DR600

User Manual and Installation Guide

K-Band Doppler Radar DR600
(Applies to both DR600-DFT and DR600-OFD versions)
Rev 4, June 5th 2024

DR600 in weatherproof enclosure
Version (DR600-DFT)

DR600 open frame
Version (DR600-OFD)

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This device conforms to the CE mark and conforms to the requirements of the applicable European Directives as follows:

EN 60950-1
ETSI EN 300 440-1 V1.4.1
ETSI EN 300 440-2 V1.2.1
ETSI EN 301 489-1 V1.7.1
EN 55022 Class B
EN 61000-4-2 8 kV/4 kV
EN 61000-4-3 3 V/m

FCC ID: TIADR600

This device meets the FCC requirements for RF exposure in public or uncontrolled environments.

This device complies with FCC part 15 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.

Changes or modifications not approved by Houston Radar could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for 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.

IC ID: 21838-DR600

This device meets the IC requirements for RF exposure in public or uncontrolled environments.

Cet appareil est conforme aux conditions de la IC en matière de RF dans des environnements publics ou incontrôlée.

IC Warning

This device complies with Industry Canada license exempt RSS standard(s). Operation is subject to the following two conditions: 1. this device may not cause interference, and 2. this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme avec Industrie Canada RSS standard exempts de licence (s). Son utilisation est soumise à Les deux conditions suivantes: 1. cet appareil ne peut pas provoquer d'interférences et 2. cet appareil doit accepter Toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositive.

Warning: DR600-OFD radar is supplied in an open frame format with exposed antenna and electronics and thus is a static sensitive device. Please use static precautions when handling. Warranty does not cover damage caused by inadequate ESD procedures and practices.

Note: Specifications may change without notice.
Note: Not liable for typographical errors or omissions.

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INTRODUCTION

Congratulations on your purchase of the Houston Radar directional Doppler Speed Radar DR600. This state of the art 24GHz K-band microwave Doppler radar is specifically designed for the license free battery operated speed measurement and monitoring market.

Utilizing high performance, ultra-low power DSP (Digital Signal Processing) technology, and microwave components based on a planar patch array antenna with integrated low power PHEMT oscillator, you will find that this high quality product meets your exacting standards for performance and reliability.

Some of the highlights of this product include:

- ✓ Complete bi-directional speed output Doppler radar with digital processing
- ✓ Best in class low power usage of only 8.1 mA at 12VDC (0.097 Watt)
- ✓ 0.6mph (1km/h) to 200+mph (322 km/h) of speed measurement range
- ✓ Advanced CFAR DSP based algorithm yields consistent performance and speed detection
- ✓ Capable of 790+m (2600+ feet) pickup distance for incoming vehicles on open and level road in range boost mode. Trucks picked up at 940+m (3100+ feet).
- ✓ Two RS232 and two 'open collector' vehicle detection trigger outputs
- ✓ Radar internal software is upgradeable in the field via RS232 PC interface
- ✓ All radar configuration parameters can be set by user via RS232 serial port
- ✓ Extensive built-in self-test
- ✓ Supports our popular Advanced In-Radar traffic statistics
- ✓ Android App to collect data when coupled with Houston Radar Bluetooth module
- ✓ Pin, form-factor, and interface compatible with our previous generation DR500 radar
- ✓ Wide variety of mounting and enclosure options
- ✓ Ground speed measurement and target speed correction mode for mounting on moving vehicle

INSTALLATION

Mounting:

DR600-OFD is supplied in an "open frame" format. It requires a weatherproof enclosure before it may be used outdoors. Alternatively it may be mounted as a component in another product that already has a weatherproof enclosure.
The DR600-OFD should be mounted such that the connector points left or right (Horizontally).

The DR600-DFT is supplied in a weatherproof encapsulated enclosure with a pigtail connection. This unit may be mounted outside without any further protection from the environment. The DR600-DFT should be mounted such that the cable gland is positioned down and the mounting bosses are horizontal.

Rotating the unit by 90 degrees from the suggested optimal mounting is not recommended, and doing so will cause detection range to be significantly reduced.

If using thread locking compound, verify it is safe for plastic. Loctite Blue 242 & 243 are not safe for plastic and will cause damage to the plastic case. Loctite 425 is recommended for use with plastic.

Direction Pointing:

The DR600 is directional in nature. It may be configured to detect and measure the speed of incoming, outgoing, or bi-directional traffic. It then rejects traffic moving in the opposite direction (unless set to bi-directional). Direction of detection is configured via the bits in the radar's MO and MD variables, or preferably, via the GUI.

Statistics are only gathered for incoming traffic when placed in incoming or bi-directional mode. No statistics will be collected in outgoing mode.

For optimal performance:

- ✓ Radar should be mounted as suggested in the section titled "Mounting"
- ✓ Radar should be pointed into the direction of the oncoming traffic.
- ✓ Radar should be placed along the side of the road to minimize the angle of the oncoming traffic to the radar.
    - If radar cannot be placed right along the side of the road, it should be pointed at least 100-150 feet (30-45 m) up the road into oncoming traffic.
- ✓ The radar may pick up rotating fans. Avoid pointing it at fans or compressors.
- ✓ Radar should be mounted at least 3 feet (1 m) high from the road for optimal performance and at least 6 feet (1.9 m) for maximum pickup distance

Recommended Enclosure for the DR600-OFD:

The DR600-OFD radar needs to be enclosed in a weatherproof enclosure for outside use. The following needs to be observed for optimal performance:

1. The front face of the radar is the antenna and the face that must point into traffic.
2. Any cover or window in front of the unit MUST be at least ¼" away from the face.

3. Do NOT spray any conformal (or other) coating, paint, or other substance on the antenna.
4. The optimum material to use as a front window is Lexan (Polycarbonate) plastic.
5. The optimum thickness of the polycarbonate window is one half wavelength at 24.125Ghz, or about 3.5 to 3.7mm (0.137" to 0.146") thick.
    a. Alternatively, a thin window of any plastic material may be used. The maximum thickness in this case should be no more than 1 mm (40 mils).
    b. Standard 0.25" thick Lexan should be avoided as it has particularly high reflection coefficient due to this specific thickness.
6. Other plastic materials may be used as a front window, but the optimum thickness will wary with the material's dielectric constant. Please contact us for details.

Alternatively, you may consider the weatherproof version, DR600-DFT, which is available from Houston Radar.

Hookup:

Power Input:

The DR600 radar features a wide operating input voltage range of 5.0V-30V. In a typical application, it may be powered from a nominal 12V DC source and will feature best in class operational power consumption of 8.1mA (average).

This ultra low operational power translates directly into a longer battery life, or the option to use smaller batteries and solar panels.

Note: The radar employs aggressive power saving measures that include turning off parts of the circuit that are not being used at any instant. To get a true measure of the power usage of the circuit use a multi-meter that has an averaging function and does not suffer from auto ranging during measurements. Otherwise you will get current readings that fluctuate from 1 mA to 30 mA.

Your power supply to the radar must be capable of supplying up to 100mA of current for up to 5 seconds at a time (startup current is higher as the radar is initializing its internal systems).

Serial Connection:

The DR600 features an RS232 interface that is used to output speed, access statistics data, and configure the unit.
The RS232 interface is factory set to "cable detect" mode and will power the interface chip down to save power if the radar RX line is not connected. Cable detect mode may be disabled and the interface forced ON via a bit in the "MD" variable. This can also be configured through the GUI.

Measured Speed Output:

The DR600 will send out the measured speed via the ASCII interface as a 3 digit speed with an optional direction indicator. The format is:
[?,+]nnn[.ddd][\r,\n]
The format of the speed output can be adjusted to any combination of:
"?": Optional prefix sent when 000 selected to be sent when no vehicles are detected
"+": Optional prefix sent when nnn speed is sent for incoming vehicles
"-": Optional prefix send when nnn speed is sent for outgoing vehicles
"nnn": Three digit ascii speed in the units selected via the UN variable
".ddd": Programmable number of digits (0-3) after decimal point
"\r": Carriage Return character, optional line ending
"\n": Line Feed character, optional line ending
At least one or both of the line endings must be selected with ASCII format. No line ending is not an option. Please see serial port configuration section for details on how to select the above format.
Alternatively, the radar may be set to output a single byte speed in binary format. No line termination is issued when format is set to binary. A fractional value cannot be output when the binary output mode is selected.

Setting variables from an ASCII Terminal program via ASCII commands:

All the radar variables can be set and queried via a simple ASCII command set over the serial port. ASCII commands may be issued via an ASCII terminal program like Hyperterminal or Teraterm Pro. Alternatively, you may issue these commands from an attached microcontroller.

All settings are written to FLASH memory and are non-volatile. Do not update settings on a periodic basis, e.g. every second or every minute. Only change settings when the user needs it. The FLASH memory has a limited number of write cycles and will wear out with an excessive (>10,000) number of writes. On the other hand, setting the variable to the same value repeatedly is OK because the radar recognizes that the variable has not changed and does not update it in FLASH.

The ASCII commands are:

get (to get a config variable)

set (set a config variable to a supplied value)

reset (resets the radar. Required after changing variables MO, MD, RS, RA, and CY. LO, HI, SP, ST, SF, UN do not require a reset.) Some variables may not be present on all radars.

info (print out some info about the radar. Info is in the format of <tag>=<value>). New tags may be added in the future. Order of tags may be moved around.

Variables are case sensitive. Commands are not.
Success is indicated by an "OK".
Failure is indicated by either:
"ERROR" - Command was recognized but some other error occurred (variable not present, format not correct etc.)
<nothing returned> - Command was not recognized. Entire line was silently discarded. This ensures that spurious characters, such as the return character, do not generate "ERROR" messages unexpectedly.

To set a variable (variables are documented in the user manual):
set: <case sensitive variable name> <value>[Enter]
e.g.
set:LO 5
alt format:
set:LO=5
sets the low speed cutoff to 5 etc.

To get a variable (variables are documented in the user manual):
get:<case sensitive variable name>[ENTER]
e.g.
get:LO
returns
LO=5 (if value is presently set to 5).

If sending the ASCII command via an attached microcontroller, the “[ENTER]” key press should be replaced by the carriage return and/or line feed ASCII character.

Wire Signal Descriptions (Terminal Block):

Molex Connector Pin #	Wire Color	Signal Name	Direction (wrt Radar)	Description
1	Red	VIN	PWR	VCC Power Supply
2	Green	TX1	Output	RS232 Transmit Signal from radar
3	Gray	RX1	Input	RS232 Receive Signal into radar
4	Brown	RX2	Input	RS232 Receive Signal into radar
5	Black	GND	PWR	Radar GND (battery "-" terminal)
6	Yellow	TX2	Output	RS232 Transmit Signal from radar
7	Violet	Trig O/P 1	Output	"Open Drain Output 1". See Note 1.
8	Orange	Trig O/P 2	Output	"Open Drain Output 2". See Note 1.
9	Blue	GND	PWR	Radar GND (battery "-" terminal)

Wire Signal Descriptions (DB9 Connector):

DB9 Pin #	Signal Name	Direction (wrt Radar)	Description
1	VIN	PWR	VCC Power Supply
2	TX1	Output	RS232 Transmit Signal from radar
3	RX1	Input	RS232 Receive Signal into radar
4	RX2	Input	RS232 Receive Signal into radar
5	GND	PWR	Radar GND (battery "-" terminal)
6	TX2	Output	RS232 Transmit Signal from radar
7	Trig O/P 1	Output	"Open Drain Output 1". See Note 1.
8	Trig O/P 2	Output	"Open Drain Output 2". See Note 1.
9	GND	PWR	Radar GND (battery "-" terminal)

Wire Signal Descriptions (5 pin M12):

Pin #	Wire Color	Signal Name	Direction (wrt Radar)	Description
1	Brown	VIN	PWR	VCC Power Supply
2	White	TX1	Output	RS232 Transmit Signal from radar
3	Blue	RX1	Input	RS232 Receive Signal into radar
4	Black	Trig O/P 1	Output	"Open Drain Output 1". See Note 1.
5	Green/yellow	GND	PWR	Radar GND (battery "-" terminal)

Note 1: See Appendix A for detailed description on how to hookup an external device to be triggered when radar detects incoming objects. Incorrect hookup may result in the output devices being destroyed and will not be covered under warranty.

The DR600 features two low impedance outputs that can trigger/turn on an external display/device to bring it out of power saving mode when a vehicle is detected. Both outputs are under radar software control and the typical functionality is to turn both on together when a vehicle is detected. This logic, however, is completely customizable. See later section for details.

