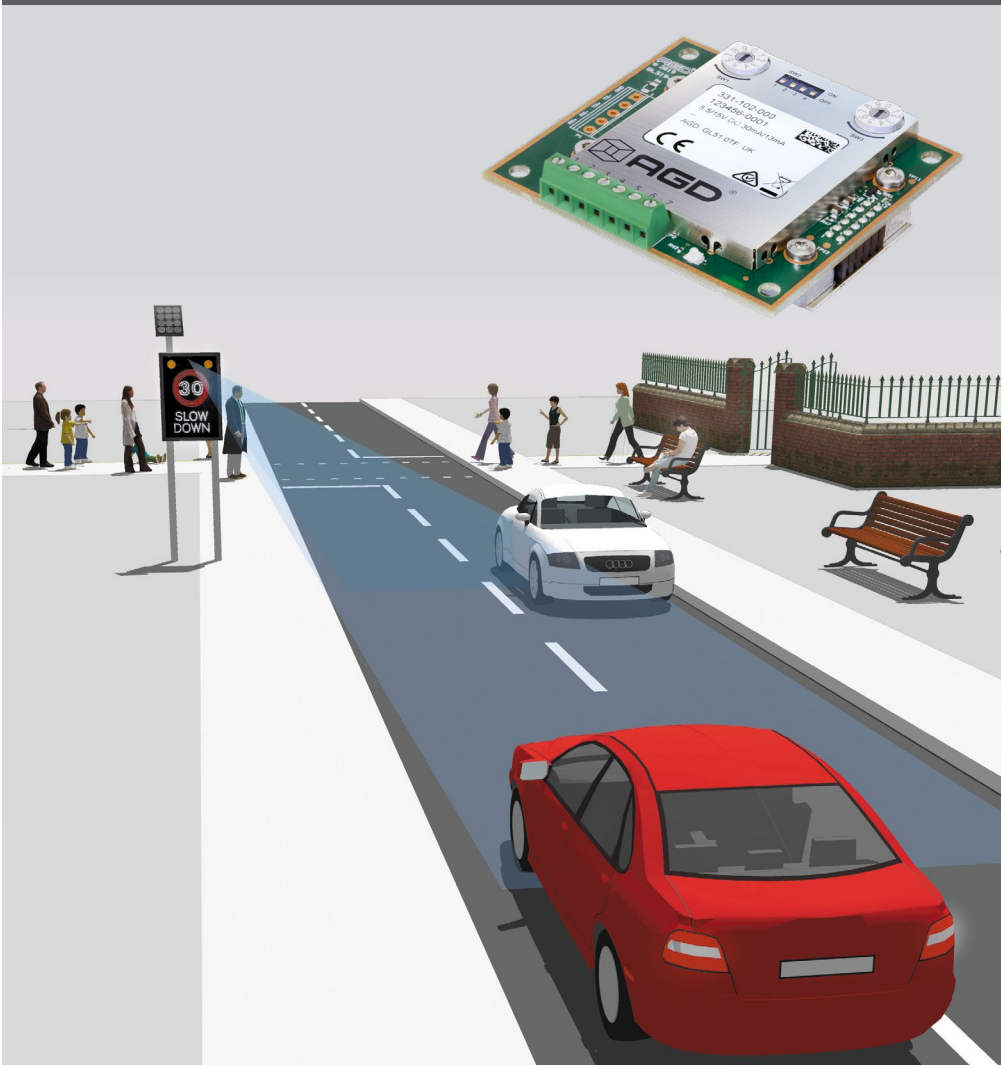
AGD **331**

IN-SIGN RADAR TRAFFIC DETECTOR

PRODUCT MANUAL



PRODUCT SOLUTIONS FOR
INTELLIGENT TRAFFIC SYSTEMS

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IN-SIGN RADAR TRAFFIC DETECTOR

safer, greener, more efficient

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Introduction

PRODUCT & TECHNOLOGY

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

The 331 detector is a true ranging FMCW radar designed for OEM integration into Vehicle Actuated Sign (VAS) applications.

Operating in the 24GHz K-band, the 331 offers an accurate speed measurement while discriminating between advancing and receding traffic.

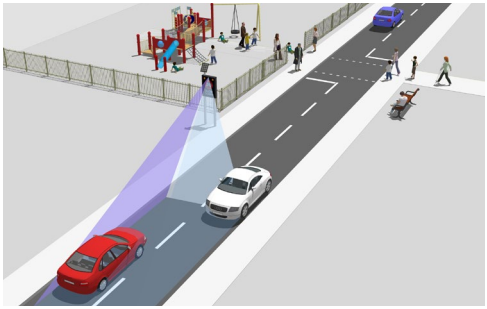
Technical advancements allow for extremely low power consumption while maintaining vehicle detection distances up to 180 metres.

KEY FEATURES

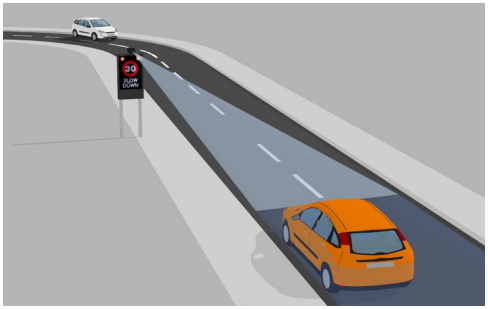
- Target speeds reported based upon multiple configurable parameters
- Range to target up to 180 metres
- Speed measurement 11kph – 160kph
- Bi-directional discrimination
- Dynamic frame rate for further reduction in power consumption (Patent pending)
- Two independent FET switched outputs
- RS232 serial communications for configuration and data output
- Simple set-up option using rotary switches

TYPICAL APPLICATIONS

Sign Activation - Speed



Sign Activation - Warning



Introduction

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

PRODUCT OVERVIEW IMAGE

* SW1 and SW3 can only be used to set the low speed threshold and range on switched output 1

PRODUCT VARIANTS

Product No.	Description
331-102-000	In sign radar/12V/24.2GHz/RS232/No connection cables
331-103-000	In sign radar/12V/24.125GHz/RS232/No connection cables (FCC)

PRODUCT OVERVIEW

The 331 radar is a ground-up development by AGD using the latest power saving radar technology. The heart of the radar's design is a unique pulsed, frequency modulated transceiver linked to a 32bit ARM Cortex processor. This helps deliver market leading radar performance while maintaining extremely low power usage.

Traditional Continuous Wave (CW) Doppler radars for sign driving applications have no ranging capability. The 331 contains filter-down technology from AGD enforcement products, this furnishes the radar with a full multi-target acquisition platform, accurate range measurement, and adjustable output rate of targets. To the VAS designer, this simply means the system power is more efficiently managed by the ability to select the area of interest accurately (regardless of vehicle size).

