
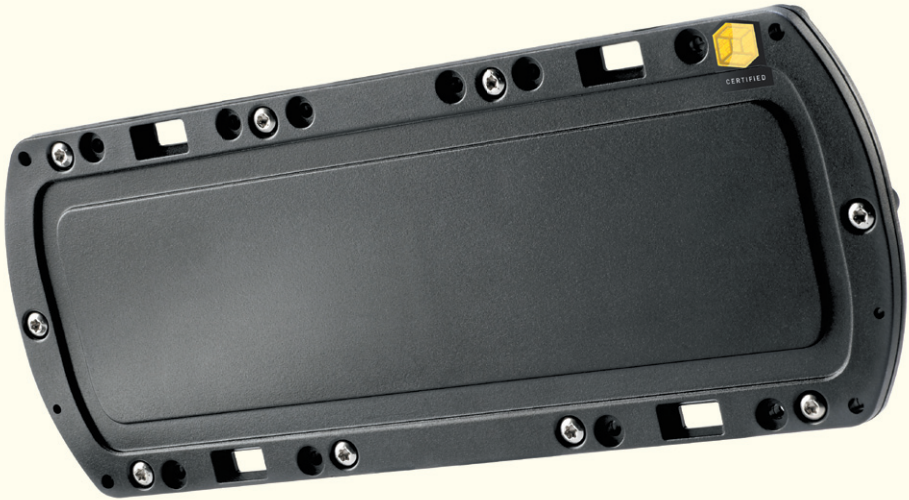
	<h1>342</h1>	
	VEHICLE DETECTION	
	Enforcement Radar Traffic Detector	



PRODUCT MANUAL



THE QUEEN'S AWARDS
FOR ENTERPRISE:
INNOVATION
2011

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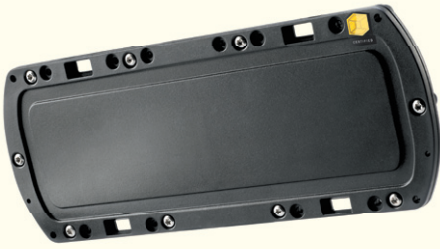
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INTRODUCTION

PRODUCT & TECHNOLOGY



342



The 342 has been designed specifically to measure the speed and range of passing vehicles for enforcement purposes in multiple lanes. The radar is able to track up to eight target signals in both approaching and receding directions simultaneously.

The radar offers fixed and mobile deployment options in conjunction with a host photographic based enforcement system.

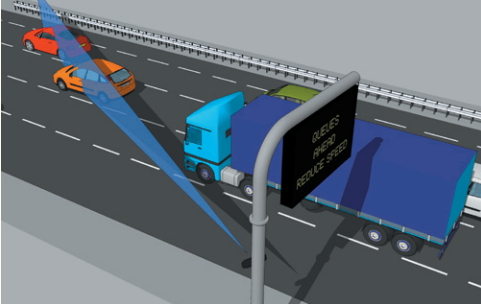
KEY FEATURES

- Radar reports speed and range to each event
- Speed measurement from 20kph to 320kph across multiple lanes
- Target range measurement from 2-60 metres
- Can discriminate between approaching and receding traffic
- Custom designed planar antenna
- Ease of integration to host system
- High speed RS422 serial communications to host equipment
- Hardware target simulation built into the radar
- Continuous radar self check features

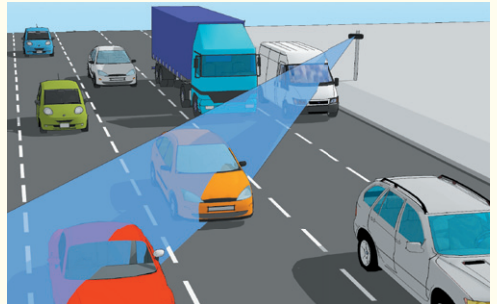
INTRODUCTION

TYPICAL APPLICATIONS

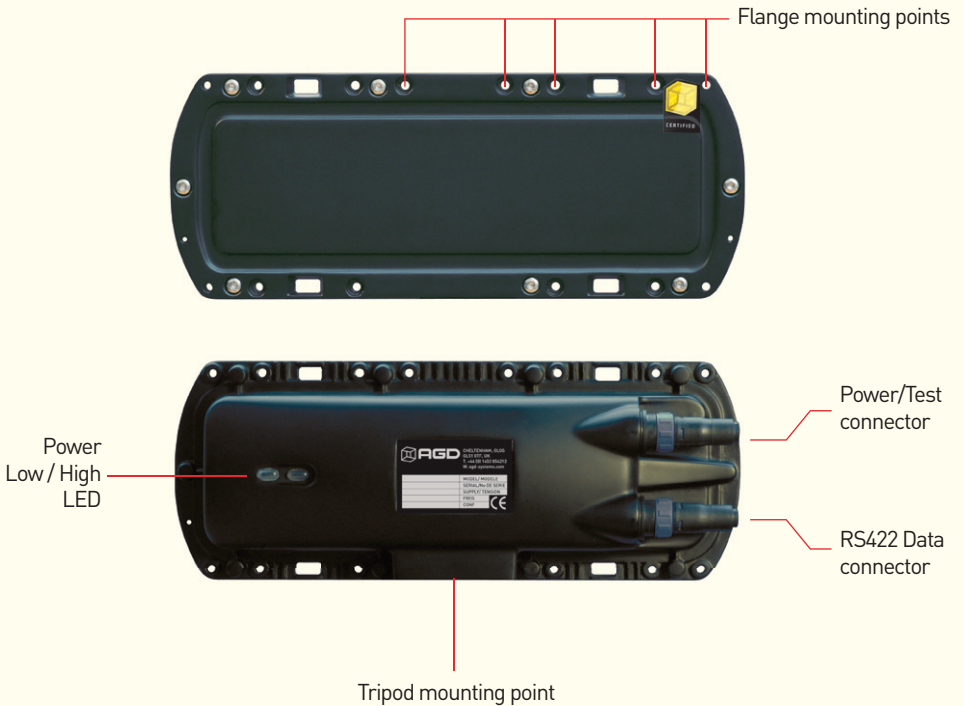
Multiple lane control from fixed infrastructure