When a vehicle is detected, with the typical configuration, and the speed is above the "LO" speed limit and below the "HI" speed limit, both pins are pulled down to GND and held low as long as a vehicle is tracked. These pins are released as soon as the radar detects no further traffic.

These are "open drain" (AKA open collector) outputs capable of sinking 500 mA each. You must limit the current externally to ensure that no more than 500 mA goes into each pin when they turn on. They may be connected in parallel to double the sink capacity to 1000 mA.

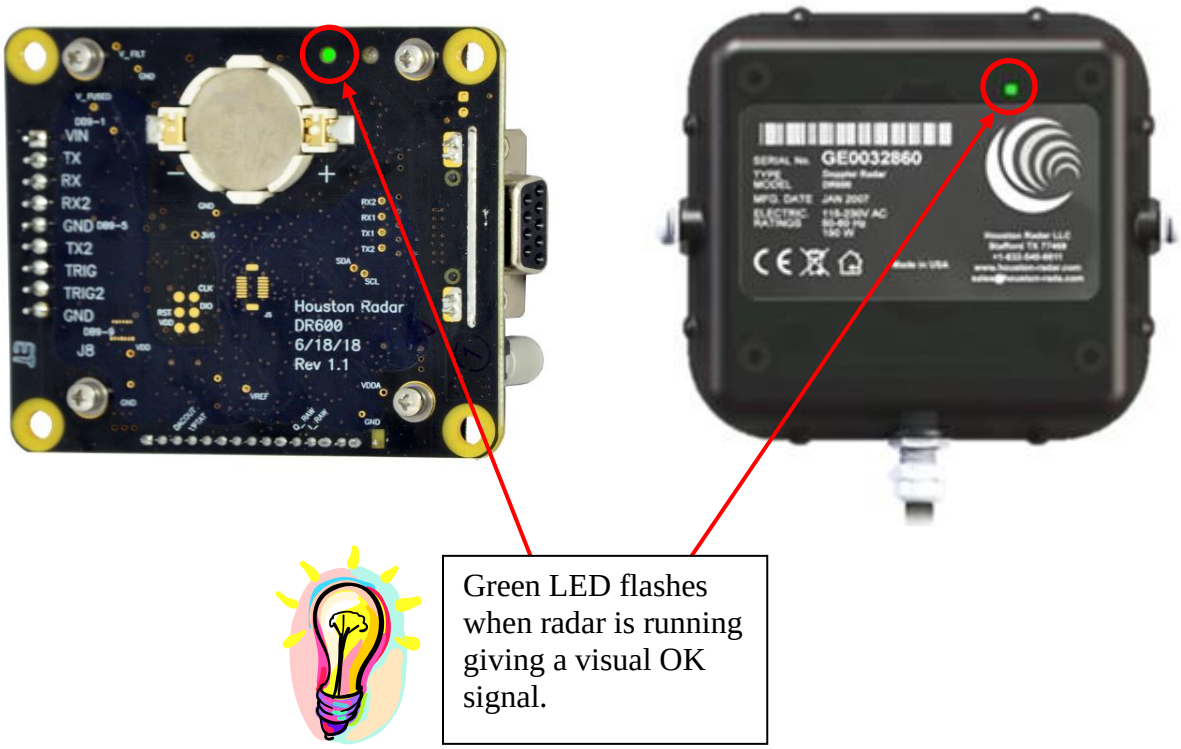
USE

Turn on the power to the DR600 to make it operational. No other action is required. The radar will typically activate OUT 1 and OUT 2 open drain outputs whenever it detects a vehicle that is above the programmed lower speed limit (the "LO" value) and below the programmed high limit (the "HI" value). The units (e.g. km/h, mph, fps, mps) are determined by UN variable. The trigger output behavior can be changed. See later section.

The radar will also keep sending out the speed in user selected ASCII format over the serial interface while a vehicle is tracked (If detection direction selection matches the direction of travel for the vehicle).

Connect the radar to a PC RS232 serial port and use the provided Windows configuration software to program the high speed limit ("HI" variable). If you do not want an upper detection limit, set this value to the maximum value available on the slider control. If you wish to disable the upper limit by setting the "HI" variable directly, set the variable to the highest detectable speed listed in the radar specifications.

Set the "LO" variable to set the lower detection speed limit. The outputs will be de-asserted for vehicles below this speed limit.



Green LED flashes when radar is running giving a visual OK signal.

Internal Clock:

The radar has a built in clock/calendar function. This is used to keep the time to date/time stamp the historical archive records saved by the Advanced In-Radar traffic statistics collection feature that is available as an option in the radar.

The DR600 radar features a built in clock backup battery that will keep the clock time in the case of power failure for over 10 years.

Configuring the Unit:

The radar's internal parameters may be configured via the radar's RS232 port after connecting to a PC's RS232 serial COM port and using the Houston Radar configuration program's Graphical User Interface (GUI). While this is the most convenient way to configure the radar, customers may also set the configuration variables directly. This is very beneficial when the radar is part of a system and connected to another microcontroller.
The radar configuration variables and their functionality are described below.

The radar supports significantly more options than can be easily listed here. If you need to manipulate the variables directly, we highly recommend contacting us or using the GUI to set the options. After setting the options in the GUI, the radar configuration can be downloaded, and the variable names and values can be examined with a text editor.

Configuration Variable Name	Description
RS	Sets the primary RS232 serial port's baud rate and output format. Do not change this value unless you understand the implications.
RA	Sets the auxiliary RS232 serial port's baud rate and output format. Do not change this value unless you understand the implications.
UN	**Lower Byte**: Sets the internal speed units of the radar. All LO, SP, HI, SI speeds are interpreted to be in these units. 0 = MPH 2=FPS (Feet per second) 1 = KM/H 3=MPS (Meters per second) **Upper Byte**: Sets number of digits after decimal point.
LO	Low speed cutoff. Vehicles are not detected below this speed. Should be set to be less than HI. Speeds above this limit trigger the O/P1 and O/P2 outputs (depends on trigger configuration) and ASCII speed output.
HI	High speed cutoff. Vehicles are not detected above this speed. Should be set higher than LO speed. Speeds below this limit trigger the O/P1 and O/P2 outputs (depends on trigger configuration) and ASCII speed output.

SP	Flashing speed limit. Any speed higher than this value "flashes" the speed output at 50% duty cycle. To "flash" the ASCII speed, 000 are interspersed in the "nnn" speed output on the serial port. Set to HI value to never "flash" the speed output.
SF	Software tracking filter bitmask options. Bits are as follows: **Bit 0 to 1**: 0: Select Strongest Target if multiple targets are detected on the road. 1: Select Fastest Target if multiple targets are detected on the road. 2: Display the Ground Speed of the vehicle the radar is mounted on. This option is only valid when the "Speed Measurement with Ground Speed Tracking" filter is selected. 3: Reserved in DR600 radar. **Bit 2 to 12**: Reserved in DR600 radar. **Bit 13 to 15**: Target tracking mode selection. 0: Speed Measurement. 1: Speed Measurement with Ground Speed Tracking. 2 to 3: Reserved in DR600 radar. 4: Demo mode. 5 to 15: Reserved in DR600 radar.
ST	Target detection sensitivity. Valid values are from 10 to 100 and are a percentage of max range. *Note: This is not a range setting but detection sensitivity. Thus, if vehicles are being detected at 1000 feet with an "ST" value of 100, an "ST" value of 50 will reduce detection range to approximately 500 feet (range values provided are for example only)*.
MO	Radar mode bitmask. Bits are as follows: **Bit 0**: SI3 ASCII command compatible flag. Contact us for more details. **Bit 1**: Enable ASCII console output on primary RS232 serial port. **Bit 2**: Enable ASCII console output on auxiliary RS232 serial port. **Bit 4**: Reserved in DR600 radar. **Bit 5 to 6**: Frequency mode. 0: Frequency A (US 24.125GHz, UK 24.200GHz) 1: Frequency B (US 24.150GHz, UK 24.225GHz) 2 Frequency C (US 24.100GHz, UK 24.175GHz) **Bit 7**: Reserved in DR600 radar. **Bit 8**: Disable power optimized mode. RF ON all the time. **Bit 9**: Disable microwave transmitter (Testing only). **Bit 10**: Enable extra filtering for "slow" (<20mph/32km/h) **Bit 11**: Enable average speed output (see note 1). **Bit 12**: Detection direction. 0 = only incoming, 1 = only outgoing (see note 2). **Bit 13**: Enable tuning fork compatible mode for 120s after power up. **Bit 14**: Reserved in DR600 radar.

	Bit 15: Enable statistics rain filter.
MD	Radar mode bitmask number 2. Bits are as follows: **Bit 0**: Enable low voltage power down below 5VDC. **Bit 1**: Reserved in DR600 radar. **Bit 2**: Force enable on the RS232 interface when set. Sets to "cable detect" mode when bit is cleared. Power usage is increased by about 12mW if this interface is force enabled or if RS232 cable is connected. **Bit 3**: Disable "count up" on startup. Speeds the startup by about 3s. **Bit 4**: Save traffic statistics (if enabled in radar) in 3mph/5kph speed bins rather than original default of 5mph/10kph speed bins. **Bit 5:** Reserved in DR600 radar. **Bit 6:** Enable range boost mode. **Bit 7:** Disable display blinking. **Bit 8:** Enable bi-directional traffic mode (see note 2). **Bit 9:** Enable auxiliary serial port. Increases power usage by about 12 mW. **Bit 10:** Reserved in DR600 radar. **Bit 11:** Display target signal magnitude with individual target speeds. **Bit 12:** Enable echo of received ASCII chars on serial ports. **Bit 13:** Enable strict detection rules for ground speed modes. **Bit 14:** Reserved in DR600 radar. **Bit 15:** Enable individual vehicle statistics records (requires statistics).
IO	Radar IO configuration bitmask. Bits are as follows: **Bit 0:** Reserved in DR600 radar. **Bit 1:** Set: IO 1 Active high. Clear: IO 1 active low. **Bit 2 to 3:** IO 1 Blink options 0: Blink disabled 1: Blink on even cycles when trigger is active 2: Blink on odd cycles when trigger is active **Bit 4 to 7:** Reserved in DR600 radar. **Bit 8:** Reserved in DR600 radar. **Bit 9:** Set: IO 2 Active high. Clear: IO 2 active low. **Bit 10 to 11:** IO 2 Blink Options 0: Blink disabled 1: Blink on even cycles when trigger is active 2: Blink on odd cycles when trigger is active **Bit 12 to 15:** Reserved in DR600 radar.
HT	Output Hold Time in seconds. Once the output is triggered, it is held for this amount of time from the last trigger source before going inactive. Note: Only the digital outputs are held. The ASCII speed output is not held. The ASCII speed output goes to 000 as soon as target is no longer tracked.
BN	Time interval in minutes for logging statistics records to flash.

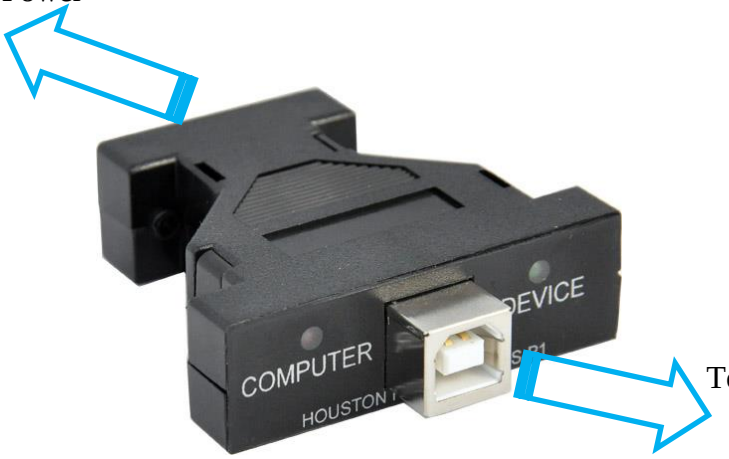
TA	Time interval in seconds for averaging and displaying average traffic speeds when average speed output mode is enabled.
TR	Radar triggers configuration bitmask. Bits are as follows: **Bit 0 to 5:** IO 1 Mode options 0: None 1: Trigger for target detected above SP 2: Trigger for target detected below SP 3: Trigger for any detected target 4 to 63: Reserved in DR600 radar **Bit 6 to 7:** IO 1 Direction options 0: Incoming 1: Outgoing 2: Bi-directional **Bit 8 to 13:** IO 1 Mode options 0: None 1: Trigger for target detected above SP 2: Trigger for target detected below SP 3: Trigger for any detected target 4 to 63: Reserved in DR600 radar **Bit 14 to 15:** IO 1 Direction options 0: Incoming 1: Outgoing 2: Bi-directional
CY	Radar cycle time in ms. Valid values include 50-1000ms. As cycle time decreases, power increases. Range is decreased by approximately 30% if cycle time is less than 115ms, and 50% if cycle time is less than 85ms. It is advised to place the radar in range boost mode if cycle time is below 85ms. The only valid value for gathering traffic statistics is 380ms. Setting any value other than other than 380ms on a statistics activated radar will prevent statistics from being recorded.
ME	Radar mode bitmask number 3. Bits are as follows: **Bit 0**: Disable the running status LED. **Bit 1:** Reserved in DR600 radar. **Bit 2**: Enable "All Targets' Speeds" output mode (see note 3). **Bit 13 to 14:** Reserved in DR600 radar.