Designed to be simple to use and quickly deployed into the end users sign solution, the 331 range and low speed can be set-up and adjusted via rotary and dip switches conveniently located on the rear of the unit. Additional parameters are accessible via an RS232 serial interface. Utilising the same compact form factor as the AGD 330 radar, the 331 radar offers a direct physical retrofit solution, for those wishing to add more functionality.

Installation

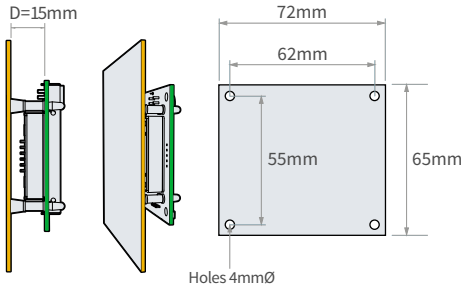
AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

RADAR MOUNTING

Installation of the radar within the sign should be in accordance with the table below which specifies the spacing (D) of the radar module PCB assembly from the inside front surface of the sign. These measurements are based upon a typical polycarbonate fascia and have been tested to provide optimum radar performance.

In the instance of different thickness front panel materials, customers are advised to contact AGD systems for further information and technical support.

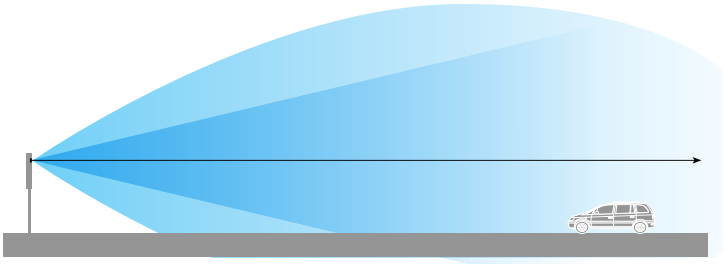
Standard fixing of the radar module is based upon a set of four mounting holes with the dimensions shown in the diagram on the right.



The recommended material situated in front of the 331 is 4mm thick polycarbonate.

Front screen material thickness	Recommended Spacing D	Comments
0.5mm	15mm +/- 1mm	Spacing for 0.5mm material is not critical
1.0mm	15mm +/- 1mm	
2.0mm	15mm +/- 1mm	
3.0mm	15mm +/- 1mm	
4.0mm	15mm +/- 1mm	Spacing for 4mm material is not critical
5.0mm	15mm +/- 1mm	
6.0mm	15mm +/- 1mm	

The relatively wide beam profile of the 331 ensures good detection coverage of single or dual lane approaches with relatively little adjustment of the sign in relation to the direction of approaching targets.
The recommended mounting height of the radar within the sign is between 2-5 meters with the optimum being 3 metres.



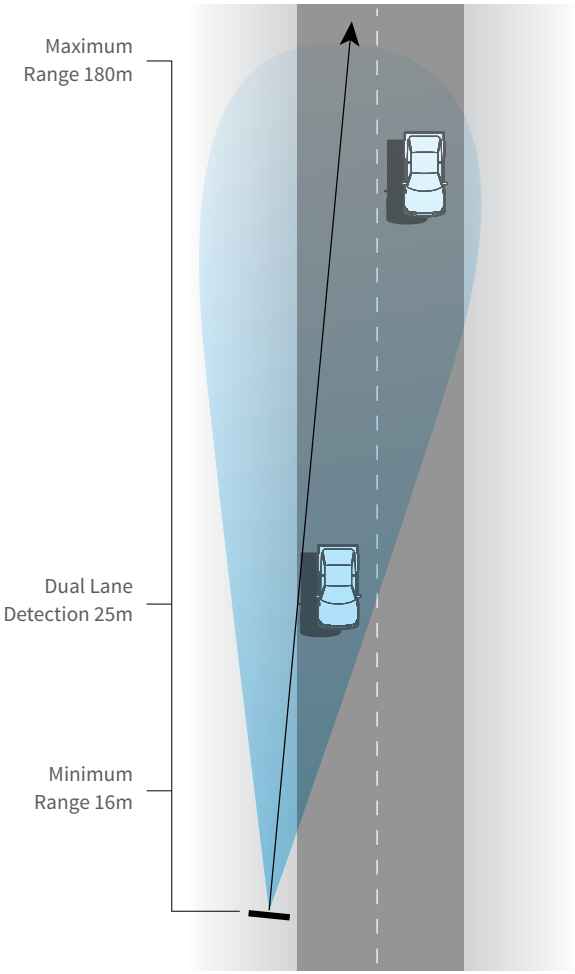
The radars planar antenna should be 90^0 to the road surface, inclines in the road surface should be catered for by adjusting the 331 radars mounting angle.

RADAR INSTALLATION - RANGE

The 331 is a true ranging radar that allows the user to select at what range the radar needs to start reporting on tracked targets.

Each target needs to return sufficient signal in order for the radar to track its range. A target returns signal related to its Radar Cross Section (RCS) which is in part related to the reflecting area of the target. Targets that have a larger RCS will return a higher signal than those with a smaller RCS.

For example: If the detection range is set at 80 metres then all targets that have enough reflective power before this point will be tracked. Only when the target reaches 80 metres will detection occur, allowing for accurate actuation of the sign at the correct range.



AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

POWER & COMMUNICATIONS

Terminal Connections				
Pin No.	**Function**	**Power Off**	**Power On - No Detect**	**Power On - Detect**
1	+5.5 to 15Vdc	-	-	-
2	0Vdc / RS232 GND / Switched GND	-	-	-
3	RS232 TX	-	-	-
4	RS232 RX	-	-	-
5	Switched Output 1 (FET1)	N/O	N/O	N/C
6	Switched Output 2 (FET2)	N/O	N/O	N/C
7	0Vdc / RS232 GND / Switched GND	-	-	-

Power

The radar is powered using a DC voltage in the range of 5.5 – 15Vdc. The power is applied to terminals 1 and 2 located at the bottom of the radar.

Power consumption whilst detecting 15mA @ 12V

Power consumption whilst not detecting with default dynamic frame rate set 10.5mA @12V (see page 15 for further detail)

* Please note that terminal 2 and 7 also serves as the RS232 GND connection and the 0V potential for FET 1 and 2 switched outputs.

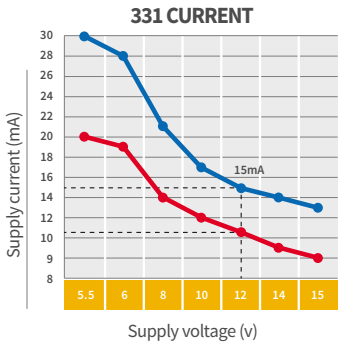


FIG 1: SUPPLY CURRENT **VS**. SUPPLY VOLTAGE

Power-Up Sequence

Upon initialisation from power-up or *REBOOT! the LED will flash five times to indicate the radar has powered-up correctly.