Multiple lane control from mobile systems



PRODUCT OVERVIEW

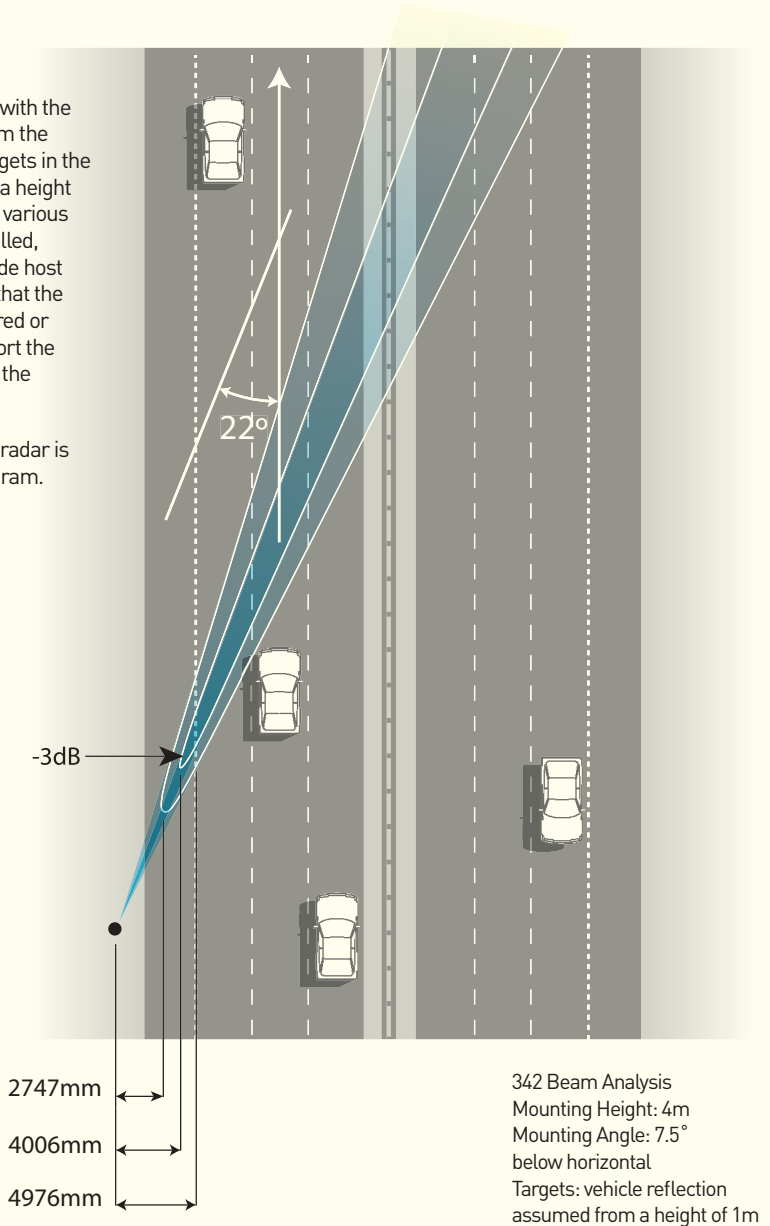


INSTALLATION

RADAR MOUNTING GEOMETRY

The radar is to be installed with the bore of the radar at 22° from the direction of travel of the targets in the lanes. It can be installed at a height in the range 1m to 5m with various considerations. When installed, especially if it is placed inside host equipment, it is important that the radar's radome is not covered or interrupted as this will distort the radar's beam and/or affect the sensitivity of the radar.

The typical coverage of the radar is shown in the following diagram.



INSTALLATION

RADAR MOUNTING HEIGHT

The radar can be installed at different heights but operation is best in the height range 1m to 3.5m. The radar can be mounted up to a height of 5m but it is important to understand that at these higher mounting heights the vertical cosine will affect the speed reading of the radar to progressively under-read for increasing heights for lanes that are too close to the radar.

It is therefore recommended that a minimum off-set, that is, a minimum perpendicular distance from the mounting position to the nearest enforceable lane is adopted as shown in the following table.

Mounting Height	Minimum Offset	Radar Declination Angle	Comment
1-2m	2m	0°	
3m	3m	0°	
4m	4m	7.5°	TBC
5m	6m	7.5°	TBC

SELECTING A SUITABLE SITE

When choosing to deploy the radar on a site the following is a non-exhaustive list of considerations which should be taken into account;

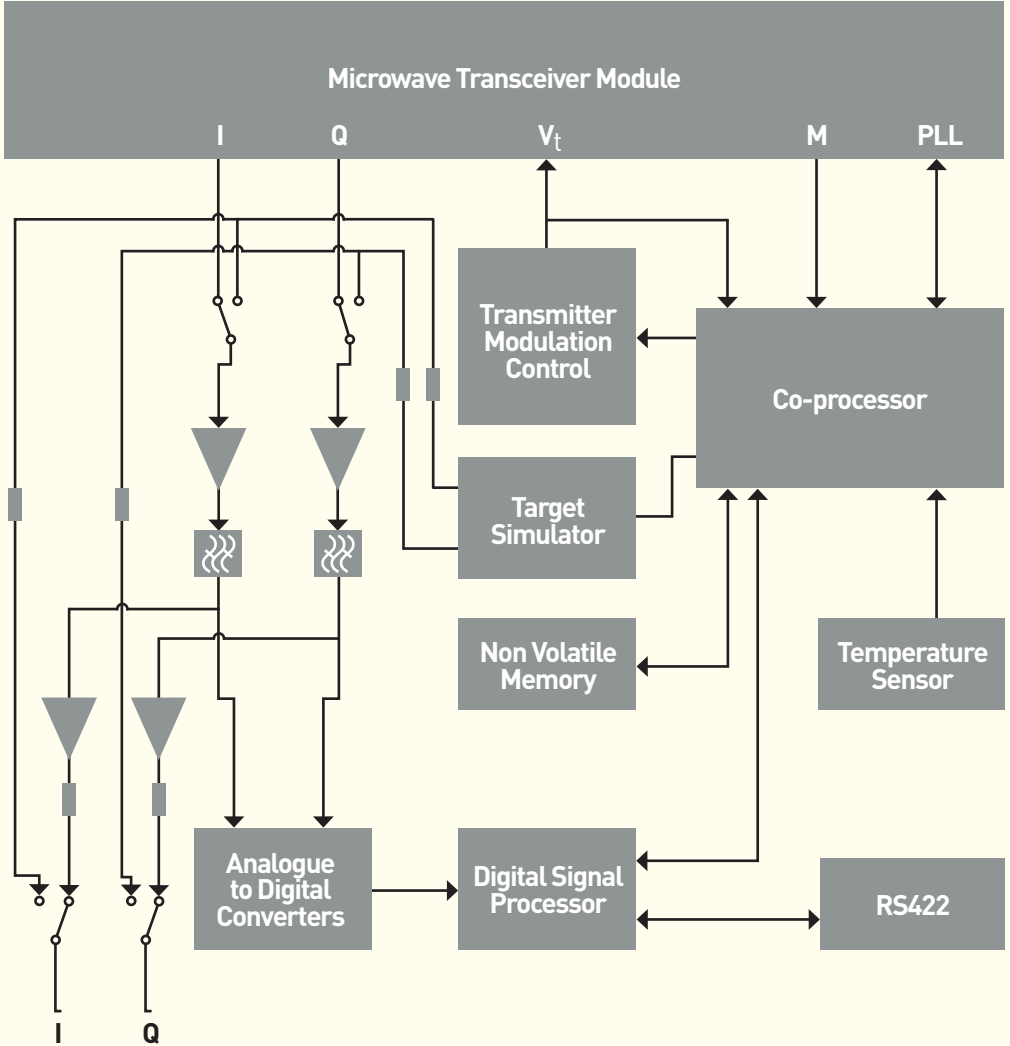
- Do the lane(s) have a measurable radius which cause the vehicles to travel on an arc around the radar?
- Does the roads surface slope in a direction excessively which means deployment is not possible or needs to be accounted for in the set-up/alignment process of the radar.
- Is the nearest lane to be covered greater than the specified offset given the proposed deployment height for the radar?
- Are there any large reflecting surfaces directly in front or behind the radar mounting position?