Configuration Variable Notes:
Note 1*:* "True Average Speed" output requires the optional Advanced in Radar traffic statistics collection functionality. Enabling this will disable normal real-time ASCII speed output.
Note 2*:* Detection direction is controlled by two different bits. Enabling bi-directional traffic by setting bit 8 of "MD" to 1 will override the value set in "MO" bit 12.
Note 3: "All Targets' Speeds" output mode requires purchase of the target list output option or statistics.

Configuring the Radar with Houston Radar Stats Analyzer GUI:

1. Install the provided Houston Radar Advanced Stats Analyzer program on a Windows 7, Windows 8, or Windows 10 computer. 32 and 64 bit operating systems are supported.
2. Connect the radar's RS232 port to the PC's RS232 serial port. If the PC does not have a serial port, you may buy a USB serial converter dongle (from BestBuy, Radioshack, or any Internet store).
3. Power up the radar. Ensure the green LED on the front (side or back as the case may be) flashes every few seconds. Power must be provided externally unless you are using the Houston Radar powered USB dongle (part #USB-RS-P1). The Houston Radar powered USB dongle (purchased separately) provides a COM port to the PC and boosts the USB 5V to 12V for the radar.
4. Start the Houston Radar Stats Analyzer program.
5. Select the "Connect to Radar" option from the top banner.
6. Select the "Connect To Radar" button.
7. Ensure you see a "Radar found on COM" message. The COM # will depend on your computer
8. Click on OK. Now you are ready to configure the radar.

To Radar RS232 + 12VDC Power

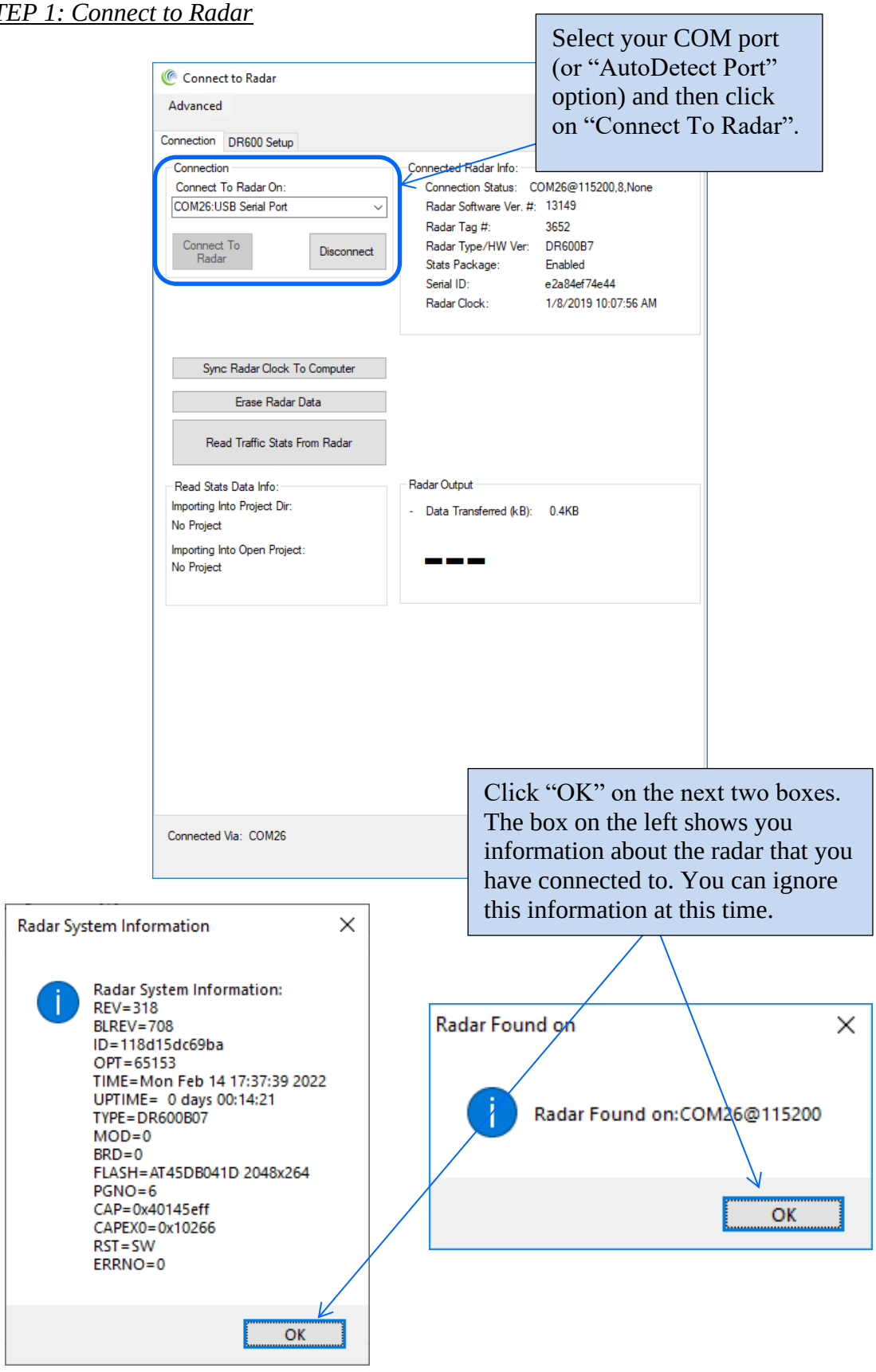


To Windows PC USB port

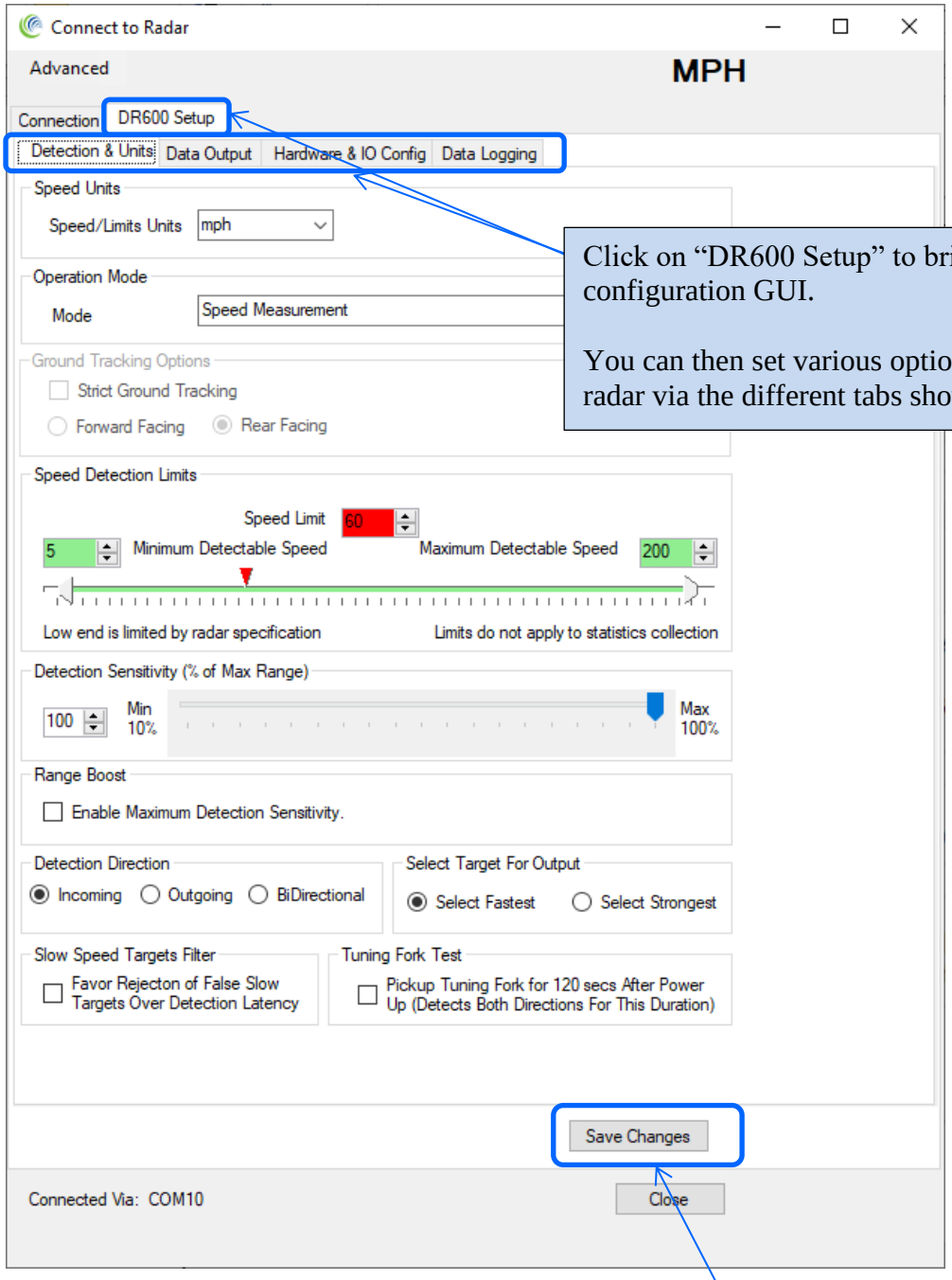
Houston Radar USB-RS-P1 USB powered RS232 interface to the radar.

For a quick and easy connection from a Windows computer to the radar, we suggest purchasing our USB-RS-P1 powered USB dongle (shown above). This device connects to a USB port on a Windows computer and provides an RS232 connection and 12VDC power to all Houston Radar devices. You can be up and taking to the radar within a few minutes of receiving your device.

STEP 1: Connect to Radar



STEP 2: DR600 Setup



Click on "DR600 Setup" to bring up the configuration GUI.

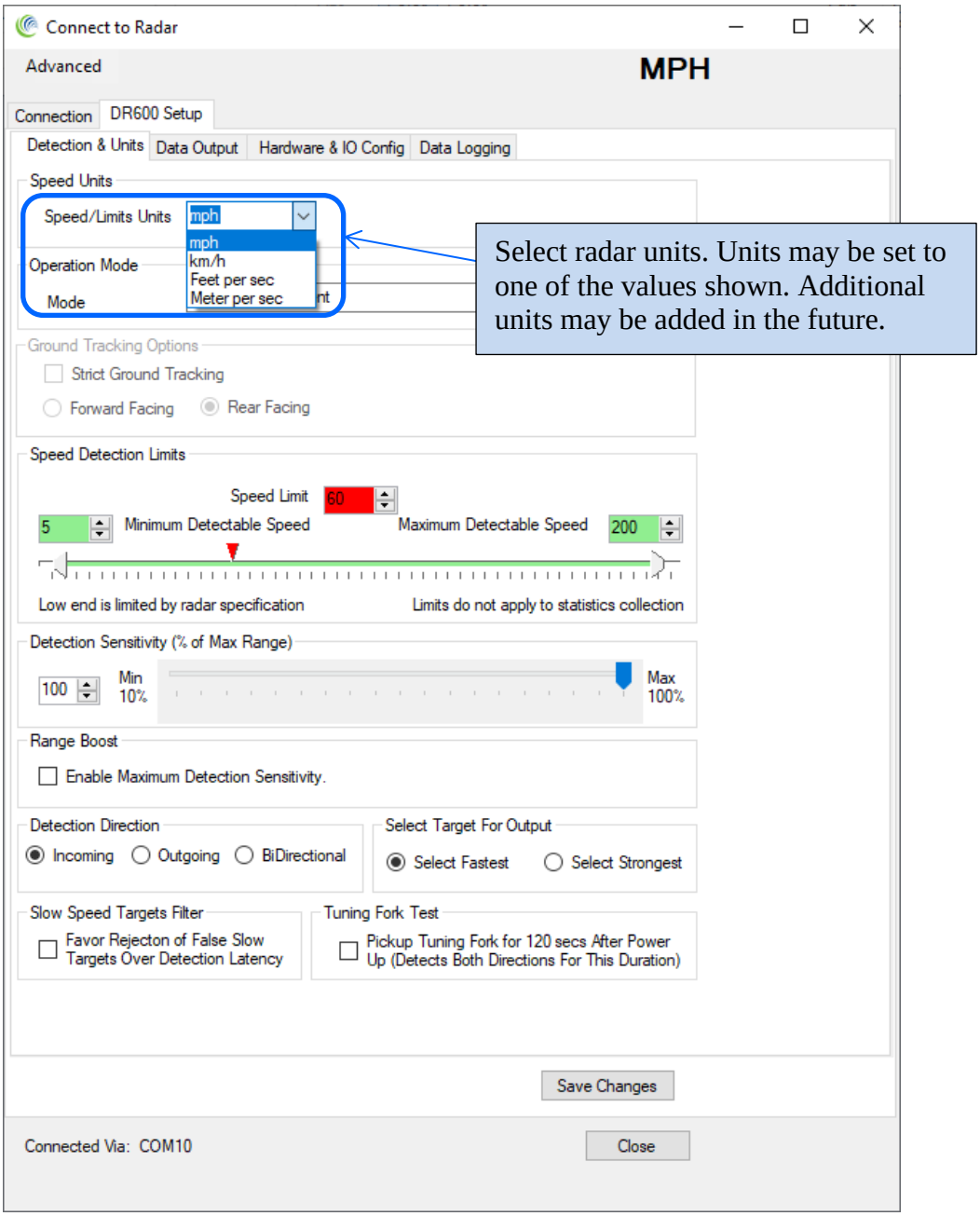
You can then set various options in the radar via the different tabs shown here.

