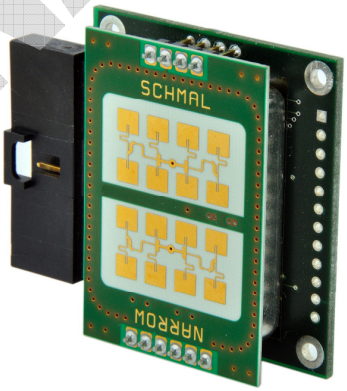
# PD300

## FMCW Radar User Manual and Installation Guide

K-Band FMCW Ranging Radar
Built Type: PD300-DFT, PD300-OFD
Rev 0.3, June 2011

PRELIMINARY

PD300 in Weatherproof Enclosure
PD300-DFT




PD300 Open Frame Version
PD300-OFD

Houston Radar LLC
13814 Sherburn Manor Dr. Cypress .TX
Http://www.Houston-Radar.com
Email: sales@Houston-Radar.com
Contact: 1-888-602-3111

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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 device carries FCC modular approval and as such is labeled with FCC ID TIAPD300. If this label is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed PD300 module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID:  TIAPD300” or “Contains FCC ID: TIAPD300.” Any similar wording that expresses the same meaning may be used.



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*Warning:* PD300-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 Ranging Radar PD300. This state of the art 24GHz K-band microwave ***frequency modulated continuous wave*** (**FMCW**) radar is specifically designed for the license free battery and solar operated presence detection market. Unlike regular Doppler radars, FMCW radars are capable of measuring range and detecting stationary targets.

Typical applications include ground loop replacement, multi-lane traffic counters, mid-block detectors, vehicle actuated signals and intrusion detectors.

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:

- World's smallest and lowest power usage ranging FMCW radar. At 0.17 Watts, it requires 10X to 20X less power than competing products.
- Up to 120ft (37m) detection range
- Simultaneously detects and tracks up to six individual targets.
- 6 user-configurable lanes allow assignment of targets to specific lanes..
- Unmatched range resolution down to 0.25 inch (0.63cm)[1].
- Highway and intersection optimized modes allow wide variety of applications.
- Two trigger outputs can be mapped to any combination of lanes.
- Companion Windows application provides intuitive GUI to set all configuration parameters and display real time plots of the targets.
- Wide input voltage range and low power consumption facilitates solar and battery operation.
- Firmware "boot loader" allows for field upgrading of the firmware.
- 100% built-in self-test for high confidence.
- IO break-out board available for quick evaluation.
- Built-in statistics storage memory for stand-alone data gathering.
- Full industrial temperature range. Potted for high reliability.
- FCC pre-approved with CE mark.



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# INSTALLATION

## Mounting:

PD300-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.
For maximum vertical angular coverage (for example when simultaneously detecting close by and far away lanes with a minimal set-back), the PD300-OFD should be mounted such that the connector points left or right as shown in the picture on the front page. This orientation utilizes the radar's wider 45º beam for the vertical direction.

The PD300-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. To achieve wide vertical beam angle, the PD300-DFT should be mounted such that the text "Houston Radar" on the face of the unit is horizontal.

This orientation is typically used in the "Highway mode" where you are measuring per-lane count and occupancy while the radar is mounted at the side of the road and fires across the lanes at 90º angle (side-firing configuration).

The unit *may* be rotated 90 degrees if you desire maximum width coverage. This would be the preferred orientation for example in "Intersection Mode" application where you may be trying to get as much width coverage as possible.

## Application Optimized Operating Modes:

The PD300 features two different operating modes that should be selected by the user depending on their intended application: "**Highway**" and "**Intersection**".

**Highway mode** is used for occupancy measurements, vehicle detection and counting at typical city and highway traffic speeds. It can easily distinguish between closely following individual vehicles in the different lanes.

**Intersection mode** is used for presence detection of stopped or slow moving vehicles. It is optimized to continuously track such targets with minimal signal dropouts and also features reduced setback requirement.

For optimal performance:

✓ Radar should be mounted as suggested in the section titled "Mounting" earlier.



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- ✓ Radar should be pointed across the direction of traffic (side-firing) so that the side of the vehicle is visible to the radar. This returns the strongest signal from the target.
- ✓ Radar should be mounted high enough to "see" over the top of the highest expected target. At least 17 feet of height is recommended in case of truck traffic. This requirement increases as you try to detect far lanes.
- ✓ Current versions of the radar firmware do not support high-speed "front firing" modes. This will be supported in the future via a firmware update. Avoid installing the radar where it will see the vehicles either approaching or receding directly at/from the radar at speeds exceeding 14 mph.
- ✓ Select the recommended operating mode via the accompanying Windows setup GUI program depending on your application.

Illustration of PD300 in side-firing intersection mode with maximum depth of view.

Illustration of rotated PD300 in side-firing intersection mode with maximum width of view.



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## Recommended Enclosure for the PD300-OFD:

The PD300-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" 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 potted version PD300-DFT that is available from Houston Radar that may be mounted directly outside.

## Hookup:

*Power Input:*

The PD300 radar features wide operating input voltage range of 5.5V-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 22mA (average). There is no other FMCW ranging radar in the world that even comes close to this ultra-low power usage. Competing products may consume up to 20 times more power.

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 8 mA to 22 mA.

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Note: when the under-voltage lockout (UVL) feature is activated, the operating voltage range is reduced to 8.5V-18V and dropping the input voltage to 4.5V-6.5V will put the radar into a sleep mode where it will update the internal clock. UVL mode is the default from the factory but may be disabled by a bit in MD variable (see later section).

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 PD300 features an RS232 interface that is used to output presence detection information, access statistics data (available in the future with a firmware update) 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 RS232 RX (receive) line is not connected. Cable detect mode may be disabled and the interface may be forced ON via a bit in the "MD" variable.

Note 1: 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.



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Wire Signal Descriptions:

| 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 | VCC | PWR | +5.5 to +18VDC Power Supply |
| 12 | 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 presence in a user configured lane.*
*Incorrect hookup may result in the output devices being destroyed and will not be covered under warranty.*

The PD300 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 in combination of user defined lanes.

When a vehicle is detected in a user defined lane and the lane is mapped to an trigger output, that pin is pulled down to GND and held low as long as a vehicle is tracked in that lane. The pin is released as soon as the radar detects no further target in that lane. 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 150 mA each. You must limit the current externally to ensure that no more than 150 mA goes into each pin when they turn on. They may be connected in parallel to double the sink capacity.