FET Switched Outputs

The switched outputs are driven via Field Effect Transistors (FET) that are biased toward 0V. All external equipment should be connected to the same 0V.

When the FET is low impedance (<25Ω), the host equipment will be at the same potential as 0V. When the FET is high impedance (>100kΩ), this will be the same as an open switch.

The field effect transistors are rated at:

Max Voltage 15V

Max Current 50mA

*All connections should be made to the unit before applying power.

POWER & COMMUNICATIONS

RS232 UART Interface

A UART interface is provided that uses RS232 voltage levels on the terminal connector:

Default UART Settings

Parameter	Settings
Baud rate	115200
Data bits	8
Parity	None
Stop bits	1
Flow control (handshaking)	None
Transmit delay	0

Communications can be established with the 331 Radar using MS-226 (FTDI USB-232 converter) cable assembly (pictured) supplied separately. The wire ends should be connected as follows:

FTDI Wire Colour	331 Terminal Connection	Function
Black	2 or 7	Ov
Yellow	3	TXD
Orange	4	RXD

RADAR COMMAND OVERVIEW

Commands can be used to control the operation of radar. These are sent over the RS232 UART Link.

Commands are immediately followed by an operator that indicates the required action. Not all the operators are supported for all commands. Where an operator is used and it is not supported the radar will respond with warning message. The table shows the commands used by the radar.

Operator	Operation
=	Set a parameter to a value e.g. *LS=50<CR>
?	Respond with value or values
^	Set default value for parameter
$	Provide help on the command
!	Do something e.g. *REBOOT! Reboots the radar

Command Operators

Where a command is used to enquire or set a radar parameter the radar will respond in a set way. The radar will respond with a hash, #, followed by the command name, operator used and then the value of parameter or parameters.

For example

***DIR=A<CR>** **Radar responds with #DIR=A<CR>**

***DIR?<CR>** **Radar responds with #DIR?A<CR>**

Communication Tasks

The operation of the 331 radar has been optimised as a low power device with minimal processing overhead. It is good practice to not 'overrun' the communication line with repeated send commands when the radar is operational.

Command requests to store settings are written to EEPROM each time they are sent from the host system, repeated sending of commands will erode the lifetime capacity of the radars non-volatile memory.

Radar Commands and Configuration

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

COMMAND LIST

Command	Suffixes	Description	Default	Lower Limit	Upper Limit	Comments
AGD	-	Shows detector type & version information	-	-	-	Reports radar model and version information
*BAUD	? = ^ $	Baud rate for RS232	115200	9600	115200	9600 or 115200 *note - the customers selected baud rate is always reported at 115200 on start up
*COUNTDIR	? = ^ $	Enquire / set the direction of vehicle count	A	-	-	A = Advancing R = Receding B = Bi-Directional
*DEFAULTS	! $	Set all radar parameters to their default values	-	-	-	-
*DEFAULTSTATS	! $	Resets the number of target detections as reported by *STATUS? command	-	-	-	-
*DFR	? = ^	Dynamic frame rate. When set to a value >1, if the radar does not detect a potential target it will not transmit again for the set number of frames	2	0	20	This is used to further reduce power consumption. See page 15.
*HELP	? $!	Displays all user commands	-	-	-	-
*HOLDTIME	? = ^ $	The time the switched output is held on after the target has left the detection zone setting global to both outputs	500	10	2000	Values are in milliseconds
*LED	? = ^ $	Enquire / set the operation of the LED on the rear of the unit.	ON	OFF	ON	*LED=0 turns off LED *LED=1 turns on LED and mimics *OUT1 on LED Off will help lower the current consumption
*MM	? ^ $ =	Targets reporting method 1 = Fastest target 2 = Oldest valid tracked target 3 = Average Speed of oldest tracked target	2	1	3	-
*MONITOR	? = ^ $	Switched output 1 will produce a constant demand if no target is seen for the duration of the monitor time	0	0	72	Hours where 0 is off
*MS	? = ^ $	Message type 02 = dd(10fps) 06 = *Sddd (10 fps) 09 = *Sddd (5fps) 12 = ddd,D Where D is A for advancing and R is for receding	12	02	12	-

COMMAND LIST CONTINUED

Command	Suffixes	Description	Default	Lower Limit	Upper Limit	Comments
*OUT1	? = ^ $ 	Controls switched output 1 Mode = detect / disabled Low speed threshold High speed threshold Maximum range Direction = A / R / B	- - - - - -	- - 11kph 12kph 40m -	- - 159kph 160kph 180m -	*OUT1 = detect, 11, 160, 180, A<CR> *OUT1=disabled<CR> Note: OUT1 can still be set with SW1 and SW3
*OUT2	? = ^ $ 	Controls switched output 2 Mode = detect / disabled / count Low speed threshold High speed threshold Maximum range Direction = A / R / B	- - - - - -	- - 11kph 12kph 40m -	- - 159kph 160kph 180m -	*OUT2 = detect, 11, 160, 180, A<CR> *OUT2 = count *OUT2 = disabled
*OUT3	? = ^ $ 	Controls RS232 output Mode = detect / disabled Low speed threshold High speed threshold Maximum range Direction = A / R / B	- - - - - -	- - 11kph 12kph 40m -	- - 159kph 160kph 180m -	*OUT3 = detect, 11, 160, 180, A<CR> *OUT3 = disabled
*REBOOT	! $	Forces firmware to restart	-	-	-	-
*STATUS	? $	Gives a detailed report showing firmware version, run time, output settings, hold time, baud rate and radar temperature	-	-	-	-
*SU	? = ^ $	Changes the radar's speed unit *SU = K<CR> #SU = K	K	-	-	K = kph M = mph
*TEMP	? $	Reports the temperature of the radar processor in Degrees Celsius.	-	-	-	-
*TS	? = ^ $	Simulates a target to test all outputs *TS=1<CR> #TS=1	0	0	1	FET 1 and 2 are set to a permanent detect (low impedance) state RS232 streams constant 88mph / 88kph using current message output setting (*MS)
*ZEROSPEED	? = ^ $	Enables or disables the outputting of a zero speed message to shut down sign after holdtime has expired	1	0	1	*Zerospeed=0 disables the output of 0 speed as the unit exits detect state *Zerospeed=1 enables the output of 0 speed

Note: 1 mph = 1.6093 kph

Radar Commands and Configuration

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

OUTPUT CONFIGURATION STRING

Using the terminal application via the RS232 it is possible to set up both switched outputs as independent triggers by adding values to *OUT command string. The string will need a carriage return for the setting to be committed to memory.

