SS400

User Manual and Installation Guide

K-Band Ultra Low Power Doppler Speed Radar
Built Type: SS400-DFT, SS400-OFD, SS400-JBX, SS400-HRD, SS400-MBD
Rev 5, 15th July 2021

SS400 in Weatherproof Enclosure (SS400-DFT)

SS400 Open Frame Version (SS400-OFD)

SS400 IP67 Junction Box Version (SS400-JBX)

SS400 IP67 Mounting Boss Version SS400-HRD, SS400-MBD
(Shown with optional mounting bracket)

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

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

Any modification or use other than specified in this manual will strictly void the certification to operate the device.

This product is compliant with ETS EN 301 489-1, 47 CFR Part 15, and Industry Canada ICES-003 standards. Contains FCC ID: UXS-IPS154US

In order to comply with FCC/ISED/MIC RF Exposure requirements, this device must be installed to provide at least 20 cm separation from the human body at all times.

Warning: SS400-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.

Table Of Contents

INTRODUCTION

Congratulations on your purchase of the Houston Radar directional Doppler Speed Sensor SS400. 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 4.5 mA at 12VDC (0.054 Watt)
- ✓ 0.6mph (1km/h) to 200+mph (322 km/h) of speed measurement range
- ✓ Ground speed measurement and target speed correction mode for mounting on moving vehicle
- ✓ Unprecedented small size to allow incorporation into virtually any location
- ✓ Advanced CFAR DSP based algorithm yields consistent performance and speed detection
- ✓ Typically 90+ m (300+ feet) of pickup distance for incoming vehicles on open and level road. Trucks picked up at 450+ feet (137+ m)
- ✓ One RS232 and two 'open collector' vehicle detection trigger outputs
- ✓ Radar internal software is upgradeable in the field via RS232 PC interface
- ✓ Optional rotary/thumbwheel switch input allows changes to speed threshold
- ✓ Optional ambient light sensor input and PWM dimming control
- ✓ 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
- ✓ Advanced algorithm almost completely rejects rain from traffic statistics
- ✓ Android App to collect data when coupled with Houston Radar Bluetooth module
- ✓ Pin, form-factor and interface compatible with our previous generation SS300 radar
- ✓ Wide variety of mounting and enclosure options

INSTALLATION

Mounting:

SS400-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 SS400-OFD should be mounted such that the connector points left or right as shown in the picture on the front page.

The SS400-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 SS400-DFT should be mounted such that the text “Houston Radar” on the face of the unit is horizontal.

The unit *may* be rotated 90 degrees from the suggested optimal mounting. However, in this case, the detection range may be reduced by about 25%.

Direction Pointing:

The SS400 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 bits in the MO and MD variables in the radar 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” earlier
- ✓ 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 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 high from the road for optimal performance and at least 6 feet off the ground for maximum pickup distance

Recommended Enclosure for the SS400-OFD:

The SS400-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 (with the golden pads) is the antenna and is the face that must point into traffic.
2. Any cover or window in front of the unit MUST be at least ¼” (6.4mm) 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 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 weatherproof version SS400-DFT that is available from Houston Radar.

Hookup:

Power Input:

The SS400 radar features a wide operating input voltage range of 6.2V-18V. In a typical application it may be powered from a nominal 12V DC source and will feature best in class operational power consumption of 4.5mA (average).

This ultra low operational power translates directly into a longer battery life or gives you an option to power the unit from smaller batteries and smaller 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 autoranging during measurements. Otherwise you will get current readings that fluctuate from 4 mA to 18 mA.

Your power supply to the radar must be capable of supplying up to 40mA 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 SS400 features an RS232 interface that is used to output speed, access statistics data, and configure the unit as explained later in this document.
The RS232 interface is factory set to default 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 may be forced ON via a bit in the "MD" variable.

Measured Speed Output:

The SS400 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 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 set a config variable to a supplied value)
reset (resets the radar. Required after changing variables MO, MD and RS, RA(for DR series radars only). LO, HI, SP, ST, SF, UN do not require a reset).
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.
e.g.
To set a variable (variables are documented in the user manual):
set: <case sensitive var name> <value>[Enter]
e.g.
set:LO 5
alt format:
set:LO=5
sets the low speed cutoff to 5 etc.

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 things like enters or other ASCII chars do not generate "ERROR" when you are not expecting them.

To get a variable:
get:<case sensitive var 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 (Molex Connector Options):

Molex Connector Pin #	Signal Name	Direction (wrt Radar)	Description
1	GND	PWR	Radar GND (battery "–" terminal)
2	N/C	N/C	Do not connect
3	I/O0	I/O	Reserved for future use
4	I/O1	I/O	Reserved for future use
5	I/O2	I/O	Reserved for future use
6	I/O3	I/O	Reserved for future use
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	RS232 TX	Output	RS232 Transmit Signal from radar
10	RS232 RX	Input	RS232 Receive Signal into radar
11	VIN	PWR	+6.2 to +18VDC VCC Power Supply
12	GND	PWR	Radar GND (battery "-" terminal)

Wire Signal Descriptions (DB9 Connector Options):

DB9 Pin #	Signal Name	Direction (wrt Radar)	Description
1	VIN	PWR	+6.2 to +18VDC VCC Power Supply
2	TX1	Output	RS232 Transmit Signal from radar
3	RX1	Input	RS232 Receive Signal into radar
4	N/C	N/C	Do not connect
5	GND	PWR	Radar GND (battery "-" terminal)
6	N/C	N/C	Do not connect
7	Trig O/P 1	Output	"Open Drain Output 1". See Note 1.
8	N/C	N/C	Do not connect
9	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 SS400 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. However, if you need different functionality please contact us.

When a vehicle is detected and the speed is above the "LO" speed limit and below the "HI" speed limit, both these 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. This logic may be inverted via a bit in the IO variable. See later section.

These are "open drain" (AKA open collector) outputs capable of sinking 130 mA each. You must limit the current externally to ensure that no more than 130 mA goes into each pin when they turn on. They may be connected in parallel to double the sink capacity to 260 mA.

The device providing this functionality on the radar board is the ON-Semi "NUD3124" relay driver. Please refer to the datasheet for this device on detailed operating characteristics for these trigger outputs.

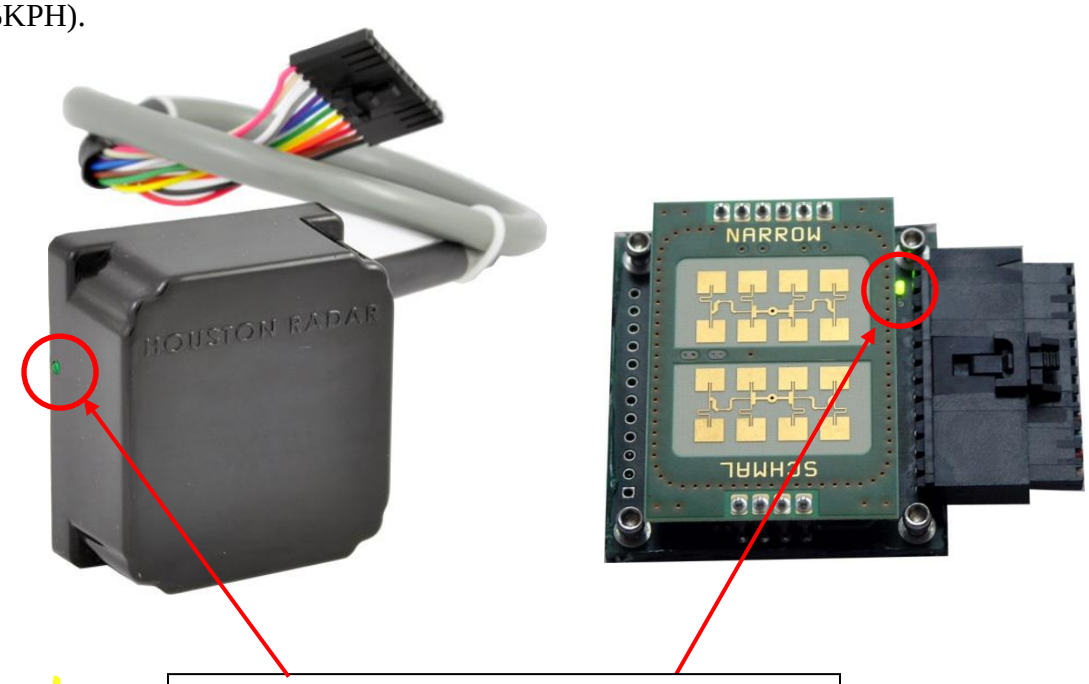
USE

Turn on the power to the SS400 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 default limits are set at 5 and 150 at the factory. The units (e.g. kph, 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 an incoming vehicle is tracked.

Connect radar to PC RS232 serial port and use provided Windows configuration software to program the high speed limit (“HI” variable). The radar de-asserts the trigger outputs above this limit. If you do not wish an upper detection limit, set this value to 250. This will ensure that the upper limit is never reached regardless if the units are set to MPH or KPH.

Set the “LO” variable to set the lower detection speed limit. The outputs will be de-asserted for vehicles below this speed limit. The lowest value this may be set is 3 MPH (5KPH).



Green LED flashes when radar is running giving a visual OK signal. In the SS400-OFD version green LED may be installed on the back depending on the requested build option.

Trigger Output #1 Visual Indicator:

If you need visual feedback when the radar is activating the trigger out #1, you may purchase it with a front visible LED indicator. See ordering section for more details.

Outdoor visible Amber LED indicates when radar has triggered Output #1. This indicator may be disabled by removing a jumper on the carrier PCB inside the box.

SS400 shown with optional trigger output visual indicator and mounting bracket.

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.

Unlike the previous generation SS300 radar, the SS400 radar features a built in clock backup battery that will keep the clock time in the case of power failure for up to 4 years. This backup time is extended when the radar is powered via VCC as the clock battery is not depleted in this case.

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, for example 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 and then downloading the radar configuration and examining the variable names and their values via a text editor.

Configuration Variable Name	Description
RS	Sets the 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 this units. 0 = MPH 2=FPS (Feet per second) 1 = KPH 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. Minimum value is 2. Should be set to be less than HI. Speeds above this limit trigger the O/P1 and O/P2 outputs and sends ASCII speeds. Note: If the Rotary switch is enabled (See MO bitmask), then the actual Cutoff speed = (LO + Rotary Switch Setting * SI)
HI	High speed cutoff. Vehicles are not detected above this speed. Maximum value is 220. Should be set higher than LO speed.
SP	Flashing speed limit. Any speed higher than this value "flashes" the trigger 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	1 = Select Fastest Target if multiple targets are detected on the road 0 = Select Strongest Target if multiple targets are detected on the road
ST	Target detection sensitivity. Valid values are from 10 to 99 and are a percentage of max range. So a value of 50 would yield about 150 feet detection. *Note: This is not a range setting but detection sensitivity. Thus if large vehicles are being detected at 400 feet, a value of 50 will reduce detection range for them to approximately 200 feet*.
MO	Radar mode bitmask. Bits are as follows: **Bit 0**: SI3 ASCII command compat flag. Contact us for more details. **Bit 1**: Enable ASCII console output on RS232 serial port **Bit 2 to 6**: Reserved in SS400 radar **Bit 7**: Enable Rotary Switch on SS400 Break out IO board. **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" (<16mph/26km/h) (*see note 1)* **Bit 11***:* Light sensor type. 0 = LDR, 1 = IC (see Light Sensor section) **Bit 12**: Detection direction. 0 = only incoming, 1 = only outgoing. **Bit 13**: Gang the effective LO/SP/HI speeds to external Rotary switch. Contact us for details if you wish to change the above speed limits in the field by turning a rotary switch rather than connecting a PC.