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



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## Principle of Operation:

PD300 modulates the frequency of the transmit signal in a linear fashion. The difference between the frequencies of the local signal and the return signal is proportional to the time delay between these signals and thus is proportional to range. In case of a moving target we also take into account Doppler shift of the return signal. PD300 uses a double linear ramp modulation, first increasing and then decreasing the frequency of the signal. Additional information derived from both ramps allows the radar to measure both the range to target and target velocity.

The PD300 utilizes advanced target tracking technique based on a proprietory algorithm that allows it to detect, measure and track multiple targets simultaneously. It also features advanced "application filters" pre-configured to optimize performance for a variety of applications. The PD300 radar may be deployed as a complete product without any further requirements for signal processing.

For a more detailed theoretical description of the principles of FMCW radar operation please see this article on the Internet.

## Radar Detection Zone:

The radar detection zone has a conical shape and is defined by its beam width of 38x45 degrees. Note that the beam does not cutoff sharply outside this angle but rather taper off in a smooth fashion. Thus weak targets near the angular boundaries may be missed while strong targets outside may still get detected. The strength of the target is determined by its radar cross-section and depends on the target material, area, shape and angle. Large metallic shapes positioned at 90 degrees to the incident radar beam make the best targets. Examples are vehicle sides, front and rear ends. Flat metal surfaces at angles other then 90 degrees tend to reflect the radar signal away (mirror effect) and reduce the target strength. Metal surfaces joined at 90 degree angle, e.g. pickup truck bed create perfect reflector and result in a very strong return signal.

The radar beam diverges with distance, thus the detection zone is considerably wider at the farthest end of the radar detection zone. This can be used to a great advantage if you need to widen the detection area. In this case, move the radar away from the target location. This may involve, for example, mounting the radar on the opposite side of the road or increasing setback and/or height. This kind of a setup is often used in a loop-replacement intersection application.

Also note that the radar beam is wider in one direction and the operation of the radar is not affect by the mounting orientation. This may also be used to either widen or narrow the detection zone.



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For a wider horizontal detection zone, mount the radar with the wider beam in the horizontal direction. This is achieved when the radar is mounted such that the connector or the cable exit is either on top or bottom side of the radar.

For a narrower horizontal detection zone, mount the radar with the narrower beam in the horizontal direction. This is achieved when the radar is mounted such that the connector or cable exist is either on the left or right side of the radar.

Important things to remember about radar detection zone:

1. The radar beam angle. The radar beam does not end abruptly at the listed angle of 38x45 degrees. Per convention, the specified angles are “half-power” angles where the energy in the beam falls off to half the value from the center of the beam. Thus it is possible for the radar to detect further out from simply a trigonometric calculation based on the beam angle.
2. The “radar cross section” of the target. Every target has different radar energy reflective characteristics. This is called the radar cross-section and is a measure of how much radar energy the target returns back to the radar. This is one of the most important factors in reliable detection. Simple rules of thumb are:
    a. Vehicle sides have larger cross section than the vehicle front
    b. Vehicle rear typically have larger cross section than vehicle front
    c. Larger target area has larger cross section than smaller targets
    d. Metal targets have larger cross section than non-metallic targets (like humans, animals, plastics etc.)
    e. Surfaces joined at a 90 degree angle create perfect reflector.
    f. Perfectly flat metal surface at an angle other then 90 degrees may reflect the radar beam away.
3. Unlike a Doppler radar, there is a fixed internal design limit to the maximum range the radar may detect and measure. This is specified in the datasheet and is different in various modes of operation (see later section).
4. Moving targets produce Doppler shift in the reflected signal that needs to be taken into account. Excessive radial speeds produce a large Doppler shift and the radar will filter such targets out..On the other hand a high tangential speed is not a problem. Thus at the moment Highway Mode may only be used in a side-firing application where the radar looks across the carriageway and the Doppler shift produced is minimal. In Intersection Mode the radar may be deployed in either side-firing or front-firing setup since the vehicles are moving at a slow speed or stopped and Doppler effect is within acceptable range.

## Radar Resolution:

The PD300 radar features an unmatched internal range measurement resolution down to 0.25 inches (0.64cm). This is achieved by utilizing a proprietary resolution enhancement algorithm. However, there are several factors that must be considered to achieve this resolution.



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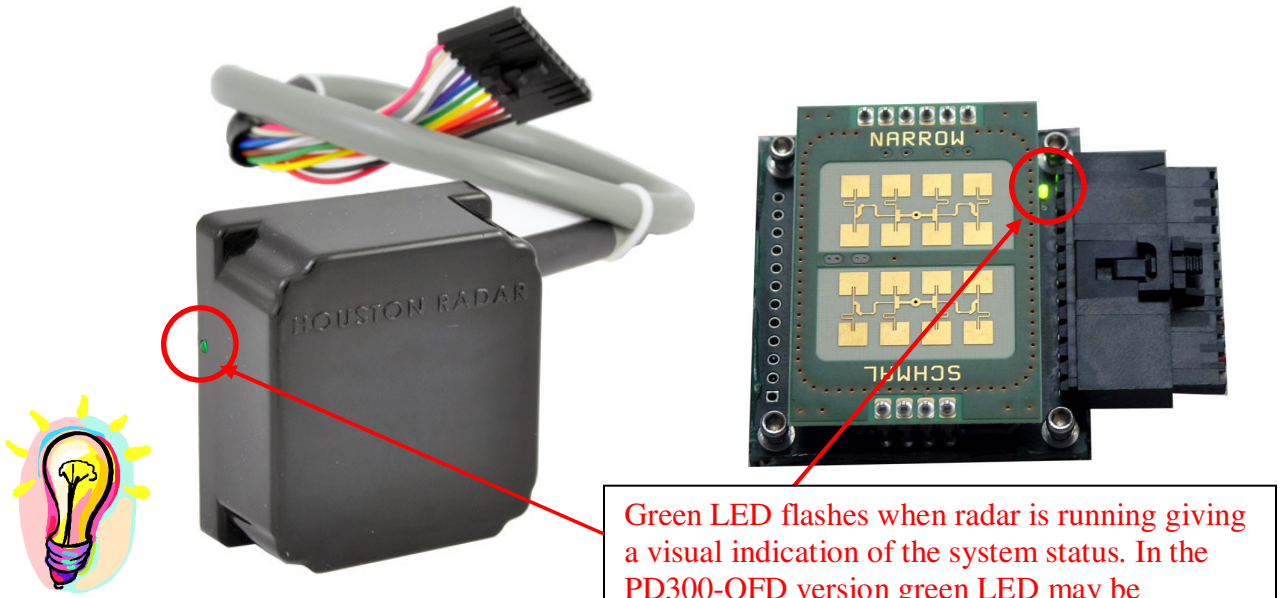
1. Signal strength. Very weak targets may not be able to achieve this resolution. A target strength of at least 100 counts is required to achieve this resolution.
2. Multiple return signals from same target. A large target with complex shape such a vehicle has many contours that return the radar energy back to the radar with different signal strengths. Additionally, these contours are located at different linear distances from the radar. Since the radar tracks individual targets, all these are merged together into a single reading for that target. As the vehicle is traveling across the radar detection zone, these combined calculations will result in a range reading that will vary materially more than the specified resolution of the radar.
   That said, the range resolution enhancement algorithm is able to achieve significantly better effective range measurement as compared to competing products, in many cases as much as 5 to 10x better performance.

