Kestrel K1 Series

Operation Manual

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Introduction

The K1 series of 24GHz K-band microwave doppler radars are the ideal solution for monitoring speed and movement in both battery & mains powered environments.

The product family uses a 32-bit micro-controller and advanced DSP techniques to provide the longest detection range at the lowest possible cost.

Standard Features:

- ✓ Direction sensitive.
- ✓ Speed measurement. (Mph or Kph)
- ✓ Low power. (typically 22mA @ 12V for low range sensor)
- ✓ Compatible with Kestrel L1 LED driver & Kestrel R1 Relay driver
- ✓ Compatible with Kestrel M1XX modem
- ✓ USB port for configuration and firmware upgrades.
- ✓ RS232 port with selectable operation. (Direct or Peripheral Control)
- ✓ Photodiode input for light level detection and LED dimming. (Using L1 LED driver)
- ✓ Common signal processor form factor & software command set across entire K1 range.
- ✓ Firmware update using USB or remotely via modem.
- ✓ Software for configuration and data analysis.

Features dependant on model:

- ✓ RS485 communications interface. (alternative option to RS232)
- ✓ TTL communications interface. (alternative option to RS232)
- ✓ Single relay output.
- ✓ Single TTL I/O.
- ✓ Real time clock.
- ✓ Micro SD card for collecting measurements.
- ✓ Short range detection distance (saloon car), typically 100+ metres.
- ✓ Medium range detection distance (saloon car), typically 200+ metres.
- ✓ Long range detection distance (saloon car), typically 400+ metres.

For OEM applications the K1 sensor is available with custom firmware which can be set to allow specific modes of operation for a customer. Please contact Kestrel Radar Sensors for more information about this service.

Operating Principles

It is important to understand some basic principles of how doppler radar works to ensure that the module is operating at peak performance.

Microwave doppler radar detects speed and direction of moving objects by emitting a radio wave (which can be visualised like the beam of a torch) and measuring how much the reflected radio wave is compressed (for an object moving towards the detector) or stretched (for an object moving away from the sensor). This compressing or stretching information is proportional to the speed of the object being detected. Because the emitted signal behaves much like the beam on a torch, the signal disperses outwards in (a “cone”)

the same manner as a “light beam” would and becomes weaker the further away from the source.

Objects of different sizes, shapes, material and distance away from the source will all reflect the signal back with different strengths, the amount of energy that is reflected back is known as the **Radar Cross Section**.

Objects close to the detector may present themselves as much larger targets than objects further away, even where the object furthest away may be physically larger. For example a pedestrian walking close to a radar detector may present a significantly larger target than a truck approaching at a distance. The radar cross section of the pedestrian in this situation will be much greater than that of the truck although from a human perspective its clear that the truck is a much larger physical target.

This situation can cause detectors to become saturated with reflections from a smaller objects in close proximity and cause the larger object to be ignored. This is a characteristic of all continuous wave doppler radar detectors.

Furthermore, this also applies to objects travelling in the opposite direction to the one of interest, for example consider the situation where there are two vehicles in the “beam” of the radar, one moving away (closest to the radar) and one moving towards. In this situation, the radar will be blind to the approaching vehicle until the radar cross section of that vehicle is larger than the radar cross section of the vehicle moving away from the radar.

It should also be noted that the angle between the radar and the target object should be kept to as minimal as possible (ideally zero) as the measurement principle dictates that as the angle between the source and target increases, the measured speed decreases, this is known as the cosine effect. All members of the K1 series include a parameter which allows the measured speed to be compensated for the installation angle (up to 45 degrees) but the ideally the sensor should always be installed such that the targets will be parallel to the sensor.

Installation Requirements

The requirements for an optimal installation are simple and a basic understanding of the operating principle above will help in ensuring that the sensor operates at its peak.

- Try to install the sensor so that it is parallel to the detection targets. For a vehicle sensor, it should be placed as close to the approaching traffic as possible.

- Ensure that there are no moving objects (Trees, rotating fans etc) closer to the sensor than the target objects.

- Ensure that the sensor has free line of sight to the target object. (i.e a wall, sign or vehicle between the sensor and target object will absorb the radar signal and make detection impossible)

- The radar can be enclosed, it is important to ensure that the material in front of the sensor does not absorb the radar signal (metal - white material can also cause problems as titanium dioxide which is a radio signal absorbent material).