RADAR MESSAGES IN NORMAL OPERATION

When the radar is installed and aligned correctly it will perform to specification.

SYSTEM HARDWARE OVERVIEW

SYSTEM HARDWARE OVERVIEW



Test Connections

SYSTEM HARDWARE OVERVIEW

RS422 SERIAL INTERFACE

A UART interface is provided that uses RS422 voltage levels on the communications connector. The default baud rate for this interface is 115200. This however may be changed using the *BAUD command to speeds of up to 926000. The *BAUD command must be followed by a *PUS command to store the new value to non-volatile memory. This new value will be used next time the radar reboots.

The serial interface default setup during normal operation is shown in table below.

DEFAULT UART SETTINGS	
Parameter	Value
Baud rate	115200
Data bits	8
Parity bits	odd
Stop bits	1
Flow control	None

The RS422 provides the primary output of the radar in the form of ASCII messages.

The communications connector is a Bulgin PX0412/08P connector, mating type PX0410/08S/6065. The pin out of the connector is shown in the table below.

RS422 CONNECTOR CONNECTIONS		
Pin No	Signal	Description
1	A (RX+)	RS422 Signals
2	B (RX-)	
3	Z (TX+)	
4	Y (TX-)	
5	Not connected	
6	Not connected	
7	GND	Ground or 0V
8	Not connected	

TEMPERATURE SENSOR

A temperature sensor has been installed in the radar. The temperature of the radar may be requested using the *TEMP command.

SYSTEM HARDWARE OVERVIEW

POWER SUPPLY

The radar is powered using a DC voltage in the range of 10 to 16 Volts. This is supplied on the power and test connector. This connector is a Bulgin PX0412/06P mating type PX0410/06S/4550.

Reverse polarity protection is included in the design. The radar can take a large current during power up that is of the order of amps which only lasts for ~1ms and as such should not affect most applications.

A thermal fuse with a 750mA rating has been installed to protect against electrical short circuit fault conditions.

POWER / TEST CONNECTOR CONNECTIONS

Pin No	Signal	Description
1	REF	Reference frequency RS422 voltage levels
2	REF	
3	I	Do not connect. I and Q port connections for directly measuring received signal or for simulated signal injection
4	Q	
5	VIN	Supply voltage 10 to 16Vdc
6	GND	Supply ground

Power-Up Sequence

Upon initialisation from power-up or *REBOOT the radar will respond with the following sequence of messages;

```
AGD SYSTEMS LTD AGD342 RANGING ENFORCEMENT RADAR
Firmware Version MI-146-2-P2
Firmware Compile Time 10:21:21 Dec 5 2012
Co-Processor Firmware MI-147-1,Nov 12 2012
.....
HB,00000000*FD
```

Whilst the radar is carrying out its self-test functions a series of decimal points will appear. When finished the radar will report a Heartbeat (HB) message to indicate the radar has successfully initialised and is normally operating. The host system should not send the radar any messages whilst it is initialising. Messages should be sent to the radar after the HB is received. The radar will always send an initial HB message after initialising following power-up even when the HB message is turned off.

Power Supply Tolerance

The radar power supply is specified between 10 and 16Vdc. These are the limits applied on test and calibration. The radar will operate outside this range but its operation is not specified. At 12V dc the current is 250mA.

When $V_{SUPPLY} < 10Vdc$ (but enough to power the radar) the LED will permanently illuminated.

When $V_{SUPPLY} > 16Vdc$ (but below fuse limit) the LED will flash.

SYSTEM HARDWARE OVERVIEW

RADAR CHARACTERISTICS

The radar has been designed to have a specific set of functional characteristics which make it suitable for speed measurements for enforcement applications.

Radar Antenna

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

Parameter	Specified	Notes
Horizontal Beam-width	4.5°	-3dB (HPBW)
Vertical Beam-width	15°	-3dB (HPBW)
Side-lobe Suppression	>15dB	
E-Field	Horizontal	Plane Polarised

Operating Frequency Band and Power

The transmitter is a Phase Locked Loop (PLL) controlled MMIC based oscillator. The design confidence means that the nominal centre frequency of the transmission shall remain within a 10MHz window for the required 7 years for a radar functioning normally.

The change in frequency with temperature is measured to be $\leq \pm 1.21$ MHz over the operating temperature range -20°C to +60°C.

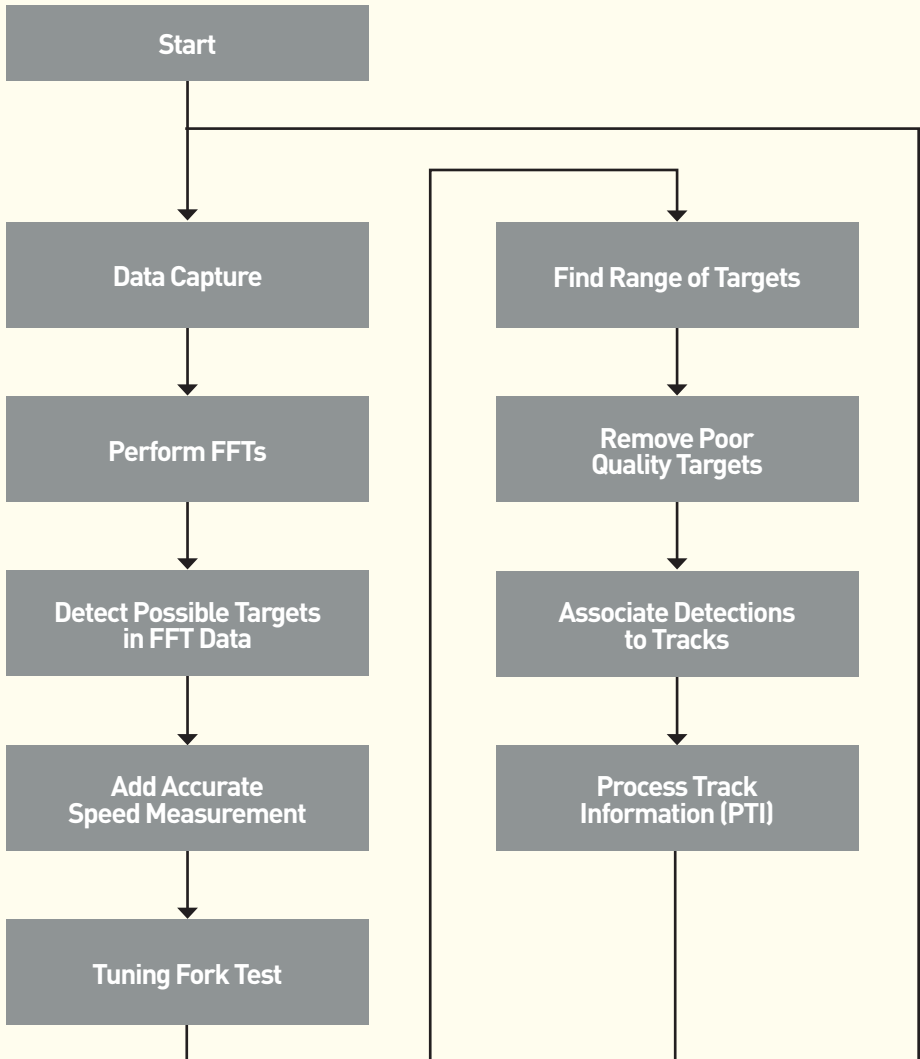
The radar frequency and power is as follows;