*Command	Switched Output	Mode	LST	HST	Maximum Range	Direction

Prefix	Bytes Value	Minimum	Maximum	Default	Notes
*Command	-	-	-	-	*OUT - followed by switched output you require
Switched Output	-	1	3	-	Identifies which output you set *OUT1 = FET1 *OUT2 = FET2 *OUT3 = RS232
Mode	detect=speeding target accusation Count=counts at dedicated range* disabled=output disabled *Only selectable on *OUT2	-	-	-	Function of Switch output Detect Count (*OUT 2 only) Disabled
LST	-	7 mph 11 kph	98 mph 159 kph	-	Minimum speed the radar will report on
HST	-	8 mph 12 kph	99 mph 160 kph	-	Maximum speed the radar will report on
Maximum Range	-	40m	180m	-	The maximum range that the radar will report targets.
Direction	A = Advance R = Recede B = Bidirectional	-	-	A	A / R / B

Example: ***OUT1 = detect, 30, 50, 70, A<CR>**

Will set output 1 to detect targets between 30 and 50 (mph or kph depending on the value of *SU) up to a range of 70 metres when they are advancing towards the radar.

Example: ***OUT1=disabled<CR>**

Will disable FET output 1 from operation in RS232 mode. However, the output can still be set using SW1 and SW3.

Example: ***OUT2=count<CR>**

Will enable the count function on FET output 2 only, and will also provide a count data line in the RS232 output.

RS232 OUTPUT MESSAGE

The speed of a single target of interest can be reported using the RS232 connection. This is typically used to display the actual speed of a target as it approaches the sign.

The ***OUT3** command allows the user to filter which target to report by it's speed, range and direction.

In the case of multiple valid targets at any one time, the ***MM** command allows the user to decide which target to report:

***MM=2 (default, recommended)**

report the valid target that's been tracked for the longest period of time

e.g. a valid target travelling at 32kph will be reported even if a new 50kph target is seen 3 seconds later

***MM=3**

report the average speed of the valid target that's been tracked for the longest period of time

e.g. a valid target travelling around 32kph (±2kph) will have its average speed reported over the duration it's been tracked, even if a new 50kph target is seen 3 seconds later

***MM=1 (not recommended)**

report the valid target with the fastest speed, regardless of distance from the sign or duration of the track.

e.g. a valid target travelling at 32kph will no longer be reported when a new 50kph target is seen 3 seconds later

The ***MS** command controls the format of a reported message & the rate at which they are sent (these selected formats are backwards-compatible with the AGD330 sign-activation radar):

Command	Output format	Output update rate (Frames Per Second)	Example - 30kph advancing target	Example - 160kph receding target
*MS=2	dd<CR>	10	30<CR>	160<CR>
*MS=6	*Sddd<CR>	10	*S030<CR>	*S160<CR>
*MS=9	*Sddd<CR>	5	*S030<CR>	*S160<CR>
*MS=12	ddd,A<CR>	10	030,A<CR>	160,R<CR>

RADAR COUNT OUTPUT

The count functionality of the radar is available in two formats. It can be presented as a digital pulse on ***OUT2** only (it cannot be configured to be output on ***OUT1**), and it can be viewed / read from the RS232 data string ***OUT3**.

There are two ways to enable the count functionality:

Configuration using Switches

If you choose to configure the 331 using the physical switches, you would set the speed threshold you wish to report a target travelling over, using SW1. The range could then be set using SW3. This would set-up FET 1 (***OUT1**) to actuate according to your set parameters. Setting SW2 dip 4 to 'ON' will then activate the count function to be output on FET 2 (***OUT2**), with pulses as designated below.

*NOTE - Activating the count function using switch configuration provides counts in 'Advancing' mode only. Activating 'Receding' or 'Bi-directional' count requires configuration through RS232 connection.

Configuration using RS232

SW1 and SW3 should both be set to position '0', thereby enabling the RS232 commands to take precedence.

The count function can then be activated using the ***OUT2=COUNT** command (also detailed in the 'Radar Command List')

With the 'Count' set, it is then possible to set the radar to count advancing, receding or bi-directional targets. These are distinguished on the FET 2 digital output by the length of pulse and in the RS232 string with either a *C,A<CR> for an advancing target, or *C,R<CR> for a receding target.

Vehicle Count Principle of Operation

The range at which vehicles are counted in both advancing and receding directions has been carefully tested and calibrated and is a non adjustable value. The distance for advancing is 20 metres and the distance for receeding is 40 metres.

FET 2 Digital Output

FET 2 in count mode will only pulse 'ON' once per frame to represent a vehicle count, the length of the pulse allows the data to be extracted from the FET 2 output:

35ms 'Pulse' = 1 advancing target counted this frame
55ms 'Pulse' = 1 receding target counted this frame
75ms 'Pulse' = 1 advancing AND 1 receding target counted this frame

Count Accuracy

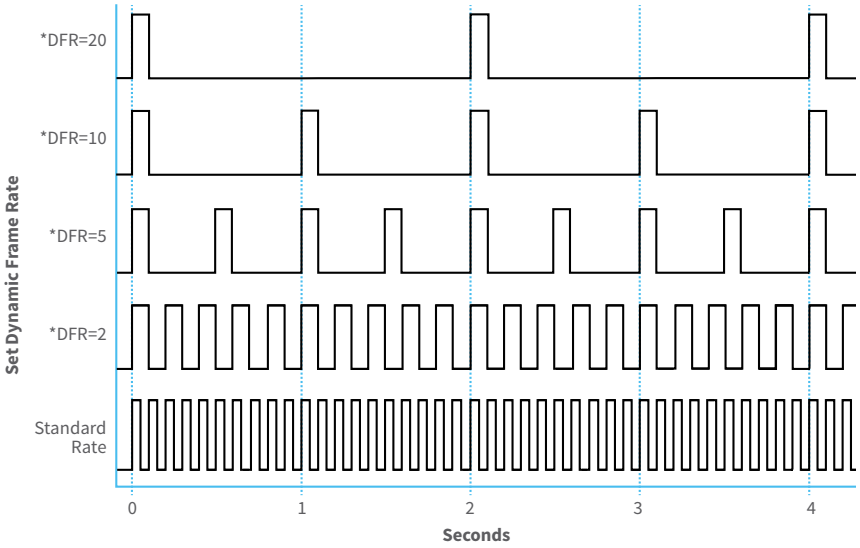
Free flow, moderate and heavy traffic flow studies have returned an average accuracy of >93%.

DYNAMIC FRAME RATE (PATENT PENDING)

Dynamic frame rate is used to reduce the power consumption of the 331 whilst no valid targets are being detected. It does this by reducing the number of times the transmitter looks for a target per second, after the 331 has not detected a target for 1 second. You can set the dynamic frame rate anywhere from 0 to 20 with a default value set at 2 by entering the ***DFR** command. Once a target is detected the transmitter will start operating at its standard rate (10Hz) and will continue to do so until the 331 does not detect a valid target for 1 second.