Furthermore, the thickness of the material should ideally be kept to around 3mm (half the wavelength of the radio wave) and a gap of around 6mm (one full wavelength) will help to ensure that the radio signal leaves the equipment unimpeded.

System Integration

To begin operation, the Kestrel K1 requires only a 12V power source and it will begin normal operation as soon as power the power source is connected.

The following diagram shows and overview of all sensor connections. (*depending on the specific K1 configuration, functionality and/or connectors may* ***not*** *be available*)

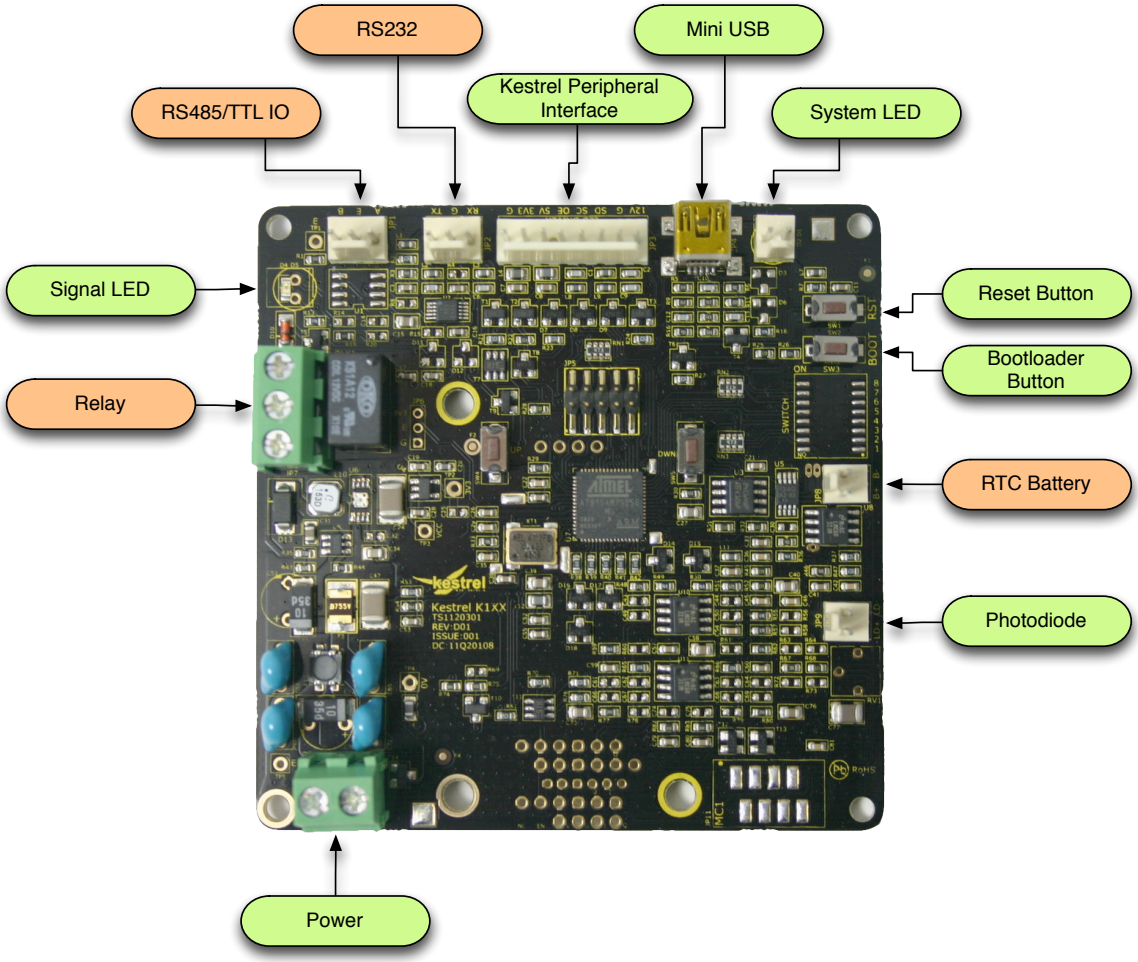


Figure 1.

Power

The K1 detector requires a 12V power supply.

It is important that the polarity of the connections is correct, failure to connect these correctly may cause damage to your K1 sensor board. See Fig. 2 for connection details.

Relay

The relay option allows a contact to be closed when a user configurable speed threshold is reached, the amount of time that the contact remains closed is user configurable.