Parameter	Specified	Notes
Operating Frequency Band	24.075 – 24.125 GHz	
Frequency Modulation [FM]	9.4MHz	
Power	<100mW eirp	
Field Strength	Typically 450mV/m	At 3m
ITU Code	9M4FXN	

SOFTWARE FUNCTIONALITY

OVERVIEW

The 342 radar uses a real time operating system that continuously samples the input. The radar is continuously performing a number of tasks simultaneously using a time multiplexing method. The main data capture and processing task flow diagram is shown below.



RADAR COMMANDS

RADAR COMMAND OVERVIEW

Commands are used to control the operation of the radar. These are sent over the RS422 UART link.

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

Operator	Operation
=	Set something to a value e.g. *LS=50<CR> sets low speed threshold to 50
?	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

*LS=50<CR>	Radar responds with #LS=50km/Hr<CR>
*LS?<CR>	Radar responds with #LS?50km/Hr<CR>
*FSN?<CR>	Radar responds with #FSN?1111111,2222222,3333333,4444444<CR>

Where a function requires to provide more feed back than can fit on a single line the radar will prefix each line with a # followed by the command name. An example of this is the MOTOROLA-FLASH command.

Communications Command Interpreter Error message

If the user enters incorrect syntax or tries to set a parameter out of range this will be reported as an error. The radar will return #ERROR followed by a description of the error.

RADAR COMMANDS

*TS COMMAND & HARDWARE SELF-TEST

The radar has a built in hardware based target simulator. This command is used to perform a self-test using this built in target simulation hardware. There are twelve targets that maybe simulated in either receding or approaching directions

The format of the command is:

***TS=<Target Number>,<Direction><CR>**

The target parameters for each target are shown in the table below.

Target Number	Speed(MPH)	Range (Metres)	Distance Travelled in Beam (Metres)
1	50	16	25
2	80	16	10
3	120	16	10
4	190	16	10
5	50	32	25
6	80	32	10
7	120	32	10
8	190	32	10
9	50	64	25
10	80	64	10
11	120	64	10
12	190	64	10

For example

***TS=1,A<CR>**

Radar Response;

<STX>ES,000018F7,00000003,X,050.0,M,016.0*16<ETX><<CR>

#TS:COMPLETE<CR>

<STX>EE,000019CD,00000003,X,050.0,M,016.0,025.2,022.0*DA<ETX><<CR>

<STX>QM,000019CD,00000003,X,050.0,00.00,M,104.4,100,100*7A<ETX><<CR>

RADAR COMMANDS

*TS COMMAND & HARDWARE SELF-TEST (CONTINUED)

It is recommended that the system uses the following pass/fail criteria for acceptance to specification for a radar self-test. It is also recommended that after power-up of the radar, the host system calls the radar self-test function to simulate at least one approaching and one receding target. When in Bi-Directional mode the radar will report both advancing and receding simulated targets.

When in Advance Mode the radar will only accept and report simulated targets that are advancing. If a recede simulated target is requested the radar processing will reject the target as 'wrong direction' and only

#TS:COMPLETE<CR>

message will be sent as confirmation that the simulation has been completed. When in Recede mode vice versa.

Parameter	Criteria For Event Start Message	Criteria For Event End Message	Criteria For Quality Message
Speed	$\leq \pm 0.2$ (mph or Km/h)	$\leq \pm 0.2$ (mph or Km/h)	N/A
Distance	$\leq \pm 0.5$ m	$\leq \pm 0.5$ m	N/A
Event Length	N/A	$\leq \pm 0.5$ m	N/A
Direction	100% correct	100% correct	N/A
Checksum	100% correct	100% correct	100% correct
Peak Power Speed (PPS)	N/A	N/A	± 0.5 of simulated speed
PPS Standard Deviation	N/A	N/A	<TBD
Peak Power	N/A	N/A	>TBD
% Speed readings	N/A	N/A	>95%
% Range Readings	N/A	N/A	>95%

The hardware target simulator is fully independent of the radar measurement system. This is used to verify the operation of the radars measurement circuitry. The self-test does NOT operate automatically on power-up of the radar. During simulation the microwave front end is disconnected from the ADC to avoid any possible interference with the simulation.

The radar self-test function can be called at any time using the *TS command.

The *TS command calls a pre-loaded simulated test target condition. There is a selection of pre-loaded test target conditions as set out.

As the test targets are a true simulation of a real target the respective event messages from the radar will occur at differing times dependant on the simulation called. i.e the time between the Event Start Message and the Event End Message will be significantly longer if a simulation is for a slow long target than if a simulation for a fast short target is selected.

To distinguish real targets from simulated targets the radar inserts an X or a Y in the direction fields of all related messages produced.

RADAR COMMANDS

***SR COMMAND & THE 50KHZ REFERENCE CLOCK**

The *SR command is used to enquire about the radars measured sample rate. This is an additional self-test feature to confirm correct operation of the radar to specification.

For example

```
*SR?<CR>
```

Radar Response

```
#SR?50002.21<CR>
```

There is no pass/fail criteria for the host system for this response as the radar periodically performs this test against pre-set criteria.

The radar uses an analogue to digital converter, ADC, to digitise the received signals. The ADC clock source is derived from a crystal on the digitiser board. The crystal used has a frequency of 12.0MHz. This clock is divided down by 240 to give a reference clock frequency of 50.0KHz.

The reference clock is provided on balanced line outputs compatible with RS422 signal levels.

The radar constantly monitors the sampling frequency by comparing how long the radar takes to collect data samples by using the processors crystal as a reference, which is independent from the ADC clock source. Measurements are compared approximately every five seconds and if measurements show a large enough error then the radar will send an error message 06. The last measurement of the ADC clock frequency can be accessed at any time by using the *SR command.

***IQ PORT COMMAND**

This command is used to enquire or set the IQ port configuration as input or output. The IQ port is default set to an output.

