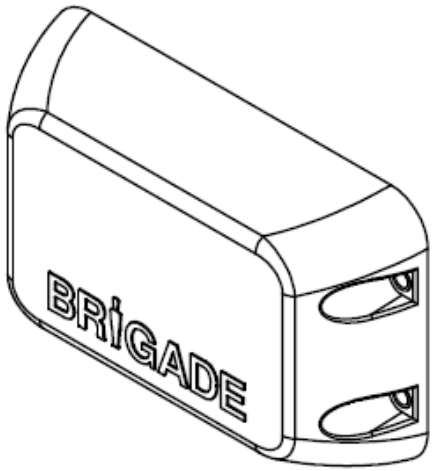
Brigade

BS-9100 / BS-9100T

Backsense®
CAN Radar Object Detection System

Installation & Operation Guide



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1 Introduction

Brigade's Backsense® uses FMCW (Frequency Modulated Continuous Wave) radar system technology to detect solid objects (e.g., vehicles, machinery, barriers) in blind spots, significantly reducing collisions.

Backsense® detects both stationary and moving objects, providing the driver with in-cab visual and audible warnings. Backsense® works effectively in harsh environments with poor visibility, including darkness, smoke, fog, and dust.

Important Characteristics: Backsense radar systems provide solid object detection (e.g. vehicles, machinery, barriers and other inanimate objects) within a specified detection range. A person or an object with low reflective properties may not be detected if one or more objects with greater reflective properties are also located within the detection zone. Backsense radar systems should not be solely relied upon to detect people or animals. If this is required, consider the addition of Brigade's AI people detection cameras.

The Brigade BS-9100 / BS-9100T radar sensor features an internal CAN interface for network connectivity, allowing the user to link up to 8 sensors and a network host on a single CAN bus, enabling monitoring of multiple detection areas around the vehicle.

Each Backsense® BS-9100 / BS-9100T sensor is capable of detecting and reporting data for up to 16 objects, enabling a fully featured system (consisting of 8 sensors) to detect and report up to 128 separate objects.

It is imperative that any Brigade Backsense® system is fitted and commissioned by competent and trained technicians. The installer is responsible for the fitness for purpose of the overall system and must adhere to relevant regulations and legislation. Operators of the vehicle or machine to which the Brigade Backsense® System is fitted must be made fully aware of how to interpret the system so they will not be distracted by or rely completely on it. Distraction can cause collisions.

The system is intended as an aid only. The operator must still concentrate on operating the vehicle, obeying traffic and local regulations. Vehicle or machine operators must continue to use their own training, senses, and other vehicle aids, such as mirrors, as if the system were not in place. Nothing removes the responsibility of the operator to operate the vehicle in a proper and lawful manner.

1.1 Detection Range

Model Name	Detection Length		Detection Width		Nominal Tolerance	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
BS-9100	0 – 60	0 – 197	0 – 16	0 – 52	±0.25	±1
BS-9100T	0 – 60	0 – 197	0 – 16	0 – 52	±0.25	±1

1.2 Object Detection Capability

Warning

- **There is no detection of objects or part of an object closer than approx. 0.3m to the sensor.**
- The Brigade Backsense® radar beam has a 140° horizontal angle out to the maximum designated width. The vertical angle is 16°. Both angles are symmetrically perpendicular to the sensor front surface.
- All dimensions for detection of objects are nominal and vary significantly depending on many parameters. For more details, see section “1.2.2 Factors Influencing the Detection of Objects”.
- The minimum number of packets transmitted by any sensor in each ~50 millisecond period will be 1. The maximum number of packets will be 16, depending in the number of objects detected by the sensor.
- After turning on power the system takes around 1 second to be active. There is no standby mode.

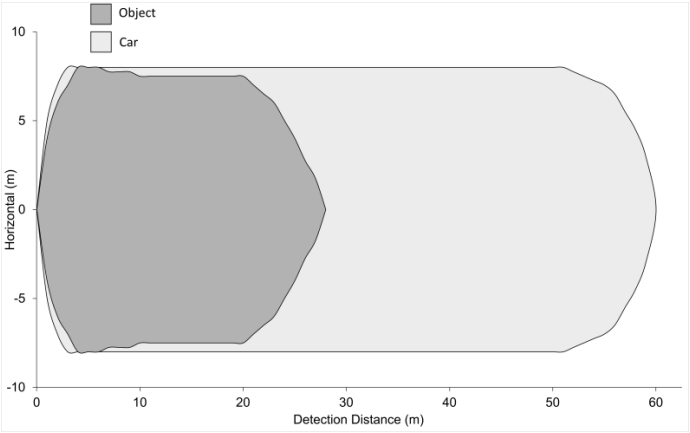
Notes:

- *For distances below 1.5m (detection with relative speed only) or below 0.3m (no detection) the space covered in general by radar systems is very small. In this scenario, Backsense® may not be the most suitable solution; therefore, Brigade recommends adding an additional or alternative detection system depending on the vehicle’s application. For example, Brigade Backscan®, based on ultrasonic sensing technology, offers superior detection at close ranges.*
- *Brigade Backsense® system is not affected if multiple systems are operating in the same area or on the same vehicle, even if they are installed in close proximity with overlapping detection ranges.*
- *Independent detection of target objects can be achieved when there is a minimum range separation of 0.8m and velocity difference of >0.7m/s between each.*

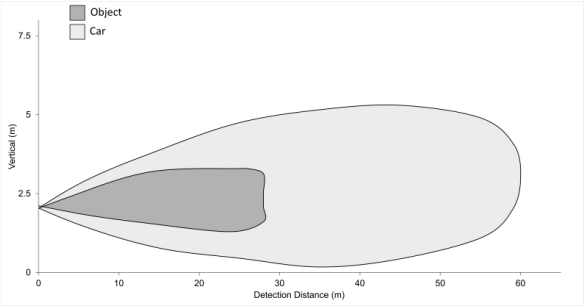
Tip: *Brigade Backsense® detection is generally better when there is relative speed between the sensor and the objects and when the direction of approach is perpendicular to the sensor front face.*

1.2.1 Detection Pattern

1.2.1.1 Horizontal Detection Area



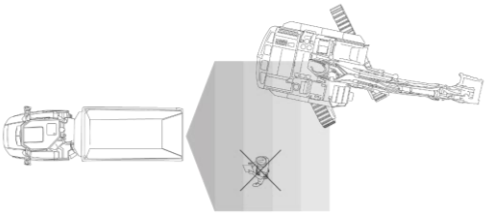
1.2.1.2 Vertical Detection Area



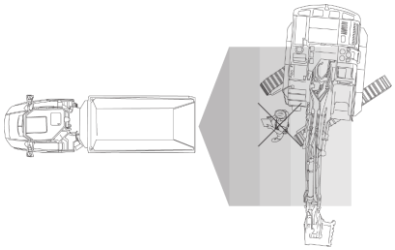
1.2.2 Factors Influencing the Detection of Objects

Brigade Backsense® shares in principle the advantages and limitations of all radar-based systems when compared to other sensing technologies. In general, it can reliably detect most objects in most environmental conditions such as dirt, dust, rain, snow, sun, fog, darkness, acoustic noise, mechanical vibration, electromagnetic noise, or similar.
However, there are some occasions when an object could stay undetected. Radar works on the principle of line of sight and relies on some of the electromagnetic energy transmitted by the sensor being reflected from the object to the sensor. If an object does not reflect enough electromagnetic energy back to the sensor it will not be detected.

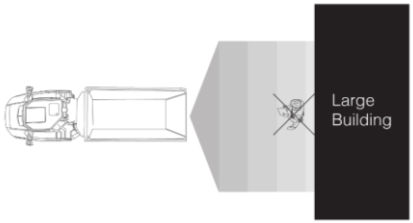
Optimal detection performance will be achieved in a clean open field environment when a target is present.
In other environments, detection of objects with lower reflective properties is not reliable. While radar is effective in broad detection and tracking, smaller objects like pedestrians in crowded areas can present a challenge for all radar systems as their radar cross-section can be lower than that of larger objects with high reflective properties, making them harder to detect.

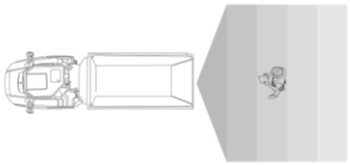


A person or an object with low reflecting properties may not be detected if one or more larger objects with high reflecting properties are located within the detection zone.



A person or an object with low reflecting properties may not be detected if located close to a larger object with high reflecting properties.





Example of a person or an object with low reflecting properties being detected in a clear open field.

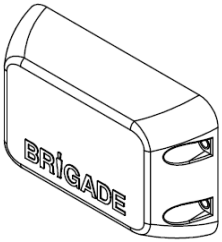
Note: We recommend that this Backsense system is used in conjunction with Brigade's AI People detection cameras.

In the case where there are multiple objects in the detection area at various distances and/or angles, the sensor will detect up to 16 of the closest objects (based on radius), which are the most important for collision avoidance.
The object properties, location and direction are key influences in determining if an object is detected or not. The influencing factors are listed below.

- **Size**: Larger surfaces are detected better than smaller surfaces. If there are small and large objects in the detection area, the smaller object might only register in Detection Zones closer to the sensor.
- **Material**: Metal is detected better than non-metal materials, e.g., wood, plastic.
- **Surface**: A smooth and solid surface is detected better than rough, uneven, porous, fragmented, or liquid surfaces, e.g., bushes, brick work, gravel, water.
- **Shape**: A flat object is better detected than a complex shape. Variation in relative location and direction can influence detection significantly.
- **Angle**: An object facing directly towards the sensor (perpendicular, orientation head on to the sensor) is detected better than an object that is located towards the edges of the detection area or at an angle.
- **Distance**: An object closer to the sensor is better detected than one that it is further away.
- **Relative speed to sensor**: Detection is better if there is a relative speed between object and sensor.
- **Ground condition**: Objects on flat, mineral material ground are better detected than on rough or metal surfaces.
- **Environmental conditions**: Dense dust or very heavy rain or snowfall will reduce the detection capability.