The dynamic frame rate entered could impact the distance at which a target is seen, the higher the dynamic frame rate the longer it could take to spot another potential target. See table below

Dynamic Frame Rate	Additional Max Delay Time (seconds)	Typical Current Consumption @12V (mA)
Standard Rate	0.1	15
*DFR=2 (Default)	0.2	10.5
*DFR=5	0.5	7.8
*DFR=10	1.0	6.9
*DFR=20	2.0	6.5



FIRMWARE UPDATE

The 331 radar is designed to be re-flashable with firmware updates. Please contact AGD technical support for further instruction.

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

DIP SWITCH SW2 CONFIGURATION

AGD **Setup**
SIMPLE MECHANICAL SWITCH SET-UP

DIP SWITCH SW2 - FOUR POSITION

4 Position Switch Number	Function
	LED output On = LED on for each detect of switched output 1 Off = No LED activation
	Test mode Activates FET 1, FET 2 outputs and reports simulated target information over RS232 (Replicates the RS232 *TS function)
	Priority vehicle to report On = Fastest tracked target Off = Longest tracked target
	Count mode On = Count on switched output 2 (advancing targets only) Off = Output 2 disabled

*Note - These switch values are ignored if SW1 and SW3 are both set to zero enabling RS232 configuration of settings

Radar Commands and Configuration

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

ROTARY SWITCH SW1 CONFIGURATION

AGD **Setup**
SIMPLE MECHANICAL SWITCH SET-UP

Rotary Switch 1 Settings - 10 positions

Rotary Switch Position	Low Speed Threshold kph	Low Speed Threshold mph
	11	7
	36	22
	50	31
	53	33
	71	44
	80	50
	96	60
	106	66
	124	77
	RS232 mode. Switches inoperable	

Only switched output one is configurable via these switches.

Rotary switch 1 - This sets the Low Speed Threshold (LST) of the radar. The low speed threshold is that speed below which the radar will not detect targets. Eg if the LST is set to 55kph the radar will only activate the output for targets travelling at 55kph or greater.

Ensure Rotary Switch 1 is set to 0 for configuring via RS232.

Further adjustment to switched output 1 and 2 outside of the designated values are made via the RS232 connection.

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

ROTARY SWITCH SW3 CONFIGURATION

AGD **Setup**
SIMPLE MECHANICAL SWITCH SET-UP

Rotary Switch 3 Settings - 10 positions

The radar's range can be easily adjusted for site specific topography and local conditions via rotary switch three.

Rotary Switch Position	Function
	16-40 m
	16-50 m
	16-60 m
	16-70 m
	16-80 m

Rotary Switch Position	Function
	16-90 m
	16-100 m
	16-120 m
	16-180 m
	RS-232 User Selectable

Only Switched output one is configurable via these switches.

Rotary switch 3 - Sets the Range for a typical saloon type target.

Ensure Rotary Switch 3 is set to 0 for configuring via RS232.

Further adjustment to switched output 1 and 2 outside of the designated values are made via the RS232 connection.

TROUBLESHOOTING

The radar has an update/frame rate of 10Hz (ie a response time of 100ms), can we not decrease the update rate and save more power?

Yes, more power can be saved but the radar has been optimised for use on both urban and high-speed roads. A vehicle travelling at 130kph (80mph) will produce a detection distance latency of about 4m at 10Hz which is of the order of the user range setting intervals. However, the 331 does have a feature to decease the frame rate (*DFR command). Dynamic frame rate reduces the power consumption of the 331 whilst no valid targets are being detected. It does this by reducing the frequency that the transmitter looks for targets when the 331 has not detected a valid target for longer than 1 second (see page 15).

What is the advantage of an FMCW radar over normal sign activation radars that are based on speed detection by simple Doppler only?

An FMCW radar is a much more complicated radar architecture that allows the speed and the range of the target to be measured. This ensures that the sign is always activated at the same target distance. It is one of the main drawbacks with traditional low cost radars that you may have the sign activating at 140m for a truck and only 60m for a small car. Additionally, the set activation distance is almost completely unaffected by rain and fog etc with an FMCW radar compared to a traditional Doppler radar.**

**There are some additional explanatory notes on performance invariance owing to weather.

The radar I currently use sometimes has a large delay in detection of an approaching vehicle and hence sign-activation when a large target is receding in the adjacent carriageway. Is this improved with the 331?

The 331 radar processes many targets simultaneously so the detection distance for the oncoming vehicle can be detected even when there are large receding targets.

Why is the ability to set a reliable sign activation distance so important?

If the detection distance is too short the driver has no response time to absorb the sign's message. If the detection distance is too large the sign is illuminated for a longer duration and hence more power is used which can be critical in low power applications. You need the sign to be on for just the right duration and at the right distance for the value of the sign message to be delivered to the driver. This distance will vary with the site and with the sign message.

Why is the LED on the 331 flashing repeatedly or intermittently?

The operational voltage supply range for the radar is 5.5 to 15Vdc (nominal 12Vdc). It is possible, especially in solar & battery based installations that the voltage supply level can fall outside the specified limits. Operation of the radar is not guaranteed outside these limits and incorrect operation can be manifest in an erratic or flashing LED state. Please check the voltage supply and reconnect the radar.

TROUBLESHOOTING

The 331 radar can be re-flashed. What does this mean?

There is a development plan to include new features in the radar going forward. Customers who use a current version of 331 will not be disadvantaged by not having access to these new features. Re-flashing means we can email new application code that can be uploaded into the 331 radar over the RS 232 link which will enable new functions as they are available. There is no requirement for the customer to return the hardware to AGD for upgrade.

I have set the detection range to 100m but motorbikes are only detected at 75m, why is this?

The signal a vehicle generates is proportional to the size of its radar cross-section (reflecting area). If you set the radar to 100m the radar will be getting signals from the cars, vans and lorries at greater distances but not actuating the output until they are at 100m. For the motorbike, it does not generate enough signal at the longer ranges owing to the much smaller reflecting area. There is a further explanatory note regarding targets that have a 'stealthy' profile and the effect on detection range.

I have mounted the 331 radar in the sign and set the detection distance to 60m but I am only getting a detection range of typically 30m which varies with each target?

The radar is designed to operate through a plastic screen which normally forms the front face of the sign. This screen acts as the protective radome for the radar and guidance for the mounting is given in the relevant section of the Manual to minimise any losses. However, in rare instances some plastics have dyes, additives or protective films which are particularly good at attenuating the radar signals. If you have poor range performance you should verify that the radar is operating correctly by removing the plastic from in front of the radar to confirm whether the screen is indeed a poor match.