For example

```
*IQPORT?<cr>
```

Radar response

```
#IQPORT?0
```

The IQ port provides connections that may be used to observe or inject IQ signals for independent test house measurement performance verification. When the IQ port is configured as an input the radar will disconnect from the microwave module and connect its baseband circuitry to the IQ port pins. The radar will measure injected events in the normal way and the radar will mark detected targets with a direction field of X or Y depending on the direction of the target indicating the test condition.

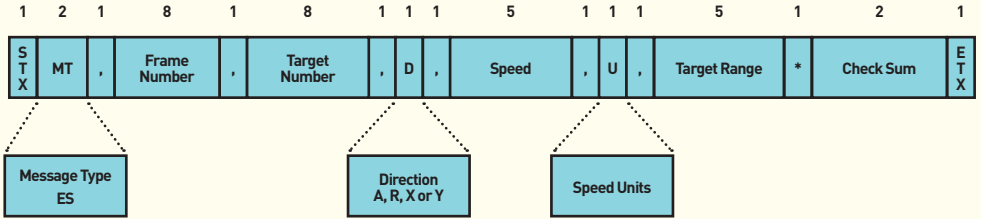
It should also be noted that the IQ Port can be configured as an input.

MESSAGE FORMATS

RADAR EVENT MESSAGES

Event Start message

This message is sent after the radar has established that a vehicle has entered the radar's beam. The numbers above the boxes in the diagram below indicate how many bytes are used for each field.



Event Start message format

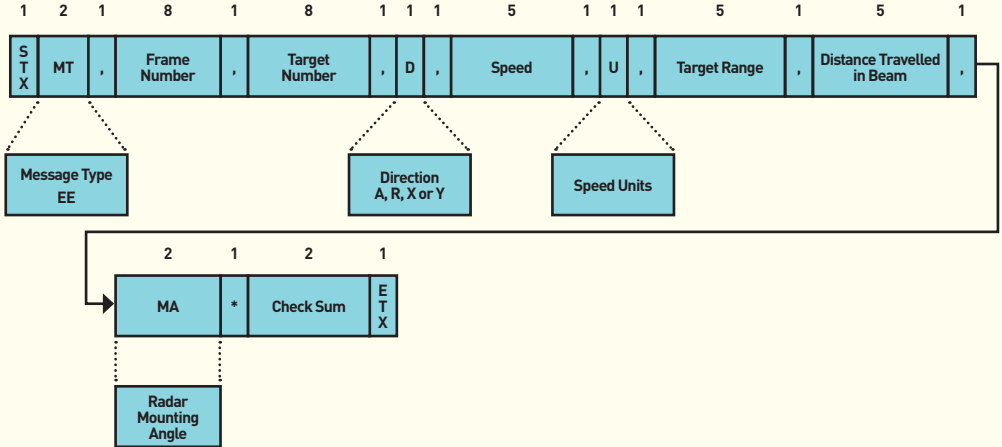
Name	Size / Bytes	Value	Notes
STX	1	2	Start of message byte
MT	2	'ES' = Event Start	Message type
,	1	','	Comma
Frame Number	8	XXXXXXXX	Frame number in hexadecimal format
,	1	','	Comma
Target Number	8	XXXXXXXX	Target identification number in hexadecimal format
,	1	','	Comma
Direction	1	'A' = Approaching Target 'R' = Receding Target 'X' = Simulated approaching target 'Y' = Simulated receding target	Direction the target is travelling.
,	1	','	Comma
Speed	5	'DDD.D'	Target speed to one decimal place in decimal format
,	1	','	Comma
Speed Units	1	'M'=MPH 'K'=km/hr	The speed units used for the measurement
,	1	','	Comma
Target Range	5	'DDD.D'	Target range in metres
*	1	'*'	Asterisk
Check Sum	2	'XX'	Check sum in hexadecimal format
ETX	1	3	End of message byte

MESSAGE FORMATS

RADAR EVENT MESSAGES

Event End Message

This message is sent once a target has been detected for a significant amount of time. This message can be used by a host system to trigger a camera to capture images for a receding target enforcement system.



MESSAGE FORMATS

RADAR EVENT MESSAGES

Event End message format

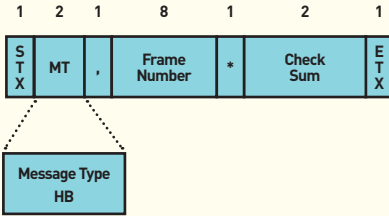
Name	Size / Bytes	Value	Notes
STX	1	2	Start of message byte
MT	2	'EE' = Event End	Message type
,	1	','	Comma
Frame Number	8	XXXXXXXX	Frame number in hexadecimal format
,	1	','	Comma
Target Number	8	XXXXXXXX	Target identification number in hexadecimal format
,	1	','	Comma
Direction	1	'A' = Approaching Target 'R' = Receding Target 'X' = Simulated approaching target 'Y' = Simulated receding target	Direction the target is travelling.
,	1	','	Comma
Speed	5	'DDD.D'	Target speed to one decimal place in decimal format
,	1	','	
Speed Units	1	'M'=MPH 'K'=km/hr	The speed units used for the measurement
,	1	','	Comma
Target Range	5	'DDD.D'	Target range in metres
,	1	','	Comma
Distance Travelled in beam	5	'DDD.D'	The distance a target has travelled while in the beam of the radar.
,	1	','	
MA	2	'DD'	Radar mounting angle in degrees. This is the angle the radar uses to calculate the speed of a target
*	1	'*'	Asterisk
Check Sum	2	'XX'	Check sum in hexadecimal format
ETX	1	3	End of message byte

MESSAGE FORMATS

RADAR EVENT MESSAGES

Heart Beat message

This message is sent each time the heart period expires. The heart beat message period is controlled using the *HBP command. The heart beat period is measured in frames.



Heart Beat message format

Name	Size / Bytes	Value	Notes
STX	1	2	Start of message byte
MT	2	'HB' = Heart Beat	Message type
,	1	','	Comma
Frame Number	8	XXXXXXXX	Frame number in hexadecimal format
*	1	'*'	Asterisk
Check Sum	2	'XX'	Check sum in hexadecimal format
ETX	1	3	End of message byte

Notes to Heart Beat Message

The heartbeat period is set in seconds using the *HBP command. Setting the heartbeat period to 0 secs will turn the heartbeat off. The maximum setting for the heartbeat period is 86400 secs.

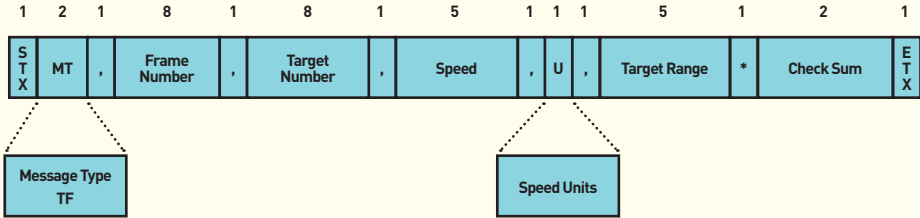
A heartbeat message will always be produced after the radar initialises even if the heartbeat is turned off. The host system should not send messages to the radar after power-up until this initial heartbeat message is received.