You must click the "Save Changes" button for your changes to be saved to the radar.

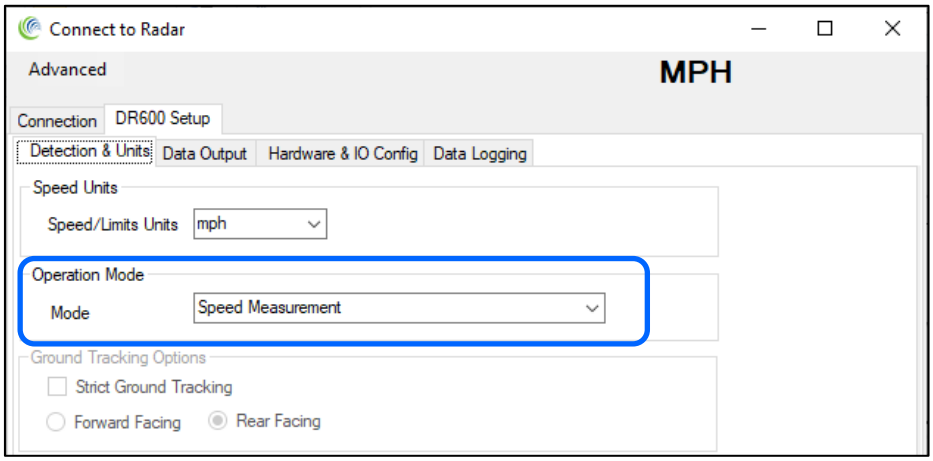
STEP 3: Select the radar units

Radar units apply to the speed output over the RS232 serial port as well the low limit cutoff and high limit cutoff settings.

Additionally, if traffic statistics gathering is enabled, statistics are saved in integer mph boundary speed bins for mph and ft/sec units and in km/h integer boundary speed bins for km/h or m/s units in the radar.



STEP 4: Setup Operating Mode Configuration:



The Radar may be set into one of the following operating modes:

1. **Speed Measurement**
   In this mode the radar operates as a Doppler radar that measures and outputs the speed of targets within its range. The radar measures the speeds of multiple targets and outputs one speed based on the user configuration of "fastest target" or "strongest target" (see later). The radar is expected to be stationary and measure the speed of moving targets.
2. **Speed Measurement with Ground Speed Tracking**
   In this mode the radar is expected to be mounted on a moving vehicle (for example in a "Your Speed" sign on the back of a truck) to measure and output the speed of moving targets within its range. However, the output speed is corrected for the speed of the radar itself. Doppler radars always measure the relative speed between itself and the target. So, if the radar is moving, a ground speed correction is required if the target speed relative to the ground needs to be measured.

   This allows for the correct speed display of approaching vehicles from the rear and displays their speeds for speed awareness.

Ground speed correction mode only operates when the radar is mounted on the rear of the truck and corrects for the speed of the truck moving forward. However, in this mounting configuration it can correct for speeds of both incoming and outgoing targets.

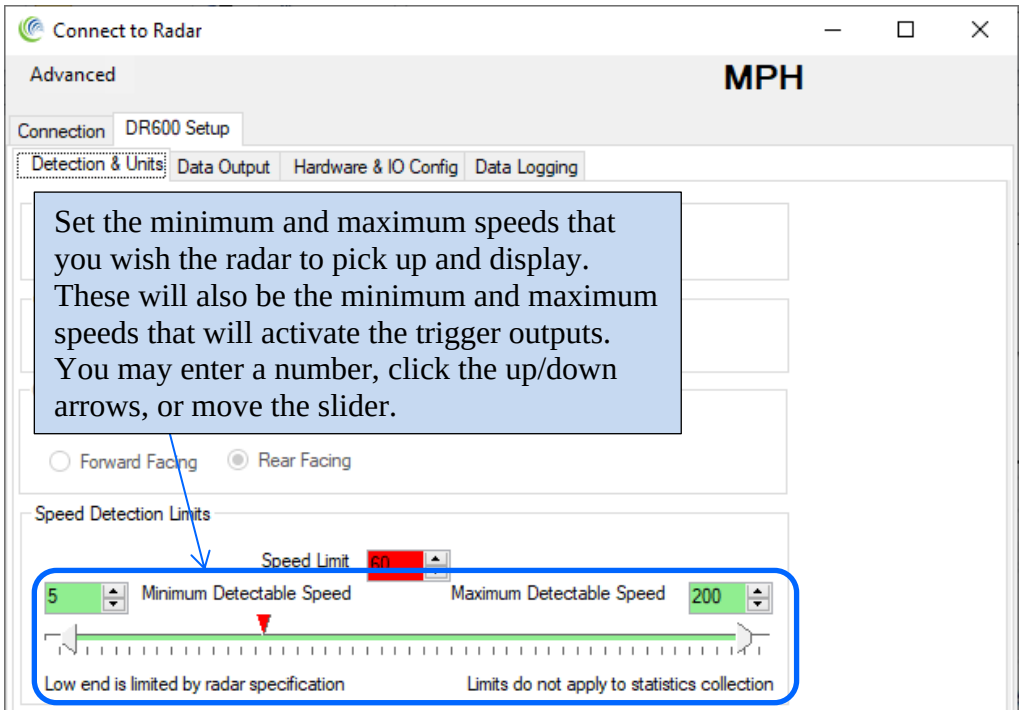
Speeds of targets that are moving exactly the same speed as the truck itself cannot be measured because there is no relative speed between the radar and the target. Doppler radars require a relative speed between the radar and the target.

3. **Demo Mode**
   In this mode the radar will simulate detection of different targets and output their speeds. This is a useful mode for demonstration purposes (especially when the radar is connected to a sign), for example at a trade show. Note that the speed limits still apply to these speeds, so selecting different limits will change what speeds are displayed and if the strobe is activated. The ambient light sensor and automatic display brightness control work as normal. This can be a useful tool to test the sign on a low traffic road or inside an office or trade show floor.

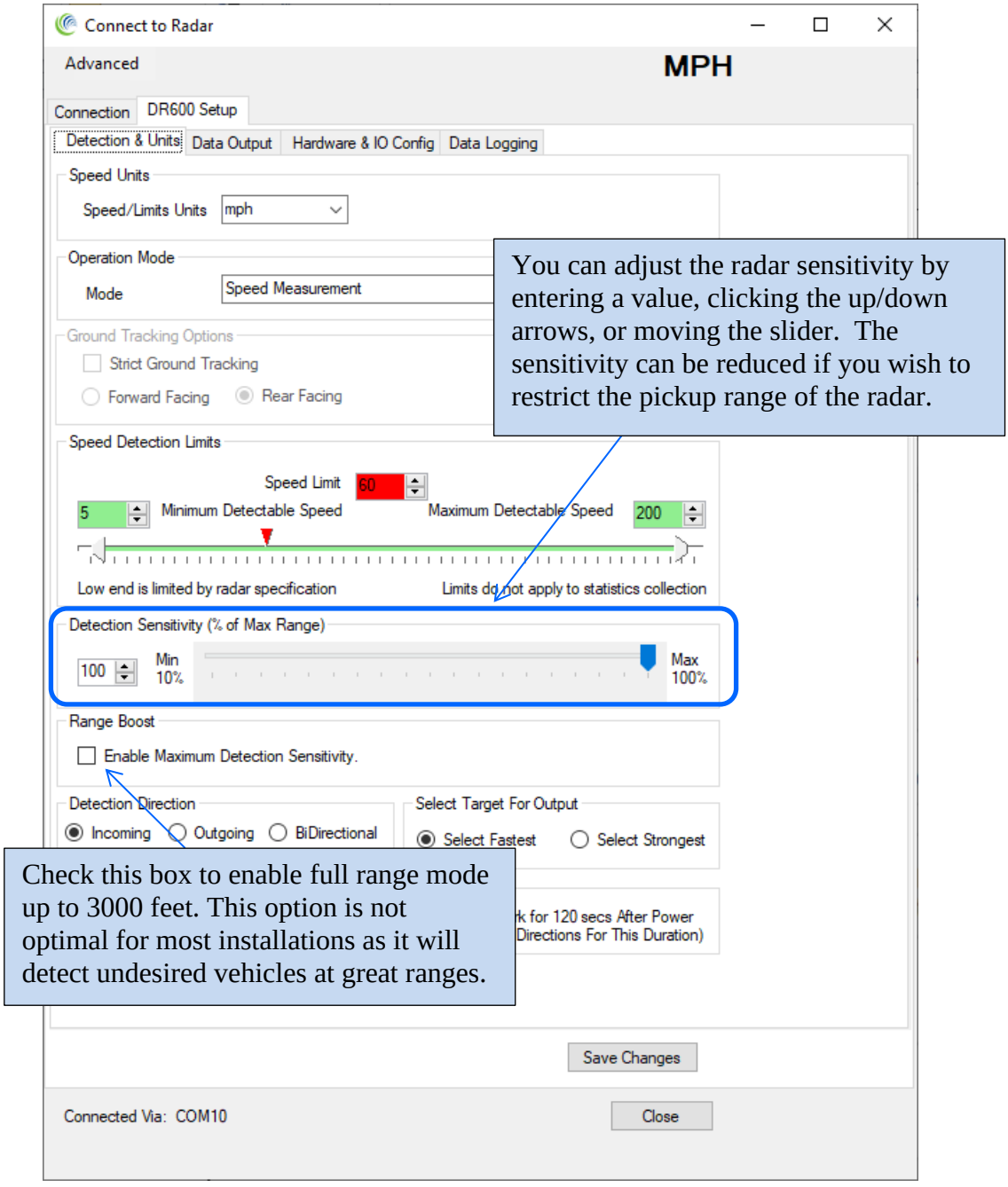
STEP 5: Set the radar cutoff speeds (low and high speed cutoff)

Cutoff speeds affect the measurement range for sending speed out over the serial port and activation of the hardware trigger outputs.