Radar Configuration Variables Continued:

Configuration Variable Name	Description
MD	Radar mode bitmask number 2. Bits are as follows: **Bit 0**: Enable low voltage power down. (*see note 4*). **Bit 1**: Enable True Average Speed output (*see note 2*) **Bit 2**: Force enable the RS232 interface when set. Sets to "cable detect" mode when bit is cleared. Power usage is increased by 0.012Watts 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 (*see note 3*) **Bit 8:** Enable bi-directional traffic mode **Bit 9:** Enable auxiliary serial port **Bit 11:** Display magnitude with individual target speed **Bit 12:** Enable echo ASCII mode **Bit 13:** Enable strict ground speed detection in ground speed modes
SI	Speed Increment of the rotary switch on the optional break out board. Effective low speed cutoff in radar = (LO + Rotary Switch Setting * SI)
HT	Output Hold Time in seconds. Once the output is triggered, it is held for this amount of seconds from the last trigger source before going inactive. Note: Only the digital output is held. The ASCII speed output is not held. The ASCII speed output goes to 000 as soon as target is no longer tracked.
IO	Radar IO configuration bitmask. Bits are as follows: **Bit 0:** IO 1 PWM Enable for brightness control. Radars reads the ambient light sensor connected to the IO Break out board and adjusts load brightness via PWM. Full darkness= 5% duty cycle. Full brightness = 100% PWM. PWM Frequency is 180Hz. **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 **Bit 8:** IO 2 PWM Enable for brightness control. Radars reads the ambient light sensor connected to the IO Break out board and adjusts load brightness via PWM. Full darkness= 5% duty cycle. Full brightness = 100% PWM. PWM Frequency is 180Hz. **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 11 to 15:** Reserved

Radar Configuration Variables Continued:

Configuration Variable Name	Description
TR	Radar triggers configuration bitmask. Bits are as follows: **Bit 0 to 5:** IO 1 Mode options 0: Inactive 1: Trigger for target detected above SP 2: Trigger for target detected below SP 3: Trigger for any detected target 4 to 63: Reserved **Bit 6 to 7:** IO 1 Direction options 0: Incoming 1: Outgoing 2: Bi-directional **Bit 8 to 13:** IO 1 Mode options 0: Inactive 1: Trigger for target detected above SP 2: Trigger for target detected below SP 3: Trigger for any detected target 4 to 63: Reserved **Bit 14 to 15:** IO 1 Direction options 0: Incoming 1: Outgoing 2: Bi-directional

Configuration Variable Notes:

***Note 1**: "Extra filtering for slow targets" requires firmware version 124 or higher*

***Note 2**: "True Average Speed" output requires the optional Advanced In Radar traffic statistics collection functionality.*

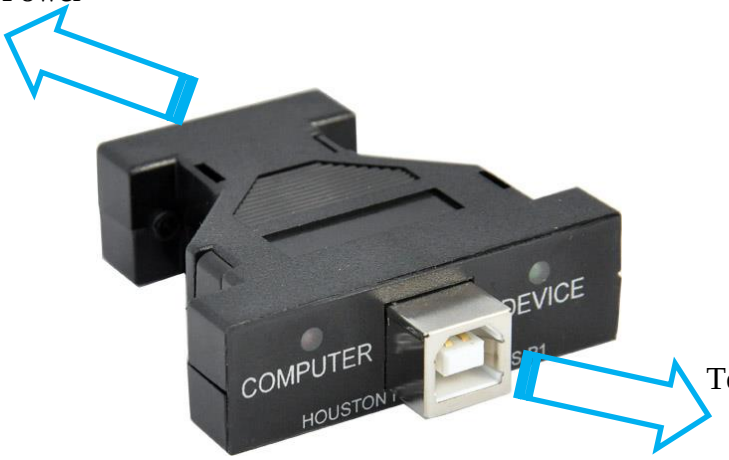
Note 3: *"3mph/5kph "high res" traffic stats requires traffic stats to be enabled in the radar and firmware version 138 or higher*

Note 4: *This bit is set by default from the factory. When set, the radar will prepare to shut down when input supply voltage drops below approx. 6.2VDC. This allows the radar to flush any unsaved statistics (if option is purchased and enabled) to flash. We recommend that you do not clear this bit. When cleared the radar will continue to operate to just below ~5VDC. The only reason to clear this bit would be if you wish to operate the radar from 5VDC and are NOT using statistics.*

Configuring the Radar via the provided Houston Radar Configuration Tool GUI:

1. Install the provided Houston Radar Advanced Stats Analyzer (or Houston Radar Configuration) Windows program on a Windows 2000, XP, Vista, Windows 7 or Windows 8 computer. 32 and 64 bit computers are supported.
2. Connect the radar 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 have purchased and are using the Houston Radar powered USB dongle (part #USB-RS-P1) which provides a COM port to the PC and boosts the USB 5V to 12V for the radar all in a single device.
4. Start the Houston Radar Stats Configuration tool program
5. Click on Start->Connect to Radar…
6. Click on "Connect" 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

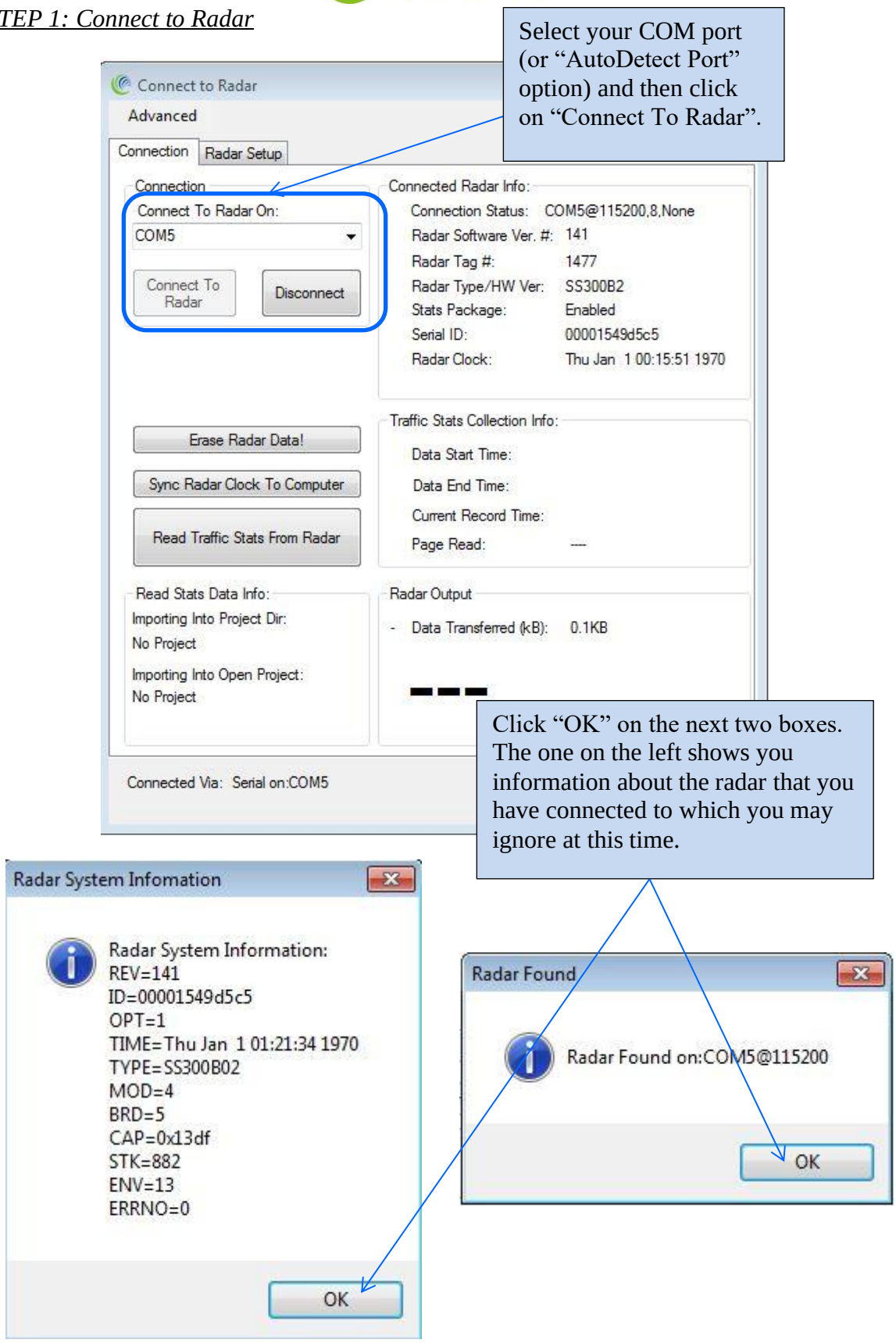


To Windows PC USB port

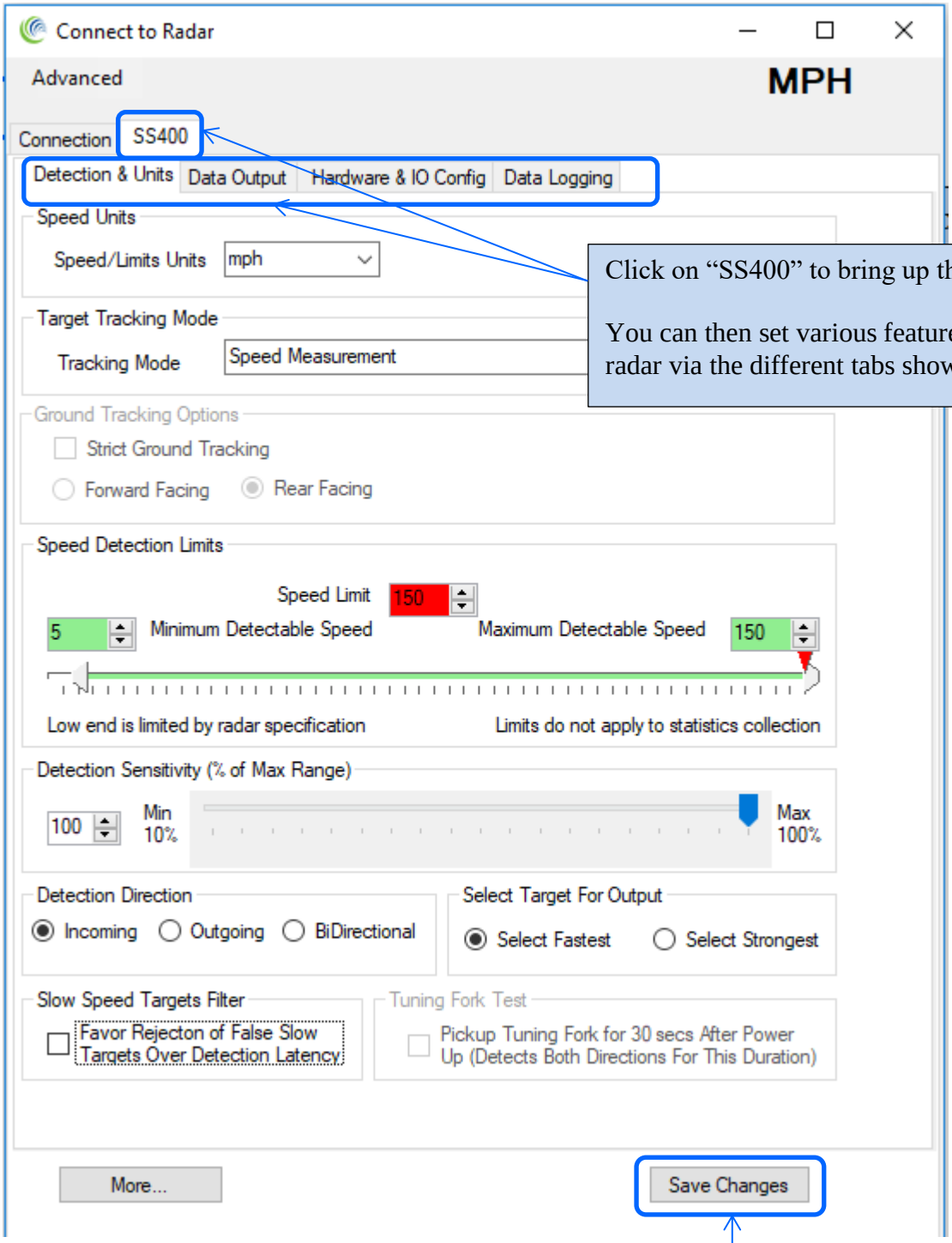
Houston Radar USB-RS-P1 USB powered RS232 interface to the radar.