MESSAGE FORMATS

RADAR EVENT MESSAGES

Tuning Fork message

This message is sent when a tuning fork target has been detected. This message is sent after a event end message is sent.



Tuning Fork message format

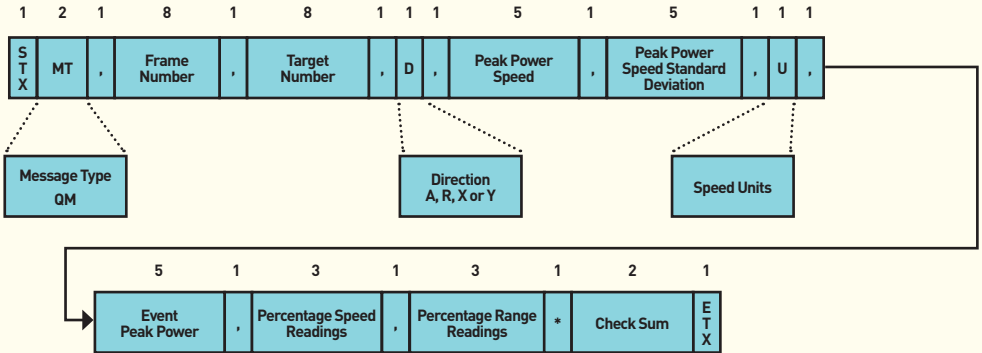
Name	Size / Bytes	Value	Notes
STX	1	2	Start of message byte
MT	2	'TF' = Tuning Fork	Message type
,	1	','	Comma
Frame Number	8	XXXXXXXX	Frame number in hexadecimal format
,	1	','	Comma
Target Number	8	XXXXXXXX	Target number in hexadecimal format
,	1	','	Comma
Speed	5	'DDD.D'	
,	1	','	Comma
Speed Units	1	'M'=MPH 'K'=km/hr	The speed units used for the measurement
,	1	','	Comma
Target Range	5	'DDD.D'	Target range in metres
*	1	'*'	Asterisk
Check Sum	2	'XX'	Check sum in hexadecimal format
ETX	1	3	End of message byte

MESSAGE FORMATS

RADAR EVENT MESSAGES

Event Quality message

Once an event end message is sent, the measurements relating to the event are analysed. These various elements of the event are reported in the Event Quality Message.



MESSAGE FORMATS

RADAR EVENT MESSAGES

Event Quality message format

Name	Size / Bytes	Value	Notes
STX	1	2	Start of message byte
MT	2	'QM' = Quality Message	Message type
,	1	;;	Comma
Frame Number	8	XXXXXXXX	Frame number in hexadecimal format
,	1	;;	Comma
Target Number	8	XXXXXXXX	Target number in hexadecimal format
,	1	;;	Comma
Direction	1	'A' = Approaching Target 'R' = Receding Target 'X' = Simulated approaching target 'Y' = Simulated receding target	Direction the target is travelling.
Peak Power Speed	5	'DDD.D'	
,	1	;;	Comma
Peak Power Speed Standard Deviation	5	'DDD.D'	
,	1	;;	Comma
Speed Units	1	'M'=MPH 'K'=km/hr	The speed units used for the measurement
,	1	;;	Comma
Event Peak Power	5	'DDD.D'	
,	1	;;	Comma
Percentage Speed Readings	3	'DDD'	The value of actual speed readings taken as a function of the total possible expressed as a percentage
,	1	;;	Comma
Percentage Range Readings	3	'DDD'	The value of actual range readings taken as a function of the total possible expressed as a percentage
*	1	'*'	Asterisk
Check Sum	2	'XX'	Check sum in hexadecimal format
ETX	1	3	End of message byte

MESSAGE FORMATS

RADAR MESSAGES IN NORMAL OPERATION

Example data from radar set in Bi-Directional Mode and the Heartbeat set to 5 seconds.

```
HB,00003560*68
HB,00003930*40
ES,00003B15,00000014,R,029.3,M,017.1*2A
EE,00003B87,00000014,R,029.5,M,023.2,009.5,022.0*DE
QM,00003B87,00000014,R,029.5,00.93,M,095.1,081,081*84
HB,00003D00*31
HB,000040D0*BE
HB,000044A0*26
HB,00004870*D4
ES,00004988,00000015,R,029.1,M,017.4*46
EE,00004A0A,00000015,R,029.7,M,022.2,010.7,022.0*78
QM,00004A0A,00000015,R,029.7,00.67,M,092.8,087,083*7E
ES,00004AE6,00000016,R,031.0,M,018.1*20
EE,00004B4D,00000016,R,031.5,M,021.7,009.5,022.0*9C
QM,00004B4D,00000016,R,031.5,00.52,M,093.4,086,085*E2
ES,00004B55,00000017,A,030.1,M,030.5*F4
EE,00004BAA,00000017,A,029.2,M,029.0,006.8,022.0*86
QM,00004BAA,00000017,A,029.2,00.82,M,080.3,070,065*9C
HB,00004C40*D1
ES,00004D86,00000018,A,033.1,M,030.2*CE
EE,00004DCE,00000018,A,032.9,M,027.9,006.7,022.0*7C
QM,00004DCE,00000018,A,032.9,00.63,M,084.4,073,071*75
ES,00004F7D,00000019,A,040.1,M,032.2*9D
EE,00004FC9,00000019,A,039.7,M,030.2,007.8,022.0*6A
QM,00004FC9,00000019,A,039.7,00.64,M,085.9,085,081*25
HB,00005010*7B
HB,000053E0*8D
```


EXPLANATORY NOTES FOR RADAR EVENT & QUALITY MESSAGES

The Event Start (ES) message contains both initial target speed and range information. The radar will have tracked the vehicle for a short distance before this message is sent. As only a relatively small amount of target information is available to the radar at this stage, the range and speed of the target are not fully evaluated by the radar and are provided for the system to make some initial decisions about whether to be interested in the target. The initial speed and range readings in the ES message will have been qualified by the radar against a series of checks to ensure that the event information is of sufficient quality to proceed with a target track. The physical position on the road of the target corresponding to the sending of the ES message can be moved by altering the Event Start Distance (*ESD). A longer ESD will improve the quality of the ES speed and distance measurement and make the ES message occur later. Reducing the ESD will have the opposite effect. Making the ESD too small may lead to premature ES messages.

When the vehicle can no longer be tracked by the radar an Event End (EE) message is generated. This message contains the speed of the vehicle which should be used for the Event as all possible speeds would have been processed during the event. The range of the target in the EE message will generally be different from that of the ES message because the target will have moved along the carriageway during the event. Generally, the ES range will be less than the EE range for receding target and vice versa. The distance the target travels after the track is lost to when the EE message is sent is set by the Event End Distance (*EED) message. Making the EED too small may result in multiple events being generated for a single target.

