

***Directional
Radar
Unit
III***

OPERATOR'S MANUAL



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REV. 0

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INTRODUCTION

This Directional Radar Unit, known as DRU III, is designed and built for target speed sensing applications.

The DRU III has designed for flexibility, simple operation, small size and extremely low current consumption. The DRU III is intended for uses in traffic, industrial, and sports products. Examples of these applications are the Kustom Signals' S.M.A.R.T. series trailers, Pole Mounted Speed Displays and StealthStat statistics gathering systems.

The DRU III is designed to be an extremely flexible unit. Kustom Signals provides PC software to allow the user to setup the DRU III to operate in many different configurations.

The radar itself is incredibly simple to operate--just connect it to a compatible display or PC, and power it up. The DRU III will output RS232 speed data in the selected output protocol as long as the unit is powered.

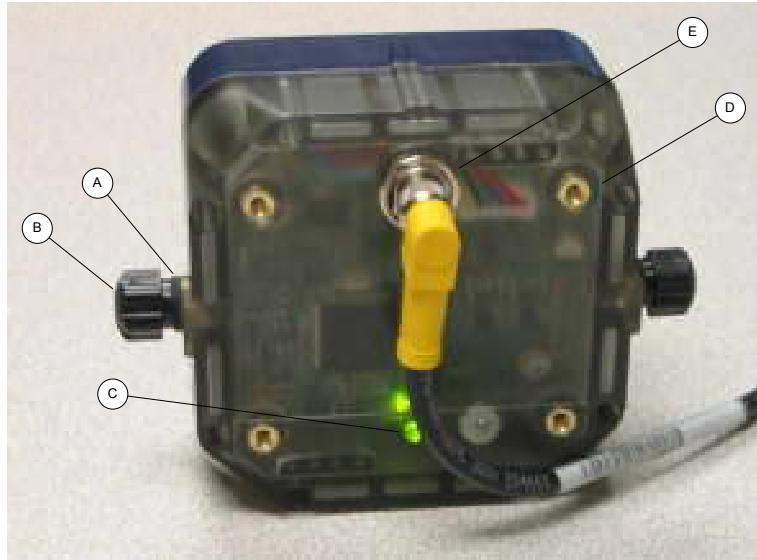
With a size of only 3" x 3" x 1.5" the DRU III is a complete one-piece unit, that can easily be mount to the user's equipment.

The DRU III sets a new standard for low current consumption. This dramatically improves run times in battery-operated applications.

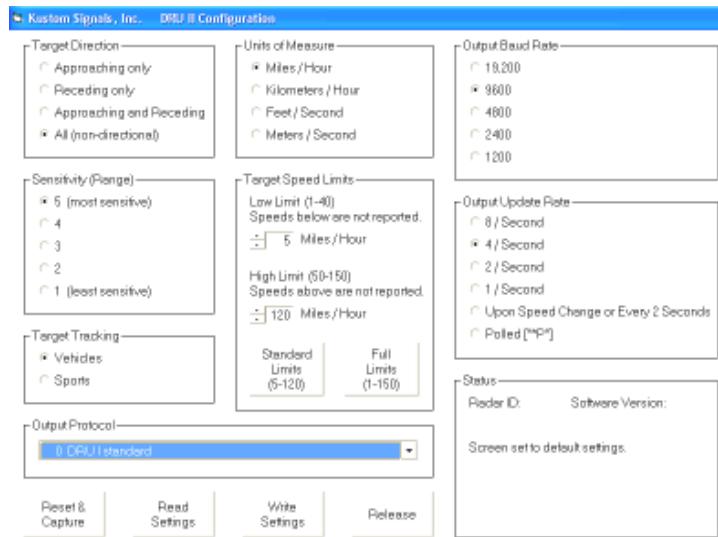
The DRU III has Kustom Signals' uncompromising quality inside to give you years of trouble-free, accurate, reliable, speed measurements.

SYSTEM OPERATION

RADAR REAR VIEW



- A. RUBBER WASHER:** (2ea.) Rests on mounting screws between mounting bracket and radar unit.
- B. MOUNTING BRACKET SCREW:** (2ea.) Connects bracket to radar unit.
- C. INDICATOR LED:** Strongest target direction indicator.
- D. OPTIONAL MOUNTING INSERTS:** (4ea.) Provides optional mounting for customer's brackets.
- E. POWER AND DATA CONNECTOR:** Connections for input power and bi-directional RS232 serial data cable.