RS232

For devices that feature the RS232 option, this connector allows either speed information to be transmitted or a Kestrel modem to be connected for remote access. This connector normally uses RS232 levels but some sensors may be fitted with a TTL level RS232, it is recommended that you check the levels of any device before connecting it to the sensor.

RS485/TTL IO

For devices with the RS485 option, this connector provides the differential signals. For devices that have the TTL/IO option, the functionality of this pin is dependant upon the firmware that is used.

Kestrel Peripheral Interface

The Kestrel Peripheral Interface is used to expand the capabilities of the K1 sensor, currently this interface is used to control the L1 display driver and R1 I/O board.

Mini USB

A mini USB connector is provided for configuration of the sensor using the Kestrel configuration software and also to allow firmware updates.

System LED

The system LED is used during the boot process for the device. The firmware consists of bootloader and application portions. The bootloader validates the application software, during this phase the system LED will glow in rising brightness until the software has been validated, at which point the application is started. In application mode, the led flashes for approximately 1/5th of a second every 10 seconds to indicate that the software is running correctly.

RTC Battery

For devices fitted with a real time clock, the battery connection allows a 3V lithium ion supply to be connected so that the can be maintained when the main power supply is not available or disconnected.

Photodiode

The photodiode input is used in conjunction with the L1 LED driver to adjust the brightness of connected LED displays, this ensures that the displays remain visible in bright sunlight and dimmed in darkness.

Micro SD Card Interface (*data collection devices only*)

The Micro SD Card is not intended to be handled by the user, the card should not be removed, removing the card may cause file system corruptions which will require that the card is formatted.

Connector Pinouts

The diagram Figure 2 shows the connector pinouts for the K1 sensor.