In the Event End message, the distance travelled in the beam by the target (Event Length) is reported in metres. This measurement is directly proportional to the length of the target in the event. Depending on the range this measurement will be approximately 8m for a saloon car and approximately 20m for a truck. Generally, a larger event length can result in a larger difference in the range measurements reported in the ES and EE messages.

The Quality Message (QM) always immediately follows the EE message. The reported Peak Power Speed in the QM is the same as that used in EE speed reading. The radar processes 195 readings per second and the standard deviation of all those readings for the associated event are reported as a standard deviation in the QM. The peak power reading is the maximum signal strength seen for the event. The peak power for a given target will be reduced at increasing range. Generally, for a given range, cars produce a lower peak power reading than for trucks.

Whilst the radar processes 195 range and speed readings per second not all these readings pass the radars quality check for a given reading. Say, 100 speed readings are collected for an event (that's an event which lasts approx. 513mS) but the radar rejects 12 of the readings, the QM field Percentage Speed Readings will report 088. That is, 88 good readings from the possible 100 taken is reported as 88%.

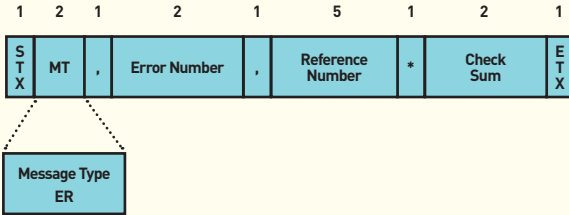
Firstly, the speed reading is assessed and then the corresponding range reading for that speed is then assessed. If a speed reading is rejected, the corresponding range reading is automatically rejected. Continuing with the example, there will be 88 ranges corresponding to the accepted speeds. Each range is then quality checked to a given tolerance and rejected or passed. If they all pass the range quality check the Percentage Range Readings will report 088. The Percentage Range Readings field is always less than or equal to the Percentage Speed Readings. Finally, if the radar had rejected 14 of the available range measurements the reported Percentage Range Reading would be 074.

MESSAGE FORMATS

RADAR ERROR MESSAGES

Operational Error message

The operational error message is an unsolicited message used to report degrees of variance of the radar from normal operation.



Operational Error message format

Name	Size / Bytes	Value	Notes
STX	1	2	Start of message byte
MT	2	'ER' = Error Message	Message type
,	1	','	Comma
Error Number	2	DD	Error number in decimal format - see table on next page for details
,	1	','	Comma
Reference Number	5	DDDDD	Reference number used to help isolate error source. This can change between software versions and should not be used by the host system.
,	1	'*'	Asterisk
Check Sum	2	'XX'	Check sum in hexadecimal format
ETX	1	3	End of message byte

MESSAGE FORMATS

RADAR ERROR MESSAGES

Error Number table

Error Number	Description	Response	Actions
01	Corruption of User Configuration Data	Radar will attempt to restore Factory Default Data configuration set	User will need to reset individual configuration variances from default set
02	Corruption of Factory Default Data Configuration set	Radar operation will automatically shut down as operation to specification cannot be assured	Return radar to AGD for repair and/or recalibration
03	Corruption of Critical Configuration Data	Radar operation will automatically shut down as operation to specification is not possible	Return radar to AGD for repair and/or recalibration
04	Internal communication error. Communication between radar processors has failed.	Radar operation will automatically shut down	Return radar to AGD for repair and/or calibration
05	General error	Radar has internal code tags to indicate resource usage and levels of processing load	User should ignore if infrequent. Repeated occurrence suggests radar nearing specification limits and should be shut down by the user. It should be noted that repeated occurrence of this message may be owing to the specific site at which it is deployed and or the associated targets making the radar work close to its operational processing limits.
06	Sampling Frequency Error	The radar will continue to operate.	If the sampling Frequency Error is persistent ie more than one message every 10 secs, then the radar operation to specification cannot be assured and should be shut down by the host system. The radar should be returned to AGD for repair and/or recalibration

CRC8 C CODE WORKED EXAMPLE

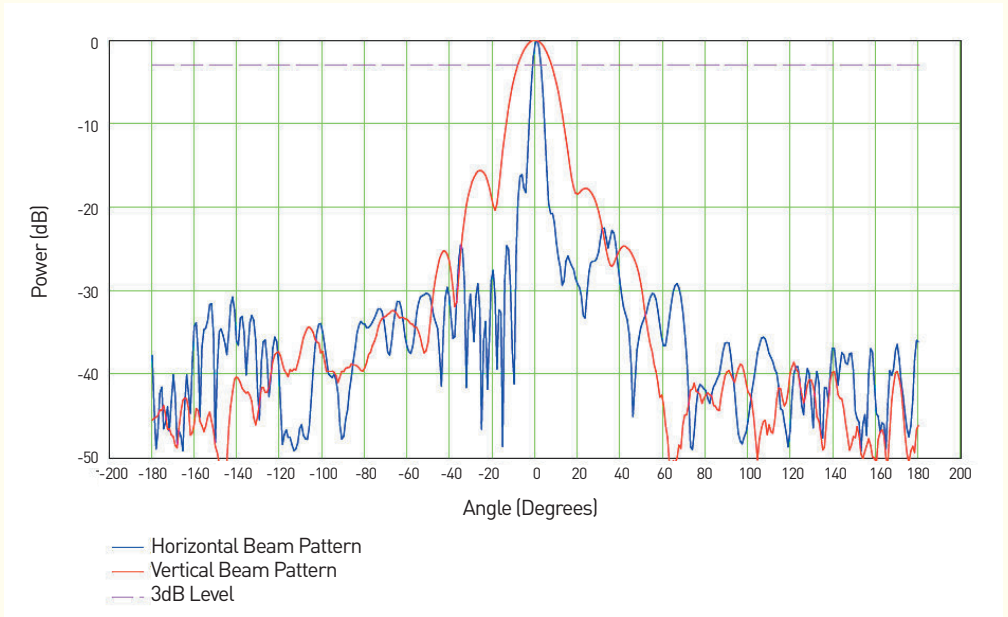
CRC8 C CODE

CRC8 checksums are used on the standard radar messages. The checksum calculation is performed on all bytes, up to and including the asterisk character. These checksums are calculated using the following C code.