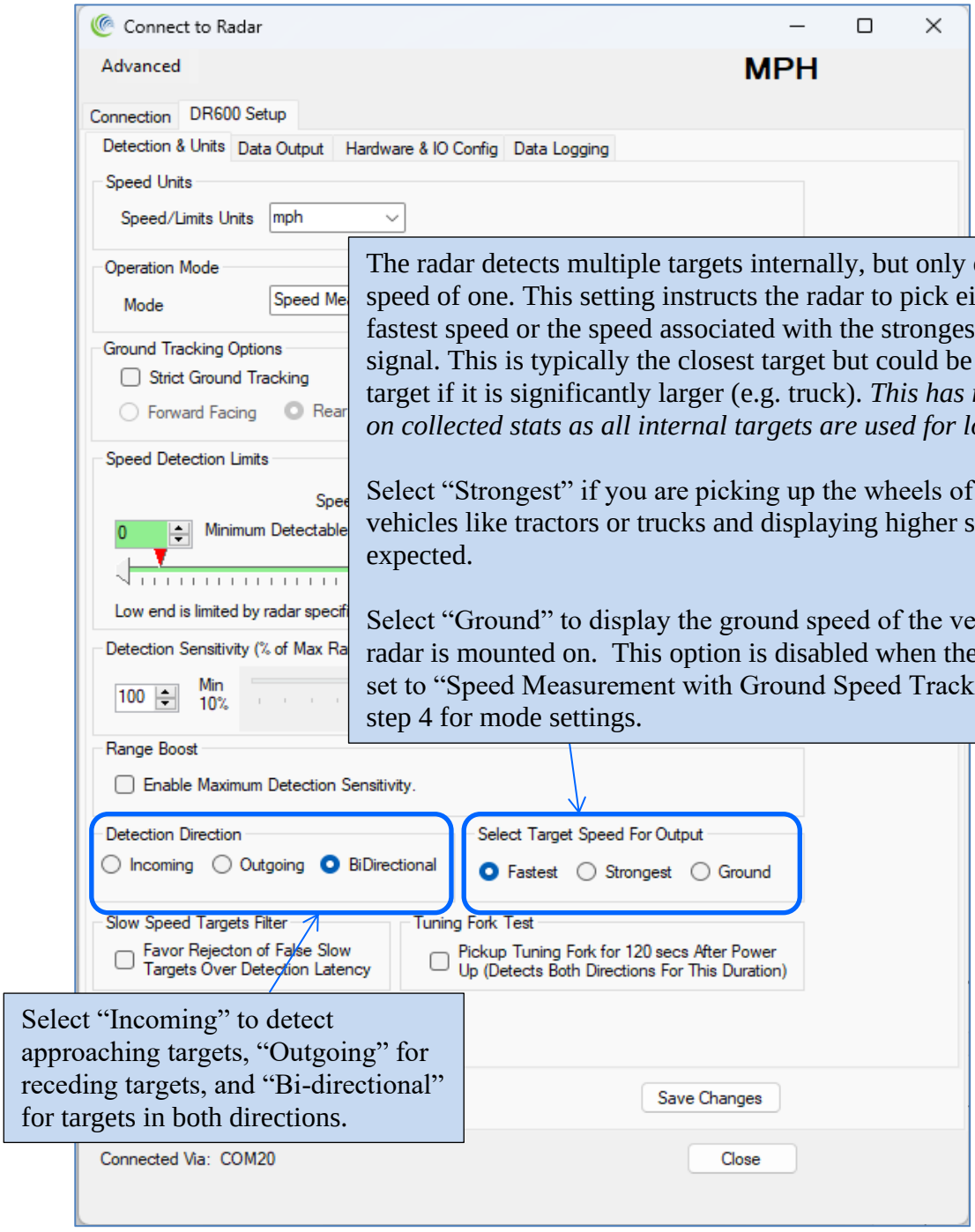
Cutoff speeds do not affect collection of traffic statistics in the radar. Traffic statistics are always collected over the entire measurement range of the radar. Thus, you can put the radar (or sign) in "stealth mode" by setting the low and high cutoff speeds to the maximum value. This will prevent the activation of the sign, but still allow the radar to collect and save traffic statistics (stats collection option purchase required. Note: The minimum and maximum speeds the radar will measure are limited by the specifications of the radar.



STEP 6: Set Detection Sensitivity



STEP 7: Set Detection Direction & Target Selector



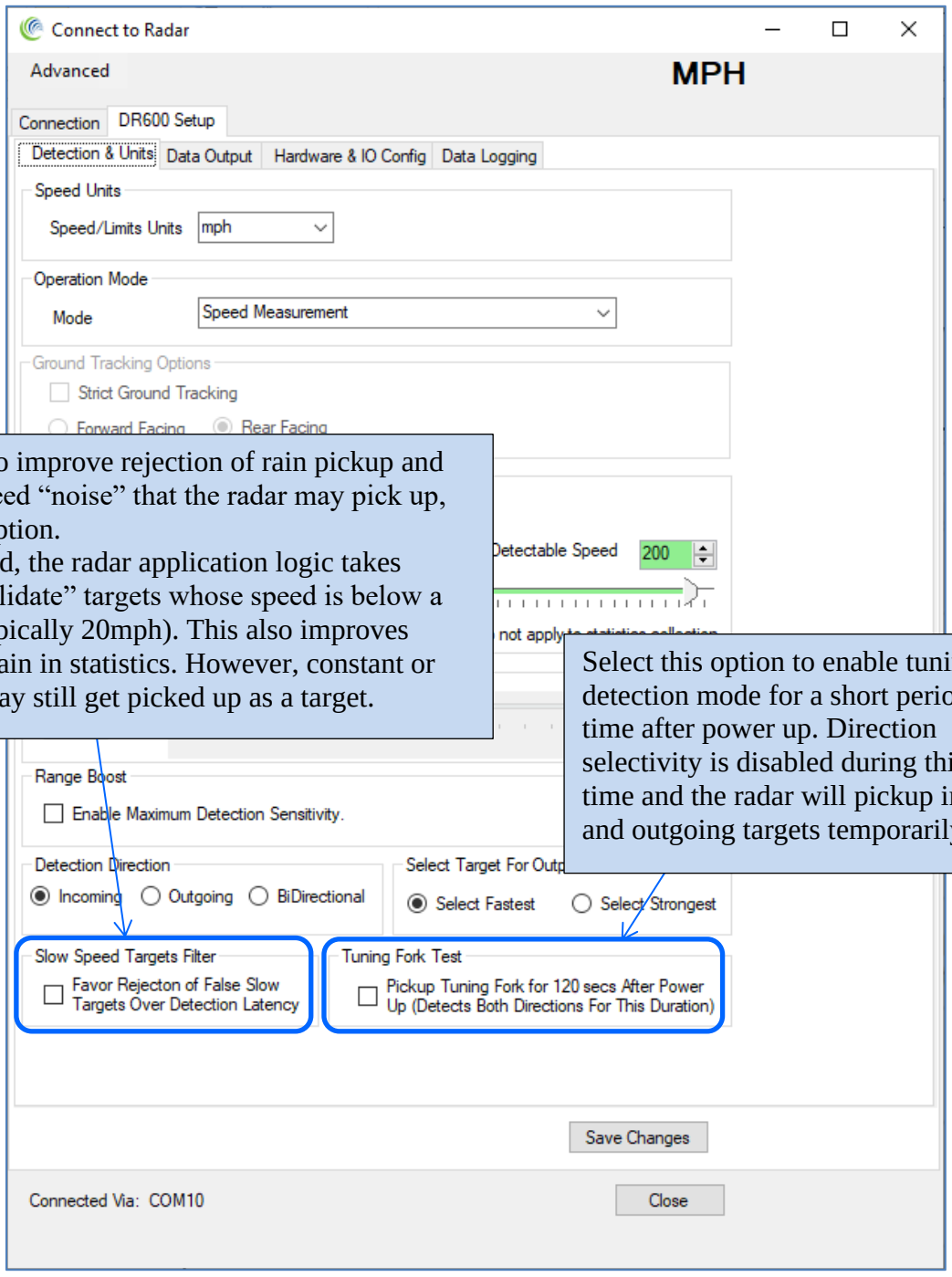
The radar detects multiple targets internally, but only outputs the speed of one. This setting instructs the radar to pick either the fastest speed or the speed associated with the strongest return signal. This is typically the closest target but could be a distant target if it is significantly larger (e.g. truck). *This has no bearing on collected stats as all internal targets are used for logging.*

Select "Strongest" if you are picking up the wheels of large vehicles like tractors or trucks and displaying higher speeds than expected.

Select "Ground" to display the ground speed of the vehicle the radar is mounted on. This option is disabled when the mode is not set to "Speed Measurement with Ground Speed Tracking". See step 4 for mode settings.

Select "Incoming" to detect approaching targets, "Outgoing" for receding targets, and "Bi-directional" for targets in both directions.

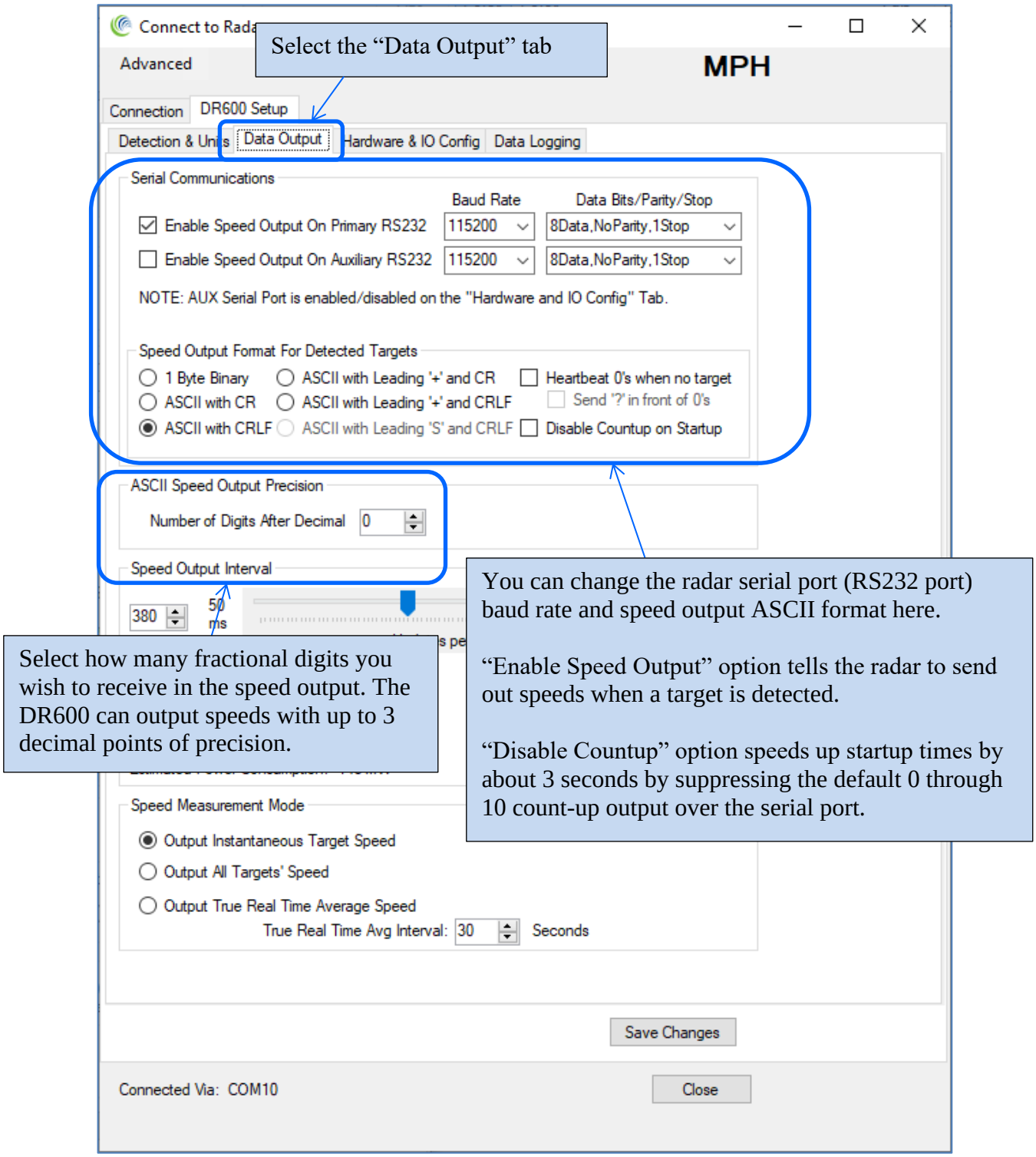
STEP 8: Set "Slow Speed Targets Filter" and "Tuning Fork Test" Modes