## Initial One Time Setup:

You should initially configure the radar for your intended application at the installation site to ensure proper operation.

To configure the radar, you must provide DC power within the specified requirements, connect the radar's RS232 interface to a MS Windows PC RS232 COM port (or a USB to serial adapter) and install Houston Radar Configuration tool or Houston Radar Stats Analyzer.

Note: only newer versions support PD300. Please contact Houston Radar for the latest version if a disk was not shipped with your radar or you have misplaced it.




Green LED flashes when radar is running giving a visual indication of the system status. In the PD300-OFD version green LED may be installed on the front or the back depending on the requested build option.



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## User Selected Operating Modes:

The PD300 features two different operating modes that should be selected by the user depending on their intended application: “Highway” and “Intersection”.

*Highway mode (side firing only)*

Highway mode in a side firing application is used for occupancy measurements, vehicle detection and counting at typical city and highway traffic speeds. It can easily distinguish between closely following individual vehicles in the multiple lanes. Traffic is expected to be moving most of the time. If traffic does slow down and come to an occasional stop, it is acceptable that the radar may experience brief dropouts as the vehicle moves across the detection zone.

The radar must be mounted so that it looks across the road and NOT directly into incoming or receding traffic.

*Intersection mode (side or front firing)*

Intersection mode is used for presence detection of stopped or slow moving (<14mph) vehicles. It is optimized to continuously track targets with minimal signal dropouts as the vehicle slowly moves through the radar detection zone or comes to a complete stop for significant amount of time.
This mode may be used in a side-firing configuration or a front-firing configuration (where the vehicle directly approaches or recedes from the radar at a low speed).

*Highway mode (front firing only)*

This mode is expected to be supported in the future via a firmware upgrade. In this mode, the radar may be mounted such that traffic approaches or recedes from the radar at considerable speed and both range and speed are measured.
Contact us if you have a requirement for this mode.

## User Configured Detection Lanes:

A lane is a user-configurable range slot within the radar’s detection zone. When a vehicle is present within this slot, the lane gets “activated”. Lane activations are used for presence indication whereas vehicle tracking is used for counting. For example if a vehicle has crossed from lane to lane it will be counted once and both lanes will get activated sequentially. If a lane is mapped to a hardware trigger output, the radar asserts that trigger and keeps it asserted for as long as the vehicle remains in that lane. Multiple lanes can be mapped to the same hardware trigger output. In this case the output will be asserted for as long as there vehicles in any of the mapped lanes.

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Target presence information in each lane is also available in real-time to an attached controller via the serial port. This requires the external controller to communicate with the radar via the Houston Radar Binary protocol. The protocol is the same as the one used with our Doppler radars. Please contact us for SDK (software development kit) if you wish to utilize this feature.

Typically, you would configure one or more detection lanes during initial setup. Please note that the radar measures distance along the linear line of view from the radar to the target. It does not correct for mounting height. This is usually not a problem as the supplied configuration program displays all targets in real time regardless of lane setup and the user simply draws the lane boundaries around the displayed targets. No manual calculations are required.

Once lanes are configured you may map one or more of them to a hardware output. When the radar detects a target presence within a configured lane(s), it will assert the associated hardware output.

If you have a controller board connected to the serial port of the radar, you may also obtain lane-by-lane target information on a real-time basis.

## Background Clutter Compensation:

Since the radar can detect stationary targets, things like fences, road curbs, lane separators, traffic signs and other unwanted targets need to be processed and eliminated from the output. In order to do so the radar maintains a clutter map where it stores all these unwanted targets. The clutter map is subtracted from the signal leaving only true targets to report.

The radar continuously adjusts the clutter map to account for changing conditions. The rate of the adjustment is called clutter time constant (CTC). CTC specifies how long does it take for an average target to fade away into the background (become part of the clutter map and no longer reported as a true target). CTC is a user programmable value and can be set from 1 second to 28 minutes.

For a fast moving traffic CTC may be set to a lower value whereas for a stopped traffic it is beneficial to be set it to a higher value. Besides automatic continuous adjustment the user can issue a command to take a snapshot of the current clutter map and use it as a new basis for further adjustment. Typical use case is to issue this command during setup when road is clear of the vehicles so you do not have to wait for an automatic adjustment to take place. The adjustment rate is asymmetric - the clutter is adjusted up slowly (targets fade away slowly) but is adjusted down fast. This facilitates improved clutter map maintenance in situations where traffic density is high.



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*Choosing a CTC value:*

Typically you would set the CTC value to be at least 10 times longer than the maximum expected presence time of real targets.

Settings the CTC to too short a value may result in real targets fading into the background resulting in poor detection.

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*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 will be available as an option in the radar in the future.

*The radar does not feature a clock backup battery. The power must remain connected to the radar for the clock to keep time. However an external clock battery may be connected to keep time while radar goes into low power sleep mode. See Appendix C for more details.*

Set Serial Baud Rate:

The supplied Windows configuration program can auto detect the baud rate of the radar serial port. However if you wish to communicate with the radar from your electronics, the radar serial port may be configured to different baud rates. Please use the supplied configuration tool to set the baud rate of the radar's serial port

## Using the Supplied Windows program to configure the radar:

1. Install the provided Houston Radar Advanced Stats Analyzer (or Houston Radar Configuration Tool) program on a Windows 2000, XP, Vista or Win 7 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 to serial converter dongle. These dongles are available from BestBuy, Radioshack or many Internet stores.
3. Power up the radar. Ensure the green LED on the front (side or back as the case may be) flashes.
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 number will depend on your computer configuration.
8. Click on OK. Now you are ready to configure the radar.
9. Use PD300 Setup tab to select and save configuration options. See a screen snapshot below.
10. Lane configuration is done via PD300 Plot tab. See a screen snapshot below.
11. To configure any advanced options, click on "Advanced->Radar Configuration". In the window that comes up, enter the two letter variable name in the "Variable" field. Enter its value in the "Value" field and click on "Set Variable" button.