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 a 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: Click on Radar Setup to bring up the configuration GUI



Click on "SS400" to bring up the GUI.

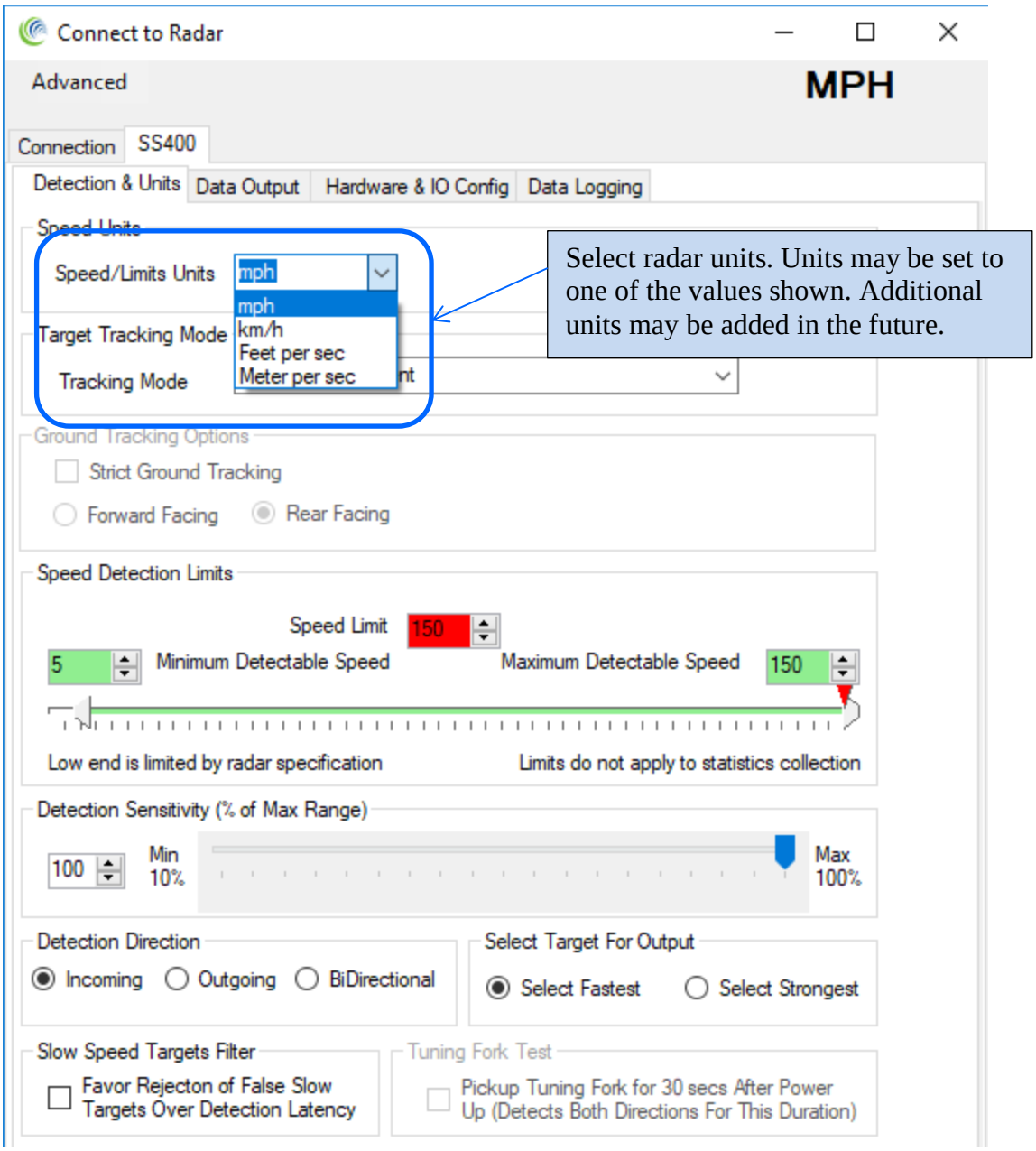
You can then set various features in the radar via the different tabs shown here.

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

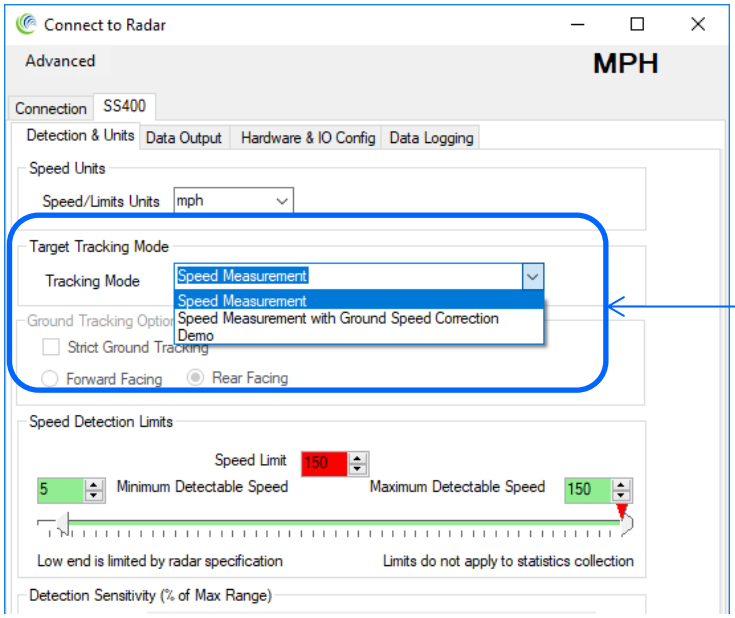
STEP 3: Select the radar units

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: Set the Target Tracking (Operating) Mode of the Radar



Select the target tracking mode of the radar based on your application.

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 Correction**
   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) and 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.

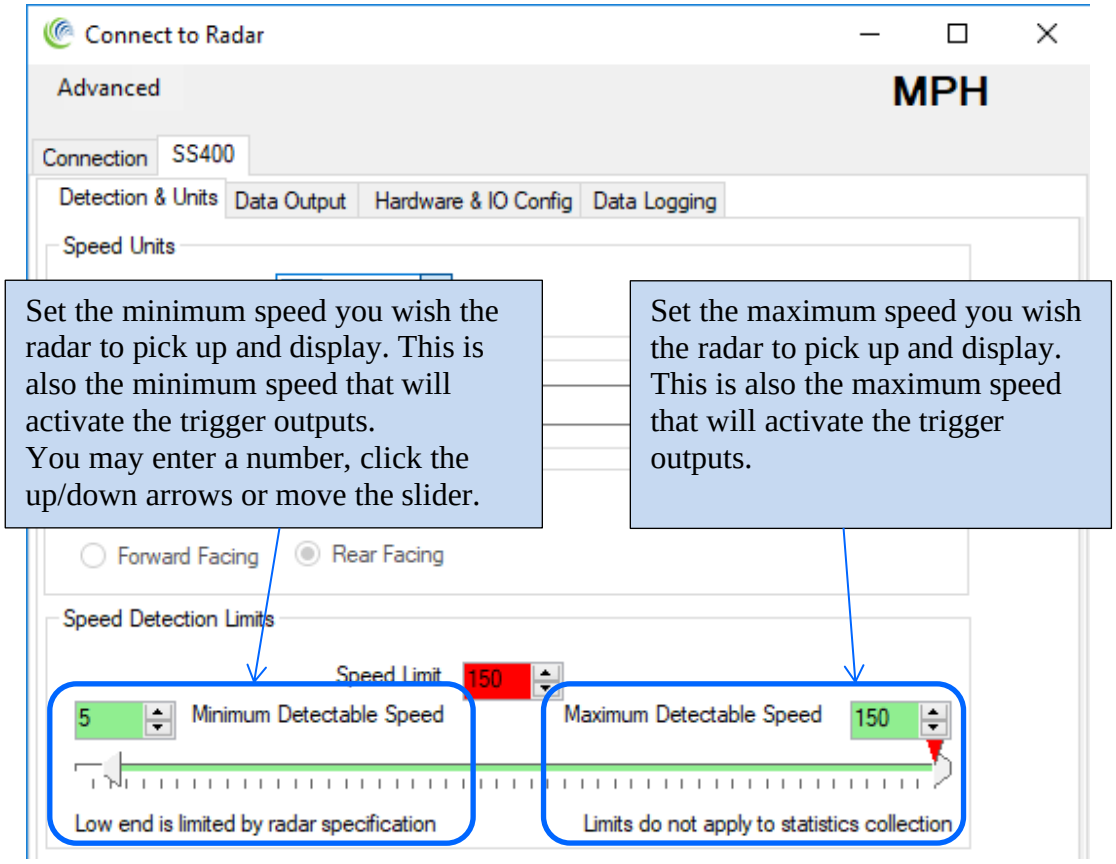
3. **Demo Mode**
   In this mode the radar will simulate detection of different targets and output their speeds. This is a useful mode for demonstration purposes (especially when the radar is connected to a sign), for example at a trade show.

4. **Ground Speed Measurement Mode** (*Future. Contact us for details*)
   In this mode the radar will measure the speed of the ground and output it over the serial port. This is useful to measure the ground speed of the vehicle the radar is mounted on. No other targets are detected and the ground is tracked as the only target.

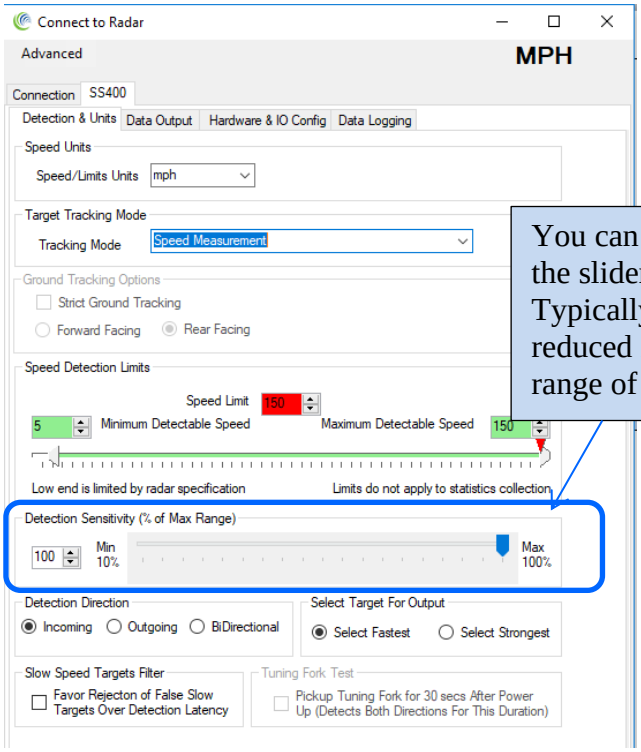
STEP 5: Set the radar cutoff speeds (low and high speed cutoff)

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. Not available in SS400U ultra-low speed radar). Note: The minimum and maximum speeds the radar will measure are limited by the specifications of the radar.