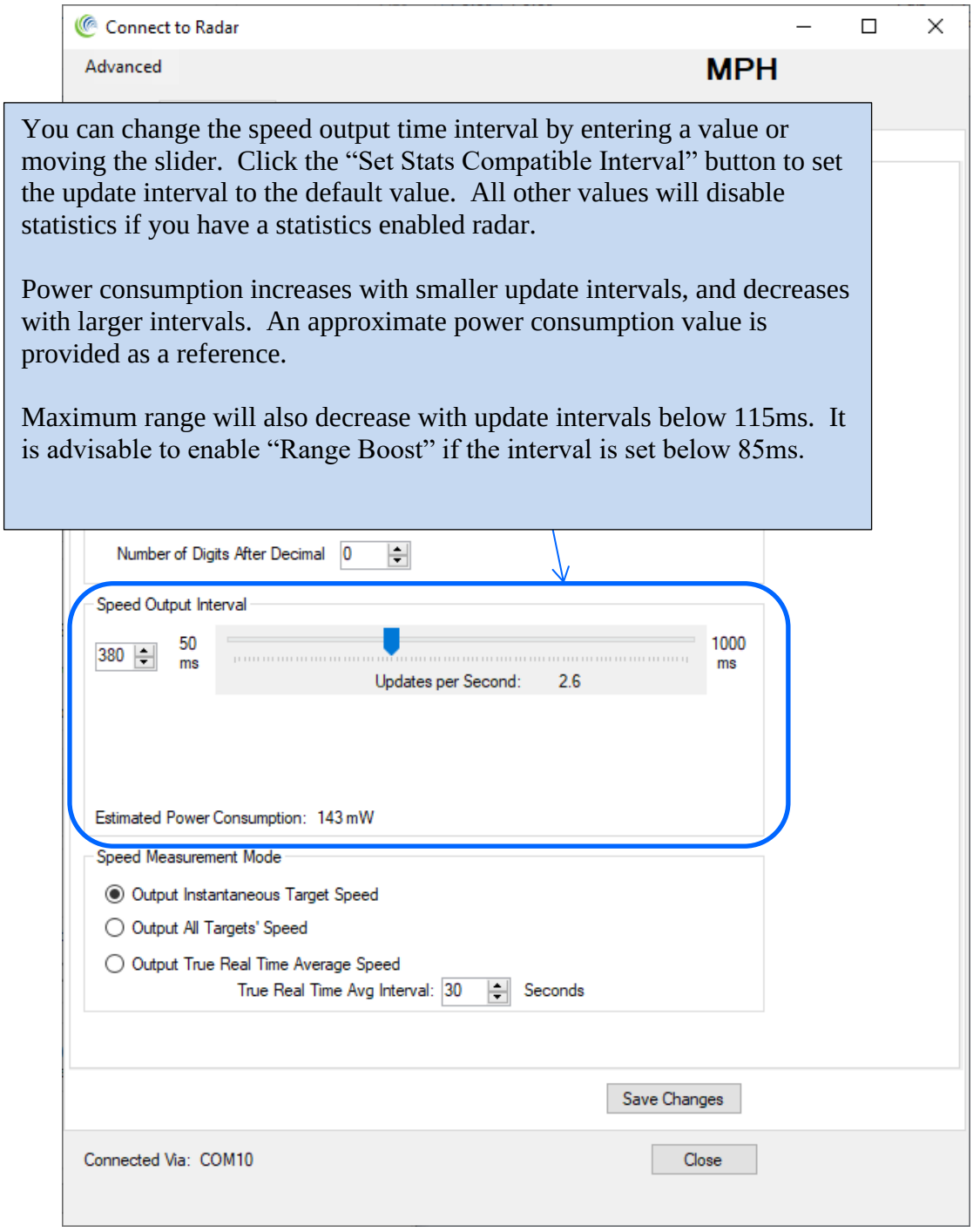
If you wish to improve rejection of rain pickup and other low speed "noise" that the radar may pick up, enable this option.
When enabled, the radar application logic takes longer to "validate" targets whose speed is below a threshold (typically 20mph). This also improves rejection of rain in statistics. However, constant or heavy rain may still get picked up as a target.

Select this option to enable tuning fork detection mode for a short period of time after power up. Direction selectivity is disabled during this startup time and the radar will pickup incoming and outgoing targets temporarily.

STEP 9: Setup Baud Rate, ASCII Format, and Output Precision

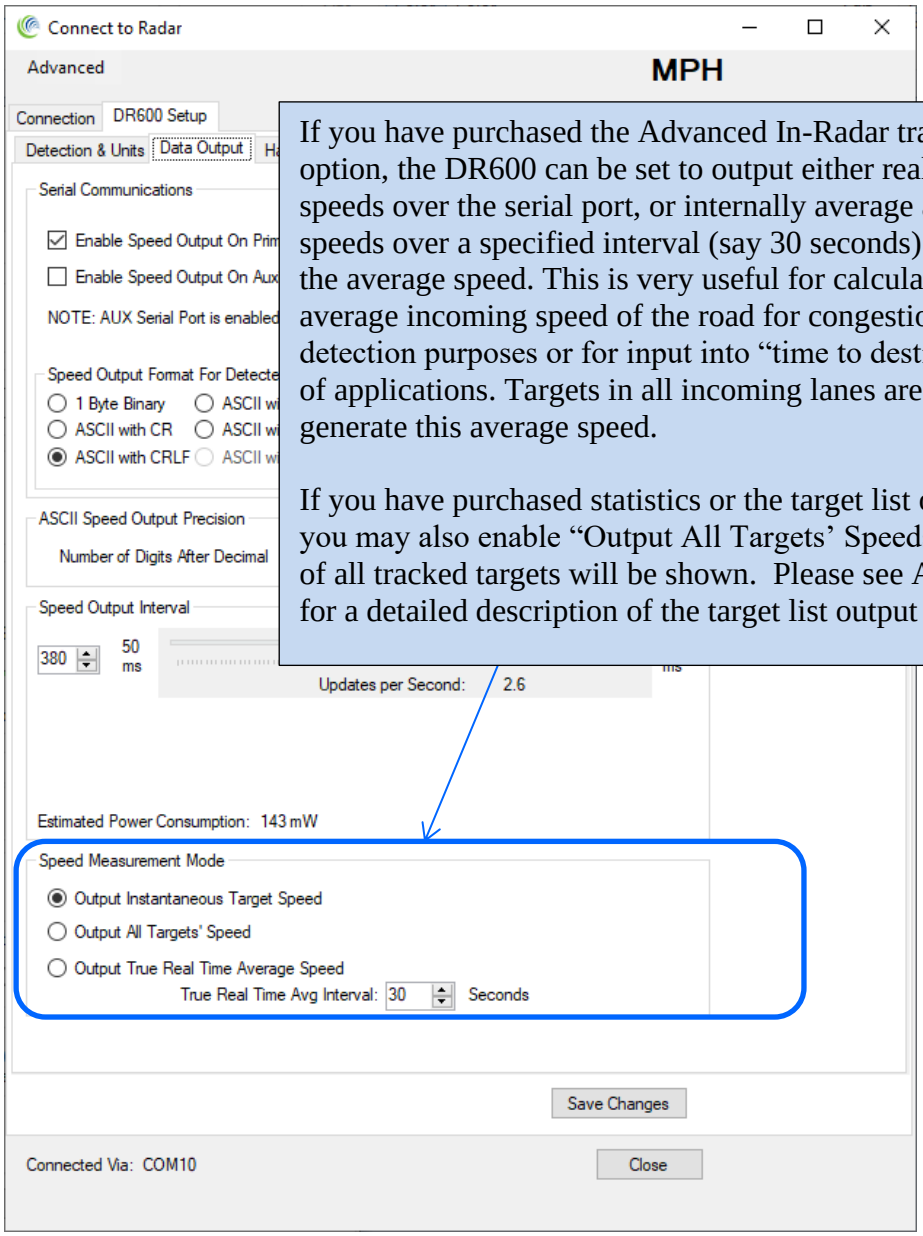


STEP 10: Select Speed Output Interval



STEP 11: Select Speed Measurement Mode

These configuration options are only available if you have purchased the 'Advanced In-Radar Traffic Statistics' option or the 'Target List Output' option in the radar. This option may be purchased and activated at any time. Contact us for more details.

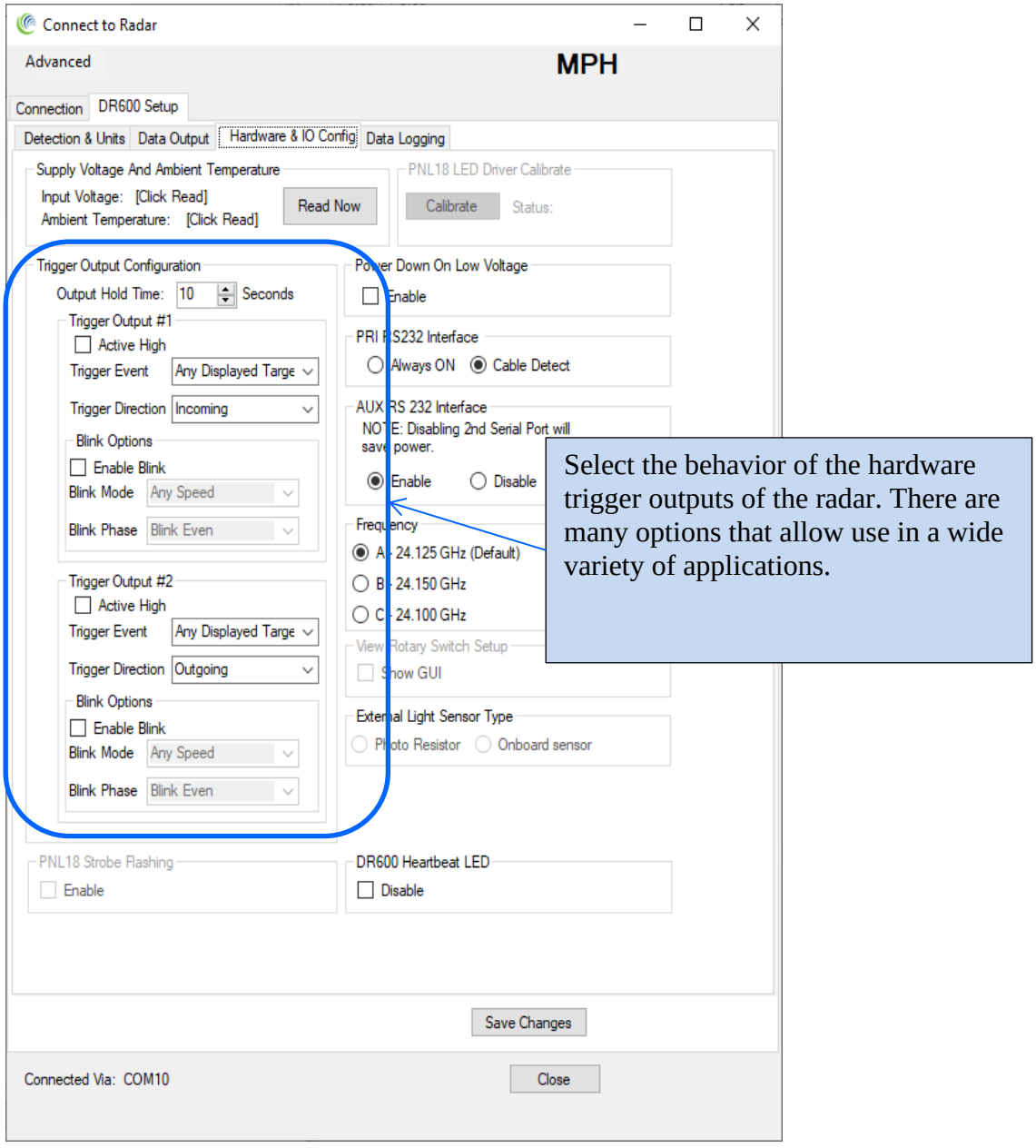


If you have purchased the Advanced In-Radar traffic statistics option, the DR600 can be set to output either real-time target speeds over the serial port, or internally average all traffic speeds over a specified interval (say 30 seconds) and output the average speed. This is very useful for calculating the average incoming speed of the road for congestion or incident detection purposes or for input into "time to destination" type of applications. Targets in all incoming lanes are used to generate this average speed.

If you have purchased statistics or the target list output option, you may also enable "Output All Targets' Speeds", and a list of all tracked targets will be shown. Please see Appendix B for a detailed description of the target list output format.

STEP 12: Configure the trigger outputs

Start by clicking on "Hardware & IO Config" Tab.



The DR600 has two hardware "open drain" trigger outputs that may be used to trigger an external device or turn on 1 or 2 LED lamps to make a stand-alone speed enabled flasher or VATCS (Vehicle Activated Traffic Calming Sign). Enable one or both the outputs and they will be activated if a speed is detected between the low and high speed cutoff values (set on the "Detection & Units" tab).

Output Hold Time: Set a value here if you want to hold or extend the trigger when it's activated. This is useful to turn ON an external device for a minimum amount of time when triggered by the radar.

Active High: When "checked", trigger output will be released. Use ~4K to 10K external pull up resistor to pull up to the desired voltage (max 30 VDC). When unchecked, trigger output will pull this external resistor down to GND (supply voltage negative/return wire).

Blink Options: Enable this option to make a flasher. The trigger output will activate when the "Trigger Event" criteria is met. Triggers can be configured to blink on alternating cycles by selecting "Blink Even" and "Blink Odd".

