

***Directional
Radar
Unit
II***

OPERATOR'S MANUAL

Copyright 2006

Kustom Signals, Inc.
All rights reserved

Printed in the United States of America

This publication may not be reproduced, stored in a retrieval system or transmitted in whole or in part in any form or by any means electronic, mechanical, photocopying, recording, or otherwise without prior written permission of Kustom Signals, Inc., 9325 Pflumm, Lenexa, Kansas 66215-3347.

TABLE OF CONTENTS

INTRODUCTION	1
SYSTEM OPERATION	
Radar Side View	2
Configuration Options	3
Installation.....	6
Monitoring Target Speeds.....	6
Tuning Fork Test.....	7
GENERAL INFORMATION	
Theory of Operation.....	9
Serial Port Output	11
LED Indicator	11
Interference	12
Recommended Care & Maintenance	13
KSI Radar Microwave Emission	14
TROUBLESHOOTING GUIDE	
Troubleshooting	16
TECHNICAL SPECIFICATIONS	
Microwave	18
General.....	18
REFERENCES	
FCC Rules.....	19
WARRANTY	21

INTRODUCTION

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

The DRU II has been completely redesigned for flexibility, simple operation, small size and extremely low current consumption. The DRU II 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 II is designed to be an extremely flexible unit. Kustom Signals provides PC software to allow the user to setup the DRU II 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 II will output RS232 speed data in the selected output protocol as long as the unit is powered.

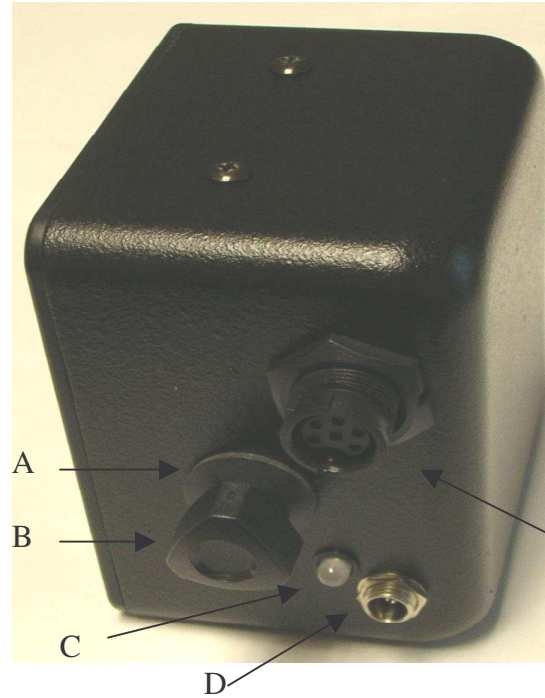
With a size of only 3.5"x 3"x 2.25" the DRU II is a complete one-piece unit, that can easily be mount to the user's equipment.

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

Although the DRU has no frills outside, it has Kustom Signals' uncompromising quality inside to give you years of trouble-free, accurate, reliable, speed measurements.

SYSTEM OPERATION

RADAR SIDE VIEW



- A. **RUBBER WASHER:** Rests on mounting screw between mounting bracket and radar unit.
- B. **MOUNTING BRACKET SCREW:** Connects bracket to radar unit.
- C. **INDICATOR LED:** Strongest target direction indicator.
- D. **POWER CONNECTOR:** Provides screw down connection to the provided power cable
- E. **DATA CONNECTOR:** Connections for bi-directional RS232 serial data cable.

CONFIGURATION OPTIONS

The DRU II 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 II 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 II can be set for sensitivity from 5 (most sensitive) to 1 (least sensitive).

SYSTEM OPERATION

3. Target Tracking: The DRU II 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 ½ second target hang time.
4. Units of Measure: The DRU II 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 tenth or units.
5. Target Speed Range: The DRU II 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 speed (speeds below this are not reported) and a High Cutoff speed (speeds above this are not reported.)
6. Output Protocol: The DRU II can output one of several different protocols. Including outputs in HEX, ASCII, multiple targets, tenth units, and many more.
7. Output Baud Rate: The DRU II can be set to output RS232 data at rates of (19200, 9600, 4800, 2400, or 1200) baud.

8. Output Update Rate: The DRU II 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 II 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 II is set to the Polled output, data is output when the DRU II receives characters [“*P”] or [“*P”0x0D].

Once all the selections have been made, click the Send Setting button to send the configuration data to the DRU II.