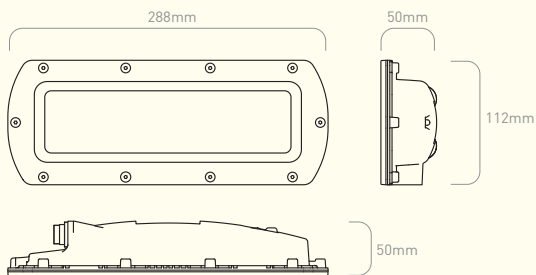
```
//Lookup table for CRC8 calculation
//Needs to be initialised with InitCRC8
U8 crc8_table[256];
/*****MemCRC8*****/
This function calculates the CRC8 of a data array pointed to by data
and of length length.
Uses polynomial  $x^8 + x^2 + x + 1$ . Lookup table used by function is initialised
by the InitCRC8 function.
*/
unsigned char MemCRC8(void *data, unsigned int length)
{
    unsigned char crc8;
    unsigned char i;
    unsigned char *dptr;
    dptr = (unsigned char*)data;
    crc8 = 0; //Start with a value of 0
    for(i = 0; i < length; i++)
    {
        crc8 = crc8_table[crc8 ^ *dptr];
        ++dptr;
    }
    return crc8;
}

#define GP 0x107 /*  $x^8 + x^2 + x + 1$  */
#define DI 0x07
/*****InitCRC8*****/
Initialises the lookup table for the MemCRC8 function
Uses polynomial  $x^8 + x^2 + x + 1$ 
*/
void InitCRC8(void)
{
    int i,j;
    unsigned char crc;
    for (i=0; i<256; i++)
    {
        crc = i;
        for (j=0; j<8; j++)
        {
            crc = (crc << 1) ^ ((crc & 0x80) ? DI : 0);
        }
        crc8_table[i] = crc & 0xFF;
    }
}
```

ANTENNA PLOTS



TECHNICAL SPECIFICATIONS



SPECIFICATIONS

Technology	FMCW Radar
Radiated Power	<100mW EIRP
Transmit Frequency	In the band 24.075 to 24.125GHz
Transmit Bandwidth	9.4MHz
Range	2 to 60m
Mounting	Flange fixings or tripod mount
Mounting Height	1 - 3.5m nominal
Speed Range	20 to 320kph
Weight	0.8 Kg nominal
Housing Material	Polycarbonate (UL94 V-2)
Housing Finish	Self coated black
Sealing	IP66
Operating Temperature	-20°C to +60°C
Power	2.9 - 3.3W
Power Supply	10-16Vdc
Radar Output	RS422
EMC Specification	ETSI EN 301 489 and BS EN 50293
Radio Specification	ETSI 300.440, FCC CFR47 Part 15.245

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

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.

See 47 CFR Sec. 15. 19

A separation distance of at least 20 centimetres should normally be maintained between this product and the body of users or nearby persons.

Changes or modifications to this equipment, not expressly approved by AGD Systems Ltd, may void the user's authority to operate this equipment.

DEDICATED TEST EQUIPMENT

The key test functions performed by Hyperion to Certify the premium performance of the 342 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



MANUFACTURING TEST PROCESS

	TEST EQUIPMENT:	HYPERION™	 <small>HYPERION was designed and developed by AGD Systems.</small>
	PRODUCT TEST:	315 316 317 335 336 342	
	TEST FUNCTION:	<ul style="list-style-type: none"> • True range simulation of target • Test cycle time 9 minutes • Radar target processing optimisation • Verification of communication protocols 	

Hyperion™ 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 342 units manufactured at AGD are Certified by Hyperion.



FULL RANGE

HYPERION 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

The key test functions performed by Hyperion 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 Hyperion on the radar under test provides a thorough examination of the performance of the 342 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 Hyperion ensures full compatibility with country requirements within the 24GHz radar operating band.

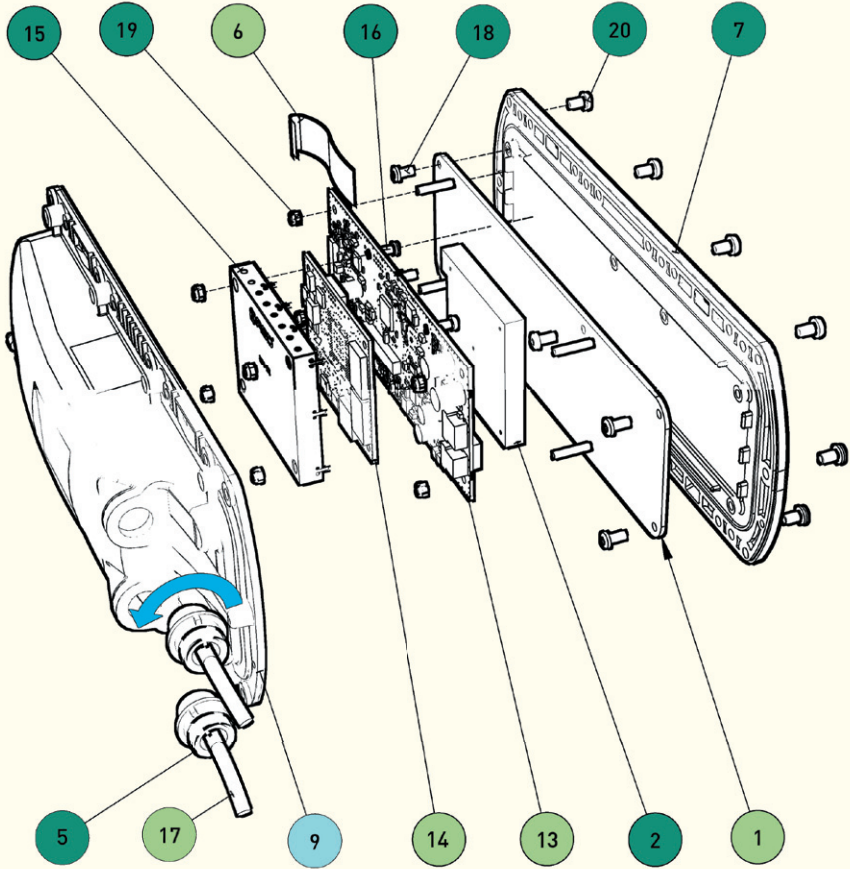
LIFETIME PRODUCT TRACEABILITY

There are clearly defined pass and fail criteria at all stages within the Hyperion 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.

END OF LIFE – DISPOSAL INSTRUCTIONS (EOL)

AGD342 RADAR TRAFFIC DETECTOR



Item	Qty	Material
1	1	PCB Assembly
2	1	Zinc Alloy
5	2	ABS
6	1	Mixed Metal & PVC
7	1	Polycarbonate
9	1	PC, Brass
13	1	PCB Assembly

Item	Qty	Material
14	1	PCB Assembly
15	1	Nickel Silver
16	4	Steel
17	2	Mixed Metal & PVC
18	6	Steel
19	8	Steel
20	10	Steel

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

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 2002/95/EG).
 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 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.



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/cm ²)	3.18μW/cm ² at 50cm (Note 3)	<50W/m ² (5mW/cm ²) (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

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 342 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.

DISCLAIMER

While we (AGD Systems) endeavour to keep the information in this manual correct at the time of 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 342 radars are supplied with a 12 month return to factory warranty. Products falling outside this period may be returned to AGD Systems for evaluation, chargeable repair or re-calibration.



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