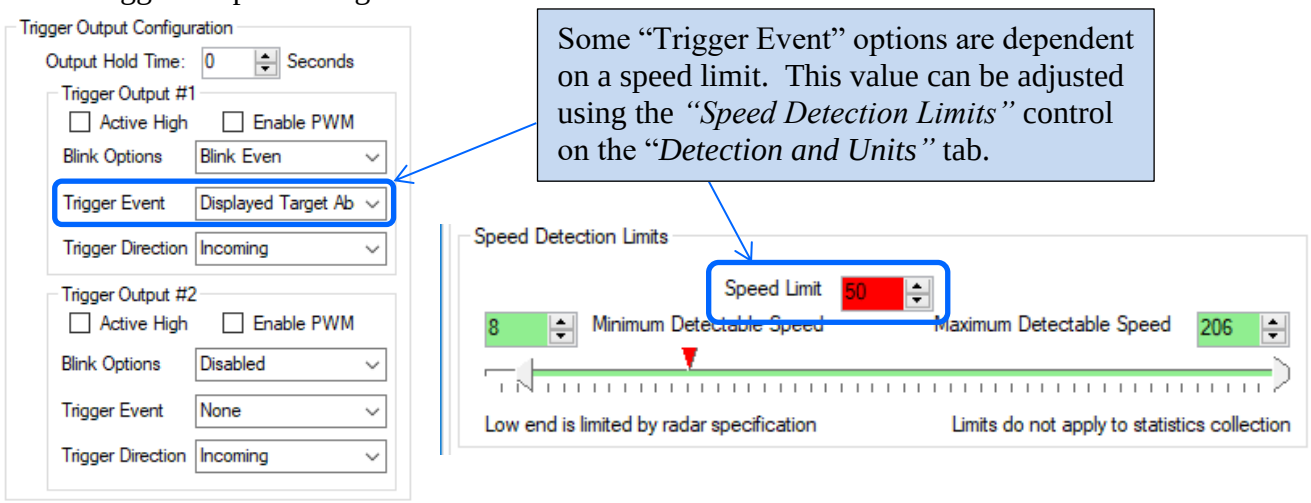
Trigger Event: Select what event triggers the output. The speed limit referenced can be adjusted on the "Detection & Units" tab.

None: Output is not triggered.
Displayed Target Above Speed Limit: Target speed is greater than "Speed Limit".
Displayed Target Below Speed Limit: Target speed is less than "Speed Limit".
Any Displayed Target: Any target detected within the cutoff speed range.

Trigger Direction: Select the target direction that will trigger the output.

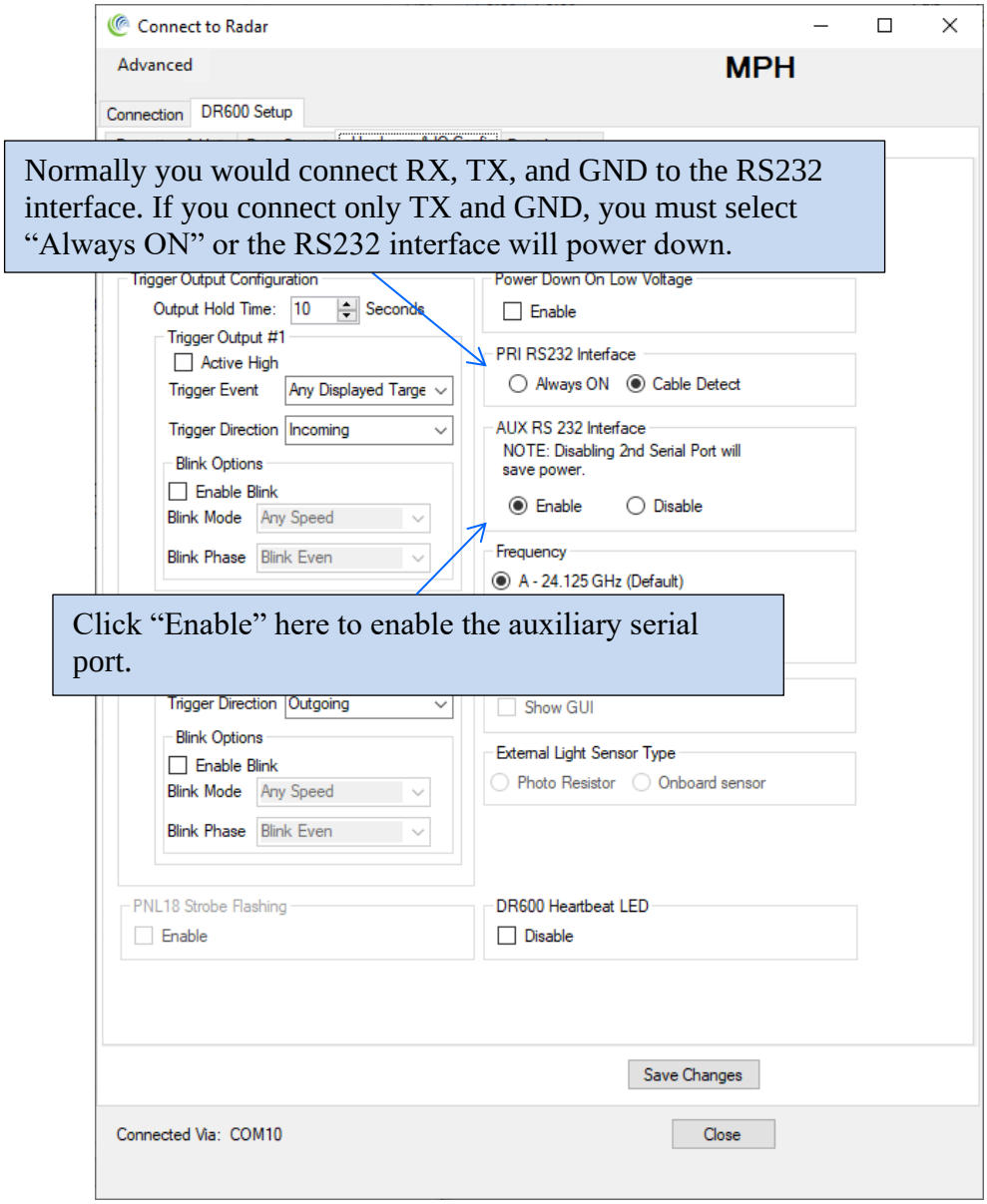
Incoming: Only incoming targets trigger this output.
Outgoing: Only outgoing targets trigger this output.
Bidirectional: Any direction targets trigger this output.

Trigger Output Configuration:

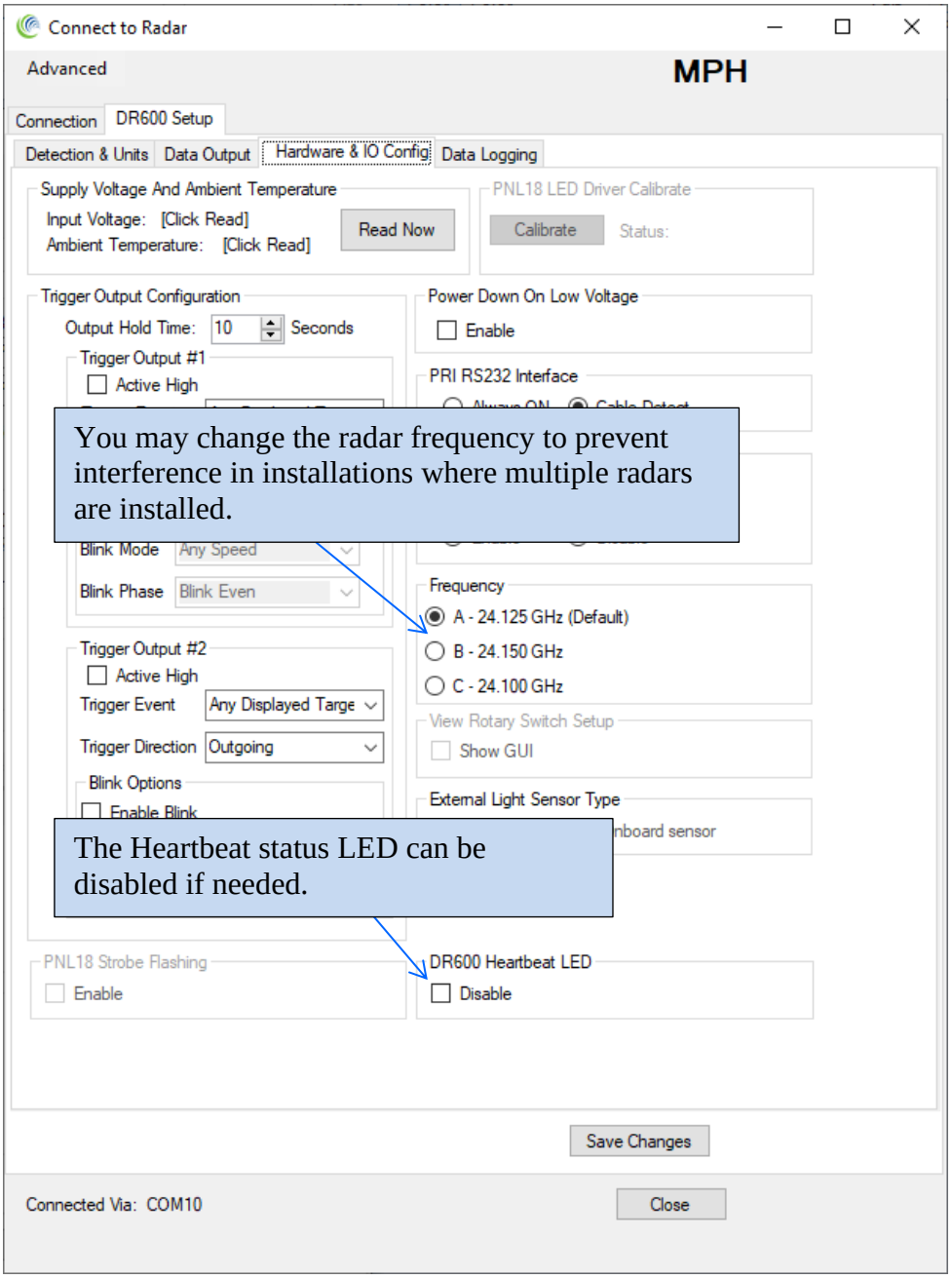


STEP 13: Select RS232 (serial data output) mode

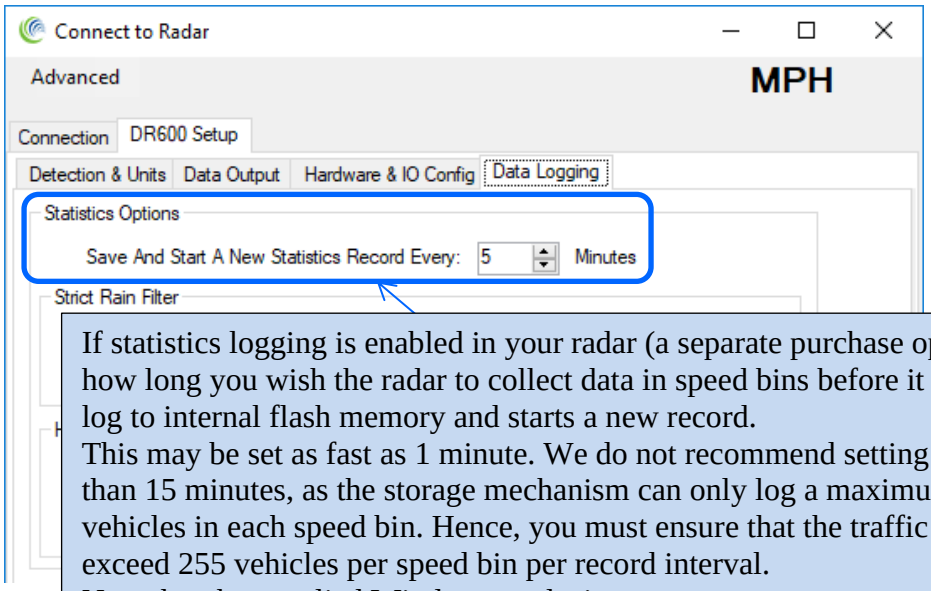
The DR600 radar turns off the internal RS232 serial driver if it does not detect any RS232 voltage level on the RX pin. It automatically powers this chip back up once you plug in a RS232 cable. This saves power when you are not connected to the device. However, if you must use the RS232 interface in TX only mode (e.g. connected only RS232 TX and GND to your microcontroller), you must configure the RS232 interface to be "always ON".