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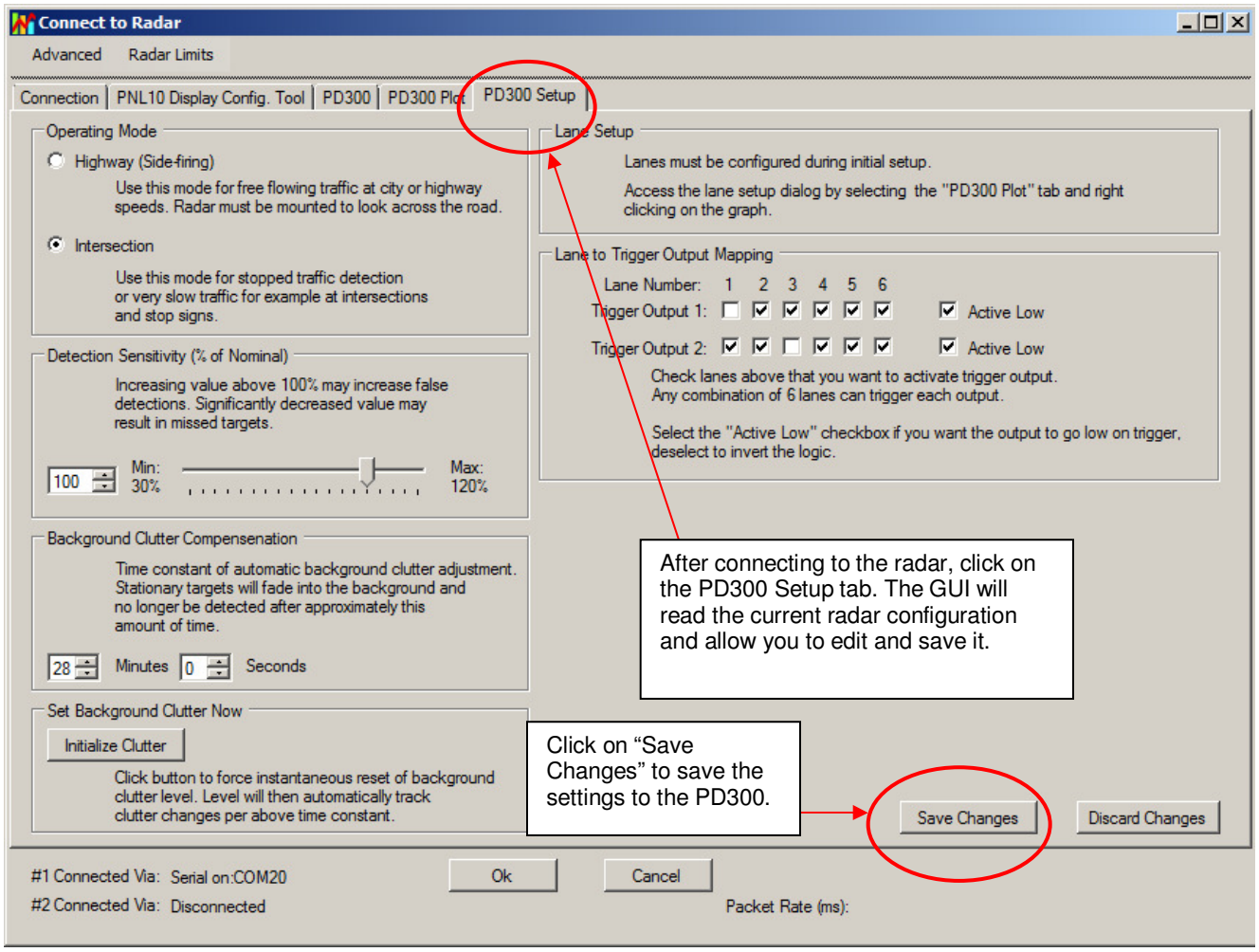
*PD300 Basic Application Setup:*

**STEP #1: Select Application Mode and back clutter adjustment time constant**.
See the section on Clutter earlier for a detailed explanation on this setting.