CONFIGURATION OPTIONS

The DRU III was designed to give the user a configurable radar unit that can be setup for their needs. A simple PC program let the user select:

1. Target Direction: The DRU III can output speeds for targets traveling in the direction of:
 - a. Approaching Only
 - b. Receding Only
 - c. Approaching and Receding
 - d. Non Directional (all targets output)
2. Sensitivity (Range): The DRU III can be set for sensitivity from 5 (most sensitive) to 1 (least sensitive).

SYSTEM OPERATION

3. Target Tracking: The DRU III can be set to Vehicle or Sports tracking. With vehicle tracking, targets are acquired with a longer tracking history and have a 2 second target hang time. Sports' tracking has a quick acquisition time and only a $\frac{1}{2}$ second target hang time.
4. Units of Measure: The DRU III can output speeds in:
 - a. Miles per hour (MPH)
 - b. Kilometer per hour (km/hr)
 - c. Feet per second (Ft/Sec)
 - d. Meters per second (Mt/Sec)

Note: All speeds are calculated in tenth units of measure. The user selects if they want the output in tenths or units.

5. Target Speed Limits: The DRU III can quickly be set to the Standard speed range for speeds from 5 – 120 MPH or the Full speed range for speeds from 1 – 150 MPH. For more flexibility the user can input a Low Cutoff limit (speeds below this are not reported) and a High Cutoff limit (speeds above this are not reported.)
6. Output Protocol: The DRU III can output one of several different protocols. Including outputs in HEX, ASCII, multiple targets, tenth units, and many others.
7. Output Baud Rate: The DRU III can be set to output RS232 data at rates of (19200, 9600, 4800, 2400, or 1200) baud.

8. Output Update Rate: The DRU III can be set to output packets of speed data at rates of (8 times per second, 4 times a second, 2 times a second, once a second, upon speed change, or when the user's equipment polls for data)

Note: If Output Update Rate is set to upon speed change, the DRU III outputs speeds immediately when the speeds changes by at least one unit or once every two seconds if the speed is not changing. If the DRU III is set to the Polled output, data is output when the DRU III receives characters [“*P”] or [“*P”0x0D].

9. During the configuration session, the Status box will display information about the connected DRU III and the status of the configuration operations.

To configure your DRU III unit, connect the DRU III data connector to the PC comm. port 1 and apply power to the DRU III. Click the Reset & Capture button to capture the DRU III for configuration. You can click the Read Settings button to populate the configuration screen with the current DRU III settings. Make any required changes in the configuration options and click the Write Settings to store these changes in the DRU III. When finished, click the Release button to return the DRU III to normal operation with the new configuration settings.

SYSTEM OPERATION

INSTALLATION

Install the DRU III unit into your system as follows:

1. Mount the radar in its bracket.
2. Attach the end of the power/data cable to the 6-pin connector on the back of the DRU III. Ensure the plug and socket is aligned properly before tightening the screw ring. Ensure the connection is firm and tighten the connector's screw ring.
3. Plug the other end of the cable's data leads to a compatible display or PC.
4. Connect the cable's power leads to 8 – 16.5VDC source.

MONITORING TARGET SPEEDS

Aim the radar carefully, as nearly as possible directly in the target path.

Once the radar has been properly set up and powered it is ready for use. Acquiring and displaying valid target speeds requires proper antenna aiming.

Be alert to terrain or roadside features, which can cause interference, incorrect readings, or display blanking. (Such features include power lines, radio/TV transmitters, bridges, guardrails, signs, buildings and other large reflectors, etc.)

TUNING FORK TEST

The DRU III unit can be configured to output speeds of targets that are approaching only, receding only, both approaching and receding, or all targets including non-directional targets. Tuning forks can only be reliably read in the all targets mode. (Tuning fork signals are generally non-directional targets).

NOTE: Some display systems only display non-directional target for a short time after power up.

A 35 MPH (or 45 KPH) tuning fork is supplied with the radar. Strike the tuning fork on a hard, non-metallic surface. Hold the vibrating tuning fork approximately one inch in front of the antenna. The output speed should register "35" ("45"). Please note--readings of ± 1 MPH (KPH) are considered acceptable.