STEP 14: Frequency and Heartbeat LED

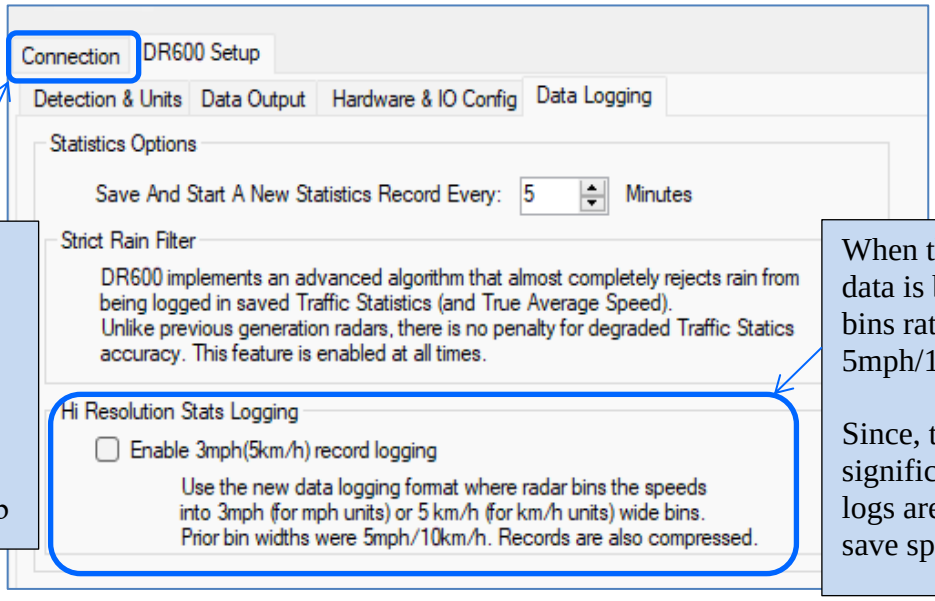


STEP 15: Optional Advanced In-Radar Traffic Statistics logging



If statistics logging is enabled in your radar (a separate purchase option), select how long you wish the radar to collect data in speed bins before it saves off the log to internal flash memory and starts a new record.
This may be set as fast as 1 minute. We do not recommend setting this higher than 15 minutes, as the storage mechanism can only log a maximum of 255 vehicles in each speed bin. Hence, you must ensure that the traffic density cannot exceed 255 vehicles per speed bin per record interval.
Note that the supplied Windows analysis program can aggregate multiple bins and generate reports in half hour or hourly intervals, but it cannot disaggregate longer bins into finer resolutions once the data has been saved in the radar. The table shows the tradeoff between logging interval and storage space.

Record Interval (min)	Number of Days Before Rollover
1	12
5	60
10	120
15	180
30	360



Stored records may be read by clicking on the "Read Traffic Stats From Radar" button location on the "Connection" tab

When this option is enabled, data is binned in 3mph/5km/h bins rather than 5mph/10km/h bins.

Since, this generates significantly more data; the logs are also compressed to save space in flash memory.

DR600 SPECIFICATIONS

General

Operating Band	K-Band
Frequency	24.125 GHz ±10Mhz (US), 24.200Ghz on request
RF Power Output	5mW
Antenna Beam Pattern	9° x 18°
Polarization	Linear
Supply Voltage	5.0V DC to 24V DC (30V Max)
Reverse Battery	Protected
Nominal Current Draw	
Default Update Rate:	8.1 mA avg. (+/-1mA) (@+12V DC)
	8.9 mA avg. (+/-1mA) (@+12V DC, RS232 connected)
1000ms Update Rate:	3.9 mA avg (+/-1mA) (@+12V DC)
50ms Update Rate:	23.5 mA avg (+/-1mA) (@+12V DC)
Operating Temp.	-22°F to +176°F (-30°C to +80°C). Electronics designed and tested to –40C.
Weatherproof	Yes (DR600-DFT build option). Open frame also available.

Approvals

Approvals	FCC Part 15 (US Version)
FCC ID	TIADR600
CE	Approved
IC	21838-DR600

Data Interfaces

Serial Communication	2x RS232
Data Rate	Baud Rates from 1200 to 115200 baud
Data & Power Connector	See Ordering Section

Mechanical

Weight	161 grams (5.7 oz.) for open frame version
	349 grams (12.3 oz.) for weatherproof version
Dimensions	3.35”x2.76”x0.71” (85x70x18mm) for open frame version
	4.13”x3.66”x1.14” (105x93x29mm) for weatherproof version

Specifications continued on next page …

Performance

Speed Measurement Range	0.6mph to 206 mph (0.97km/h to 331 km/h).
Resolution	±0.003 mph
Accuracy	±0.5% of reading + 0.1mph
Detection Range	In non-range boost mode, typically 450+ m (1500+ feet) for compact vehicles on open and level road with radar mounted 1.5 m (5 feet) high and pointed straight into oncoming traffic. 760+ m (2500+ feet) for larger trucks and vehicles with inherently large radar cross-sections. In range boost mode (or full range mode), these values increase to 790+m (2600+ feet) for compact vehicles and 940+m (3100+ feet) for large vehicles. These values will vary with installation and road conditions. Detection range specified is typical for speeds between 12km/h and 300km/h (8 to 186 mph). Range will taper off below and above this speed range.

Ordering Options

Order Code	Description	Field Connection	Mounting
DR600-OFD	Open Frame	Right side via terminal block, or left side via DB9	4x holes for up to #8-32 size screws
DR600-DFT	Encapsulated IP68	Male DB9	2x #8-32 ¼”
DR600-OFMP	Open Frame	Right side via terminal block, or left side via DB9	4x holes for up to #6-32 size screws
DR600-CMH-M12-5	Encapsulated IP68	Female 5 pin M12	2x #8-32 7/16”

Appendix A: Connecting to the radar trigger outputs

The DR600 radar features two current and voltage limited “open drain” outputs.

The two outputs OD1 and OD2 are brought out on the DB9 connector pins 7 and 8. As well as the labelled terminal block (if installed).

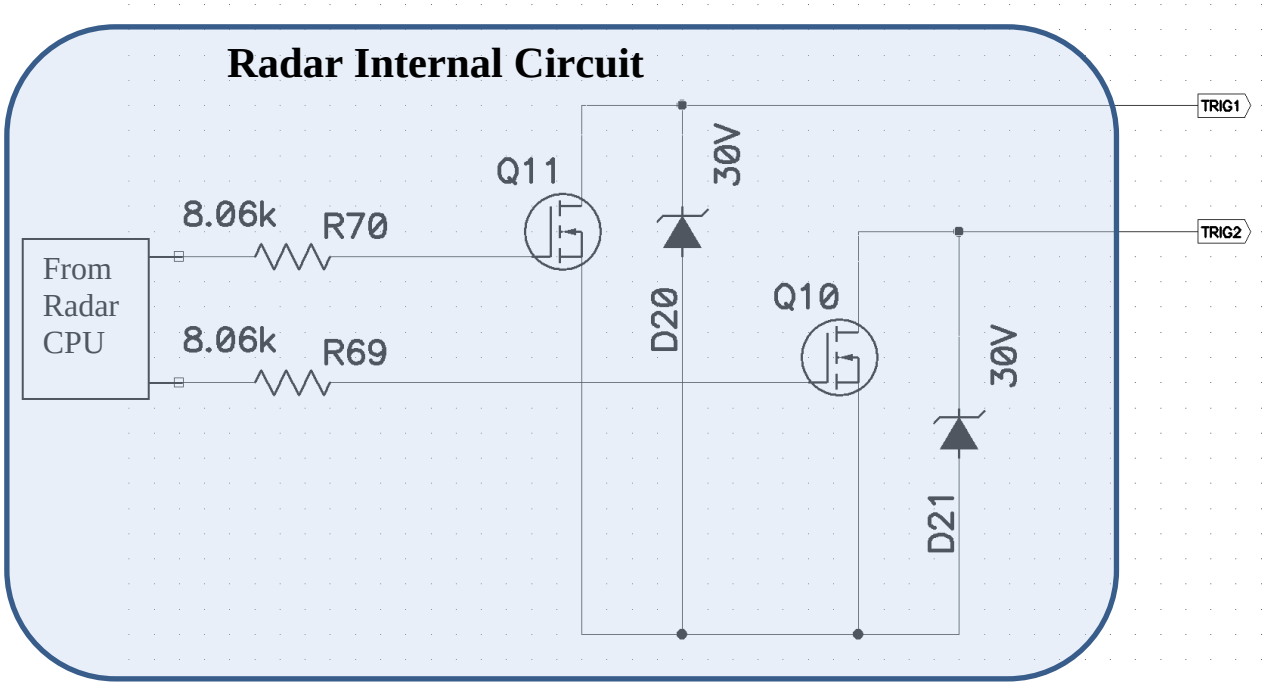
This device can sink 500mA of DC current at up to 30VDC.

These are low impedance fused outputs, which means that you must externally limit the maximum current that will flow into these outputs to no more than 500mA.

There are two ways to ensure this:

1. Connect an output device that is rated to draw no more than 500mA at your supply voltage. This device can be powered up to 30VDC. For example, this can be a 12 or 24VDC relay coil rated at less than 500 mA coil current or

2. Connect an external resistor in series with the output load and the O/P1 or O/P2 pins. The value of this external resistor should be calculated as follows (ohms law): R (in K Ohms) = (Vsupply – Vloaddrop) / 500



Appendix B: All Targets' Speeds Output

Standard Houston Radar products implement complete multi-target tracking algorithm to facilitate deployment into vehicle detection, tracking, and speed measurement applications. However, for most "Your Speed Is" speed feedback applications, only one speed needs to be reported. The user can select which speed is output on the serial port by selecting either the fastest of all speeds being tracked or the speed associated with the strongest return signal. This is select via the SF variable (or the GUI). However, there are other applications that may require the speed output for all the tracked targets. To facilitate this, the radar provides an option to output the speeds of all tracked targets in incoming, outgoing, or both directions.

Only DR600 firmware versions 318 or later support this feature. This feature depends on the internal "Advanced In-Radar Traffic Feature" and thus the optional statistics activation is required for this feature to function. This feature may also be purchased separately without a full statistics activation license. Please contact Houston Radar for more information on this option.

Target List Output Format:
Once multi-target output format is enabled, you will see output in the following format (units are configured to be mph in this example):

tgl 13:012,18:020 *(in this example two incoming targets are being tracked, the first has our internal id 13 at a speed of 12 mph and the other has our internal id 18 at 20 mph.*
tgl 15:-021,16:-040 *(Outgoing speeds shown in Bi-Directional mode) (in this example, two targets are being tracked in the outgoing direction as well, one at 21mph and another at 40mph).*
?:0 *(no targets are present and "heartbeat 0's turned on in the output format).*

Configurable Format Description:
tgl id:[-]nnn[.ddd][,…] [,…] [,…] [,…] [,…] [\r][\n]
Where:
tgl: ASCII string descriptor indicating a targetlist string is being printed.
id: ASCII target ID number from 0-255 used to identify targets between updates.
The DR600 can simultaneously track up to 6 targets per direction.
If no target is present and the "Heartbeat 0's when no target" option is enabled, an ASCII question mark prefix (?) will be used in place of an ID number. id's will in most cases rollover and repeat for new targets.
The same id in consecutive update implies that the radar is tracking the same target. Once the id is missing even for one update, it means the radar has stopped tracking this target and the id will be reused for future targets. Note: While in most cases, id's correspond to actual targets on the road, there are situations where this is not true and the same target on the road may generate different id's. This may happen for example if the target is obscured and is dropped and then picked up again.

It's also possible that two vehicles while being tracked at different speeds when originally picked up may change speeds to the same value. In this case the radar's tracking algorithm will merge the targets internally and one of the targets will be dropped in the output.

Finally, it's also possible that the target is dropped in the output but is still being tracked internally. In this case, the same id will be used if the algorithm decides to output it again (this may happen for temporarily obscured targets).

The internal tracking algorithm is complex and not all situations can be described here. Additional, we may make changes to the internal algorithm in future firmware versions or radar models to improve it. It is recommended that you do NOT place too much emphasis on the actual id value in the output.

[-]: ASCII Prefix to the speed value is used to identify outgoing vehicle speeds when detection direction mode is set to "BiDirectional".

nnn: Three digit ASCII speed in the units selected via the UN variable.

[.ddd]: Programmable number of digits (0-3) after decimal point.

[,…]: This pattern will be repeated based on the number of targets being tracked in a direction.

[\r]: Carriage Return character, optional line ending.

[\n]: Line Feed character, optional line ending.

At least one or both of the line endings must be selected with ASCII format. No line ending is not an option. Please see serial port configuration section for details on how to select the above format.