What is the difference between configuring the radar using the switches and a terminal window ?

For quick configuration the radar can be set-up using the physical switches on the rear of the unit. SW1 is used to configure the low speed threshold, SW3 the range at which the target starts being reported. Note that SW2 becomes active if SW1 and SW3 are set to anything other than zero (zero denotes RS232 configuration). SW2 controls parameters for *OUT2, *MM, *LED and *TS commands.

The sign has been EMC tested and the radar has a CE mark. If I put the radar in the sign will that be enough to legally put this on the market in the EU?

This is not a safe assumption to make. There are special directives and associated specifications in the EU regarding radio devices (radar is classed as a radio device) and care should be taken on building a file for conformity. AGD has good experience on this and can give guidance or your usual Notified Body will give you independent advice on your required test documentation, Declaration of Conformity and product labelling etc.

TROUBLESHOOTING

The accuracy of the speed measurement appears very good in the documentation is this likely to be the same for real targets?

The real world is a complex place and there are several known effects that can affect the speed accuracy. For a single target at 50m travelling directly towards the radar with a speed of 60kph will return a speed reading from the radar of 60kph ±3 with close to 100% confidence level. If the vehicle is quite close to the radar such that it is starting to 'pass' the sign, the vehicle is no longer travelling directly towards the radar and an angle is formed between the direction of travel of the target and the bore of the radar. In this case the speed of the target is effectively reduced at the radar by the cosine of this angle. Additionally, if the radar is used on a dual carriageway two vehicles in the adjacent lanes at similar distances travelling at a speed difference <8kph will have their speeds merged by the radar. In this specific case, the speed output of the radar will be between the two vehicle speeds.

The radar has a high speed measurement specification of 160kph (99mph). What happens for targets travelling above this speed?

For targets travelling above the upper speed threshold limit there will be no output from the radar in normal operation. The radar will 'see' the target but not in a meaningful way that will allow the radar to make an output.

If we need the radar to output for targets over 160kph (100mph) is there anything that can be done?

The radar has been optimised for low power and as a result the speed processing task has been restricted to keep the processing overhead low. The upper threshold for speed could be increased but at the expense of current consumption. This change is not a simple internal radar setting and would require a revision to the radar operational firmware.

How accurate is the speed measurement?

The speed measurement algorithm in the 331 radar is a cut-down version of the speed measurement algorithm used in high grade speed enforcement radars manufactured by AGD. The 331 radar outputs the speed of the target to the nearest integer. It is rounded to the nearest integer from a calculation of more significant figures. Each radar is calibrated with a tolerance of +/-3kph using AGD's traceable calibration equipment. Calibration results are available upon request for each serial numbered radar.

The target range measurement is treated in the same way as the speed measurement.

My 331 has a different product number to the ones listed on page 4. What is the difference?

The general operation and function are the same for new and old 331 radars. The 24.2GHz variant 331-100-000 has been superseded by 331-102-000 and the 24.125GHz FCC variant 331-101-000 has been superseded by 331-103-000. If you are unsure please contact AGD.

Radar Characteristics

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

GENERAL

Radar Antenna

The antenna design is a planar patch array with the following performance:

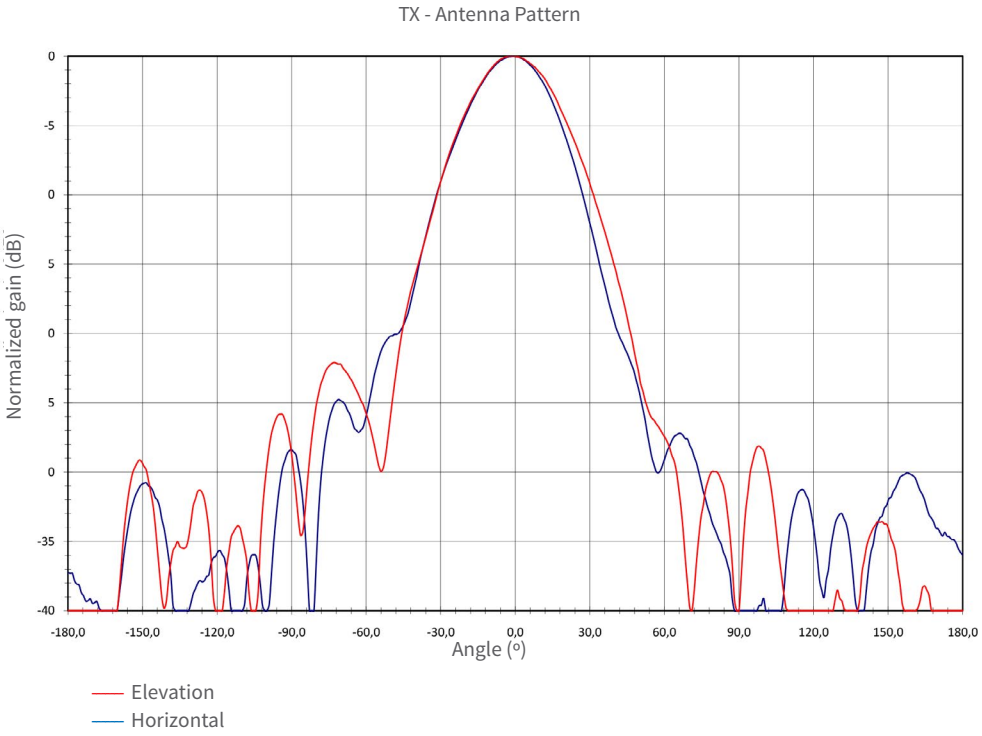
Parameter	Specified	Notes
Horizontal beam-width	33˚ approx	-3dB
Vertical beam-width	33˚ approx	-3dB
Side-lobe suppression	16dB	Minimum
E-Field	Vertical	Plane polarised

Operating Frequency Band and Power

The radar frequency and power is as follows:

Parameter	Specified	Notes
Transmit centre frequency	24.200GHz*	FCC variant uses 24.125GHz
Transmit bandwidth	14MHz	
Transmit power	<100mW EIRP	
Field strength	<500mV/m	@ 3m
ITU code	13M3FXN	

ANTENNA PLOTS



Radar Characteristics

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

FREQUENCY VARIANTS

Several versions of this product are available at frequency options which are for use in different geographic regions related to the radio requirements of that specific jurisdiction as follows;

Frequency Variant	EU Country of Use	Other Countries	Notes
24.200GHz	No current restrictions within the EU	AU, NZ, ZA*, KR*, TR	*May require local approval
24.125GHz		USA, CA, BR*,	FCC compliant variant *May require local approval

This table is periodically updated: if the required country is not shown please enquire on availability.