If the proper reading is not obtained:

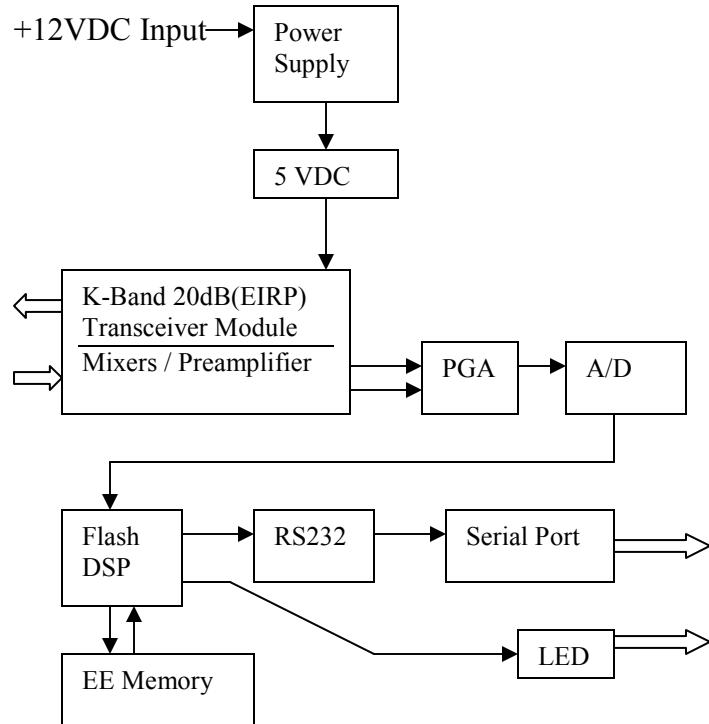
1. Make sure that Kustom Signals K-Band tuning forks have been used ("K-Band" is stamped plainly on each fork). A different band tuning fork, or tuning forks designed for other manufacturers' radar, will not give the proper readings.
2. Striking the tuning forks too hard may produce false overtones, which may be read as speeds above or below those specified. These possible false readings are momentary, and the proper readings should appear as the false overtones dissipate. Do not move the tuning forks after placing them in front of the antenna.

SYSTEM OPERATION

3. Extremely cold or extremely hot tuning forks may give readings slightly above or below those specified, due to the effect of extreme temperature on the metal. If this is the case, warm or cool the forks to normal room temperature before use.

THEORY OF OPERATION

Block Diagram:



The Directional Radar Unit (DRU III) transmits a radio frequency of 24.125 Gigahertz, in accordance with Federal Communications Commission regulations. When the transmitted signal strikes a moving target, it returns at a different frequency because there is relative motion between the two objects (radar unit and target). Targets approaching the radar will return an echo higher than the transmitted frequency. Targets receding from the radar will return a lower frequency echo.

GENERAL INFORMATION

This returning signal is mixed with the transmitted signal in a balanced I/Q demodulator mixer. The difference in frequency (Doppler frequency) is proportional to the speed of the target; the difference in phase is related to the direction of target travel. These returned echo signals are a very low level. The Preamplifier and Programmable Gain Amplifier stages increase the signal levels.

The signals are then converted from analog to digital by the A/D converter. This digital signal stream is feed to the Digital Signal Processor (DSP). The DSP transforms the data to the frequency domain, where the data is analyzed and processed to find valid targets.

To become a valid target the signals must meet the criteria setup by the user for target directionality and speed limitations. The DSP will convert the speed of the valid targets into the unit of measure set by the user and output the RS232 data via the serial port.

POWER / DATA CONNECTOR

The user configures the format of the serial data that comes out the data port. There are several different protocol formats and baud rates to choose from. The pin out for the Power / Data connector is as follows:

1. Brown – Input power (8 – 16 VDC)
2. White – RS232 data into the DRU III
3. Blue – RS232 data out of the DRU III
4. Black -- Hold Control
5. Gray -- Ground
6. Pink – Open collector alarm

LED INDICATOR

The DRU III has a bicolor LED to indicate the status of the current strongest valid target. The statuses the LED can indicate are as follows:

1. Short burst of flashing red = DRU III is running, no valid target present.
2. Red flashing at 50% duty cycle = strongest target is not moving.
3. Solid Red = strongest target is receding.
4. Solid Green = strongest target is approaching.