2 Contents

2.1 Standard System Contents

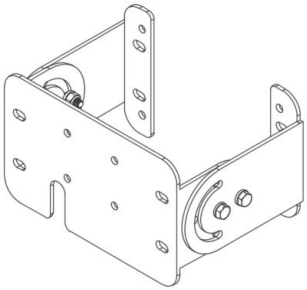


Sensor
BS-9100-S
or
BS-9100T-S (Terminated Option)

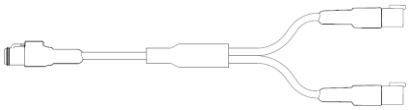
Sensor Fixing Kit
BS-FIX-02

2.2 Optional items (not included)

Extension Cables 2m, (6ft) 5m (16ft), 9m (29ft) or 25m (82ft)
BS-02DCX BS-05DCX or BS-09DCX
BS-25DCSX



Adjustable Sensor Bracket
BKT-023



Network Y Cable
BS-00NYC

Network Power Input Cable
BS-02PIC

120Ω Network Terminator
BS-00NT

3 Object Detection

3.1 Separate Object Detection

Each Backsense® BS-9100 / BS-9100T sensor is capable of detecting and reporting data for up to 16 objects, within the limitations detailed in section 1.2 if there are more than 16 objects within the detection area of a particular sensor, only the closest 16 detections will be reported based on object radius from sensor.

3.2 Detected Object Data

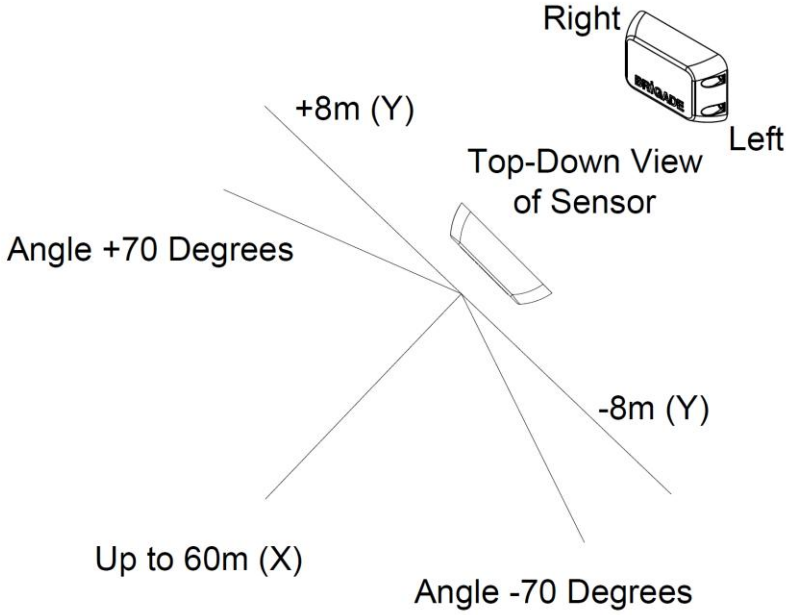
The BS-9100 / BS-9100T will transmit data for each detected object in separate CAN messages. The following detection data will be reported:

Data Definition	Minimum Value	Maximum Value	Description
Polar Radius	0.25m	60m	Line of sight distance between object and sensor front face.
Polar Angle	-70º (Left)	+70º (Right)	Angle between object and sensor front face. Position perpendicular to the sensor represents 0º.
Co-ordinates X	0.25m	+60m	Object distance forward from front face of sensor.
Co-ordinates Y	-8m (left)	+8m (Right)	Object distance left or right of sensor position.
Relative Speed	-64KPH	+63.5KPH	Speed difference between sensor and object. Negative value indicates object approaching the sensor. Positive value indicates object leaving the sensor.
Reflected Signal Level	0dB	127dB	Power of reflected radar signal from object.
Object ID	0	15	Object identity. 0 represents closest object to sensor.
Object Appearance Status	0	1	Logic ‘1’ indicates detection of new object. Logic ‘0’ indicates detection of existing object.
Trigger Event	0	4	This parameter identifies the reason for message transmission. 0 = Keep Alive, 1 = Object detection, 2 = Unprogrammed Sensor, 3 = Future use.
Detection Flag	0	1	Logic ‘0’ indicates object detection. Logic ‘1’ indicates no object detection.
Sensor Errors	Refer to section 5.7 for details.		

Further technical details of detection data are available in section 0.

3.3 Detected Object Position Relative to Sensor

The image below illustrates the relative position of detected objects with respect to the sensor's front face.



4 Hardware Installation

4.1 Recommended Network Layouts and Limitations

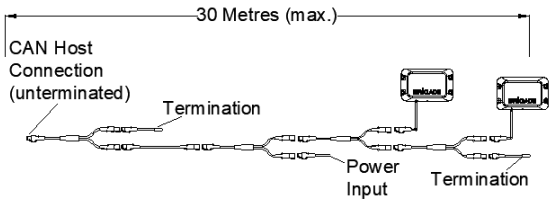
Any installation of a Backsense® BS-9100 / BS-9100T System must adhere to a strict network topology to ensure reliable communications between all sensors and the host.

The network topology must be of a bus configuration featuring 120Ω termination at both ends. Sensors must be connected to the bus via Network Y-Cables only. The user must not install any extension cable between the non-terminated sensor and the Y-Cable. Examples for good and bad network arrangements are show below:

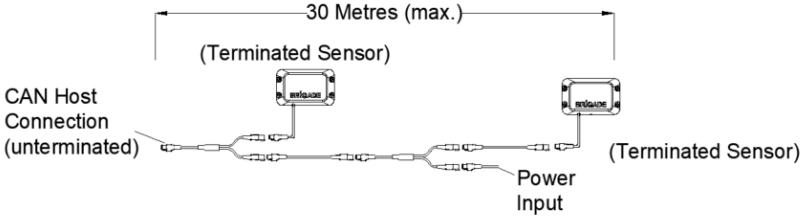
4.2 Good Network Arrangement

The features of a good network topology include:

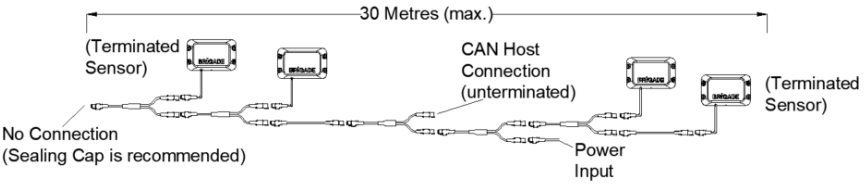
- 120Ω Termination at both ends, either via Network Terminator Cable or Terminated Radar Sensor
- Bus length limited to 30m between terminations.
- Power input position balanced depending on the sensor's physical distribution on the bus. This should be optimised to minimise voltage drop over the cable for each sensor.
- No extension cables installed between the sensor and the Y-Cable. Only sensor tail cable to Y-Cable is allowed.



Example 1: Good network topology with host connection at end of bus



Example 2: Good network topology using terminated sensors with host connection at end of bus

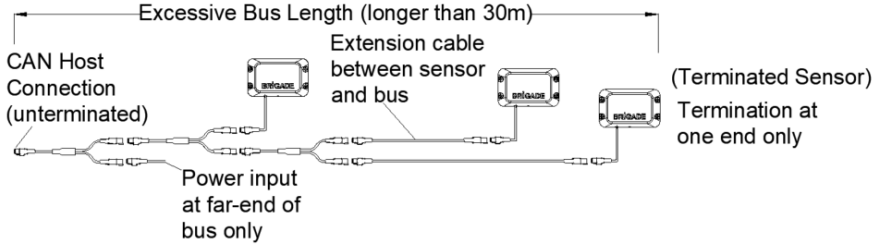


Example 3: Good network topology using two terminated sensors with host connection in middle of bus

4.3 Bad Network Arrangement

The features of a bad network topology, to be avoided, include but are not limited to:

- Long bus length (>30m).
- Non-bus configuration (e.g., star, mesh etc.).
- Power at one end only (resulting in possible voltage drop in cable).
- Termination missing at both ends of network.
- Omission of Network Terminator cable or terminated sensor.
- Extension cables used between non-terminated sensor and Y-Cable.
- Connection to more than 8 sensors on single bus (not shown).
- Connection to other CAN nodes apart from system host (not shown).

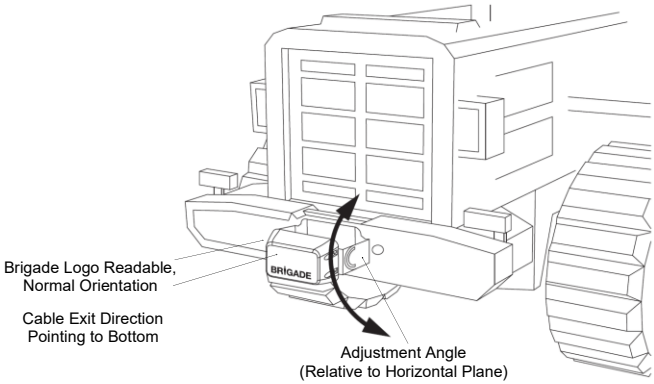


Example 4: Bad network topology, with host connection at the end of bus.

4.4 Test Site

The system test site must be larger than the detection range of each sensor in the intended Backsense® system network and should be relatively flat without excessive deviation. This will allow for basic setup, configuration, and testing of the Backsense® system.

4.5 Sensor Mounting and Location



4.6 Sensor Direction

The sensor should be mounted in an upright position with the cable exit on the sensor pointing downwards, such that the Brigade logo on the front of the sensor is readable when standing in the required detection area. The front of the sensor should have line of sight to all areas where objects should be detected.

4.6.1 Sensor Fixing

Each unit is supplied with four M5x30mm screws and four M5 polymer locknuts for mounting purposes. The recommended torque is 6Nm or 50 inch/lbs.

4.6.2 Vehicle Overhang into Detection Area

It is recommended that the mounting position on the vehicle should avoid any vehicle furniture overhanging into the detection area, as such objects will cause false alarms (for exceptions refer to section “1.2 Object Detection Capability”, paragraph “Warning”).
The detection area of the Brigade Backsense® radar beam has a 140° horizontal angle to the maximum designated width and a vertical angle of 16°, see section “1.2.1 Detection Pattern” for details.
If such a scenario is unavoidable, the host system must be configured to ignore these detections.

4.6.3 Mounting Angle

Brigade recommends mounting the radar on a bracket (available from Brigade, see Section “2.2 Optional items (not included)”, which can have its angle adjusted relative to the horizontal plane to optimise performance. The table below suggests adjustment angles depending on the sensor installation height on the vehicle. Note that the angles stated are dependent on the vehicle face that the bracket is mounted on being 90° relative to the ground.
Depending on the vehicle, working environment, and typical objects to be detected, an adjustment of a few degrees around the suggested values can improve the detection performance or avoid false alarms.