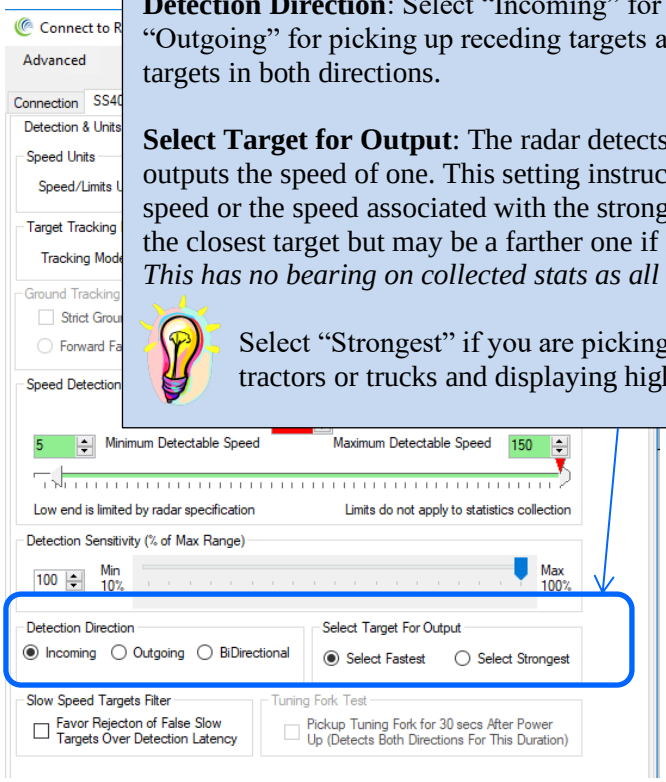


STEP 6: Set Detection Sensitivity



You can adjust the radar sensitivity via the slider or the numeric up/down. Typically the sensitivity may need to be reduced if you need to restrict the pickup range of the radar.

STEP 7: Set Detection Direction & Target Selector

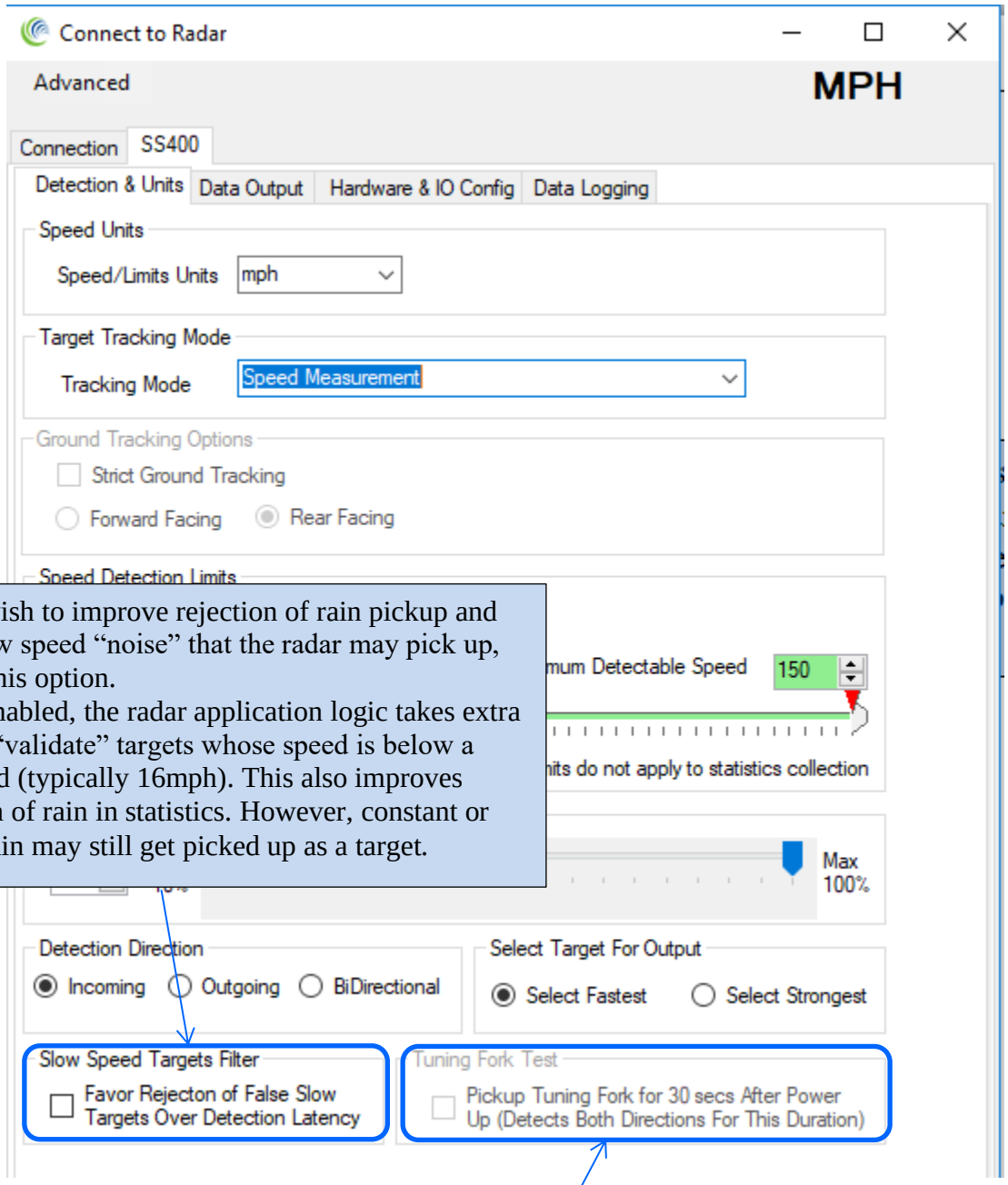


Detection Direction: Select “Incoming” for picking up approaching targets, “Outgoing” for picking up receding targets and “Bi-directional” for picking up targets in both directions.

Select Target for Output: 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 which is typically the closest target but may be a farther one 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.

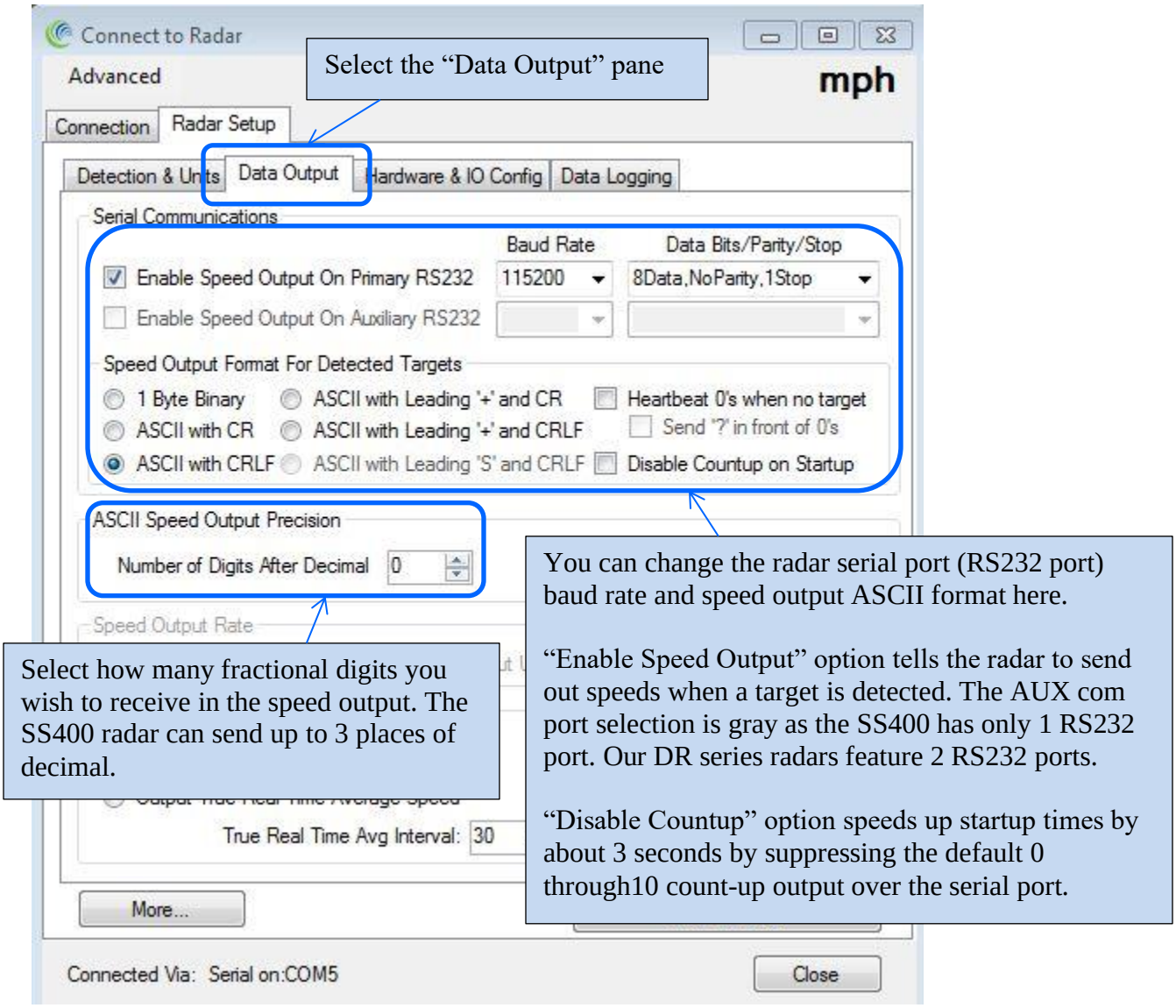
STEP 8: Set "Slow Speed Targets Filter" and "Tuning Fork Mode



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 extra long to "validate" targets whose speed is below a threshold (typically 16mph). This also improves rejection of rain in statistics. However, constant or heavy rain may still get picked up as a target.

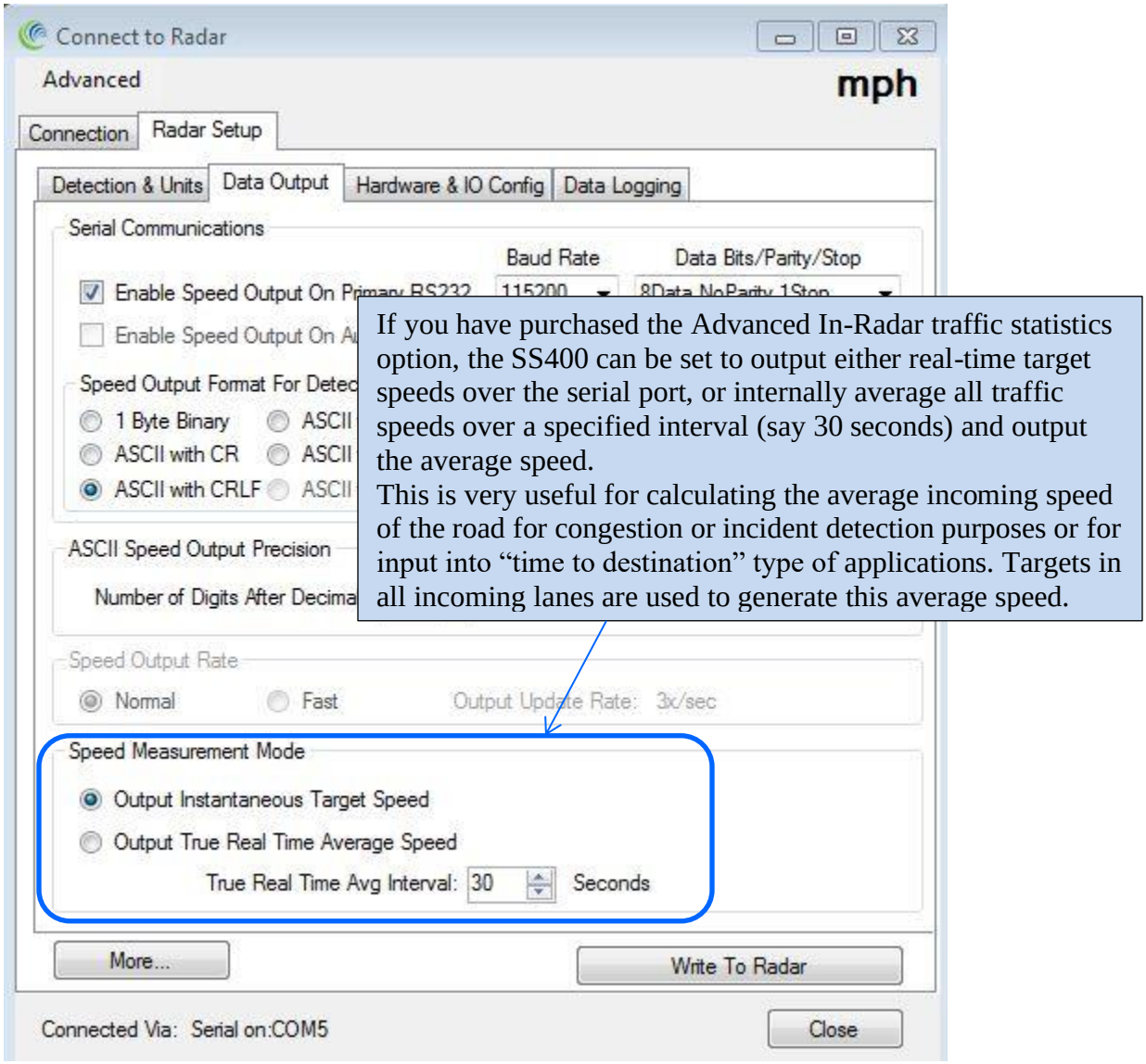
Directional Doppler radars typically reject tuning forks as they do not appear like a true moving target.
If you wish to use a tuning fork to activate the radar for testing purposes, enable this option (if available in the firmware). This will disable direction selectivity for the first 30 seconds after a power up making tuning fork pickup possible.
The radar will automatically revert to normal operation after this time. To renter tuning fork mode, power-cycle the radar again.