INSTALLATION

Install the DRU II unit into your system as follows:

1. Mount the radar in its bracket.
2. Attach one end of the data cable to the 6-pin data connector on the side of the DRU II. Ensure the connection is firm and tighten the connector's locking ring.
3. Plug the other end of the cable to the compatible display or PC.
4. Connect the power cable to the power connector on the side of the DRU II.
5. Connect the power cable 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 II 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:

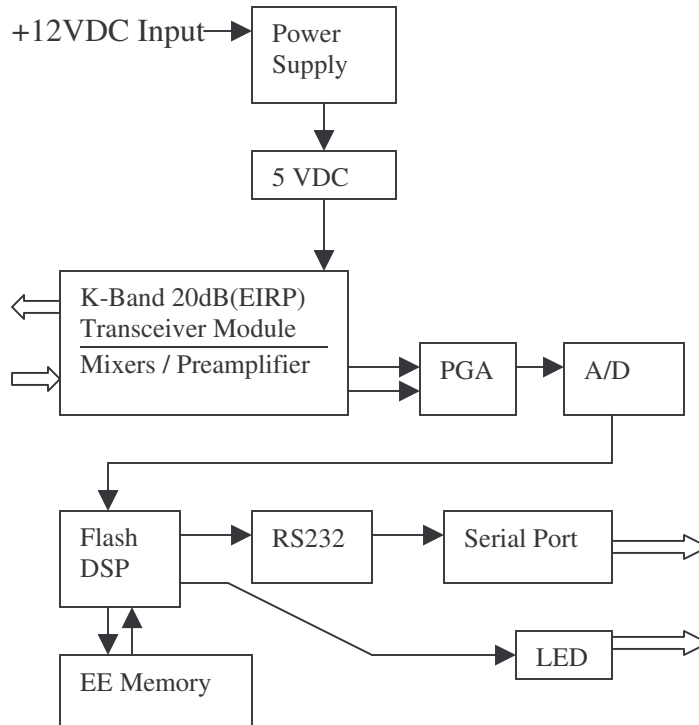
1. Make sure that Kustom Signals K-Band tuning forks have been used ("K-Band" is stamped plainly on each fork). A different band tuning fork, or tuning forks designed for other manufacturers' radar, will not give the proper readings.
2. Striking the tuning forks too hard may produce false overtones, 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 II) 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 an echo lower than the transmitted.

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. Preamplifiers and Programmable Gain Amplifiers increase the signal level.

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 moving 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.

SERIAL PORT OUTPUT

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

1. RS232 data out of the DRU II
2. Ground
3. Doppler Q analog signal
4. Hold Control
5. Doppler I analog signal
6. RS232 data in to the DRU II

LED INDICATOR

The DRU II 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 II 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.

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. Should 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 II 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 II 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. Other than the fuse at the end of the power cable, there are no user-serviceable parts in the unit. Replace fuses with the correct size and type. NEVER wire directly into AC current!!
3. Do not pick up or carry the DRU II by the power or data cables. Do not yank or twist the cables, especially near the base. Broken wires inside the cables are a common cause of intermittent operation.
4. Use care when attaching or removing the connecting cable between the DRU II and other equipment to avoid bending or breaking connector pins. Do not twist the connectors, as this can break or pinch wires inside the unit.
5. Remove system power before connecting or disconnecting any cabling.

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/cm² 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/cm² limit is clearly accepted by most reputable scientific and medical authorities.

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

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

<u>Problem</u>	<u>Possible Solution</u>
No indications on LED.	Check fuse. For access to fuse, remove tip of power plug by turning counter-clockwise. NOTE: Replace radar fuse with ONLY 2A Fast-Blow. Ensure power 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 data cable connections.
Intermittent speed readings	Often caused by interference from stray noise (Fans, electrical equipment, RFI).

TROUBLESHOOTING GUIDE

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°C; 90% relative humidity at +37°C, noncondensing
Target Speed Range:	User selectable from 1 – 150 MPH.
Size:	3.5”H x 3.0”W x 2.3”D
Accuracy:	\pm 1 MPH or KPH

**FEDERAL COMMUNICATIONS COMMISSION:
TRANSMITTER RULES AMENDED**

The Commission has amended its rules to eliminate the required annual measurement of transmitter power, frequency and modulation, and to specify transmitter power in terms of output power for licensees in the Public Safety, Industrial, and Land Transportation Radio Services.

The action was the result of a rulemaking procedure initiated October 29, 1976 on request of HT & B Electronics.

Under the rules, which amend Parts 89, 91, and 93, licensees will continue to be required to operate their transmitters within the specified technical parameters.

For the sake of convenience and simplicity of transmitter power measurement, the FCC specified that in the future, transmitter output power, rather than the direct current input power to the final radio frequency stage, be the standard parameter used to indicate transmitter power. The FCC defined transmitter output power as that power measured at the transmitter output terminals when connected to a load of the impedance recommended by the equipment manufacturer.

REFERENCES

FEDERAL COMMUNICATIONS COMMISSION; RADAR UNIT LICENSING AMENDED (PART 90)

The Commission has eliminated a requirement for local governmental entities licensed in the Public Safety Radio Services to obtain a separate authorization for radar speed detection devices.

This change will reduce paperwork for the Commission's licensing staff and for police and other local government units, which will no longer have to apply for new radar authorizations or modify or renew existing licenses and may operate speed detection devices as part of their base/mobile communications systems.

To provide the Commission with a record of such units in use, licensees will be required to list the number of speed detection units and the frequencies on which they operate at the time of renewal of their land mobile authorizations. Ordinarily, this would be once every five years and would not be a significant addition to the renewal process, the Commission noted.

This action became effective February 1, 1983.

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