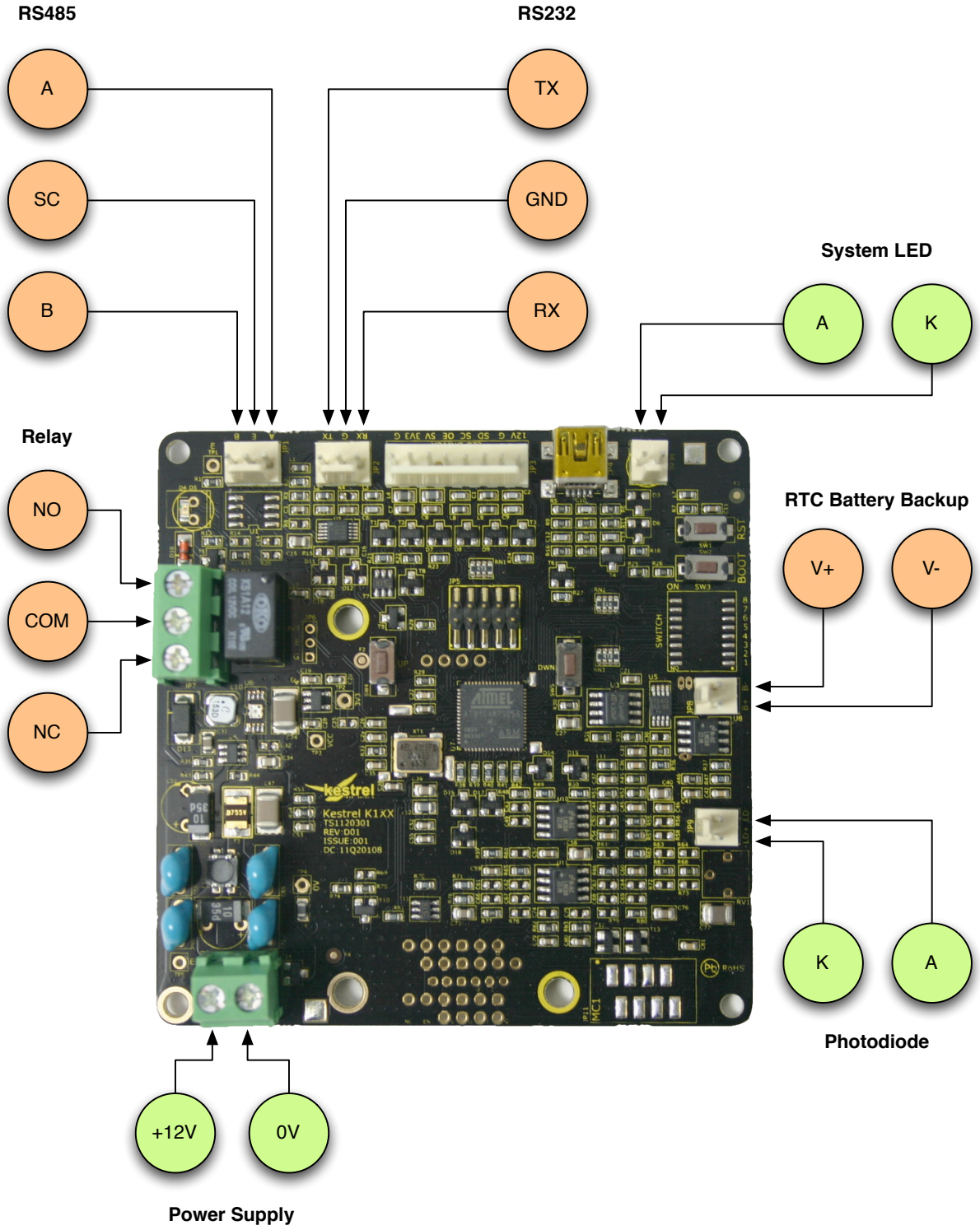


Figure 2.

Operation

The K1 sensor will enter normal operation mode as soon as power has been applied, during normal operation mode the System LED will flash once every 10 seconds as a visual indication that the unit is powered on and operating correctly. If the device does not contain a valid application image, then the device will enter a special bootloader operating mode which will require that application firmware is loaded onto the device, this mode is characterised by the Signal LED pulsing in brightness.

The K1 sensor can be used in a standalone mode using RS232/relay output to control external equipment or it can directly control external equipment (i.e signs) using either the Kestrel L1 (LED) or R1 (relay) driver boards. The L1 and R1 drivers are optimised for ultra low power usage and are recommended for battery powered applications.

Please note, this manual provides generic information about the K1 series. Because we are able to provide OEM specific firmware, certain functions or operating modes may not be available on a particular device, your particular mode of operation will have been discussed and implemented as per your requirements.

Standalone Operation

When operating in standalone mode, the K1 will close a relay contact when a vehicle is being detected. In this mode of operation, the K1 is set to operate within a range of speeds.

Kestrel L1 Operation

The Kestrel L1 board provides direct LED drive capabilities from the K1. The L1 can be used to drive up to 6 external led banks and two full “7 Segment” digits and one half “7 segment” digit (depending on build options). In this mode, the brightness of the external displays can be automatically set using a photodiode input.

Kestrel R1 Operation

The Kestrel R1 board extends the capabilities of the unit so that an up to 4 extra digital inputs and 4 extra relay outputs become available. Because the operation of these inputs and outputs may vary from customer to customer, typically the R1 is used in OEM applications where the required functionality is built into that customers firmware.

As an example, the 4 inputs could be configured to operate a HEX encoded rotary switch, which would give 16 different settings which could be used to select different speed limits in the device.

Furthermore, the R1 is connected to the radar via the LED driver interface and includes a secondary connector so that other Kestrel Peripheral Interface devices can be used simultaneously.

Scheduled Operation

The K1 sensor can also operate to a user defined time schedule (for devices fitted with a real time clock and with this option). This allows the mode of operation to be selected by time and day of week, this allows control and flexibility and can be used to automatically place the device into the lowest power “standby” mode during times where full operation is not required, this can be used to extend the battery life.

Data Collection

For devices with data collection capabilities, the device will log vehicles to the internal SD card. This information can then be retrieved remotely or via the USB connection and processed with our analysis software.

Firmware Updates

The firmware for the device is updatable. For devices with remote access, this can be done via the modem without having physical access to the device. The firmware may also be upgraded using the USB port and the configuration software provided.

Troubleshooting

The K1 has been designed for plug and play operation, however, in some circumstances it may be necessary to alter device parameters to suit the installation location. Some common issues are described below:

The range of my device is lower than expected

There can be a number of causes for this, and you should check.

1. Ensure that the sensor is pointing in the correct direction.

2. Check that the sensor has an unobstructed view of the target area. If you have placed material in front of the sensor, you should contact us to ensure that this material and thickness is not causing a problem.

3. Check that the orientation of the sensor is correct. There transmit and receive antennas should be separated vertically (i.e they should be above and below each other, not to the left and right). Generally speaking, the antenna has a much narrower beam in this orientation, if the orientation is incorrect you may be picking up vehicles moving away from the sensor on another carriageway.