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



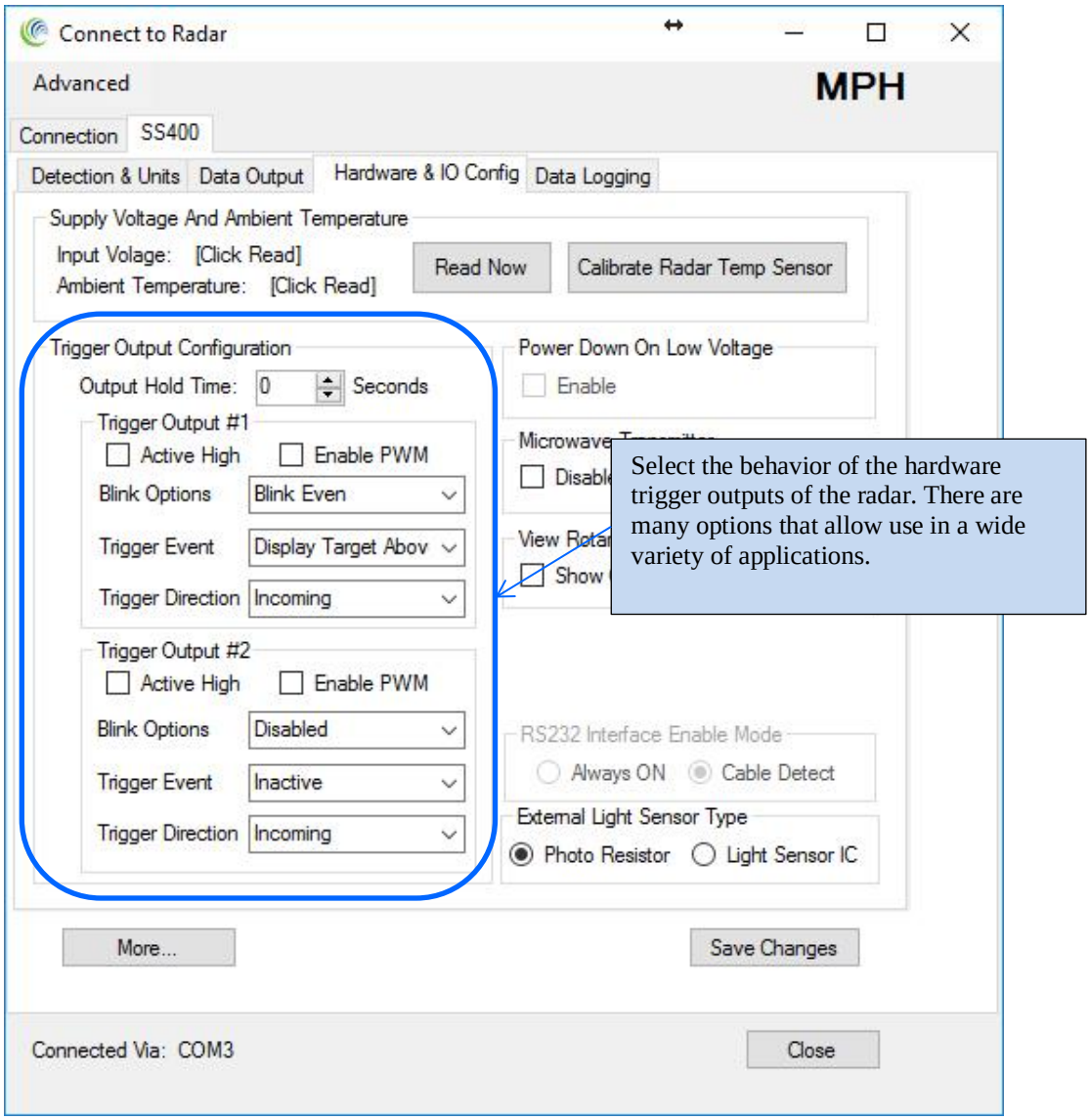
STEP 10: Select Speed Measurement Mode

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



STEP 11: Configure the trigger outputs

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



The SS400 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 whatever voltage you desire (max 28 VDC). When unchecked, trigger output will pull this external resistor down to GND (supply voltage negative/return wire).

Enable PWM: Check this box if you have a LED lamp connected to the output and wish the radar to adjust the brightness based on ambient light. You will also need to connect a light sensor to the SS400 to measure the light.

Blink Options: Check this box if you want to make a flasher. The lamp connected to the trigger output will blink when measured speed exceeds the "speed limit" setting. When this box is checked, you can set this limit on the "Detection & Units" tab.

Triggers can be configured to blink on alternating cycles by selecting "Blink Even" and "Blink Odd"

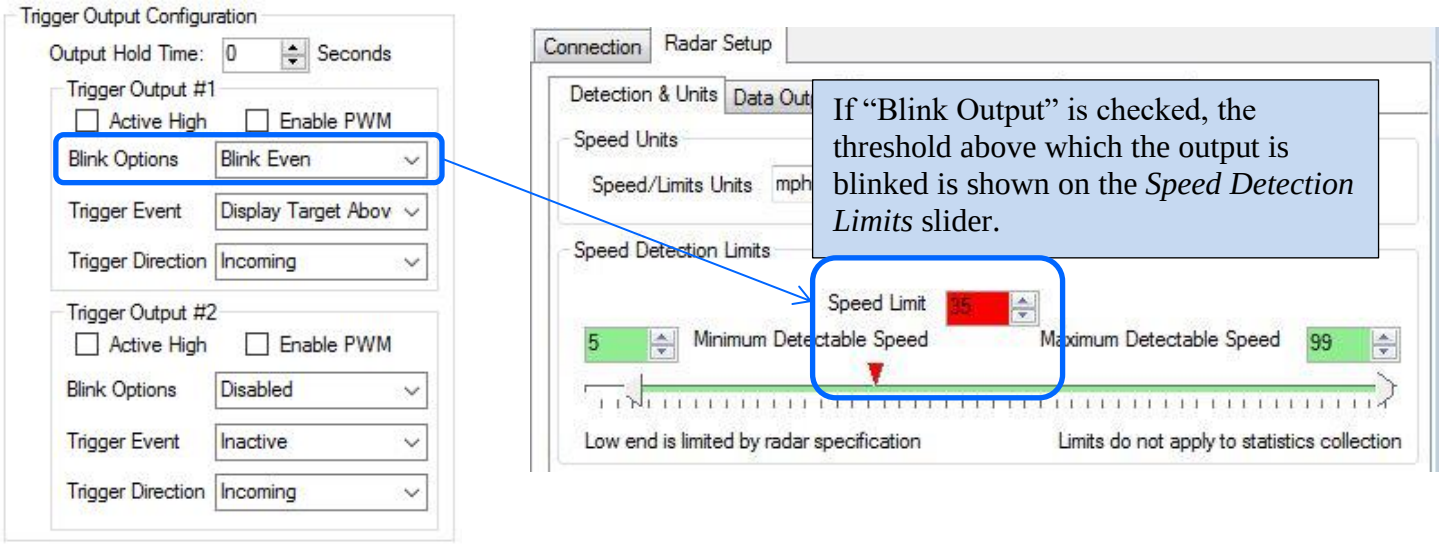
Trigger Event: Select what event triggers the output

Inactive: Output is not triggered
Display Target Above Speed Limit: Target Speed is greater than SP variable value ("Speed Limit" on Detection tab).
Display Target Below Speed Limit: Target Speed is less than "Speed Limit".
Any Display Target: Any target is detected.

Trigger Direction: Select what direction target triggers the output

Incoming: Only an incoming target triggers this output
Outgoing: Only an outgoing target triggers this output
Bidirectional: Any direction target triggers this output

"Blink" Output Details:

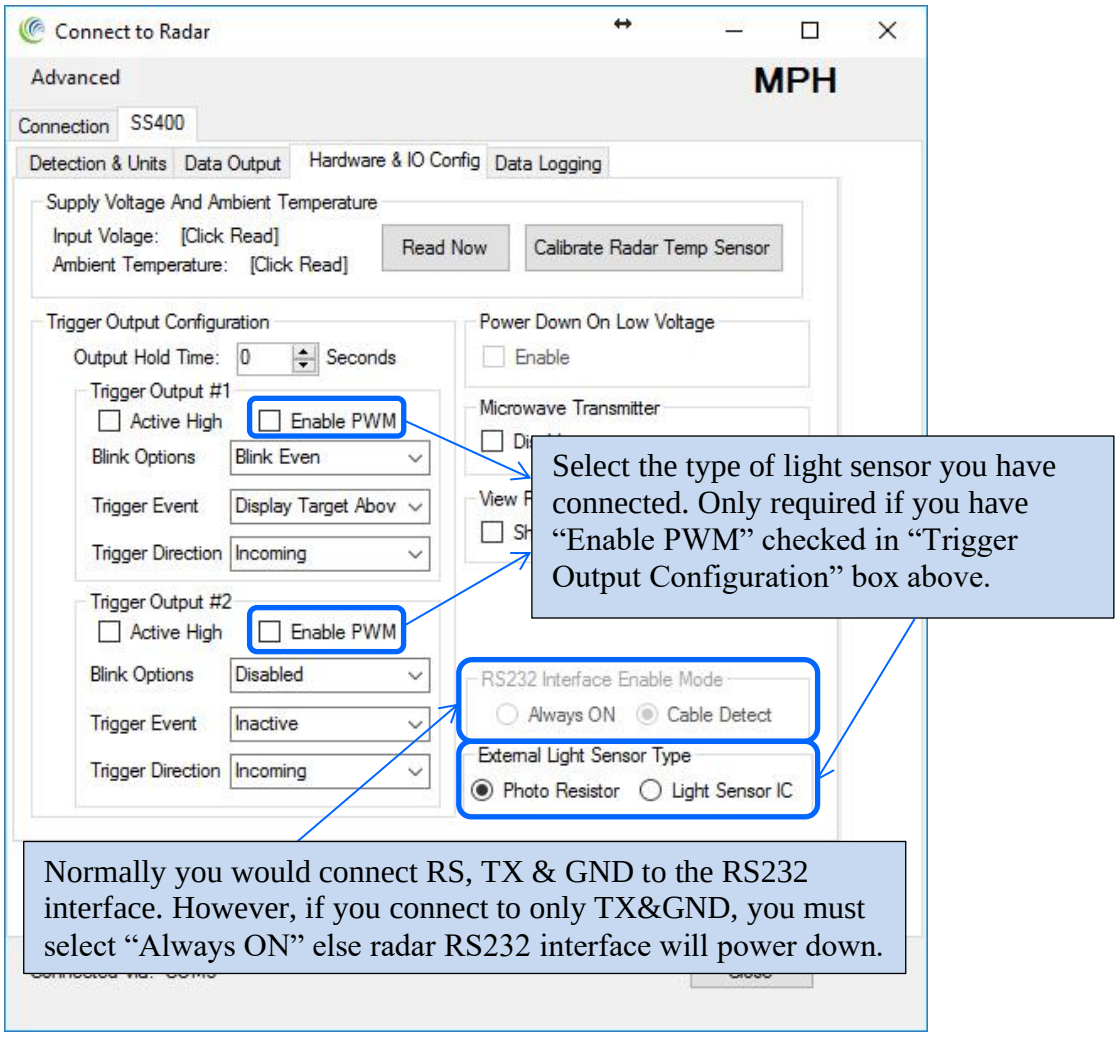


STEP 12: Select the light sensor type

If you selected to have the radar control your attached LED lamp's brightness, you must attached an external light sensor. The radar will then measure the ambient light via this sensor and adjust the "ON" duty cycle via PWM (pulse width modulation). This is done with a frequency of 180Hz so that the attached lamp does not appear to be flickering. There are two types of sensors that may be used, LDR (light dependent resistor) or "IC". The LDR is much easier to use and mount and available as a flange mounted weatherproof unit from us. The IC type sensor is more linear and calibrated to the human eye, but requires you to place it on an external PCB as it is a fine pitched SMT IC.