These products may not be used in the following geographic regions;

Restriction Type	EU Country	Other Countries
Relevant 24GHz band not allocated		
Licence required for use	none currently identified	
Frequency allocated but EIRP too high		

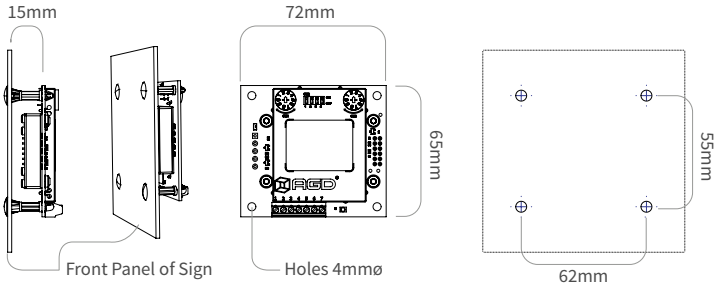
It is important to note that this table is updated from time to time. Please contact AGD for latest information if your intended country of use is not currently represented.

(Note: Countries are listed by their ISO 3166 2 letter code)

Technical Specifications

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

PRODUCT DIMENSIONS



SPECIFICATIONS

Description	In-Sign Radar Traffic Detector
Technology	FMCW Doppler Radar
Frequency	24.2GHz / 24.125GHz (FCC)
Mounting Height	2-5m nominal (optimum 3m)
Range/Zone	Up to 180m (dependent on sign mounting and user selection)
Low Speed Threshold	9 preset selectable thresholds from 11 to 160kph and user defined via RS232
Direction	Advance / Recede / Bidirectional
Operating Temp	-20°C to +60°C
Power Supply	5.5/15Vdc
Current	Detect: 15mA nominal at 12Vdc Non Detect: 10.5mA nominal at 12Vdc
Product Mounting	4 off ø4mm mounting holes
Product Finish	Open PCB finish for mounting inside sealed enclosures
Detect Outputs	x2 FET Switched / x1 RS232
Weight	100g nominal
User Adjustments	• Range via rotary switch 3 or RS232 • Low speed threshold via rotary switch 1 or via RS232 • KPH or MPH via RS232 • Full configuration of all parameters via RS232
Approvals	EN 301 489, EN 50293, EN 300 440, FCC CFR47 Part 15.245, RSS-210, AS/NZS 4268

ACCESSORIES

932	Target Simulator
MS-226	USB - RS232 Converter

Owing to the Company's policy of continuous improvement, AGD Systems Limited reserves the right to change their specification or design without notice.

RoHS COMPLIANT
Restriction on Hazardous Substances

Manufacturing Test Process

AGD **ARIEL**™
TEST COMPLIANCE EQUIPMENT

Ariel™ is a bespoke set of test equipment designed and developed by AGD Systems. It is dedicated to the testing of the AGD portfolio of 'ranging' FMCW vehicle radars. 100% of the 331units manufactured at AGD are Certified by Ariel.

The key test functions performed by Ariel to Certify the premium performance of your Intelligent Detection System are:

- True range simulation of target
- Target speed and direction simulation at a given range
- Radar target processing optimisation
- Transmitted radar frequency modulation measurement
- Verification of interface and communication protocols
- Test cycle time of 9 minutes

The radar test sequences performed by Ariel on the radar under test provides a thorough examination of the performance of the 331 radar and specifically the ranging measurement capability provided by the FMCW technology deployed. This gives full control of simulated targets' signal size, speed, direction and range.

Optimisation of frequency signals on Ariel ensures full compatibility with country requirements within the 24GHz radar operating band.

Ariel™ is dedicated to the testing of the AGD portfolio of 'ranging' FMCW vehicle radars. It provides true range simulation and both target speed and direction simulation at a given range

LIFETIME PRODUCT TRACEABILITY

There are clearly defined pass and fail criteria at all stages within the Ariel test process. The test results in association with the product build revision are recorded on a product serial number basis. The full suite of test measurements is instantly sent to the dedicated product database within the AGD secure server facility, providing full traceability during the product lifetime.

The AGD Certified symbol is your mark of assured performance.

Certification

EU Declaration of Conformity

Certificate No: CE-068 Issue: 4

PRODUCT SOLUTIONS FOR
INTELLIGENT TRAFFIC SYSTEMS

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Web: agd-systems.com

We AGD SYSTEMS LTD
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Staverton
Cheltenham
Gloucestershire
GL51 0TF
UNITED KINGDOM

as manufacturer hereby declare that the following product(s)

Equipment Model Type(s): a) AGD331-1xx-xxx

Equipment Description: a) In Sign Radar- Traffic Detector

conform with the provisions of the following EC Directive(s), including all amendments, and with national legislation implementing this / these directive(s):

2014/53/EU relating to Radio Equipment.

2011/65/EU RoHS Directive

and that the following harmonised standards and Technical Specifications have been applied:

EMC (Art 3.1(b)):	EN301 489-51 V2.1.0
	EN301 489-1 V2.1.1
Health & Safety (Art 3.1(a)):	EN 60950-1:2006 +A1:2010 +A11: 2011 +A12:2011 +AC:2011 +A2:2013
	EN 62479:2010
Spectrum (Art 3.2):	EN300 440 V2.2.1
ROHS	EN 50581:2012