4. The smaller sensors have a wider field of view and when used on dual carriageways may pick up vehicles on the wrong carriageway (and moving in the wrong direction). In this case, you should try to angle the sensor away from both carriageways such that the sensor picks up more of the carriageway of interest.

5. Check the settings on the device, if may be that the “Detection Threshold” or “Detector Sensitivity” has been set incorrectly and has reduced the range of the detector.

6. Ensure that there are no other detectors located close to the device. Multiple detectors may cause the signals to become confused.

The sensor is not detecting any vehicles

This is normally down to the misconfiguration of the sensor, to remedy this please check the following items.

1. Ensure that the parameter for detection direction is set to the correct value.

2. Use the configuration tool and enable the live view and ensure that both signal bars are moving in response to a hand being waved in front of the sensor and to a vehicle.

3. Check that the minimum speed threshold is not set too high, because the sensor uses DSP techniques to analyse the signal, it will not show any signal for speeds below it's minimum threshold.

4. Ensure that there is no interference from other sources of movement in the field of view of the sensors, these could cause the radar to remain locked onto a "noise source" rather than the intended targets.

5. If you are still having problems, please contact us for more information.

The speeds being detected by the sensor are lower than expected

Please check that the sensor is as parallel as possible to the target and the angle between the target and the sensor is as small as possible. Under-reading is caused by this angle (the cosine effect).

If you are enable to physically rectify this problem, you can set the angle parameter to adjust for this.

The "raw" log files are showing a time offset

The K1 sensor is usually set to UTC (Coordinated Universal Time), this allows the device to ignore complex daylight saving calculations (which for some regions are set a couple of years in advance by the local government) and store data in a known time frame. When importing data in our software, the UTC time is automatically converted to local time which will apply any daylight saving time shifts to the data.

If you are not using our collection software and are using your own data importing/ conversion then you will need to do these time conversions yourself.

System Parameters

The following table lists the currently available system parameters. *(Depending on the configuration of your module, some of these may not be available - in addition extra parameters may be available to specific OEM builds)*

Name	Description	Values/Units
Operation Mode	Selects the mode of operation for the sign. *(Default Standard)*	Standard Sign Smiley Sign Dual Zone Sign Covert Five Zone
Detection Threshold	Sets the threshold at which the signal is deemed to be valid. Setting this value too low will cause the device to detect "noise" as a valid signal, setting this too high will result in the unit ignoring valid signals. *(Default 0%)*	0%-100%
Sign Sensitivity	Sets the number of events above the detection threshold required to trigger the sensor. *(Default 2)*	
Detection Direction	Selects the direction of traffic that will cause the sensor to trigger. *(Default Towards)*	Away, Bidirectional, Towards
Speed Units	Sets the measurement units which the device uses to determine the speed limit. *(Default Mph)*	Mph, Kph
Display Hold Time	The length of time that the sensor will remain in the triggered state once the sensor stops detecting a valid signal. (4 Seconds)	

Name	Description	Values/Units
Logger Detection Threshold	Sets the threshold at which the signal is deemed to be valid for logging. Setting this value too low will cause the device to detect "noise" as a valid signal, setting this too high will result in the unit ignoring valid signals. *(Default 6%)*	
Logger Sensitivity	The number of readings above the detection threshold that are required to constitute a valid log event. Setting this value too low will cause the device to detect "noise" as a valid event, setting this too high will result in events being ignored. *(Default 5)*	
Logger Minimum Speed	The minimum speed that shall cause an event to be logged. Setting this value appropriately will allow low speed events to be filtered out. *(Default 10)*	
Display Update Rate[2]	The rate at which a connected L1 sign will be updated. Setting this value low will result in a smooth transition of speeds but will cause the sign to “flick” between values when a vehicle is just within 2 displayed values. *(Default 0.5 Seconds)*	
Sensor Angle	The angle of the sensor with respect to the road. *(Default 0 Degrees)*	
Minimum Displayed Speed	The minimum speed that the sensor will trigger at, speeds below this will not cause the sensor to trigger. *(Default 30)*	