STEP 13: Select RS232 (serial data output) mode

The SS400 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 about 5 to 10% 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: Disable microwave transmitter (testing only)

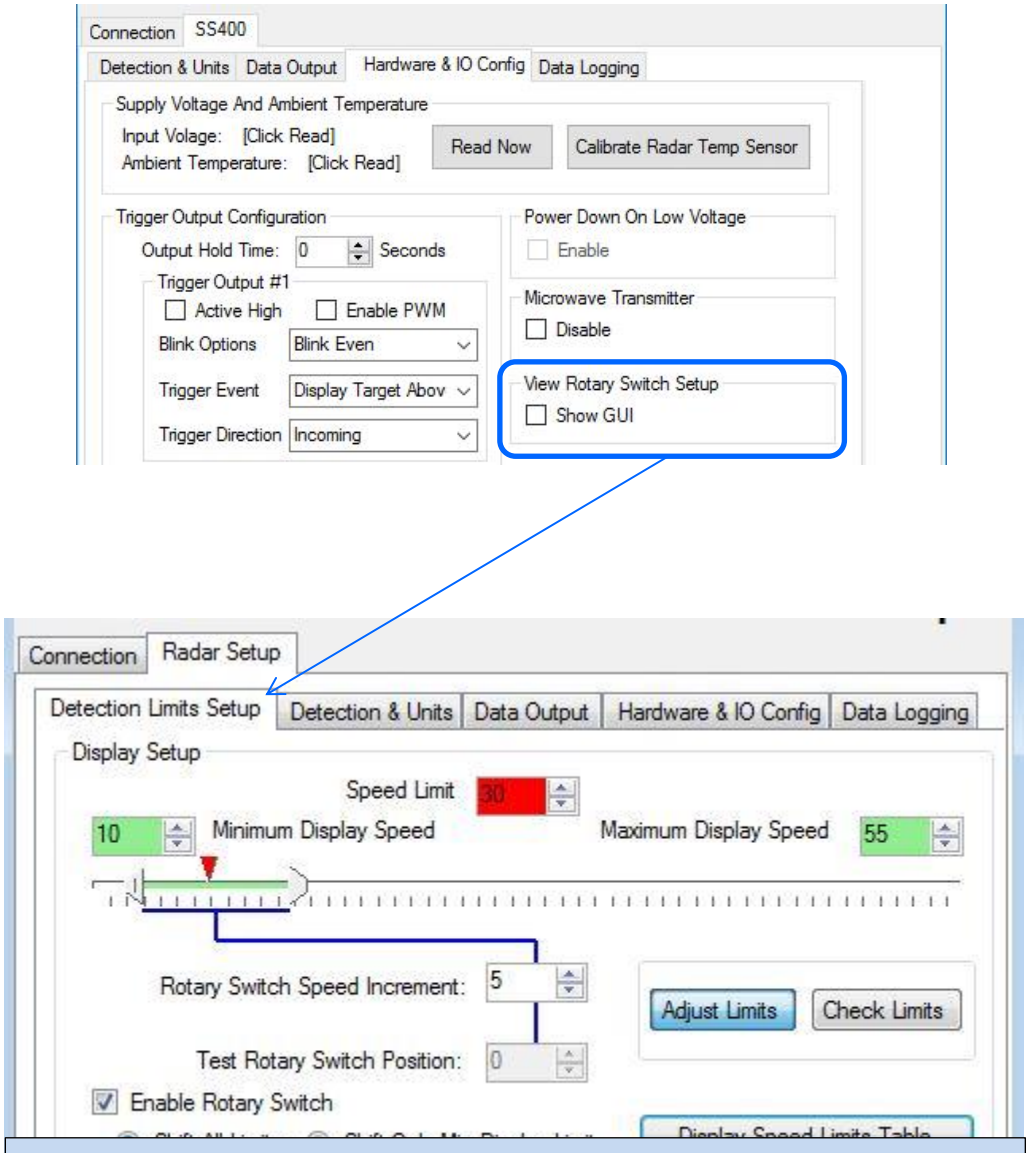
Check this box in case you wish to turn off the microwave transmitter. This will prevent normal operation of the radar and is provided only for testing purposes.

STEP 15: Show Rotary Switch GUI (if rotary switch connected)

The SS400 radar measurement speed limits (including the blinking speed limit) may be set/changed in the field via a convenient rotary switch. This avoids having to connect a computer to the radar/sign to make this change.

This rotary switch is present on the optional IO Breakout board or you may use your own switch.

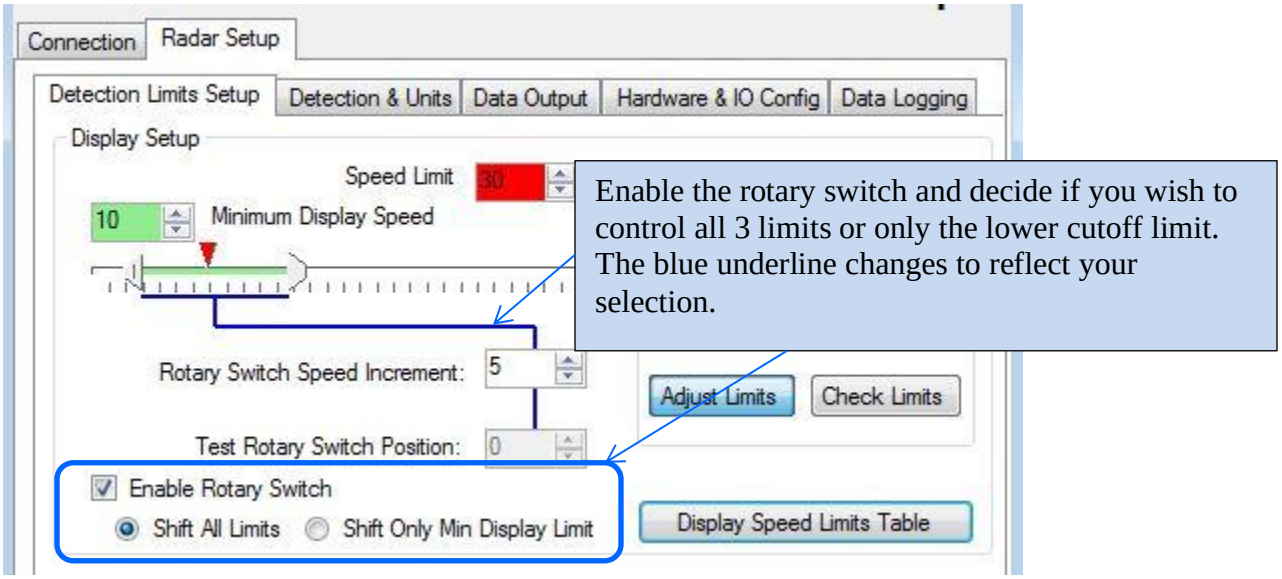
However, you must first setup the radar to use this rotary switch. If you wish to use this feature, check the "Show Rotary Switch GUI" to bring this interface up.

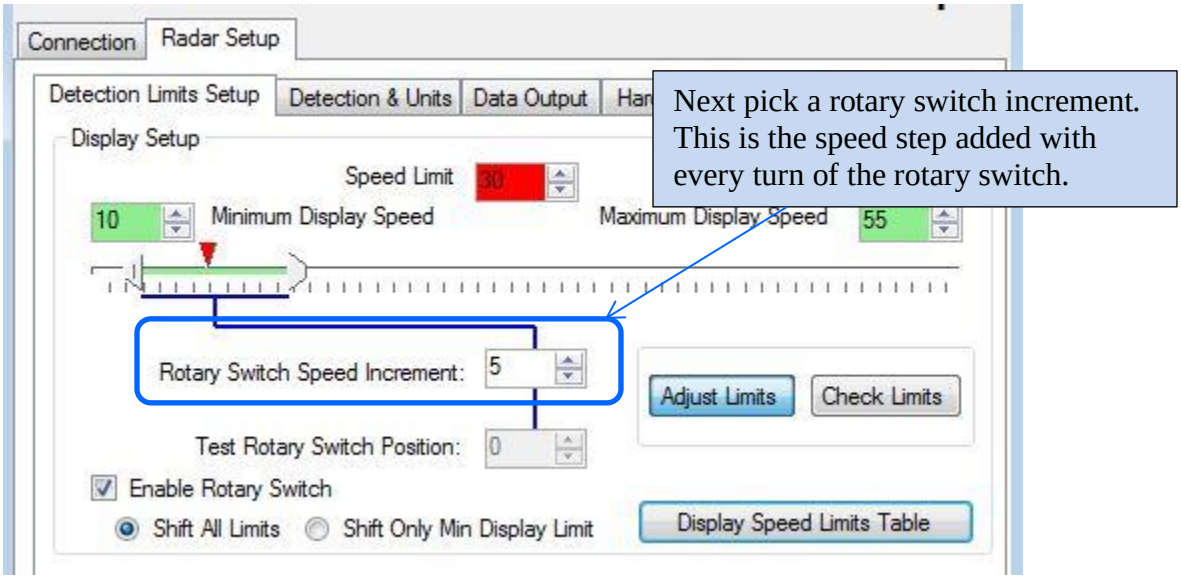


The above GUI interface is shown when you check the "Show Rotary Switch GUI" checkbox. You can now enable the rotary switch and set the limits as explained below.

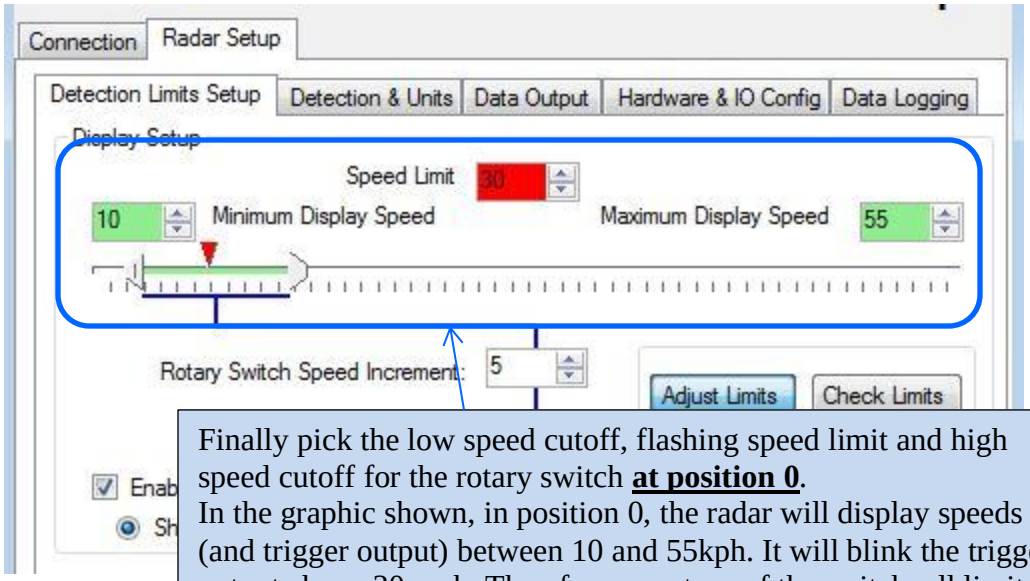
STEP 16: Using the Optional Rotary Switch GUI

(Applicable only if you wish to use a rotary switch on the optional "breakout board").