Notified Body Element Materials Technology 0891

EU type certificate: EMT19RED1140

Signed Dated: 17/9/19

For and on behalf of AGD Systems Ltd
P M Hutchinson
Managing Director

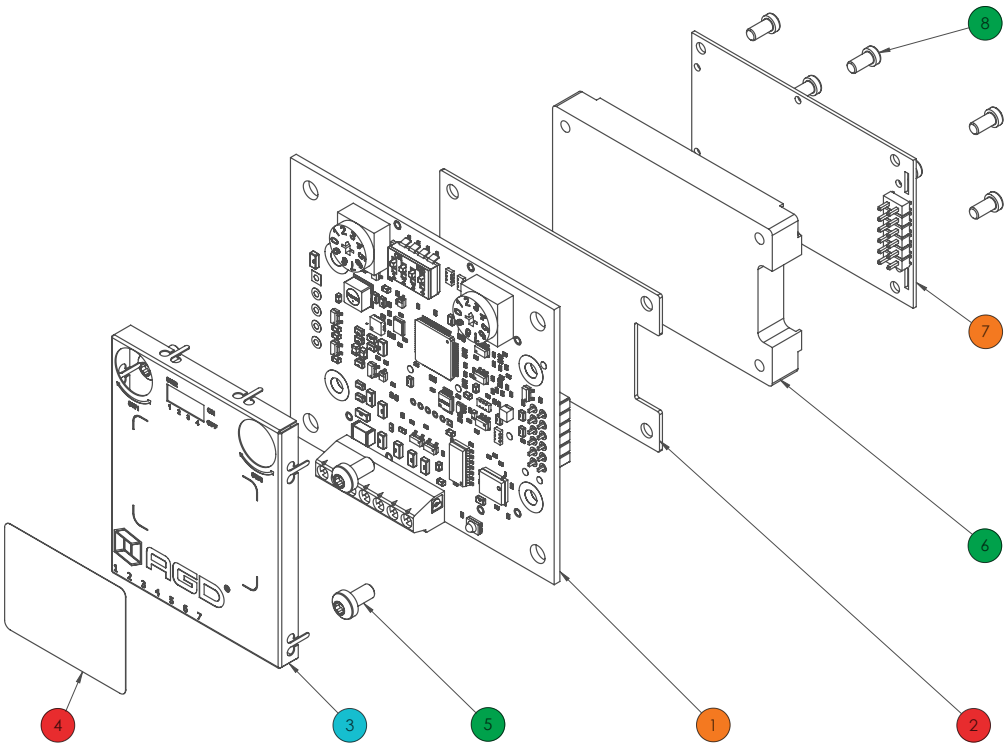
safer, greener, more efficient

Registered in England and Wales No. 2666988

End Of Life – Disposal Instructions (EOL)

AGD331 RADAR TRAFFIC DETECTOR

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR



Item	Qty	Material
1	1	Printed Circuit Board
2	1	FR4
3	1	Nickle Silver Alloy
4	1	Polyester
5	4	Stainless Steel
6	1	Aluminium
7	1	Printed Circuit Board
8	6	Stainless Steel

- Reuse / Recycle
- Separate & Recycle
- Downcycle
- Hazardous Recovery
- Non - Recyclable

This document serves as a guideline only for EOL procedures and further guidance may need to be sought from the appropriate authority or agency.

Important Safety Information

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

SAFETY PRECAUTIONS

All work must be performed in accordance with company working practices, in-line with adequate risk assessments. Only skilled and instructed persons should carry out work with the product. Experience and safety procedures in the following areas may be relevant:

- **Working with mains power**
- **Working with modern electronic/electrical equipment**
- **Working at height**
- **Working at the roadside or highways**

1. This product is compliant to the Restriction of Hazardous Substances (RoHS - European Union directive 2011/65/EU).
2. Should the product feature user-accessible switches, an access port will be provided. Only the specified access port should be used to access switches. Only non-conductive tools are to be used when operating switches.
3. The product must be correctly connected to the specified power supply. All connections must be made whilst the power supply is off or suitably isolated. Safety must take always take precedence and power must only be applied when deemed safe to do so.
4. No user-maintainable parts are contained within the product. Removing or opening the outer casing is deemed dangerous and will void all warranties.
5. Under no circumstances should a product suspected of damage be powered on. Internal damage may be suggested by unusual behaviour, an unusual odour or damage to the outer casing.
   Please contact AGD for further advice.
6. 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.

   • This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance such that the module should not be installed in equipment intended to be used within 20cm of the body.

   • The transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

   • Changes or modifications not expressly approved by AGD Systems Ltd could void the user's authority to operate the equipment.
7. This Product is Compliant with the European Radio Equipment Directive 2014/53/EU.
   There is no restrictions of use within any EU Member state for this product.
   This product is Receiver Category 2.
8. Indicates compliance with all applicable Australian ACMA technical standards and associated record-keeping (including testing) arrangements.

Important Safety Information

AGD **331**
IN-SIGN RADAR TRAFFIC DETECTOR

IMPORTANT INFORMATION

Low Power Non-Ionising Radio Transmission and Safety

Concern has been expressed in some quarters that low power radio frequency transmission may constitute a health hazard. The transmission characteristics of low power radio devices is a highly regulated environment for the assurance of safe use.

There are strict limits on continuous emission power levels and these are reflected in the testing specifications that the products are approved to. These type approval limits are reflected in the product specifications required for a typical geographic area such as those for the EU (ETS300:440), for the USA (FCC part 15c) and for Australia/New Zealand (AS/NZS 4268). The limits adopted in these specifications are typically replicated in many other localized specifications.

The level of safe human exposure to radio transmission is given by the generally accepted guidelines issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). This body has issued guidance for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz) which are quoted below.

	Radar and ICNIRP limit comparison			Typical Informative Limits for Radar Transmission Approval		
	Radar Transmitted Level (Note 4)	ICNIRP Limit (Table 6)	Exposure Margin	ETS300:440	FCC (part15c)	AS/NZS 4268
Power (mW EIRP)	<100mW (<20dBm)	N/A	N/A	100mW (20dBm)	1875mW (Note 1)	100mW (20dBm)
Max Power Density (mW/cm2)	3.18µW/cm2 at 50cm (Note 3)	<50W/m2 (5mW/cm2) (Note 2)	0.064%	N/A	N/A	N/A
Field Strength (V/m) at 3m	<0.58V/m (5.8mV/cm) (Note 1)	<137V/m (1370mV/cm)	0.42%	0.58V/m (5.8mV/cm) (Note 1)	2500mV/m (25mV/cm)	0.58V/m (5.8mV/cm) (Note 1)

Note 1 Values are calculated conversions for comparison purposes.

Note 2 Other equivalent limits include; Medical Research Council Limit of 10mW/cm2, IACP limit of 5mW/cm2 (at 5cm) and UK CAST limit of 5mW/cm2. Power density at the radome typically 4µW/cm2.

Note 3 Calculation is made on the assumption antenna is a point source therefore the actual value is likely to be significantly less than that quoted. Note that a theoretical max level at a 5cm distance (which gives 0.318mW/cm2) is at a point in the field where the radar beam is not properly formed.

Note 4 Comparison for product model 331 operating in the band typically 24.050GHz to 24.250GHz

From the table it can be seen that it is extremely unlikely that a potentially hazardous situation could occur owing to the use of such low power devices.

It is considered to be good practice not to subject humans to radiation levels higher than is necessary. In a works environment where multiple equipment on soak test are to be encountered then it is considered good practice to contain the equipment in an appropriate enclosure lined with radar absorbing material.

Notes

Disclaimer

While we (AGD Systems) endeavour to keep the information in this manual correct at the time of download or print, we make no representations or warranties of any kind, express or implied, about the completeness, accuracy, reliability, suitability or availability with respect to the information, products, services, or related graphics contained herein for any purpose.

Any reliance you place on such information is therefore strictly at your own risk. In no event will we be liable for any loss or damage including without limitation, indirect or consequential loss or damage, or any loss or damage whatsoever arising from loss of data or profits arising out of, or in connection with, the use of this manual.

WARRANTY

All AGD products are covered by a 12 month return to factory warranty. Products falling outside this period may be returned to AGD Systems for: evaluation, repair, update or re-calibration, any of which may be chargeable.

AGD®
PRODUCT SOLUTIONS FOR
INTELLIGENT TRAFFIC SYSTEMS

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