Installation height on vehicle (to sensor centre point)		Adjustment angle in upward direction from the horizontal plane
[m]	[in]	[°]
0.3m	12	0.5
0.5m	20	0.5
0.7m	28	0.5
0.9m	35	0.5
1.1m	43	0.5
1.3m	51	0
1.5m	59	0

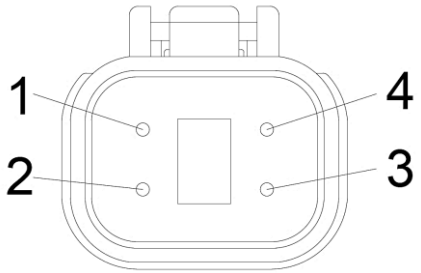
4.7 Cable

Cables should be run in conduit and along suitable cable runs throughout the vehicle. A 24mm (0.95in) hole is required to pass the connectors through.

Note:
- *Allow a reasonable bending radius when folding excess cabling or for the routing of the cable.*
- *Avoid tight bends close to the connectors.*
- *Avoid pulling on the connector.*
- *Ensure all cables are fitted into suitable protective conduit*
- *Ensure cabling and connectors are fitted away from sources of excess heat, vibration, movement, water, and dirt.*

4.8 Electrical Connections

Refer to the vehicle manufacturer or bodybuilder guidelines for installation procedures and connectivity in all applications. The sensor pinout is shown in the table below, and the connector details are provided in Section 9:



Deutsch Pin	Signal Name	Brigade Wire Colour
1	Ground	Brown
2	CAN High	Green
3	Positive (+12V/24V DC)	Yellow
4	CAN Low	Blue

4.9 Power Input

Power must be applied to the BS-9100 / BS-9100T sensor network via a dedicated Brigade power cable. Only one power input to the system is permitted and must be suitably positioned within the network to ensure that loading from all sensors is balanced and excessive voltage drops are avoided.

The network must be adequately powered under all operating conditions. The installer must verify that any volt drop throughout the network does not cause the supply at the sensor to drop below the minimum recommended value during operation.

A single fuse must be installed per network. Multiple fuses are not permitted. The table in section 4.10 provides power consumption data and fusing recommendations for various network sizes under a range of supply voltages.

4.10 Recommended Fuse Values

Supply Voltage	Network Size (Number of Sensors)	Power Consumption	Steady State Current	Inrush Current	Recommended Fuse Value
12VDC	1	2.8W	0.23A	<0.85A, <20mSec	1A
	2	5.6W	0.46A		1A
	3	8.4W	0.69A		1A
	4	10.7W	0.92A		2A
	5	13W	1.15A		2A
	6	15.3W	1.38A		2A
	7	17.6W	1.61A		2A
	8	19.9W	1.84A		3A
24VDC	1	2.9W	0.12A	<0.45A, <20mSec	1A
	2	5.8W	0.24A		1A
	3	8.7W	0.36A		1A
	4	11.6W	0.48A		1A
	5	14.5W	0.6A		1A
	6	17.4W	0.72A		1A
	7	20.3W	0.84A		2A
	8	23.2W	0.96A		2A

5 CAN Bus

5.1 Network Parameters

The BS-9100 / BS-9100T system must operate on an independent CAN bus with only one host (available from Brigade or customer-supplied), power, and terminations connected.

CAN communication parameters from the sensor network are detailed below:

- Complies with CAN 2.0A Base Frame Format (11-bit Identifier)
- Programmable ID range per sensor
- Individual CAN ID for each detected object
- 500Kbits/second Baud Rate (Non-Configurable)
- Maximum of 8 sensors connected to the bus at any time
- Keep Alive message transmitted by sensors when no objects are detected
- Object detection or Keep Alive message refresh rate of ~50mSec
- Intel Standard message format

5.2 Keep Alive Message

The Keep Alive message function provides a regular CAN message from each sensor when there are no objects detected by that sensor, or when the sensor has not been re-configured from the default CAN ID (detailed in section 5.3). The Keep Alive message may be used by the host system to verify that the radar is operational and working correctly during periods of no object detection.

5.3 CANbus Base ID

All BS-9100 / BS-9100T sensors are shipped from Brigade with a pre-set Base ID of 0x390. Messages with this ID value do not contain any detection data but do provide a Keep Alive message to the host.
The installer must alter the 0x390 Base ID at system configuration and ensure that each BS-9100 / BS-9100T sensor within a network is configured with a different Base ID. Instructions for altering sensor Base ID values are detailed in section 5.4.
The range of permissible Base ID values is given in the table below:

Sensor ID:	1	2	3	4	5	6	7	8
Base ID:	0x310	0x320	0x330	0x340	0x350	0x360	0x370	0x380

It is not permitted to connect sensors together that have the same Base ID. Therefore, during system configuration, the installer must ensure that each sensor's Base ID is programmed whilst only that sensor is connected to the host.

5.4 Base ID Configuration

System installers may configure sensor base ID values using their own host system, or through use of the Brigade Test tool detailed in Section 7. Each BS-9100 / BS-9100T sensor within a network must be configured with an individual Base ID. The method for Base ID configuration entails sending a single configuration message to each individual sensor in the CAN network using a specific “Configuration ID” for that sensor. The procedure is as follows:

1. Connect one unconfigured sensor (with default Base ID 0x390, which is the default sensor number 0x09) to the network. There must be no other sensors connected to the network during configuration.
2. Apply power to network.
3. Send configuration message (containing the desired sensor number) from host to connected sensor using the connected sensors configuration ID.
4. Disconnect and reconnect power from sensor or network.
5. Monitor the CAN bus and verify that the Base ID for the sensor under configuration has now changed from 0x390 to the Base ID configured in step 3.
6. Repeat from step 1 for next sensor to be configured

The tables below detail the various ID values used in the BS-9100 / BS-9100T system.

Current Sensor ID values (Before Configuration)
Base ID and corresponding Configuration ID to be used

Current Base ID	Configuration ID to be used
0x310	0x150
0x320	0x151
0x330	0x152
0x340	0x153
0x350	0x154
0x360	0x155
0x370	0x156
0x380	0x157
0x390	0x158

Resulting Sensor ID values (After Configuration)
Desired Sensor Number and corresponding desired Base ID

Desired (target)Sensor Number	Desired (target) Base ID
0x01	0x310
0x02	0x320
0x03	0x330
0x04	0x340
0x05	0x350
0x06	0x360
0x07	0x370
0x08	0x380
0x09	0x390

5.5 Configuration Message Structure and Examples

Configuration Message Structure

11- Bit CAN ID	Data Byte 0	Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7
Current Sensor Configuration ID to be used	Sensor Number for desired (target) Base ID	Fixed value 0x00	Fixed value 0x00	Fixed value 0x00	Fixed value 0x00	Fixed value 0x00	Fixed value 0x00	Fixed value 0xFF

Configuration Message Example, Base ID change from 0x390 to 0x310

11- Bit CAN ID	Data Byte 0	Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7
0x158	0x01	0x00	0x00	0x00	0x00	0x00	0x00	0xFF

Configuration Message Example, Base ID change from 0x320 to 0x330

11- Bit CAN ID	Data Byte 0	Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7
0x151	0x03	0x00	0x00	0x00	0x00	0x00	0x00	0xFF

5.6 Addressing Strategy for Detected Object and Generated Messages

Each BS-9100 / BS-9100T sensor can detect and report data for up to 16 objects, selected based on closest proximity to the sensor. Each detected object has an individual message ID whose value is dependent on the proximity of the detected object to the sensor.

	Sensor ID Number							
Object Proximity to Sensor	**0x01**	**0x02**	**0x03**	**0x04**	**0x05**	**0x06**	**0x07**	**0x08**
Closest Object	0x310	0x320	0x330	0x340	0x350	0x360	0x370	0x380
2nd Closest Object	0x311	0x321	0x331	0x341	0x351	0x361	0x371	0x381
3rd Closest Object	0x312	0x322	0x332	0x342	0x352	0x362	0x372	0x382
4th Closest Object	0x313	0x323	0x333	0x343	0x353	0x363	0x373	0x383
5th Closest Object	0x314	0x324	0x334	0x344	0x354	0x364	0x374	0x384
6th Closest Object	0x315	0x325	0x335	0x345	0x355	0x365	0x375	0x385
7th Closest Object	0x316	0x326	0x336	0x346	0x356	0x366	0x376	0x386
8th Closest Object	0x317	0x327	0x337	0x347	0x357	0x367	0x377	0x387
9th Closest Object	0x318	0x328	0x338	0x348	0x358	0x368	0x378	0x388
10th Closest Object	0x319	0x329	0x339	0x349	0x359	0x369	0x379	0x389
11th Closest Object	0x31A	0x32A	0x33A	0x34A	0x35A	0x36A	0x37A	0x38A
12th Closest Object	0x31B	0x32B	0x33B	0x34B	0x35B	0x36B	0x37B	0x38B
13th Closest Object	0x31C	0x32C	0x33C	0x34C	0x35C	0x36C	0x37C	0x38C
14th Closest Object	0x31D	0x32D	0x33D	0x34D	0x35D	0x36D	0x37D	0x38D
15th Closest Object	0x31E	0x32E	0x33E	0x34E	0x35E	0x36E	0x37E	0x38E
16th Closest Object	0x31F	0x32F	0x33F	0x34F	0x35F	0x36F	0x37F	0x38F

5.7 Detection Message

Detection data for each detected object (per sensor) is reported in a single CAN message from the sensor with a message as detailed in Section 3.2. Detection location data, relative speed, reflected power level, and various detection flags are contained in individual bytes for ease of processing. The message structure for the data field is detailed in the following table:

Detection Data	Data Field Start		Data Length	Data Offset	Message Resolution	Physical Value		Byte Value	
	Byte	Bit	(No. Bits)			Min	Max	Min	Max
Polar Radius Line of sight from sensor to object	0	0	8	0	0.25m	0m	60m	0x00	0xF0
Polar Angle Position perpendicular to front face is 0◦	1	0	8	-128	1º	-70º	+70º	0x3A	0xC6
Co-ordinates X Distance in front of sensor	2	0	8	0	0.25m	0m	+60m	0x00	0xF0
Co-ordinates Y Distance Left/Right of sensor	3	0	8	-128	0.25m	-8m	+8m	0x60	0xA0
Relative Speed Difference between object & vehicle speeds	4	0	8	-128	0.5KPH	-64 KPH	+63.5 KPH	0x00	0xFF
Signal Power (dB) Radar signal power reflected from object	5	0	8	0	1	0dB	127dB	0x00	0x7F
Object ID Closest object has lowest ID number	6	4	4	0	1	0	15	0x00	0x0F
Object Appearance Status 1 = New detection 0 = Repeated detection	6	3	1	0	N/A	0	1	N/A	N/A
Trigger Event 0 = Keep alive 1 = Object detection 2 = Unprogrammed sensor 3 = Not used	6	1	2	0	1	0	3	N/A	N/A
Not used	6	0	1	N/A	N/A	N/A	N/A	N/A	N/A
Sensor Error 4 0 = No Error 1 = CAN Error	7	7	1	0	1	0	1	N/A	N/A
Sensor Error 3 0 = No Error 1 = Temperature Error	7	6	1	0	1	0	1	N/A	N/A
Sensor Error 2 0 = No Error 1 = MMIC Error	7	5	1	0	1	0	1	N/A	N/A
Sensor Error 1 0 = No Error 1 = Voltage Error (min./ max. limits at 9V and 32V DC)	7	4	1	0	1	0	1	N/A	N/A
Not used	7	2	2	N/A	N/A	N/A	N/A	N/A	N/A
Identification Flag 0 = BS-9000 1 = 77GHz Radar BS-9100 / BS-9100T	7	1	1	0	1	0	1	N/A	N/A
Detection Flag 0 = Valid detection 1 = No detection	7	0	1	0	1	0	1	N/A	N/A

Note: sensor error flag is transmitted on the base ID's only for example 0x310, 0x320 etc. rather than of 0x311, 0x321.