GENERAL INFORMATION

INTERFERENCE

Interference from any external event can influence the operation of the radar. These influences can be natural or man-made. A knowledgeable operator will not be confused by these external influences.

Natural events such as driving rain or blowing dust can cause a scattering effect, or diffusion, which can decrease the effective range of the radar. Terrain can also affect the radar's range. If the device be on a slight decline, the antenna could be shooting short of the target. If on a slight incline, it could be shooting over the target. Range will be decreased in either case.

Man-made influences are by far the most troublesome, because they generally involve electronic signals, which may cause spurious displays. Power transformers, radio transmitters, fans, etc generate electronic noise signals.

If the power supply voltage to the DRU III unit drops below the level required for proper operation, power to the microwave transmitter will be turned off. This prevents false readings from occurring during periods of low voltage.

RECOMMENDED CARE AND MAINTENANCE

The DRU III radar is a sturdy, reliable piece of equipment designed and built to give trouble-free service. Following certain basic care guidelines will help ensure you receive that trouble-free service.

1. As with all electrical or electronic equipment, protect from moisture. Should liquid of any kind get inside the unit, remove power immediately and send for repair. Prompt action can minimize damage.
2. Over-current protection is provided by an internal automatic resetting device. There are no user-serviceable parts in the unit. NEVER wire directly into AC current!!
3. Do not pick up or carry the DRU III by the power / data cable. Do not yank or twist the cable, especially near the base. Broken wires inside the cables are a common cause of intermittent operation.
4. Use care when attaching or removing the power / data cable to the DRU III to avoid bending or breaking connector pins. Ensure the plug and socket are aligned properly before tightening the screw ring.
5. Remove system power before connecting or disconnecting any cable wiring.

GENERAL INFORMATION

KSI RADAR MICROWAVE EMISSION

A traffic radar operator may justifiably have some concerns about the biological effects of exposure to the microwave energy produced by the radar device. According to all credible evidence, the emission levels resulting from traffic radar use pose no threat whatsoever, either to the radar operator or to target vehicle occupants.

One widely recognized authority for safe limits of nonionizing radiation exposure is the American National Standards Institute, which recommends a maximum power density of 10.0 mW/cm^2 for the frequency bands on which Kustom Signals traffic radar systems operate (ANSI C95.1-1994, "American National Standards Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300 KHz to 100 GHz").

The Center for Devices and Radiological Health, an agency of the U.S. Food and Drug Administration, recommends similar limits (Title 21 Code of Federal Regulation, Subchapter J, Section 1030.10, "Performance Standards for Microwave and Radio Frequency Emitting Products"). The 10.0 mW/cm^2 limit is clearly accepted by most reputable scientific and medical authorities.

GENERAL INFORMATION

All Kustom Signals' radar systems utilize microwave oscillators, which produce aperture power densities, measured directly at the face of the antenna, in the range of approximately 0.3 to 2.3 mW/cm². The vast majority of units produce values in the 0.3 to 0.6 mW/cm² range. Under no circumstances would a Kustom Signals traffic radar unit be capable of producing an aperture power density in excess of 4.0 mW/cm², still well below the safe limit. Bear in mind that these are level measurements taken directly in the main beam of the antenna, and that the power densities produced at the sides and rear of the unit are typically at least one hundred times lower than in the main beam.

Another reference document on this topic is a DOT publication entitled "Field Strength Measurements of Speed Measuring Radar Units" (NHTSA Technical Report #DOT-HS-805 9 8). This report documents a series of tests performed by the National Bureau of Standards on twenty-two commonly used traffic radar units. Aperture power density levels measured were from 0.25 to 2.82 mW/cm², while back-lobe power density values ranged from 0.001 to 0.02 mW/cm². These measurements were obtained with the radars mounted inside vehicles, as in normal operating conditions.

While traffic radar devices do emit microwave radiation, the levels are so low that there are no possible harmful effects. You may use your Kustom Signals radar unit with complete confidence in its safety, as well as in its accuracy.

TROUBLESHOOTING GUIDE

TROUBLESHOOTING

If you are having operating difficulty, recheck the operating information in this manual, then check the following before notifying your Kustom Signals service representative of a problem.