Name	Description	Values/Units
Maximum Displayed Speed	The maximum speed that the sensor will trigger at, speeds above this will not cause the sensor to trigger. *(Default 199)*	
Logger Measurement Interval	Sets the granularity at which detected signals are written to the log file. It is not recommended to change this value from it's default. *(Default 0.86 seconds)*	
Primary Speed Limit[1,3]	The primary speed limit that the sign uses. *(Default 20)*	
Secondary Speed Limit[1,3]	The primary speed limit that the sign uses. *(Default 30)*	
Aux Speed Threshold[2]	The speed at which the auxiliary sign will be illuminated. *(Default 31)*	
Happy Speed Threshold[2,4]	The speed at which the happy face is illuminated. *(Default 20)*	
Sad Speed Threshold[2,4]	The speed at which the sad face will be illuminated. *(Default 31)*	
Flash Speed Threshold[2]	The speed at which the main and auxiliary sign will be flashed. *(Default 35)*	
Flash Speed Rate[2]	The rate at which the sign will flash. *(Default 0.4 Seconds)*	
Detector Activity LED	Selects the operation mode for the activity LED on the radar detector. *(Default Disabled)*	Disabled,Sign Detection,Log Detection

Name	Description	Values/Units
Serial Port Mode	Selects the mode of operation of the serial port. *(Default Disabled)*	Disabled,M101 Modem
First Speed Limit[2,5,6]	The threshold at which the display is activated when this limit is selected. *(Default 5)*	
Second Speed Limit[2,5,6]	The threshold at which the display is activated when this limit is selected. *(Default 20)*	
Third Speed Limit[2,5,6]	The threshold at which the display is activated when this limit is selected. *(Default 30)*	
Fourth Speed Limit[2,5,6]	The threshold at which the display is activated when this limit is selected. *(Default 40)*	
Fifth Speed Limit[2,5,6]	The threshold at which the display is activated when this limit is selected. *(Default 50)*	

1. *Requires OEM sensor with single input option.*
2. *Requires the L1 led driver module.*
3. *Requires the mode of operation to be “Dual Zone”*
4. *Requires the mode of operation to be “Smiley Sign”*
5. *Requires the R1 interface module*
6. *Requires the mode of operation to be “Five Zone”*

Detection Distance

The “Detection Threshold” and “Sign Sensitivity” are co-dependant parameters, the default settings are known to work well in the “real world”, but in some situations it may be necessary to modify these parameters, the general rule of thumb is as follows:

If “Detection Threshold” is set to a value > 20% then “Sign Sensitivity” can usually be set to zero.

If “Detection Threshold” is set to a value < 20% then “Sign Sensitivity” will usually need to be set to 1 or higher.

The logic behind this is that the “Detection Threshold” parameter determines how strong a signal is required to indicate a lock. Due to the signal processing involved, the sensor can determine whether a signal is valid below the noise floor, therefore it is possible to set this parameter lower than 20%.

However, when the “Detection Threshold” parameter is set below the noise floor, it is important to check more than 1 reading to prevent any remaining “noise” from activating the radar, this is why the “Sign Sensitivity” parameter needs to be set to a value greater than 1.

When the “Detection Threshold” parameter is above the noise floor, it is not possible for noise to appear like a valid signal and therefore the “Sign Sensitivity” parameter can be set to 0, so the detector will trigger as soon as it detects a valid signal.

You should note that these parameters have an effect on how quickly a signal becomes locked and therefore the overall detection distance.

Declaration of conformity

Follows on next page.

EC Declaration of Conformity

In Accordance with EN ISO 17050-1:2004

We Tsien (UK) Ltd
of Zion Building,
Park Street
Chatteris
Cambridgeshire
PE16 6AE
United Kingdom

hereby declare that:

Kestrel K1XX Radar Sensors

are in conformity with the applicable requirements of the following standards:

EN 50293:2000
EN 55022:1998
CFR47:2009
ANSI C63.4.2003
EN301 489-1 V1.8.1 Class B
EN301 489-3 V1.4.1

following the provisions of the directive(s):

2004/108/EC of December 15th, 2004 (The EMC directive).

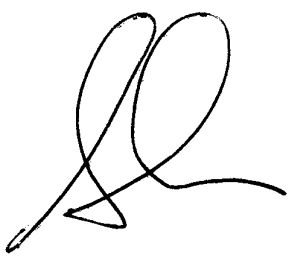
I hereby declare that the equipment named above has been designed to comply with the relevant section of the above standards. The device complies with all the applicable essential requirements of the directives outlined.

Signed for on behalf of: Tsien (UK) Ltd

Date: 7th October 2011

Position: Director

Name: Mr Satvinder Sidhu



Signed: .....

Test Report Reference: R2981_1.pdf