5.8 Sensor Start-up Messages

Each sensor will transmit various messages to the host upon power up. These messages may be used by the host to confirm that each sensor in the network has correctly started and is operational.
The transmission of the start-up messages is sufficient to verify that the sensor is operational. Start-up time (from power-on to completion of start-up messages) is detailed in section 9. The content of the start-up message has no functional use for the normal operation of the sensor and provide no information to the user.

The table below details start-up message vs sensor Base ID

	Sensor ID Number								
	0x01	**0x02**	**0x03**	**0x04**	**0x05**	**0x06**	**0x07**	**0x08**	**0x09**
Base ID	0x310	0x320	0x330	0x340	0x350	0x360	0x370	0x380	0x390
Start-up Message 1	0x700	0x701	0x702	0x703	0x704	0x705	0x706	0x707	0x708

6 System Host

6.1 Host Responsibilities

The BS-9100 / BS-9100T system requires connection to a customer-supplied host to receive and utilise object detection messages from the sensor via CAN bus. The host system is responsible for interpreting the detection data detailed in section 4 and applying any logic, conditioning, filtering, activation, or blind zone settings (e.g., ignoring certain detection under pre-determined conditions) that may be required in the application of the system.
These features are not provided by the BS-9100 / BS-9100T and detection data output from the sensor is not configurable.

7 Brigade Backsense CAN Radar Test Tool

7.1 PC Interface for BS-9100 / BS-9100T

As detailed in section 5, the Brigade BS-9100 / BS-9100T radar sensors use CAN for all communications to the host system, including configuration and test activities.
To configure and test the system using Brigade's software applications such as the Backsense Test Tool, a Softing CANpro USB Interface and associated drivers are required.
The interface is not available from Brigade but may be purchased from Softing or their distributors – refer to the manufacturer's website (www.softing.com).
Note that the Brigade Backsense Test Tool will not run without a Softing Interface plugged into the PC.
An image of the CANpro USB Interface is shown below. Note that although other CAN – PC interfaces will connect to the BS-9100 / BS-9100T network, only the CANpro USB will work correctly with the Brigade Backsense CAN Radar Test Tool.

Alternatively, Kvaser Leaf Light V2 and U100 CAN interfaces can be used with Brigade's Test Tool applications (associated drivers are required).
The hardware interface is not available from Brigade but may be purchased from Kvaser or their distributors – refer to the manufacturer's website (https://kvaser.com/).

Note that the Brigade Backsense Test Tool will not run without a CAN Interface plugged into the PC.

The software version used depends on what CAN interface is used as shown below:

Backsense CAN Radar Test Tool version	V1.3.1 (or older)	V2.3.0
CANpro	✓	✗
Kvaser Leaf Light V2	✗	✓
Kvaser U100	✗	✓

7.2 PC System Requirements

The Brigade Backsense CAN Radar Test Tool requires a PC with a USB 2.0 Type-A connector for connection to the CANpro USB interface. A USB cable with USB standard type A plug to B plug should be used and is included with the CANpro USB Interface. Kvaser Leaf Light V2 and U100 is integrated with USB cable.
The Backsense CAN Radar Test Tool is compatible with Microsoft Windows 7 & 10 (32-bit or 64-bit version) operating systems. The Backsense CAN Radar Test Tool V2 is compatible with Microsoft Windows 11 as well.

7.3 CANpro / Kvaser – BS-9100 / BS-9100T Network connection cable

Users will require a cable for connection between CANpro / Kvaser interface and BS-9100 / BS-9100T sensor network. This cable is not available from Brigade and must be provided by the user. Pinout details are given in the table below. Note that the CANpro / Kvaser interface does not include termination and therefore Brigade Network Terminator Cable or Terminated Radar Sensor will be required in this instance.

CANpro 9-way D-Type Pin Number	Deutsch 4-way Radar Connector	Signal Name
2	4	CAN LOW
7	2	CAN HIGH

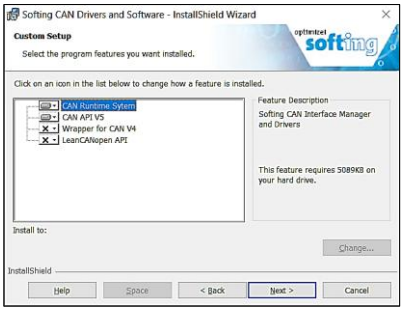
7.4 Software Installation (v1.3.1 or older and CANpro interface)

7.4.1 Softing CAN Drivers and Software installation

Once the driver installation file has been downloaded from www.softing.com it should be installed as per standard practice. Screenshots of the process are shown below.
Note: *Layout may vary depending on Softing software version.*

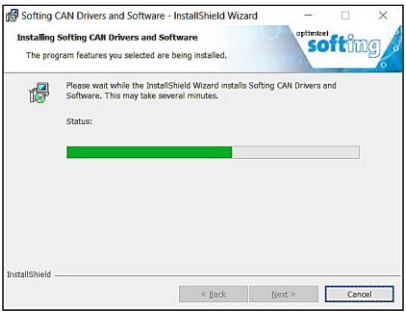
Step 1 – Initial installation window

Step 2 – License agreement



Step 3 – Feature selection

Step 4 – Feature confirmation



Step 5 – Installation in progress

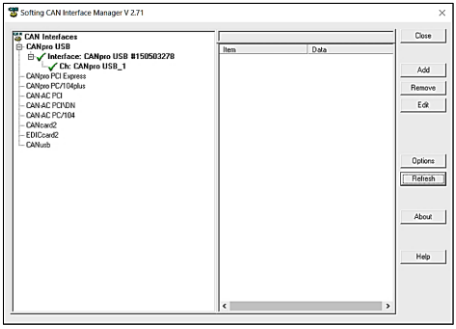
Step 6 – Installation complete

The application can now be launched from the Start Menu under the heading Softing CAN.

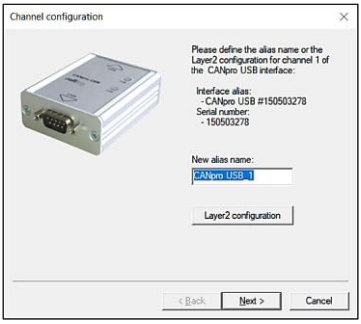
7.4.2 Softing CAN Drivers and Software configuration

Once the setup has been completed, the Softing CAN Interface Manager should be launched.

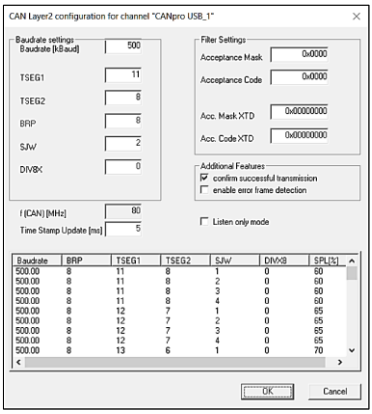
Once the CAN interface has been connected to the PC, the Softing Interface Manager should automatically detect and list it as a device. The following steps should then be performed to configure the interface for use with the Brigade Backsense CAN Radar Test Tool.



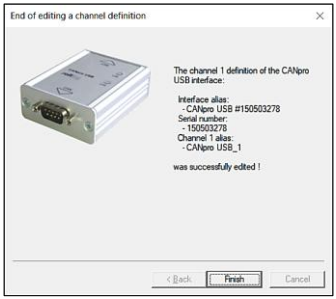
Step 1 – Softing Interface manager shows an interface has been connected; select the CAN interface and select Edit



Step 2 – Select Layer 2 configuration



Step 3 – Leave all values as default and confirm the configuration by selecting OK.

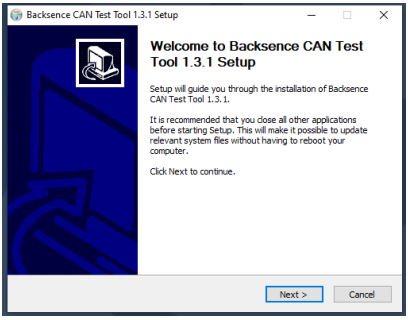


Step 4 – Select Finish to complete the configuration

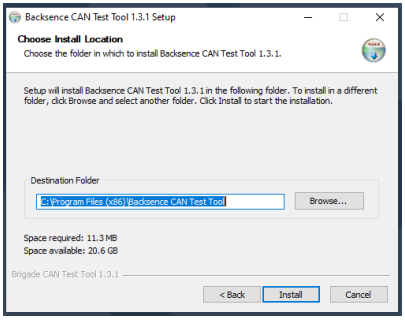
Once completed, the Backsense CAN Radar Test Tool can be installed. Note that without this application installed the Backsense CAN Radar Test Tool will suffer significant errors.

