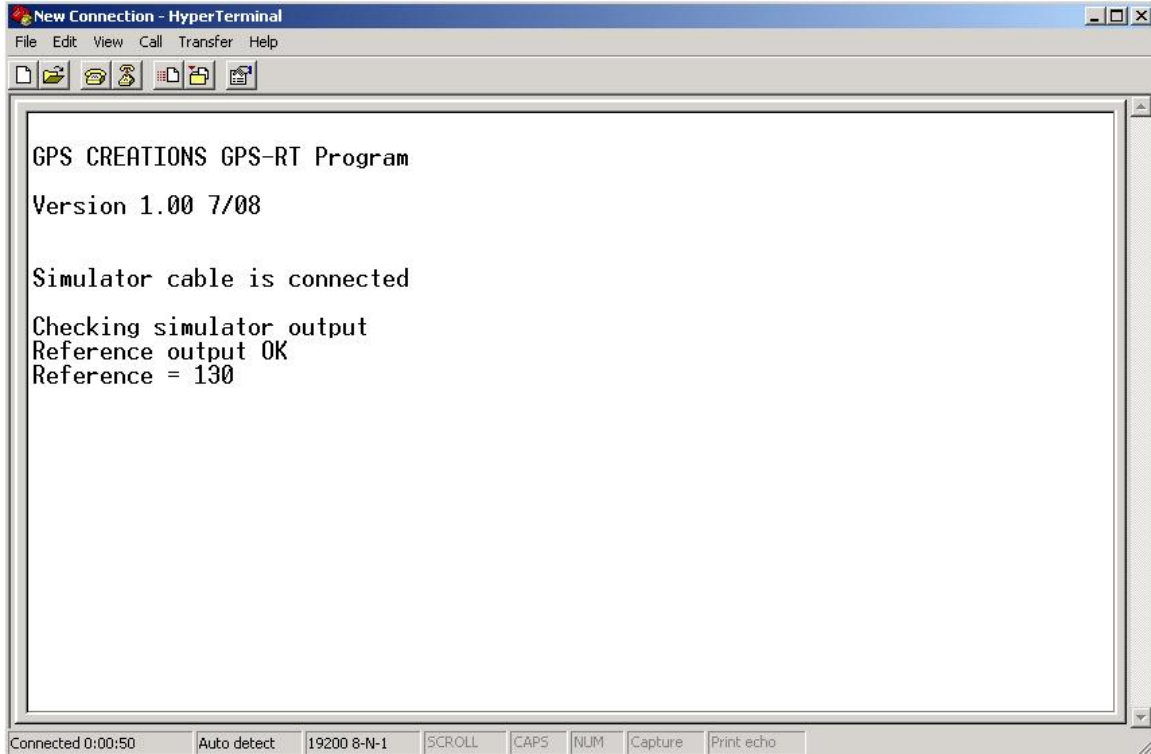
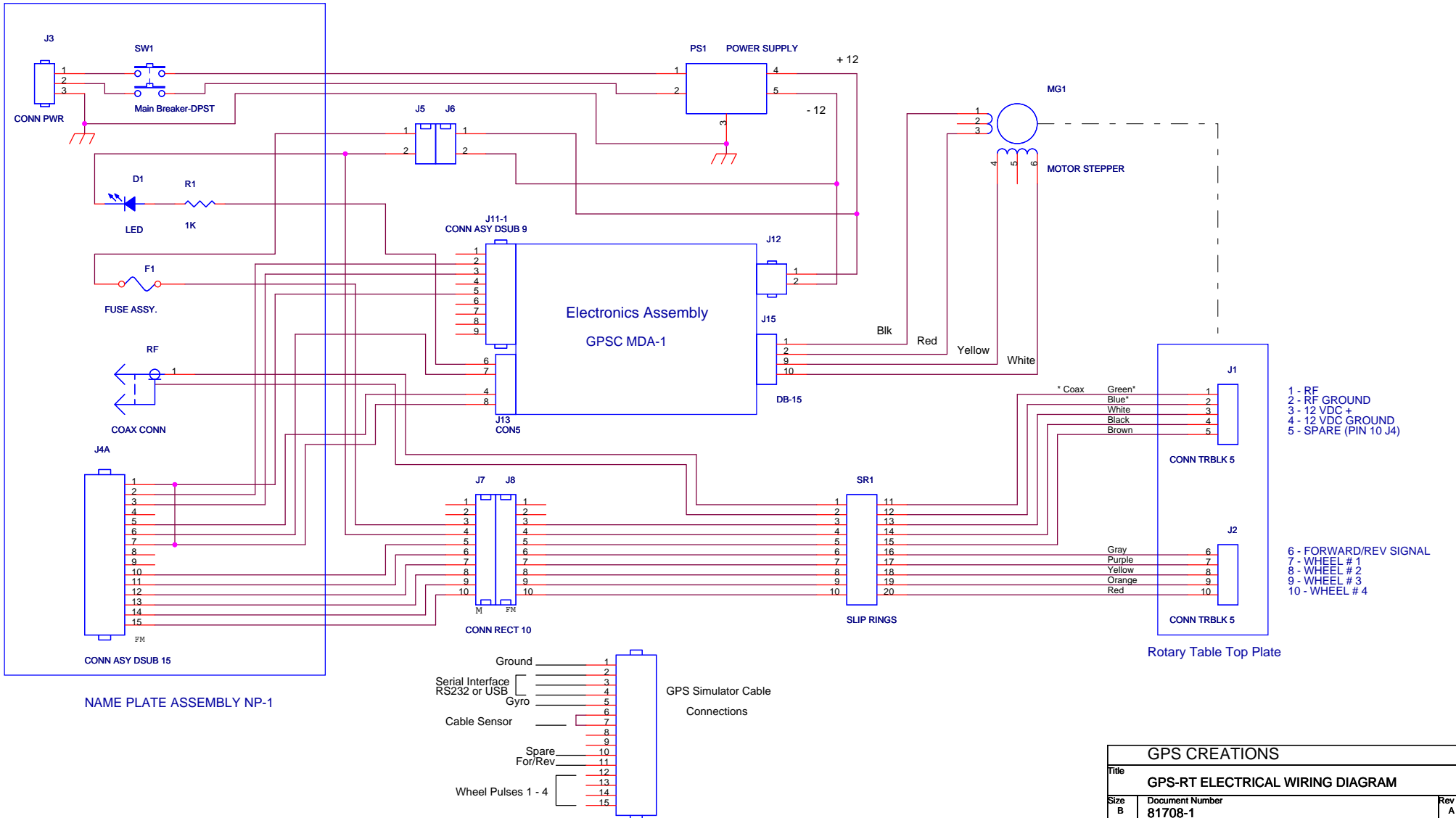