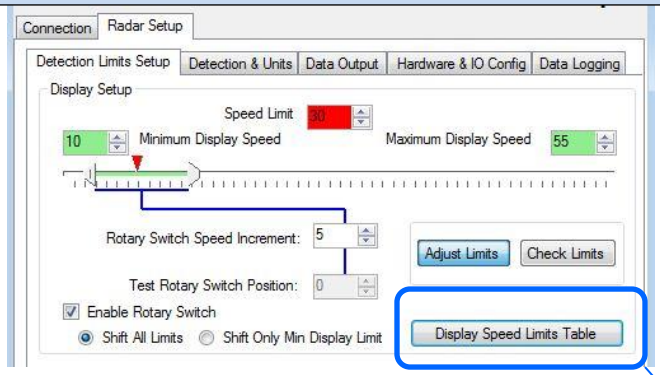


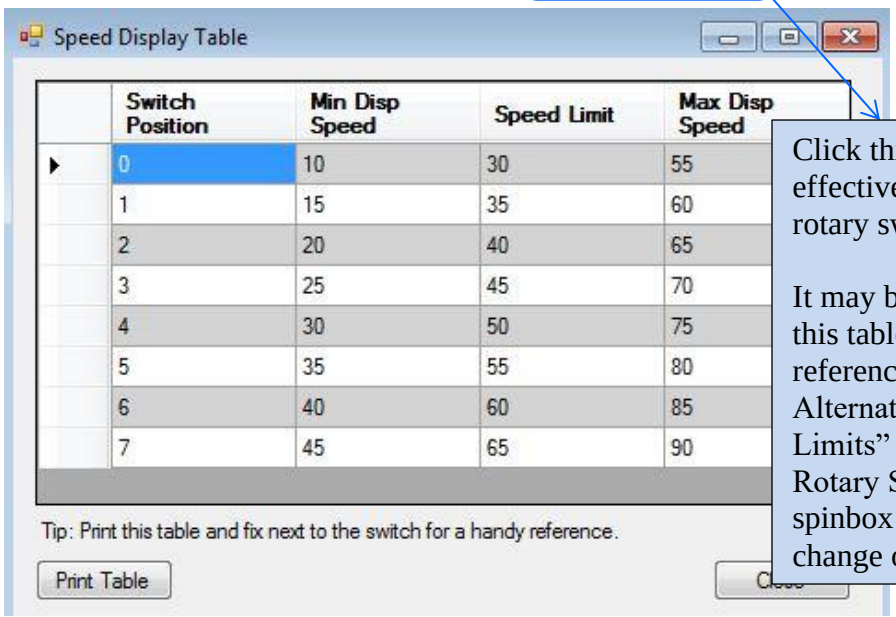


Rotary switch GUI setup continued…



Finally pick the low speed cutoff, flashing speed limit and high speed cutoff for the rotary switch **<u>at position 0</u>**.
In the graphic shown, in position 0, the radar will display speeds (and trigger output) between 10 and 55kph. It will blink the trigger output above 30 mph. Then for every turn of the switch, all limits will be shifted up by 5mph (the increment value).

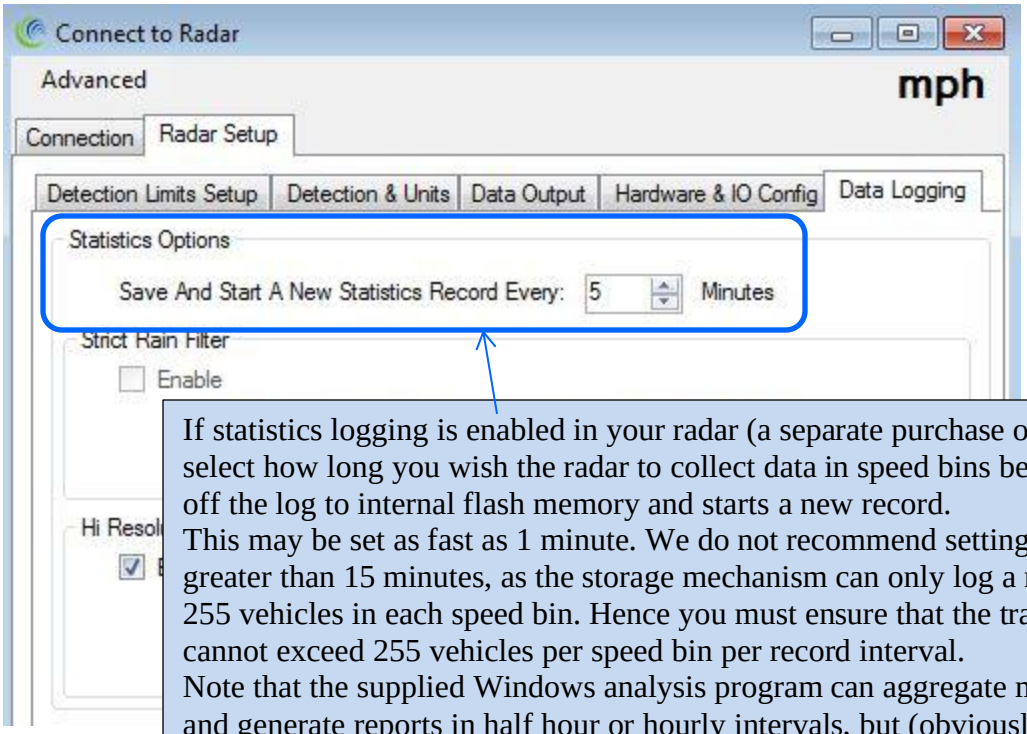




Click this button to display the effective limit values when the rotary switch it turned.

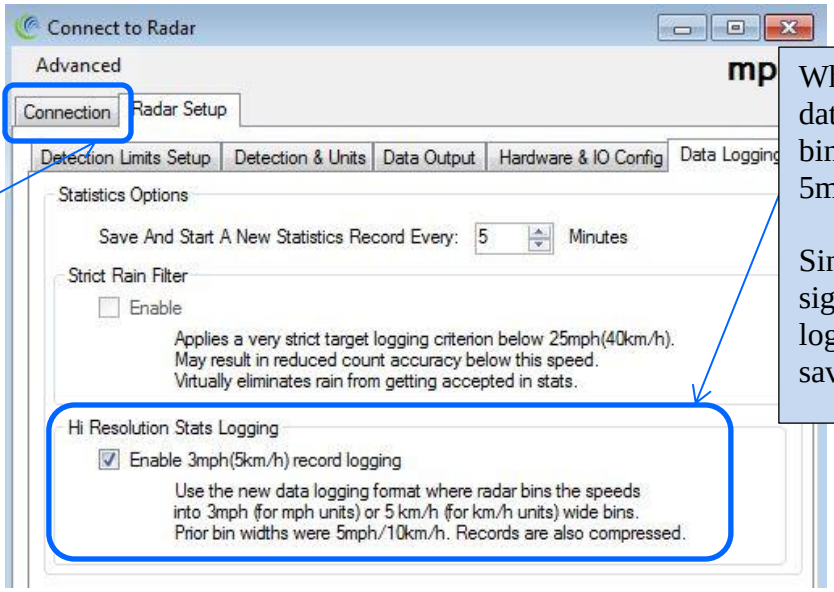
It may be convenient to print this table and use it as a handy reference in the field. Alternatively, click “Check Limits” and turn the “Test Rotary Switch Position” spinbox and see the limits change on the GUI.

STEP 17: 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 to greater 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 (obviously) 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.

SS400 SPECIFICATIONS

General

Operating Band	K-Band
Frequency	24.125 GHz ±50Mhz (US), 24.200Ghz on request
RF Power Output	5mW
Antenna Beam Pattern	45° x 38°
Polarization	Linear
Supply Voltage	6.2V DC to 18V DC
Reverse Battery	Protected
Nominal Current Draw	4.5 mA avg. (+/-1mA,) (@+12V DC) 5.3 mA avg. (+/-1mA)(@+12V DC, RS232 connected)
Operating Temp.	-22°F to +185°F (-30°C to +85°C). Electronics designed and tested to –40C.
Weatherproof	Yes (SS400-DFT build option). Open frame also available.
IR Remote Programmable	No

Approvals

Approvals	FCC Part 15 (US Version), CE Mark, IC Canada

Data Interfaces

Serial Communication	RS232
Data Rate	Baud Rates from 1200 to 230400 baud
Data & Power Connector	See Ordering Section

Mechanical

Weight	Approximately 33 grams (1.16 oz) (open frame version)
Dimensions	2.1”x1.75”x0.6” (LxWxD) 52 x 46 x 16mm (open frame version)

Specifications continued on next page …

Performance

Speed Measurement Range	0.66mph to 220 mph (1.06km/h to 354 kph). 0.16mph to 55mph "SS400U" option available.
Resolution	±0.003 mph
Accuracy	±0.5% of reading + 0.1mph
Detection Range	Typically 90+ m (300+ feet) for compact vehicles on open and level road with radar mounted 1.5 m (5 feet) high and pointed straight into oncoming traffic. 150+ m (500+ feet) for larger trucks, lorries and vehicles with inherently large radar cross-section. May vary with installation and road conditions. Detection range specified is typical for speeds between 20kph and 88kph (12 to 55 mph). It tapers off below and above this speed range. At the low end of the speed range (2mph (5kph), the detection range is about 34+ m (110+ feet). SS400 is not recommended for roads with speeds above 90 kph (56 mph) due to reduced range and tracking time. Contact factory for a different radar version if you need to detect vehicles outside said speed range.

Ordering Options

Order Code	Description	Field Connection	Field Connector Type	Mounting	Trigger Out #1 Visual Indicator
SS400-OFD	Open Frame	On side via right angle Molex SL connector	Molex “C Grid SL” male shrouded 12 pin RA part #70553-0011	4x holes for #2-56 screws	No
SS400-DFT	Encapsulated IP68 (connector not IP rated)	Encapsulated cable from back	Molex “C Grid SL” female 12 pin part #0050579412	Four #2-56 female standoff’s embedded on module	No
SS400-JBX	IP66 Junction Box	Cable Gland. Screw terminals inside box. DB9 at cable end	DB9 male	Banding Straps on mole mounting bracket	No
SS400-HRD	IP68 Rated box	Cable gland with DB9 at end. Screw terminals inside box.	DB9 male	Mounting boss on sides with #8-32 screw thread	Yes. Visible through front lid.
SS400-MBD	IP68 Rated box	Cable gland with DB9 at end. Screw terminals inside box.	DB9 male	Mounting boss on sides with #8-32 screw thread	No

Appendix A: Hooking up to the trigger outputs on the radar

The SS400 radar features two “open drain” outputs. The device used for this purpose is the On Semiconductor relay driver NUD3124. The output configuration of this device is shown below (from the On Semi datasheet).

The two outputs O/P1 and O/P2 are brought out on the radar connector pins (see IO connector pin out in manual for connector pin numbers).