**STEP #2: Initialize clutter to correct startup value.**
The PD300 continuously adjusts clutter to changes in the background with the time constant specified above. However, to facilitate immediate view of real time targets and lane setup, it's advantageous to set the initial clutter level to eliminate fixed targets when no real targets are present in the radar's view.
To do this, ensure radar is securely mounted in desired position, wait for the field in front of the radar to clear of any real targets (vehicles you wish to detect), and then click on the "Initialize Clutter" button in the screen shown above.
If you now click over the "PD300 Plot" window, no new targets should be streaming from the x=0 (right most) side. Of course you may still have older targets showing on the plot but they will scroll off eventually off the left side of the chart. **You should re-initialize clutter if you make any changes to the radar mounting (height or angle).**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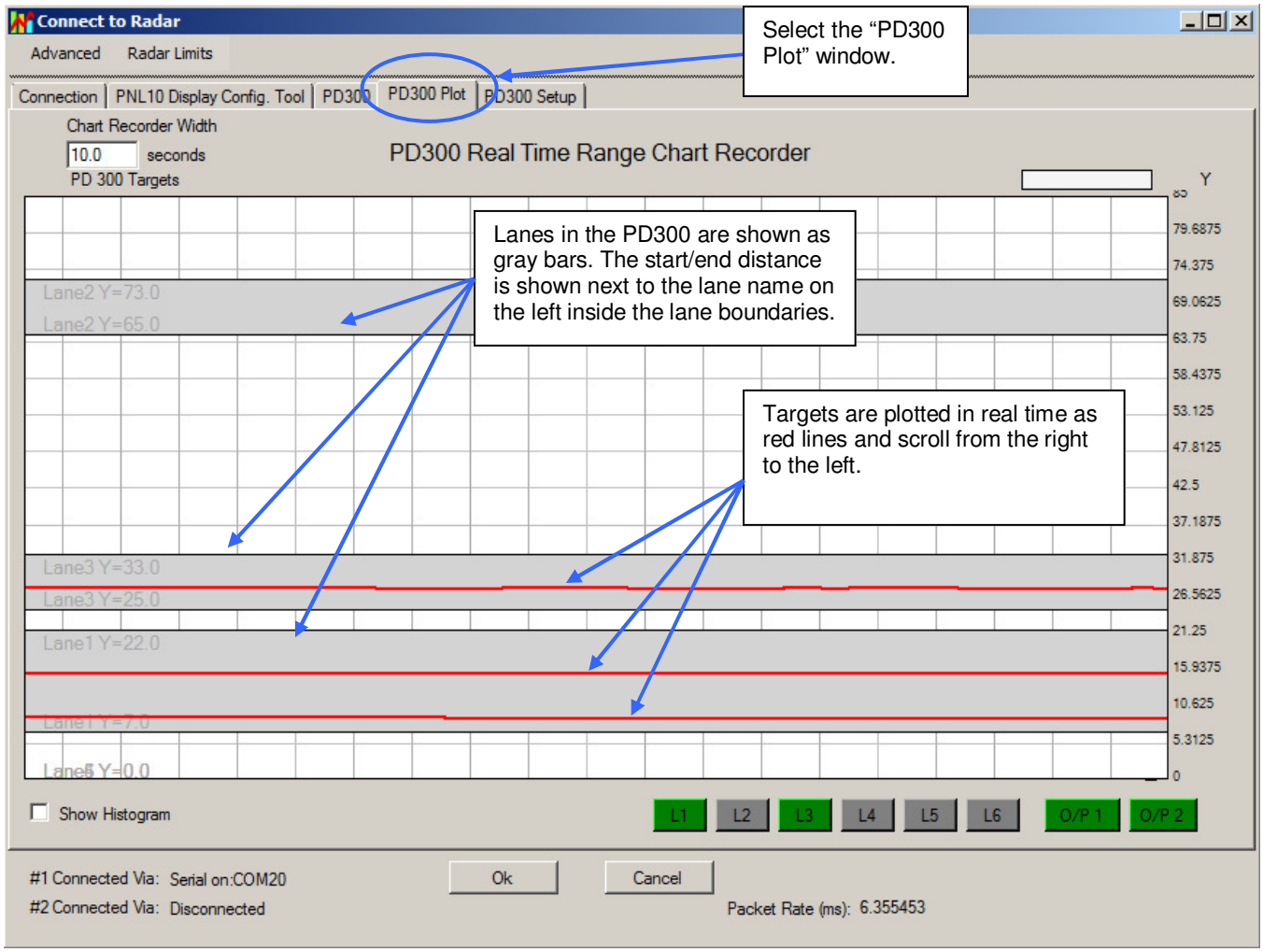
*PD300 Lane Setup:*

**STEP #3: Setup lanes per your requirement within the radar's detection zone.**

After selecting the application ("Highway" or "Intersection"), click on the "PD300 Plot" tab. This will bring up a real time "chart recorder" type plot of tracked targets as shown below.




Typical Real Time Chart Recorder View of "Intersection Mode". 3 targets are shown and are stationary in this view (horizontal target lines means distance to target is not changing over time). You may enable histogram to show all observed targets stacked up on the left. This will provide better statistical data for lane configuration.

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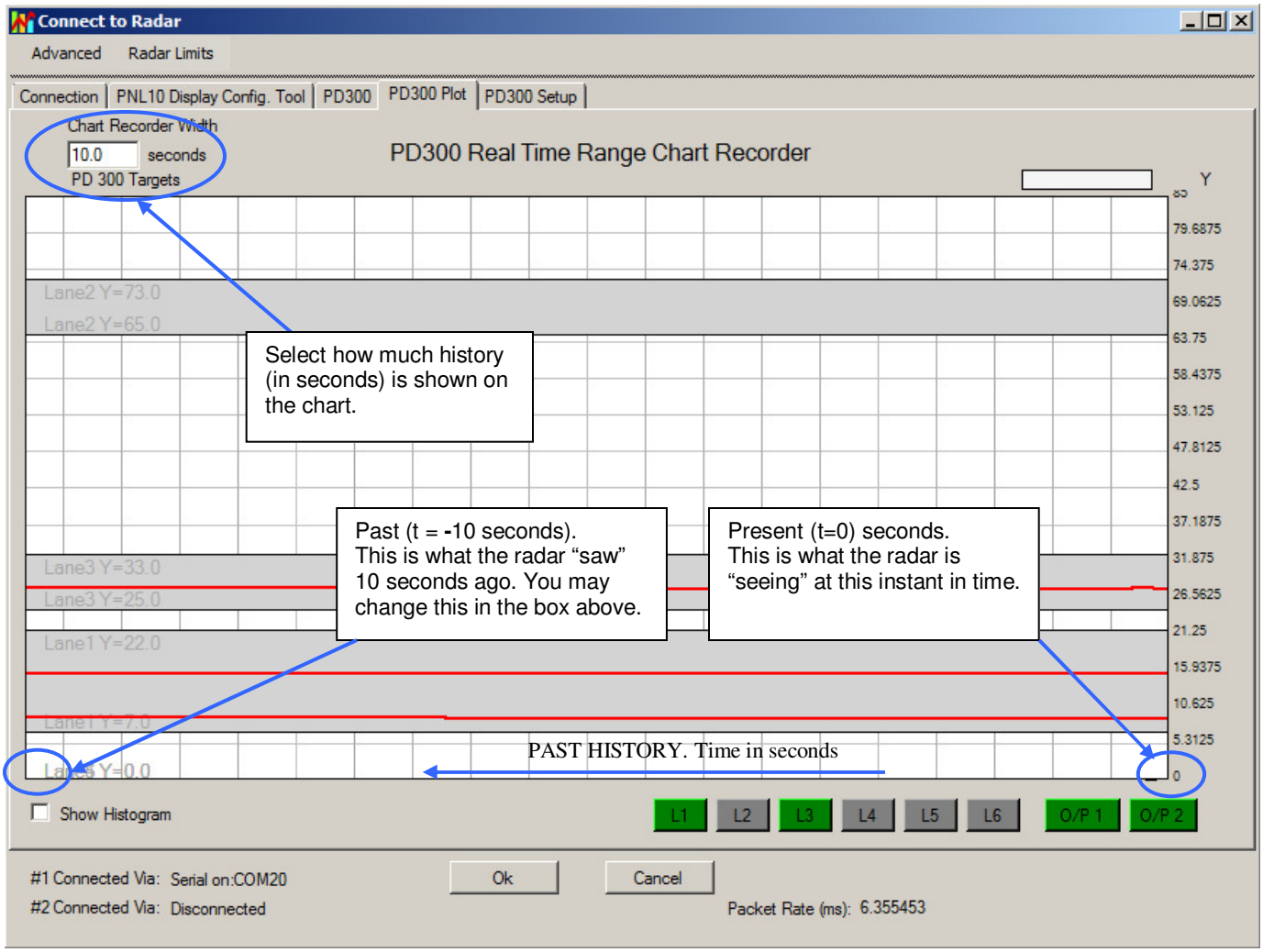
PD300 Lane Setup Continued:

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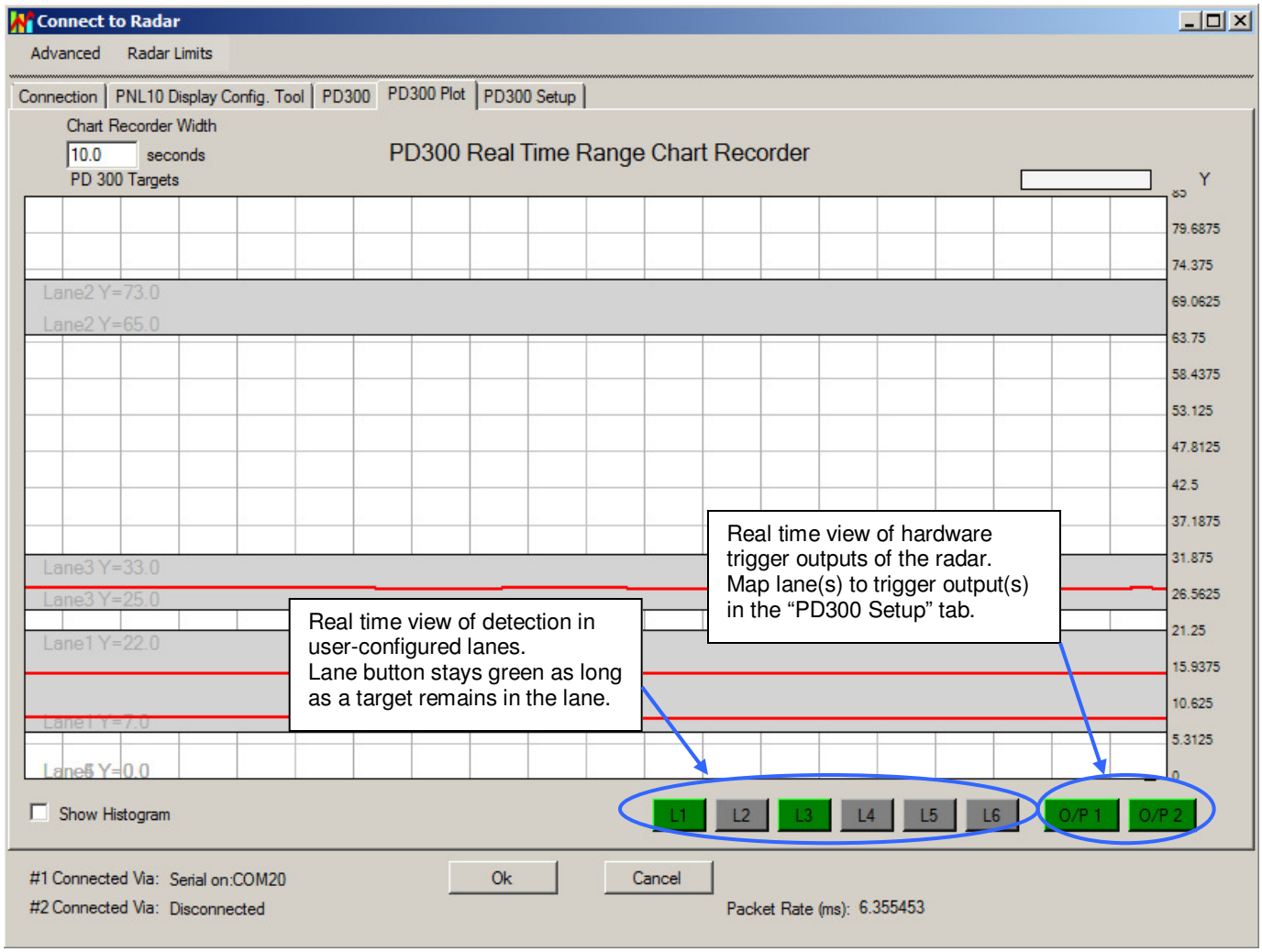
PD300 Lane Setup Continued:



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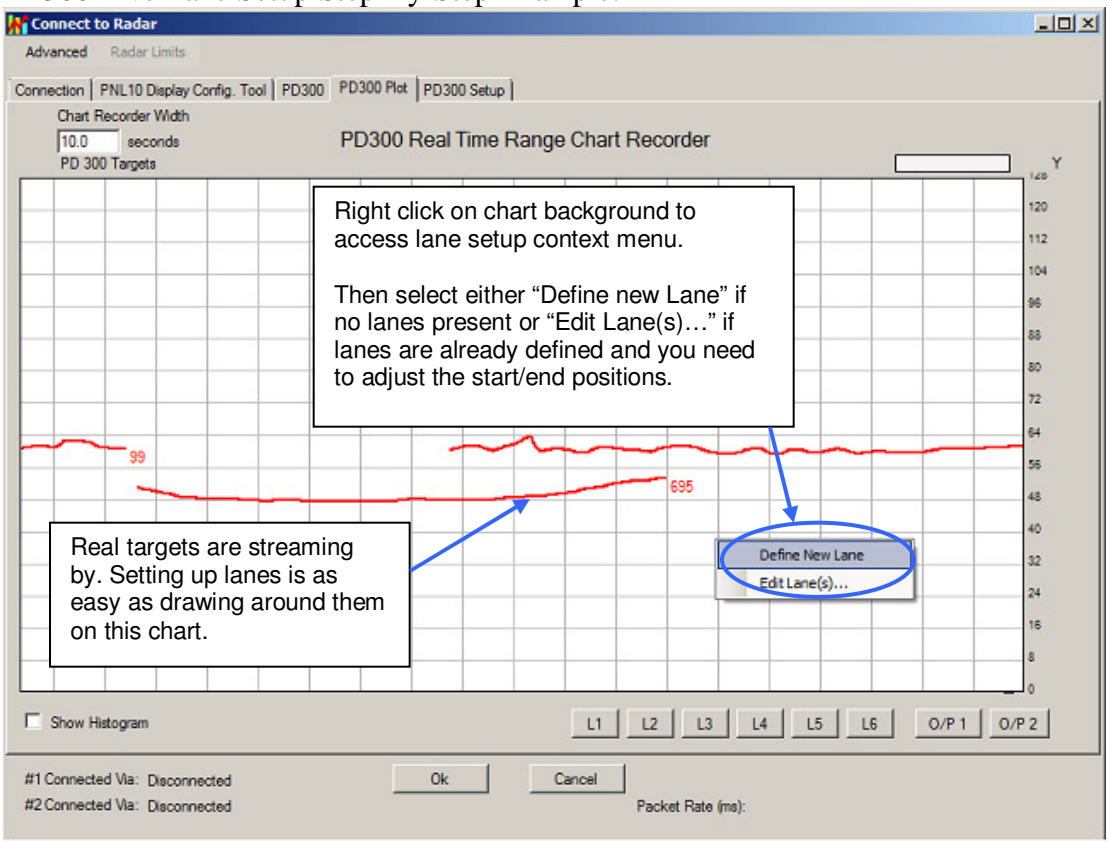
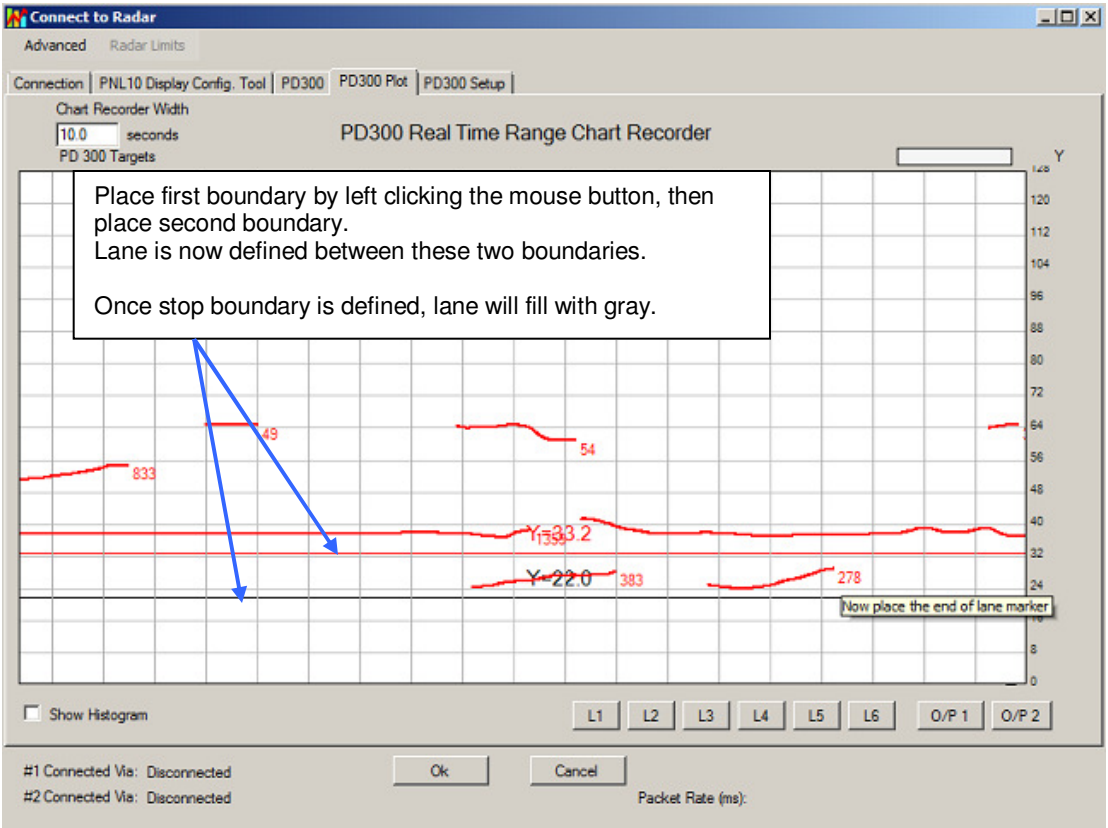
PD300 Live Lane Setup Step-By-Step Example:

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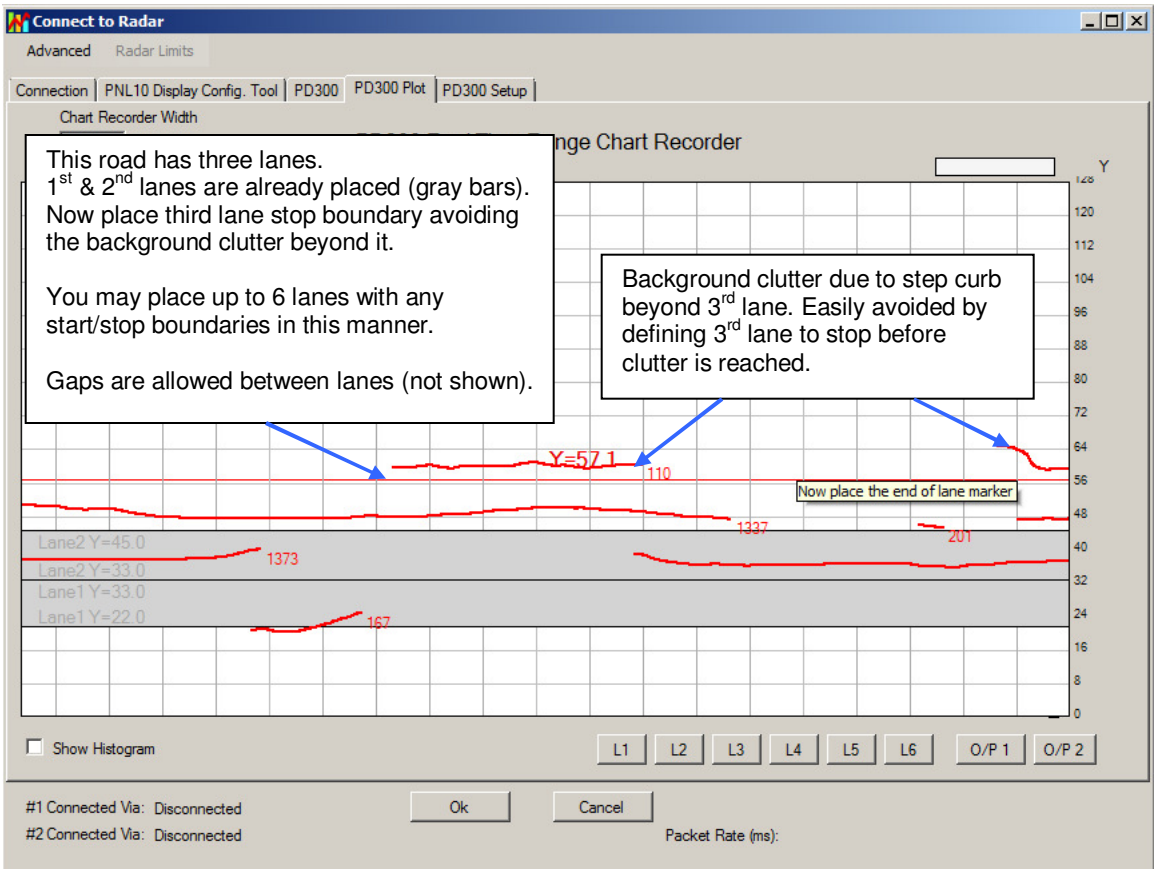
PD300 Live Lane Setup Step-By-Step Example Continued…