Problem	Possible Solution
No indications on LED.	Ensure power /data cable is firmly attached. Check for dirty power receptacle or dead battery.
No target indication on LED, no speed readings RS232.	Check antenna aim; ensure beam is not being obstructed.
No speed-readings RS232, LED indicating targets.	Check power / data cable connections.
Intermittent speed readings	Often caused by interference from stray noise (Fans, electrical equipment, RFI).
Lack of Range	Check antenna aim and ensure the beam is not being obstructed. Check and ensure the sensitivity level has not been set to low level by configuration software.

NOTE: Problems with the displays can be caused by a malfunction of the radar, the connecting cable, as well as the display itself. Try to determine which component of the system is causing the problem by switching radar units and cables if possible.

TECHNICAL SPECIFICATIONS

MICROWAVE

Frequency: $24.125 \pm .1$ Ghz (K-Band)
Output Power (EIRP): 20dBm
Source: PHEMT or DRO
Antenna Type: Planar Array
Polarization: Linear
Horizontal Beamwidth: 12°
Receiver Type: Dual Channel low noise

GENERAL

Supply Voltage Range: 7.4 - 24.0 VDC
12.6 VDC (nominal)
Supply Current < 100ma. @12.6 VDC
Environmental: -30°C to $+65^{\circ}\text{C}$; 90% relative humidity at $+37^{\circ}\text{C}$, noncondensing
Target Speed Range: User selectable from 1 – 150 MPH.
Size: 3.7" H x 3.0" W x 1.5" D
Accuracy: ± 1 MPH or KPH

REFERENCES

FCC INFORMATION

FCC IDENTIFIER	IVQDRU-III
Name of Grantee	Kustom Signals Inc.

The DRU III has been tested and found to comply with the limits pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Warning: Changes or modifications to this device not expressly approved by Kustom Signals Inc. could void the user's authority to operate the equipment.

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.

WARRANTY

The Kustom Signals ***Traffic Safety Radar*** system is guaranteed to be free of defects in materials and workmanship for a period of two (2) years from date of delivery to the Owner or Lessee.

- This Warranty applies only to the original registered Owner or Lessee on file at Kustom Signals, Inc., and cannot be assigned or transferred to a third party.
- The Owner or Lessee shall use the Equipment in accordance with the manufacturer's operational instructions.
- The Owner's or Lessee's exclusive remedy under this Warranty is limited to repair to the manufacturer's operational specifications or replacement, at the sole discretion of Kustom Signals, Inc. or its agent, of the Equipment as (i) is covered by this Warranty; (ii) is delivered to Kustom Signals, Inc. or its agent at the Owner's or Lessee's expense within the term of this Warranty; and (iii) upon examination thereof discloses to the exclusive satisfaction of Kustom Signals, Inc. or its agent to have been defective in material or workmanship. Warranty service and repairs must be performed by an Authorized Kustom Signals Warranty Service Center or the Factory Customer Service Center or this Warranty is void.
- Failure of the Owner or Lessee to observe any conditions set forth in this warranty; or equipment damage arising from flood, fire, vehicle collision, act of God or similar event or catastrophe; or tampering, abuse, or misuse of the equipment by Owner, Lessee or third party will render the Owner or Lessee responsible for the cost of bringing the system within the manufacturer's operational specifications.

WARRANTY

- This warranty is not intended to supplant normal care and service by the Owner or Lessee, as specified in the Operator's Manual, and shall not apply to Equipment which has been defaced or damaged through normal usage.
- The liability of Kustom Signals, Inc., if any, with respect to the equipment, shall be limited as provided in this Warranty. Kustom Signals, Inc. disclaims any obligation or liability for the loss of use of the Equipment warranted, loss of time, inconvenience, commercial loss or other direct, consequential, special or incidental damages. Kustom Signals, Inc. makes no warranties of any kind other than as herein expressly provided, expressed or implied, and specifically disclaims the implied warranties of merchantability and of fitness for a particular purpose. You may have additional rights under this Warranty that vary from state to state.
- No action for breach of this warranty may be commenced more than one year after the date of alleged breach.

EQUIPMENT SUPPLIED WITH CONSUMABLE ITEMS

Items such as tires, non-rechargeable batteries, light bulbs, transmitter carrying pouch, and microphone cables w/microphone and windscreen are considered consumable items and as such are not covered by this warranty.

SMART RADAR

SMART system radar units are warranted for two years, subject to the warranty terms listed above.

9/2003