Figure A3 – Typical Data Monitoring Screen

The schematic diagram on the following page shows the electrical wiring inside the GPSRT and is for reference purposes only. The user should not attempt repairs or modifications without first contacting GPS Creations for consultation.



- 1 - RF GROUND
- 2 - RF GROUND
- 3 - 12 VDC +
- 4 - 12 VDC GROUND
- 5 - SPARE (PIN 10 J4)

- 6 - FORWARD/REV SIGNAL
- 7 - WHEEL # 1
- 8 - WHEEL # 2
- 9 - WHEEL # 3
- 10 - WHEEL # 4

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TERMS AND CONDITIONS

1. **Acceptance and Agreement.** The provisions outlined in the sales order constitute an agreement between GPS Creations and the buyer and it supersedes all other prior or contemporaneous communications between the parties whether written or oral. This document constitutes an offer to sell (and not an acceptance of any offer to purchase) the goods and services described herein which may be accepted only in accordance with its terms and without modification, deletion or alteration. All orders are received subject to acceptance by GPS Creations.
2. **Prices.** Unless otherwise noted, prices quoted are FOB GPS Creations factory. Quoted prices are valid for a period of sixty (60) days from the date specified on the quotation. Shipment of goods to occur in the timeframe specified or earlier if possible. If shipment can not be made within the time specified, buyer will be notified when shipment is expected.
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4. **Taxes.** Quoted prices do not include sales, use, excise, privilege or any taxes levied by any governmental body, and any such applicable taxes shall be paid by the Buyer, or in lieu thereof, the Buyer shall upon request provide GPS Creations with a tax exemption certificate acceptable to the appropriate taxing authority.
5. **Payment.** The net amount for products purchased shall be due upon receipt of invoice from GPS Creations, unless agreed to otherwise. Invoices not paid within thirty (30) days of invoice date are subject to carrying charges. Such charges shall accrue in the amount of one and one-half (1½) percent per month on any overdue unpaid balance.
6. **Risk of Loss.** All risk of loss or damage to products sold shall pass to the buyer upon delivery by GPS Creations of such products to the common carrier for shipment even if GPS Creations has agreed to pay the shipping charges.
7. **Law.** This agreement shall in all respects be governed by and construed according to the laws of the State of Tennessee.
8. **Warranty.** GPS Creations warrants its products to be free from defects in design, material and workmanship for a period of one year from date of shipment. Subject to the conditions contained in this warranty, GPS Creations will, at its option, repair or replace the product, if it proves defective, at its own expense. The following conditions apply to this warranty:
 - The defect must be due to design, material or workmanship and the product must not have been modified in any way by the Buyer.
 - GPS Creations will, at its option, conduct repairs on customer premises or at GPS Creations' factory.
 - If repair is at GPS Creations' factory the product must be shipped at customer's expense to GPS Creations and if the defect is found to be within the warranty period, GPS Creations will pre-pay shipping charges for return of the product to the customer.

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NOTES