Example of placing three lanes. 3rd lane has clutter beyond it due to a curb reflecting back. Real time range plot easily allows user to place 3rd lane boundary (thin red line) visually based on real time plot of targets.

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# PD300 SPECIFICATIONS

## General

| | |
|---|---|
| Operating Band | K-Band |
| Occupied Bandwidth | 24.020 GHz to 24.230 GHz |
| RF Power Output | 5mW |
| Antenna Beam Pattern | 45deg x 38 deg |
| Max Range | 120 feet in Highway mode, 80 feet in Intersection Mode |
| Range Resolution | 0.375 inch in Highway Mode, 0.25 inch in Intersection Mode |
| Polarization | Linear |
| Supply Voltage | 5.5V DC to 18V DC |
| Reverse Battery | Protected |
| Power Consumption | 0.17W |
| Nominal Current @12V | 14mA typ avg. |
| Operating Temp. | -22°F to +185°F<br>(-30°C to +85°C). Electronics designed and tested to –40C. |
| Weatherproof | Yes (PD300-DFT build option). Open frame also available. |
| IR Remote Programmable | No |

## Approvals

| | |
|---|---|
| Approvals | FCC and CE. |

## Data Interfaces

| | |
|---|---|
| Serial Communication | RS232 |
| Data Rate | Baud Rates from<br>1200 to 230400 baud |
| Data & Pwr Connector | PD300-OFD:Molex “C Grid SL” male shrouded 12 pin RA part #70553-0011<br>PD300-DFT:Molex “C Grid SL” female 12 pin (mate to above #) |

## Mechanical

| | |
|---|---|
| Weight | approx 33 grams (1.16 oz) |
| Dimensions | 2.1”x1.75”x0.6” (LxWxD) 52 x 46 x 16mm |
| Cable Exit | PD300-OFD: Side via right angle connector<br>PD300-DFT: Encapsulated cable from back |
| Mounting | Four #2-56 standoff’s embedded on module |

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

The PD300 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).

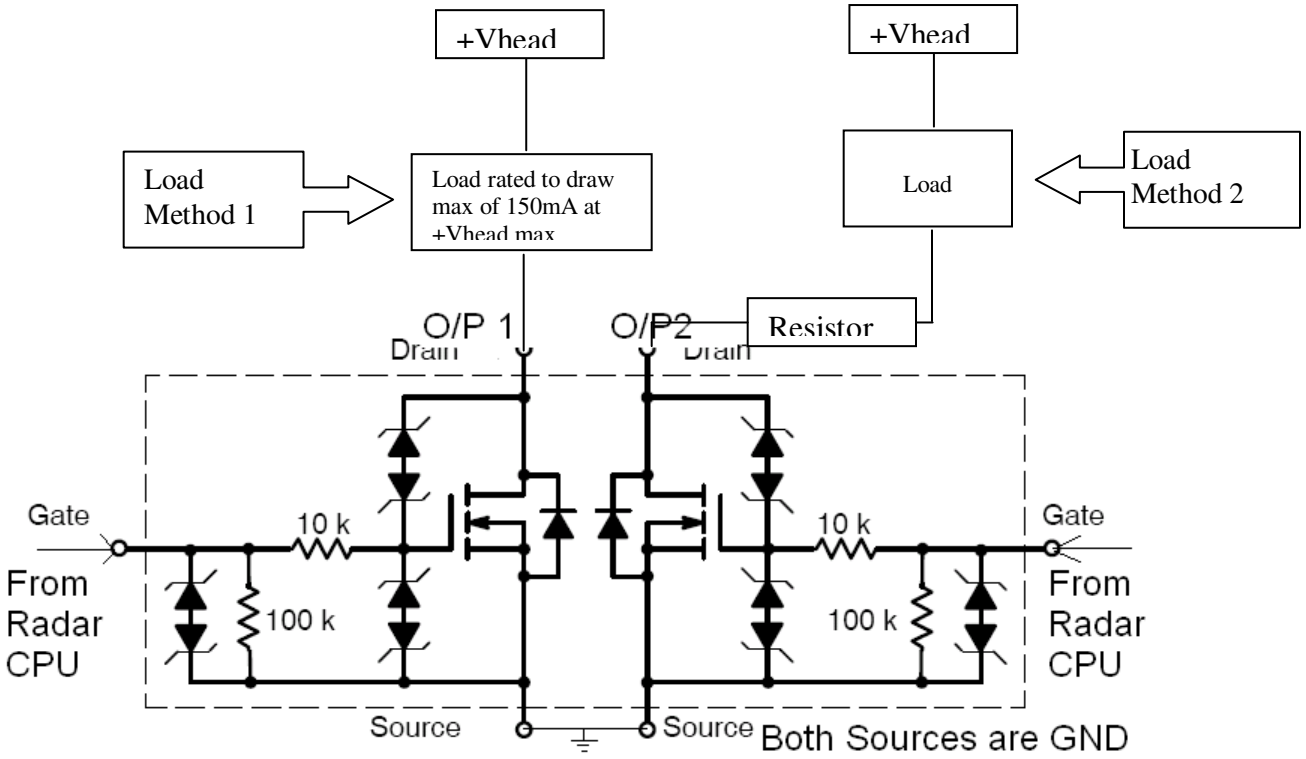
This device can sink 150mA of DC current at up to 28VDC.

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



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