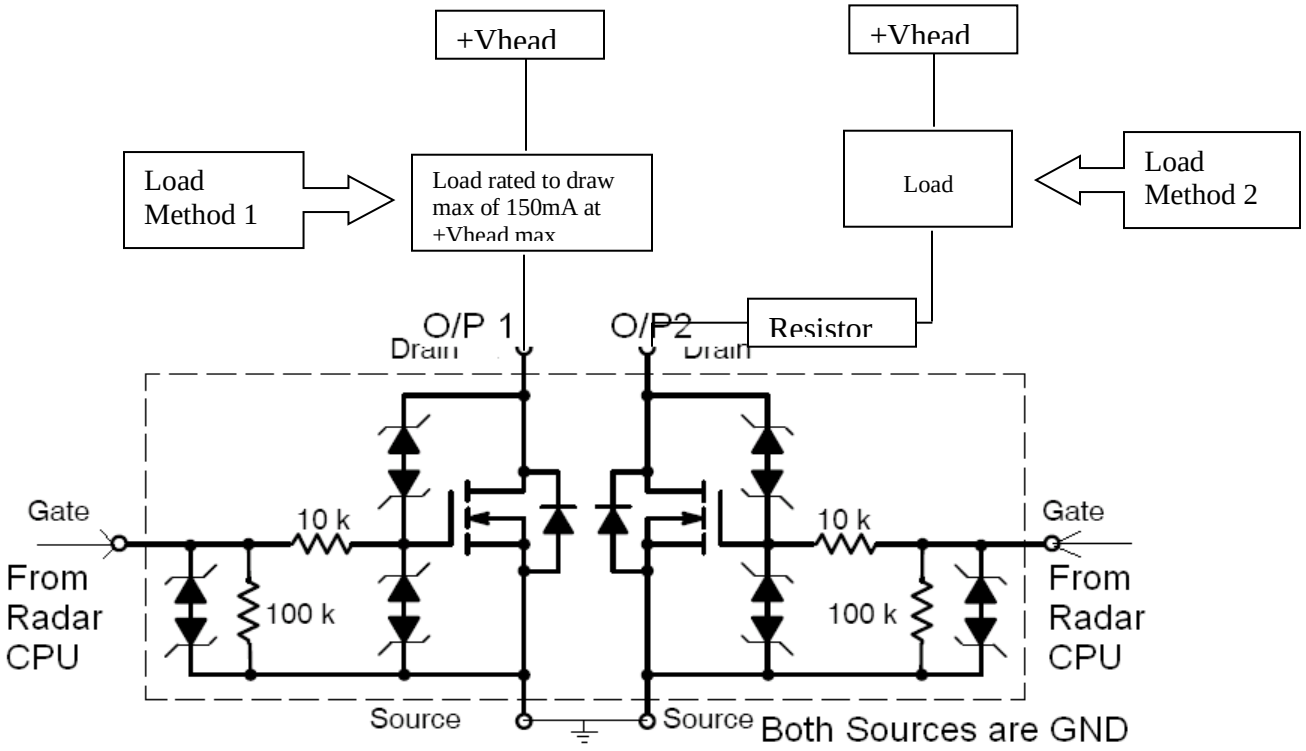
This device can sink 130mA of DC current at up to 28VDC.

However, these are low impedance outputs, which means that you must externally limit the maximum current that will flow into these outputs to 150mA at the worst-case head voltage. They may be parallel together to increase this value to 300mA.

There are two ways to ensure this:

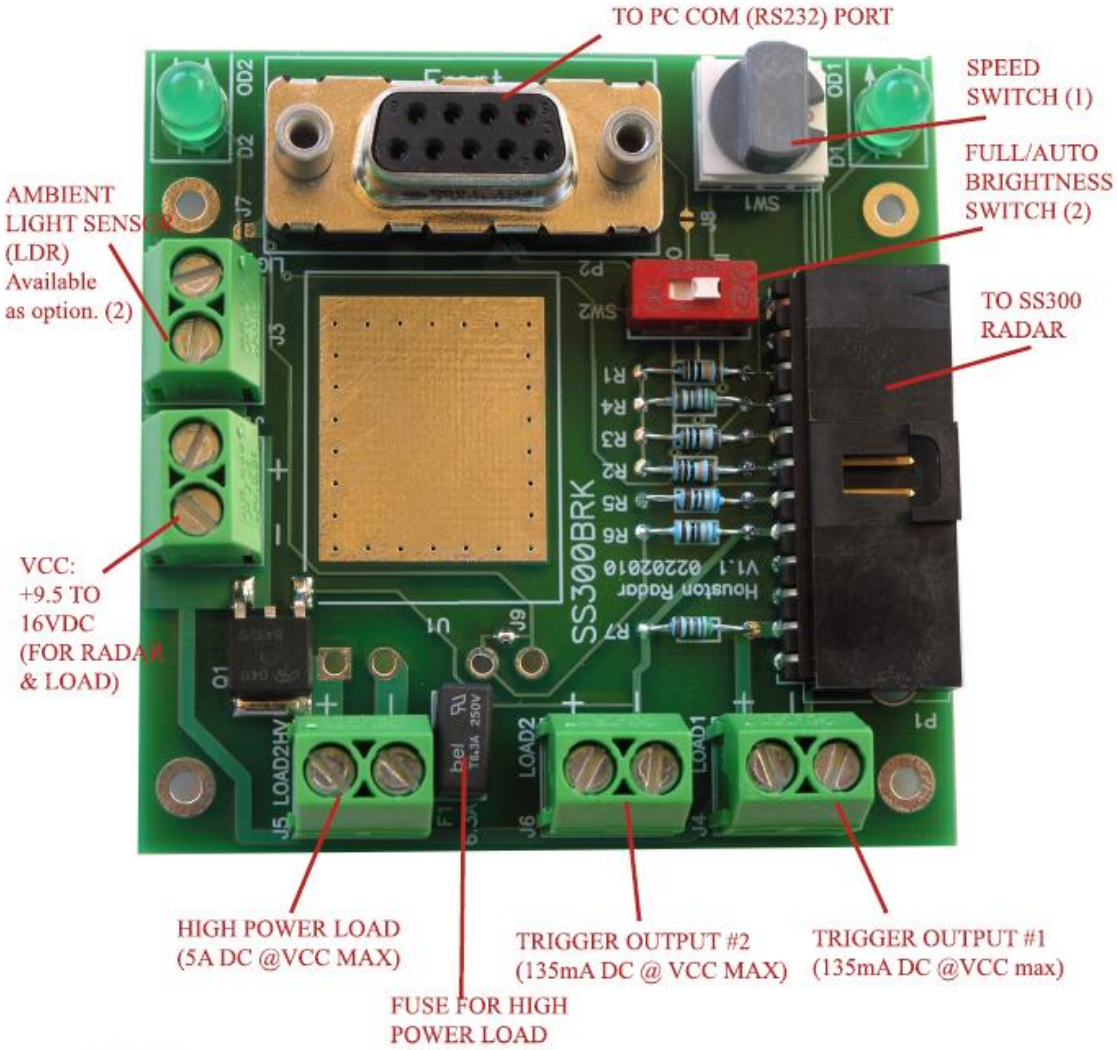
1. Connect an output device that is rated to draw no more than 150mA at your supply voltage (+Vhead). This device can be powered up to 28VDC. For example, this can be a 12 or 24VDC relay coil rated at more than 150 mA coil current or

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)= (Vhead –Vload drop)/150



Appendix B: Optional Breakout IO Board Connections:

(Non-Isolated Mosfet version with PWM Brightness Control)



NOTES:

(1) Switch can be enabled in software to change the effective low speed cutoff below which radar will not pickup targets. See MO & SI variables in user manual for more information.

(2) Automatic brightness adjustment of LED loads can be enabled via PWM of the load outputs. See user manual for more information.

HOUSTON RADAR LLC SS300 IO CONNECTOR BOARD QUICK START

(DC Mosfet, vertical connectors/led/switch version. right angle DB9, switch & LED's option is also available. Isolated high power AC electronic relay option is available.)

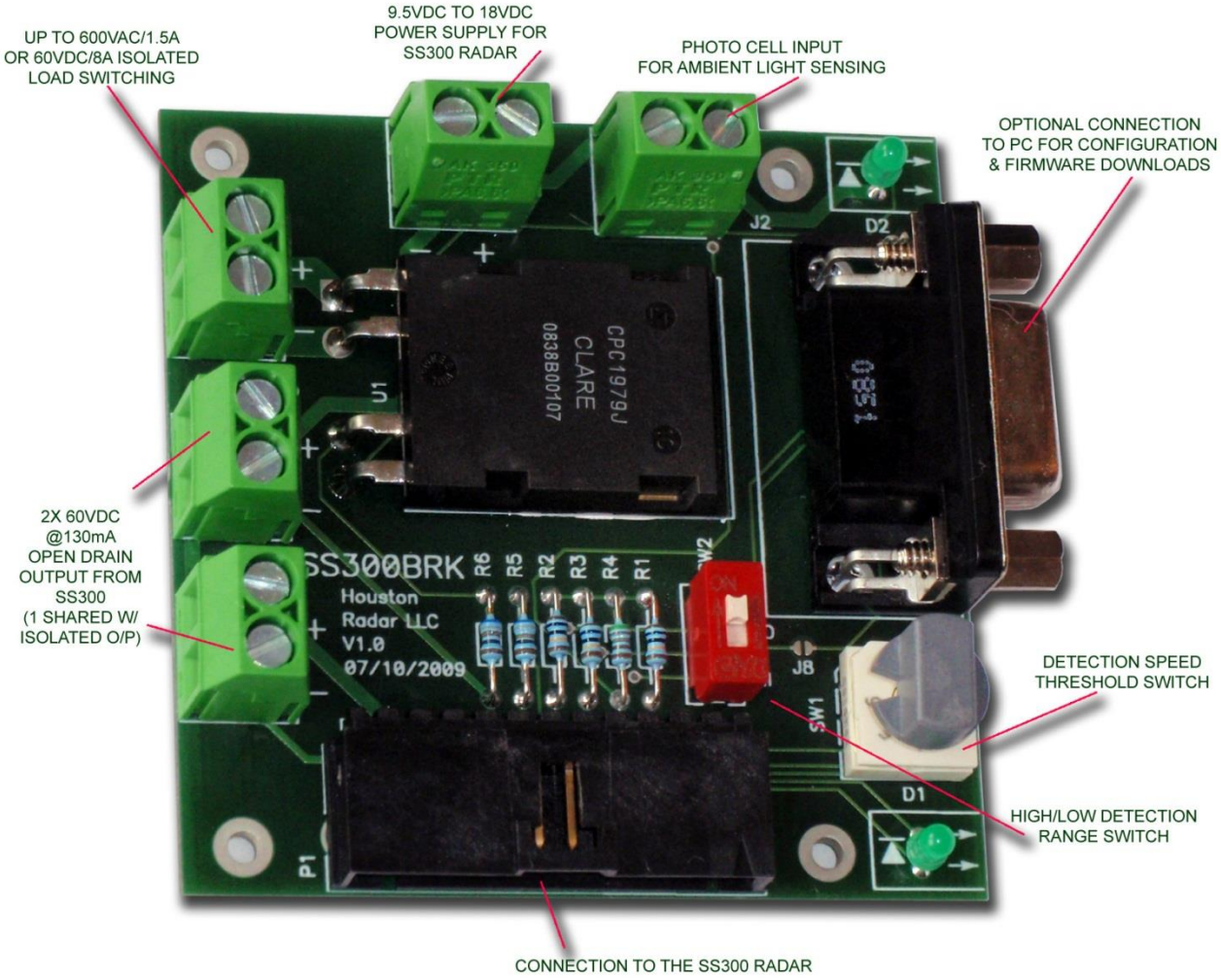
Connecting the load to the High power and trigger outputs:

You may directly connect your high power DC load + & - to J5. The load is activated via fuse F1 when the output is triggered.

You may directly connect a <150mA relay coil or other low power load to the J4 & J6 connectors. The + load terminals are always wired to VCC. The (-) terminals are connected to GND when a vehicle is detected and the output triggered. J5 is always triggered at the same time as J6.

Optional Breakout IO Board Connections:

(Isolated Solid-State Relay version, AC or DC capable)



SS300 DOPPLER RADAR BREAK OUT AND SWITCH PANEL BOARD

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