7.4.3 Backsense CAN Radar Test Tool installation

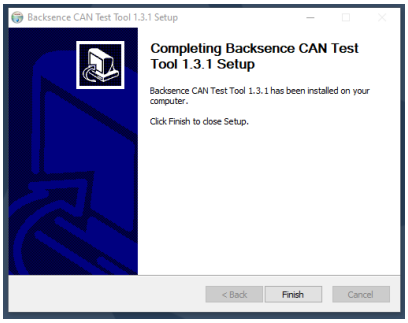
Download the Brigade Backsense CAN Radar Test Tool installation file from the Brigade Electronics website (www.brigade-electronics.com) and install the software as per standard practice. Screenshots of the process are shown below.
Note: *Layout may vary depending on software version.*



Step 1 – Initial installation window



Step 2 – Installation location



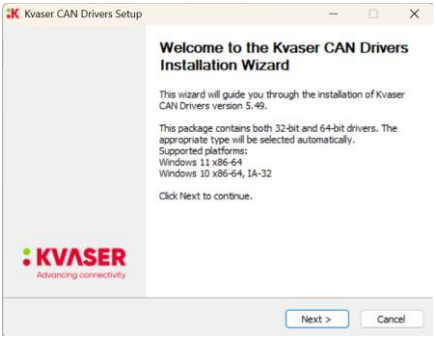
Step 3 – Installation complete

The application can now be launched from the Start Menu under the heading Backsense CAN Radar Test Tool.

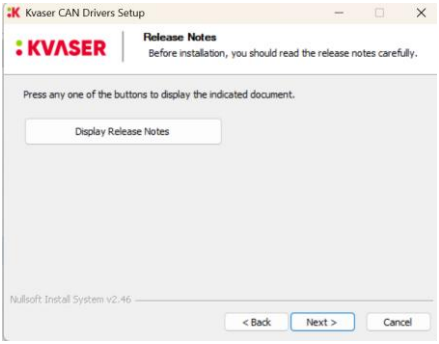
7.5 Software Installation (v2.3.0 and Kvaser interface)

7.5.1 Kvaser CAN Drivers and Software installation

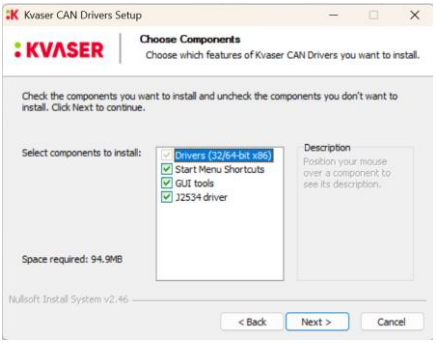
Once the driver installation file has been downloaded from (https://kvaser.com/).it should be installed as per standard practice. Screenshots of the process are shown below.
Note: *Layout may vary depending on Kvaser software version.*



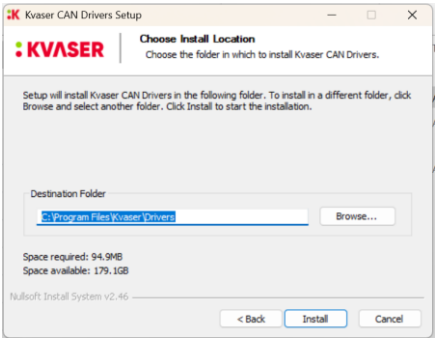
Step 1 – Initial installation window



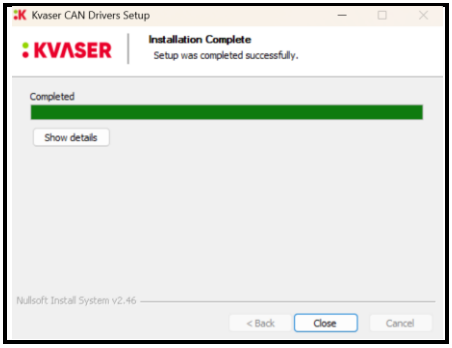
Step 2 – Release Notes



Step 3 – Choose components

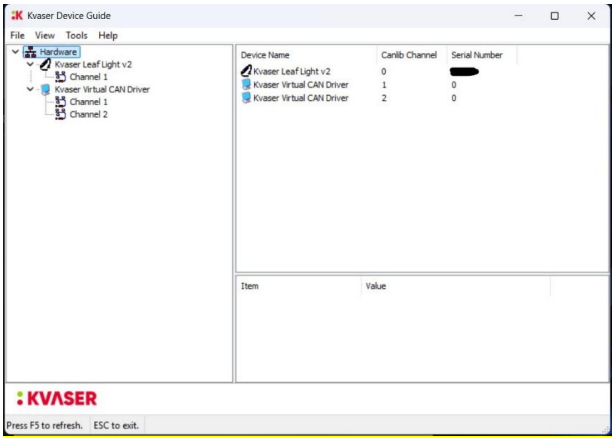


Step 4 – Choose Install Location



Step 5 – Installation Complete

Once the setup has been completed, the Kvaser CAN Interface will be shown in the Kvaser Device Guide as below:

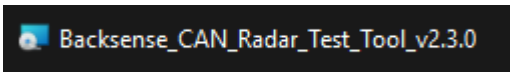


Once the CAN interface has been connected to the PC, the Kvaser Interface should automatically detect and list it as a device. The following steps should then be performed to configure the interface for use with the Brigade Backsense CAN Radar Test Tool V2.

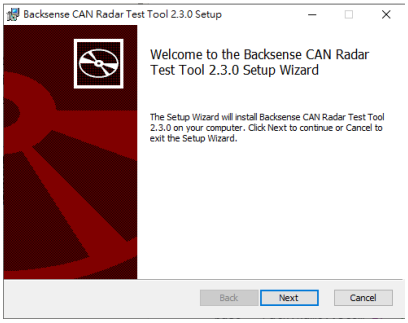
7.5.2 Backsense CAN Radar Test Tool V2.3.0 installation

Download the Brigade Backsense CAN Radar Test Tool installation file from the Brigade Electronics website (www.brigade-electronics.com) and run the software shown below.

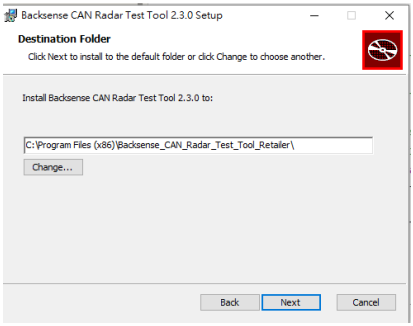
1. Double-click the .msi installation file to begin.



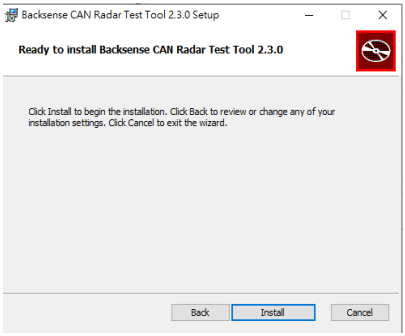
2. Software Installation



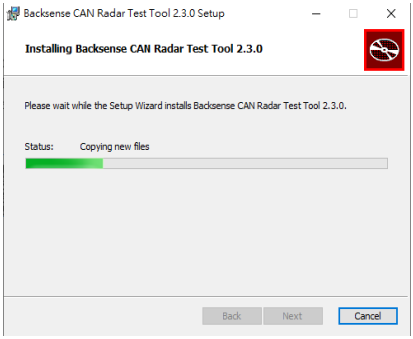
Step 1 - In the setup window, click Next to continue.



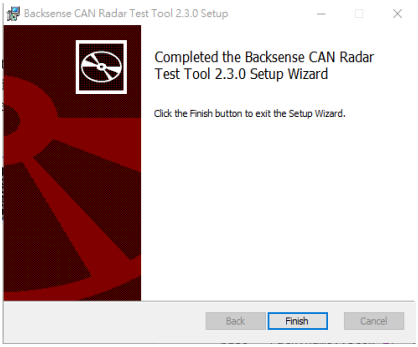
Step 2 - Select the installation path if a different folder is preferred, otherwise keep the default.



Step 3 - Click Install to begin installation.

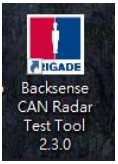


Step 4 - Wait for the installation process to be completed.

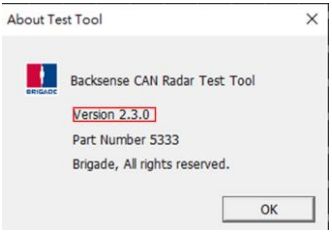


Step 5 - When the installation is finished, click Finish.

3. A shortcut icon will be created on the desktop. You may double-click it to launch the software.



4. Launch the tool and click About to view the current version.



Note: If the test tool would not run due to a message stating missing file “mfc140.dll”. Downloading and installing “Visual C++ Redistributable for Visual Studio” x86 version from the Microsoft website resolved the missing file problem.

7.6 Backsense CAN Radar Test Tool

The Brigade Backsense CAN Radar Test Tool is a Windows application that allows users to view all physical detection data from the BS-9100 / BS-9100T radar system in real time. The test tool consists of a main Graphic & Control Window which displays a top-down view of detected objects for one selected sensor, a sub-window for that sensor's detection data, and an additional sub-window displaying detected object positions for all sensors in the network. The Test Tool does not provide any CAN data from the sensor network; however, the Configuration Tool detailed in section 7.7 allows the user to view live CAN data and configure the Base ID for individual sensors. Each part of the test tool is explained in the following sub-sections. For operating errors, see Section 7.8.

7.6.1 Graphic & Control Window

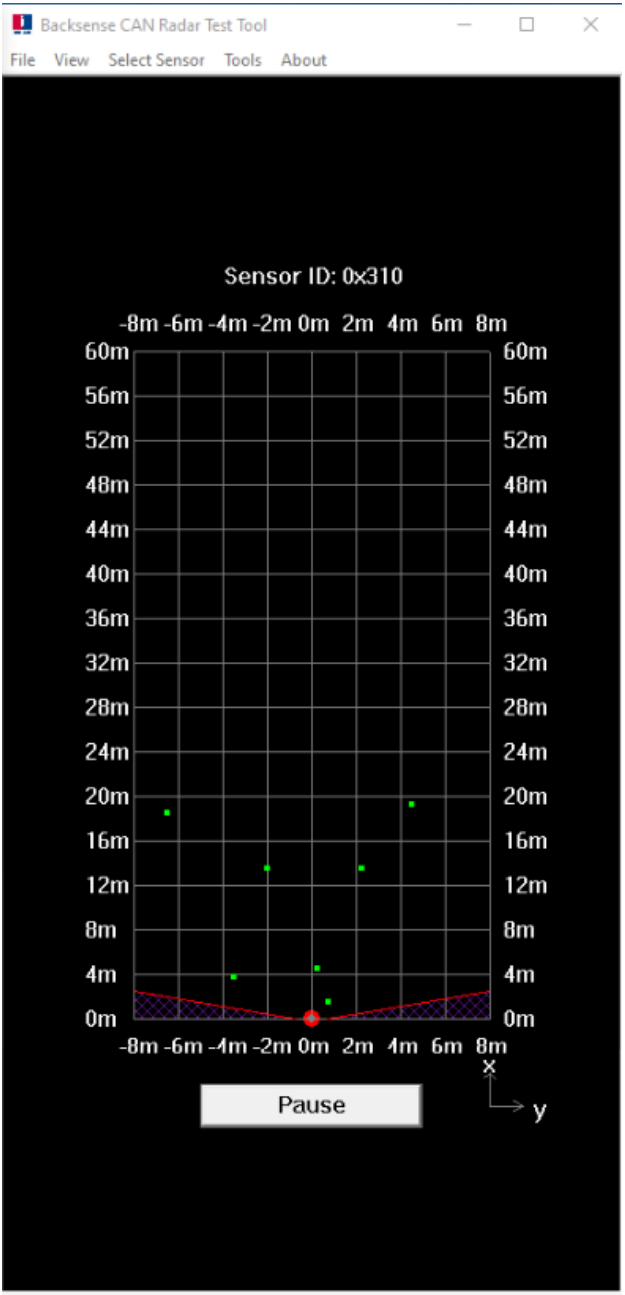
The Graphic and Control Window features a menu bar with the following menus and options:

- File
  - Exit Application
- View
  - Backsense Detection Table – Opens in new sub-window.
  - Backsense Network Summary Table – Opens in new sub-window.
- Select Sensor – Change sensor selection for top-down detection view and Backsense Detection Table from below list:
  - Sensor ID 0x310.
  - Sensor ID 0x320.
  - Sensor ID 0x330.
  - Sensor ID 0x340.
  - Sensor ID 0x350.
  - Sensor ID 0x360.
  - Sensor ID 0x370.
  - Sensor ID 0x380.
  - Sensor ID 0x390.
  - Refresh – Refreshes the above list of connected sensors.
- Tools
  - Configuration Tool – Opens in new sub window.
- About
  - About Radar Test Tool.

The centre of the Graphic and Control Window displays a 2m grid representing the 60m long, 16m wide detection area for one BS-9100 / BS-9100T sensor. A red filled circle at the bottom middle position of the grid represents the sensor location, whilst purple triangle hatchings either side of the sensor location represent the area in which objects cannot be detected due to the 140° detection angle.

During operation, detected objects are displayed as small green filled squares within the 60m x 16m detection area. The approximate position of the detected objects may be estimated by referencing their position with respect to the 4m grid lines. Note that the size of all green squares is constant and does not vary according to object size or detection data values.

A Pause/Run button is provided for the user to freeze live detection information on the screen. Note that the user may select which sensor they would like to view from the Select Sensor menu at the top of the screen. By default, the sensor with lowest base ID value is selected. An example of the Graphic and Control Window is shown on the following page.



Graphic and Control Window displaying six detected objects for sensor 1 (CAN ID 0x310).

7.6.2 Backsense Detection Table

The Backsense Detection Table is a floating sub window of the Graphic and Control window which displays numerical values for all detection data of up to 16 closest objects detected by the selected sensor as well as diagnostic information.
There is no user interaction available for the Backsense Detection Table. As with the detection grid of the Graphic and Control, the sensor with lowest base ID value is selected by default. An example from the Detection Table is shown below:

Backsense Detection Table

Sensor Parameter	Unit	0x310	0x311	0x312	0x313	0x314	0x315	0x316	0x317	0x318	0x319	0x31A	0x31B	0x31C	0x31D	0x31E	0x31F
Object Distance	m	1.75	4.50	5.25	13.75	13.75	19.75	19.75									
Object Angle	Deg	29	6	-42	9	-9	-19	13									
X Coordinate	m	1.50	4.50	3.75	13.50	13.50	18.50	19.25									
Y Coordinate	m	0.75	0.25	-3.50	2.25	-2.00	-6.50	4.50									
Object Relative Speed	KPH	0.0	-0.5	-0.5	0.0	-0.5	-0.5	-0.5									
Object Signal Level	dB	75	81	78	78	78	64	64									
Object Appearance Status	n/a	0	0	0	0	0	0	0									
Trigger Event	n/a	1	1	1	1	1	1	1									
Detection Flag	n/a	0	0	0	0	0	0	0									
Identification Flag	n/a	1	1	1	1	1	1	1									
Voltage Fault	n/a	0															
MMIC Fault	n/a	0															
High Temperature Fault	n/a	0															
CAN Fault	n/a	0															

Backsense Detection Table displaying detection data for six objects from Sensor ID 0x310.

7.6.3 Backsense Network Summary Table

The Backsense Network Summary Table is a floating sub window of the Graphic and Control window which displays X, Y co-ordinates for up to 16 detected objects of up to 8 connected sensors as per the maximum capability of the system. There is no user interaction available for the Backsense Network Summary Table. As with the detection grid of the Graphic and Control, the sensor with lowest base ID value is selected by default. An example from the Detection Table is shown below:

Backsense Network Summary Table

CAN ID X, Y	Unit	0x3X0	0x3X1	0x3X2	0x3X3	0x3X4	0x3X5	0x3X6	0x3X7	0x3X8	0x3X9	0x3XA	0x3XB	0x3XC	0x3XD	0x3XE	0x3XF
0x310_X	m	1.50	4.50	3.75	13.50	13.50	18.50	19.25									
0x310_Y	m	0.75	0.25	-3.50	2.25	-2.00	-6.50	4.50									
0x320_X	m																
0x320_Y	m																
0x330_X	m																
0x330_Y	m																
0x340_X	m																
0x340_Y	m																
0x350_X	m																
0x350_Y	m																
0x360_X	m																
0x360_Y	m																
0x370_X	m																
0x370_Y	m																
0x380_X	m																
0x380_Y	m																

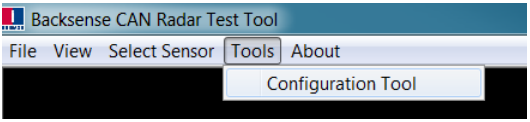
Backsense Network Summary Table displaying detection data
for six objects from Sensor ID 0x310

7.7 Backsense Configuration Tool

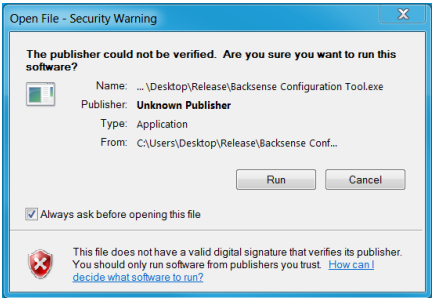
The Backsense Configuration Tool is a command line type application that allows the user to perform the following functions within the BS-9100 / BS-9100T system:

- Alter the CAN ID of each sensor within the permitted range.
- View live CAN data from the entire network.

The Backsense Configuration Tool may be launched from the “Tools” menu within the Backsense CAN Radar Test Tool, as shown below:

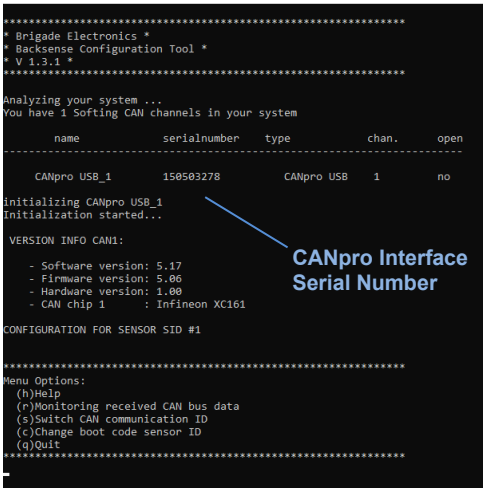


Depending on PC security settings, the following warning may be seen. The user must select “Run” to proceed to the application:

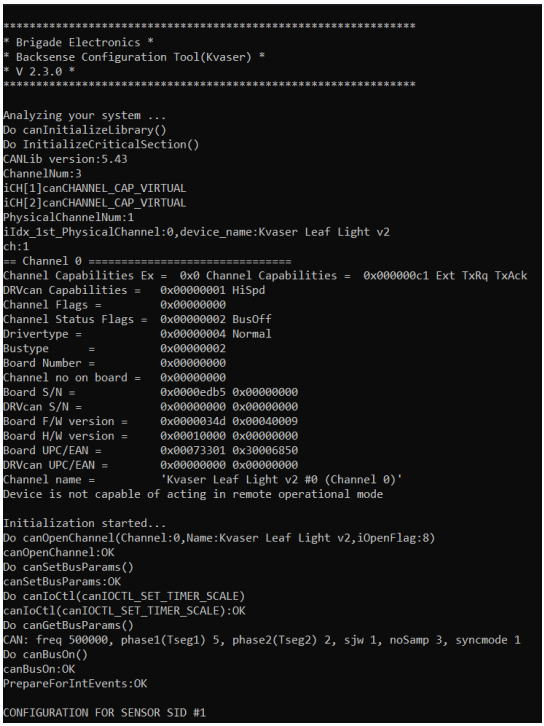


The launch screen of the Backsense Configuration Tool will appear as below. The connected CANpro interface is identified by serial number.

The user must press Return on the keyboard to continue:

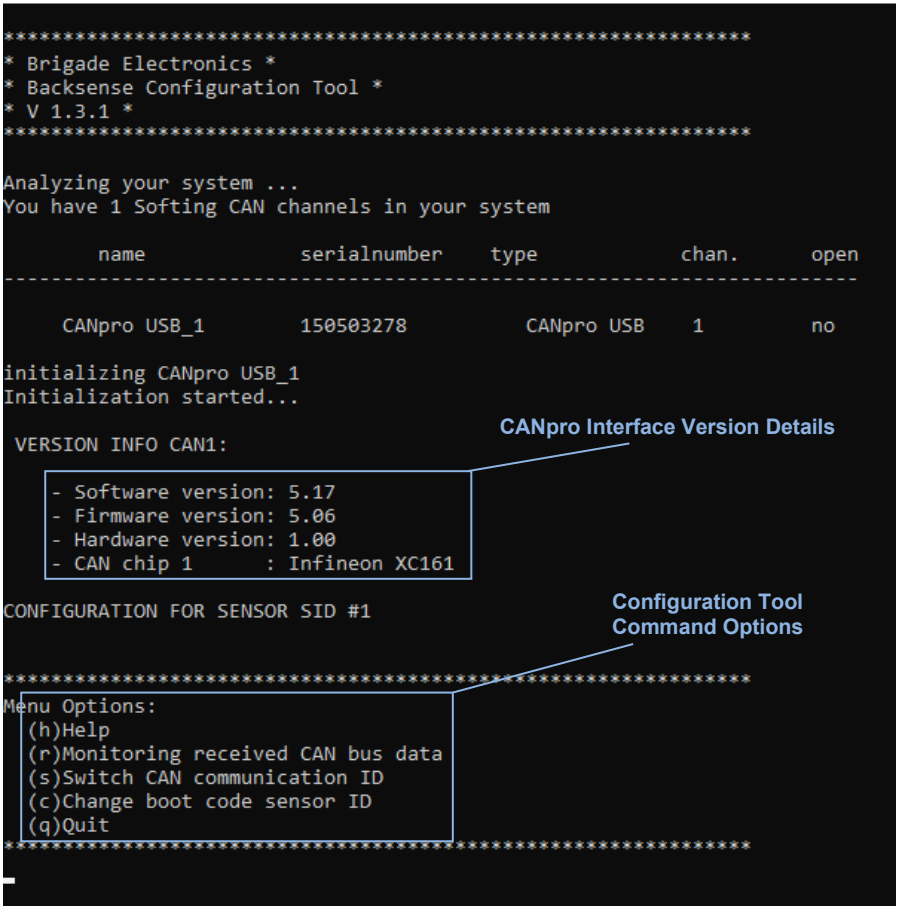


Configuration Tool initial windows for CANPro



Configuration Tool v2.3.0 initial windows for Kvaser Leaf Light V2 and U100

The Initialisation screen of the Backsense Configuration Tool will appear as shown below. Command options are displayed on the screen:



The Configuration Tool Command Options are as follows:

- **h**
  - Display help menu – Configuration Tool Command Options will be re-displayed.
- **r**
  - Monitor CAN Bus Data – Allows the user to view all CAN data that appears on the bus.
  - **[Enter]**
    - Start the live view of CAN Bus Data.
  - **[Space Bar]**
    - Resume the live view of CAN Bus Data.
  - **[Mouse Left Click]**
    - Pause the live view of CAN Bus Data.
- **s**

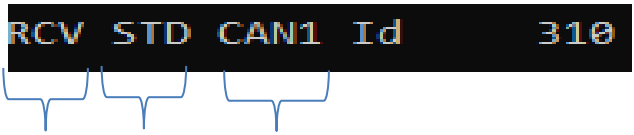
- Switch CAN ID for connected sensor – Allows the user to select the sensor ID number that is to be re-configured.

- **c**
  - Change Boot Code Sensor ID – User must select the desired target sensor ID number that is to be configured for the connected sensor.
- **q**
  - Exit Configuration Tool application.

The user may start or restart monitoring of live CAN data from the sensor or the entire Backsense network by pressing the “R” key on the keyboard. To pause the live CAN data, position the mouse cursor inside the window and left click. Use the “h” key to return to the main menu.

```
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T5743c167 D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b3  d 90 7d 4d 22  2 T5743c255 D     238
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T5743c345 D     240
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T574483c3 D   49278
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T574484b5 D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b3  d 90 7d 4d 22  2 T574485a6 D     241
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T57448695 D     239
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T5745460b D   49014
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T574546fd D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b3  d 90 7d 4d 22  2 T574547ec D     239
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T574548de D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T57460a60 D   49538
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T57460b52 D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T57460c42 D     240
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T57460d34 D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T5746cdb2 D   49278
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T5746cea4 D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T5746cf95 D     241
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T5746d087 D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T57479003 D   49020
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T574790f5 D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T574791e7 D     242
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T574792d9 D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T57485459 D   49536
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T5748554b D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T5748563b D     240
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T5748572d D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T574917a3 D   49270
RCV STD CAN1 Id      311 Dlc8 Data 14 90 13 85 7b 4c 12  2 T57491895 D     242
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T57491985 D     240
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T57491a77 D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T5749d9ea D   49011
RCV STD CAN1 Id      311 Dlc8 Data 13 90 12 85 7b 4c 12  2 T5749dadb D     241
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T5749dbcc D     241
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T5749dcbe D     242
RCV STD CAN1 Id      310 Dlc8 Data  7 6f  6 7e 80 49  2  2 T574a9e40 D   49538
RCV STD CAN1 Id      311 Dlc8 Data 13 90 12 85 7b 4c 12  2 T574a9f30 D     240
RCV STD CAN1 Id      312 Dlc8 Data 15 b4  d 91 7d 50 22  2 T574aa020 D     240
RCV STD CAN1 Id      313 Dlc8 Data 17 54 10 71 80 4f 32  2 T574aa112 D     242
RCV STD CAN1 Id      310 Dlc8 Data  6 6f  6 7f 7f 4a  2  2 T574b6193 D   49281
```

The description for Configuration Tool data is as follows:

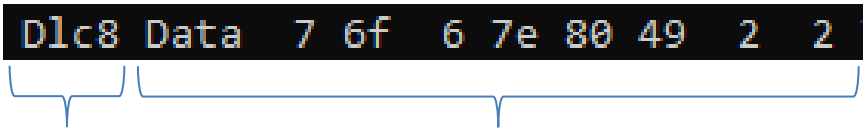


RCV = "Received Data"

STD = "Standard Frame"

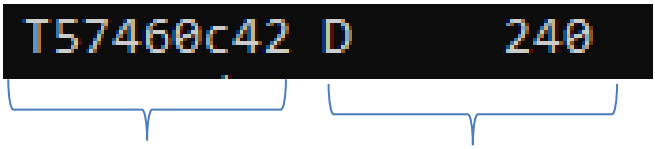
CAN1 = CANpro Channel No.

ID 310 = CAN Message ID Value (Hex)



DLC8 = Data Length Code is 8 Bytes

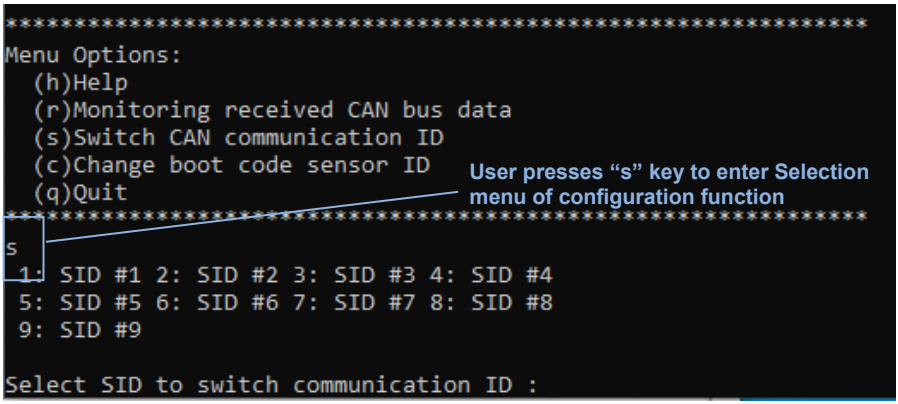
Data XX XX XX XX XX XX XX XX= Detection Data in Hex format from sensor



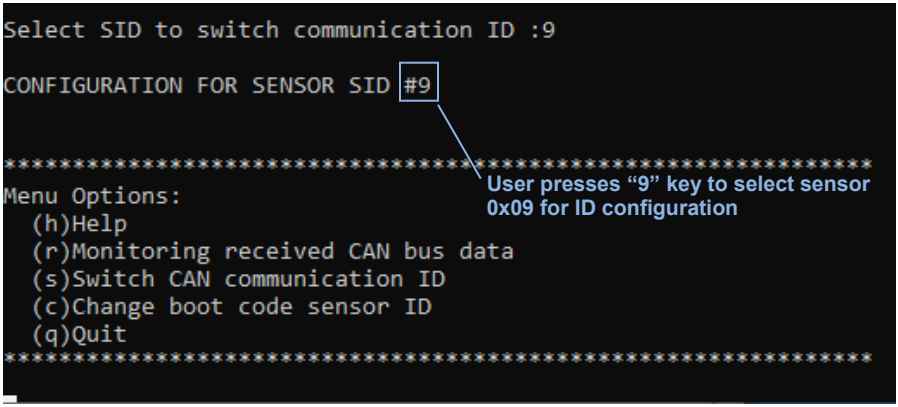
T 57460c42 = Timestamp from launch of CAN driver (Hex uSec)

D 240 = Delta time since previous message (Dec uSec)

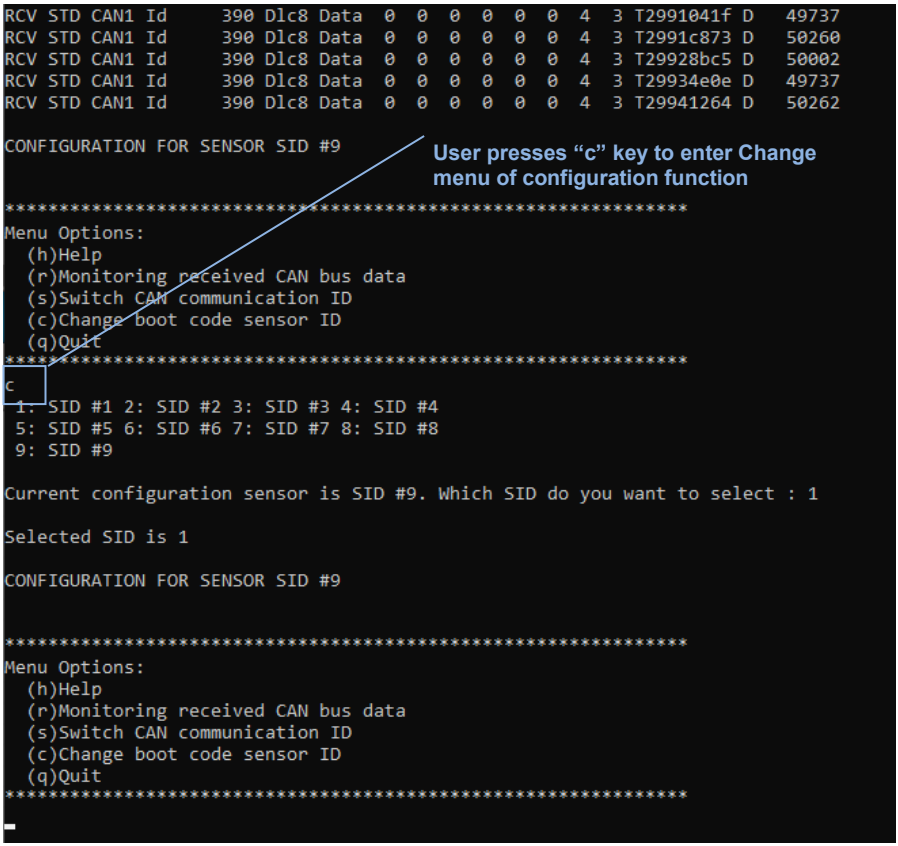
Pressing the "s" key on the keyboard will enter the sensor ID configuration function as shown below:



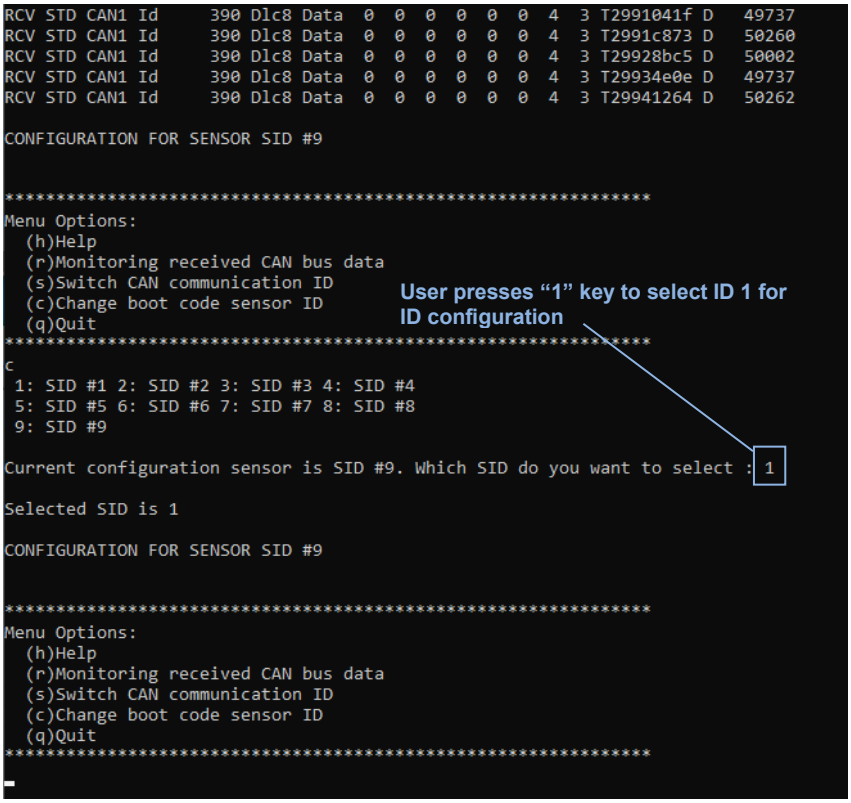
The user must select the sensor to be configured by pressing the number of that sensor on the keyboard. In the example below, only one sensor with Sensor ID 0x09 is connected, as identified by “390” CAN data. In this instance the user will press “9” on the keyboard.



To re-configure the sensor ID, the user must press the “c” on the keyboard as below:

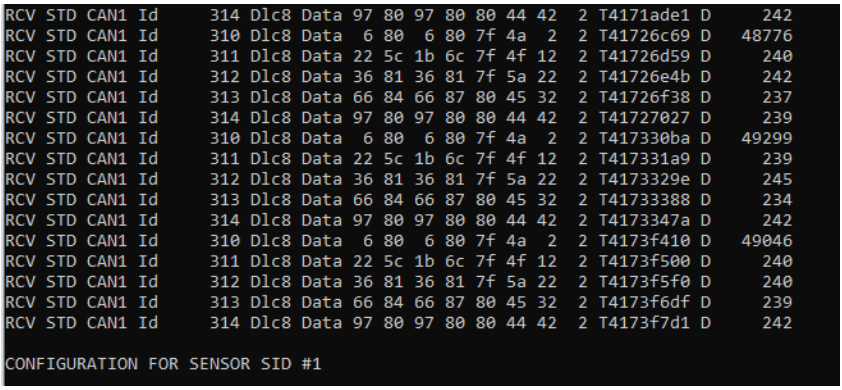


The user must select the number for the desired sensor ID. In the example below, the desired ID is 1, therefore the user presses “1” on the keyboard.



Reset the radar system by cycling the power.

The user can confirm that the ID has been changed correctly by monitoring the live CAN data from the sensor. Press the “r” key on the keyboard to start monitoring.



The Backsense Configuration Tool must be closed to return to the Backsense CAN Radar Test Tool.

7.8 Application Errors

The Backsense Test Tool will produce the following error if the Softing CANPro interface either isn't connected to the PC or is not correctly configured:

Error message: *"canchd.dll was not found."*
To resolve this, the user should ensure that the Softing CANPro interface is connected, its drivers are installed, and it is correctly configured before continuing.

7.9 System Errors

In the event of a system error, loss of CAN data from one or more sensors may occur.
The user should consider the failure modes below before suspecting a faulty sensor:

- Sensor or extension cable not connected.
  Action: *Check all connectors are plugged together fully.*

- No data connection between sensor and host.
  Action: *Check for damage on connectors and cables.*

- No power connection to sensor.
  Action: *Check for damage on connectors and cable.*

- CAN communication error with sensor; cable is routed, or system is installed too close to an electrical noise source in vehicle.
  Action: *Try to relocate affected part of the system.*

- Incorrect sensor is connected, "Sensor model detected in 0xxxx is not recognised".
  Action: *New error flag when incorrect sensor is connected. Check the sensor model and try again. Application must be relaunched.*

The Brigade Backsense® System cannot self-diagnose potential sensor detection issues caused by the build-up of ice, dirt, mud, heavy rain, or immersion in water, all of which may impede system performance. Therefore, it is important to follow section "8 Testing and Maintenance".

8 Testing and Maintenance

8.1 Operator Instructions

This information is addressed to the operator of the vehicle where a Brigade Backsense® System is installed:

1) Backsense® is intended as an Object Detection System and should not be relied upon as your primary defence for the safe operation of the vehicle. It is a driver aid intended to contribute to established safety programmes and procedures to ensure a safe operation of the vehicle in relation to objects, and not to replace such measures.
   It remains the driver's responsibility to ensure the proper and safe operation of the vehicle or machine.
2) Drivers should not attempt to reconfigure the Backsense® system; this should only be performed by technically trained operators when the vehicle is stationary.
3) Testing and inspection of the system should be carried out in accordance with this manual. The driver or operator is responsible for ensuring the Brigade Backsense® System is working as intended.
4) Operators using this equipment are strongly recommended to check the system's proper operation at the beginning of every shift.
5) Improved safety depends on the proper function of this product in conformance with these instructions. It is necessary to read, understand and follow all instructions received with the Brigade Backsense® System.
6) The Brigade Backsense® System for object detection is intended for use on commercial vehicles and machinery equipment. Correct installation of the system requires a good understanding of vehicle electrical systems and procedures along with proficiency in installation.
7) Keep these instructions in a safe place and refer to them when maintaining and / or reinstalling the product.
8) Drivers and machine operators must be trained on the Backsense system, including detection limitations of FMCW radar detection systems and factors influencing its performance, prior to use.

8.2 Maintenance and Testing

This information is addressed to the operator for maintenance and testing of a vehicle with the Brigade Backsense® System installed. This is also to familiarise the operator with the detection area and behaviour of the system. More frequent inspections should be performed in cases where:

- The vehicle is operating in a particularly dirty or harsh environment.
- The operator has reason to suspect the system is not working or has been damaged.

Procedure:

1) Clean the sensor housing of any accumulation of dirt, mud, snow, ice, or any other debris.
2) Visually inspect the sensor or sensors where multiple sensors are installed and verify that they are securely attached to the vehicle and are not damaged.
3) Visually inspect the system's cables as well as possible and verify that they are properly secured and not damaged.
4) Ensure that the location of the test is larger than the detection range of the installed Brigade Backsense® System, and that the area in front of the sensor is clear of obstacles.

If any of the following tests fail, follow the Hardware Installation instructions in Section 4 and fault-finding guidance in Section 7.8, or contact Brigade technical support if still in doubt. For the following tests, the operator requires objects to be placed in the sensor's detection areas or an assistant (to observe the host activity).

5) Activate the Brigade Backsense® System and verify the detection distance accuracy for each sensor: Starting from the outside of the detection area, the operator should check several points along the centre line of the detection width down to approximately 0.4m distance from each sensor. The operator should note down the distance at which host system functions occur and verify that these are in line with the system configuration for this vehicle.
6) Very close detection awareness: Verify that objects less than 0.3m away from each sensor are not detected.
7) Similar to the previous tests the operator should scan all the edges of the detection area according to the installed system or configuration for this vehicle. They should note down the detected locations and check if they match with the detection area set when this Brigade Backsense® System was installed on this vehicle.

9 Specifications

Operation Characteristics

Model name	BS-9100 / BS-9100T
Detection length	60m (197 ft approx.) [1]
Detection width	16m (52ft approx.) [1]
Nominal tolerance	±0.25m / (1ft approx.) [1]
Radar beam angle	Horizontal 140° out to the maximum designated width Vertical 16° (symmetrically perpendicular to sensor front surface)
Distance resolution	0.25m (1ft approx.) [1]
Object detection	The minimum number of packets transmitted by any sensor in each ~50 millisecond period will be 1. The maximum number of packets will be 16, depending in the number of objects detected by the sensor.
Power on to system ready	≤ 2.5 seconds
Maximum simultaneous objects per sensor	16
Maximum sensors per system	8

[1] Limitations apply, see section "1.2 Object Detection Capability" for details.

Communication between Sensor and Host

Physical layer	CAN bus 2.0A Base Frame Format
Protocol layer	Proprietary Protocol (see section 5 for details)
Max. cable length between termination points	30m (98ft approx.) Note: 24V supply recommended to allow for voltage drop across the CAN bus network. Alternatively, power may be applied in the middle of the CAN bus network.

Sensor Specifications

Transmitter	Frequency Modulated Continuous Wave (FMCW)
Frequency and bandwidth	77GHz
Dimensions (all in mm)	160 x 100 x 40
Connector	Manufacturer Deutsch Part Number DT06-4S-CE06 (female)
Cable length	1.0m / 3ft 3in
Weight	0.34kg (including pigtail cable)
Operating temperature	-40°C to +85°C, -40°F to +185°F
IP protection	Protective housing: IP69K (Protected from dust & pressurised water jets) Connector: IP66K, IP67 (protected from dust and pressurised water jets & immersion into water)
Vibration	8.3G
Shock	51G all three axes
Mounting	Four 5.2mm (0.2in) diameter holes on 147mm (5.79in) horizontal centres, and 43.5mm (1.71in) vertical centres. Unit is supplied with M5 (13/64in) x 30mm (1.18in) screws and M5 polymer locknuts for mounting purposes. Recommended torque is 5.6Nm, (50 inch/lbs approx.).

Bracket	Optional, adjustable for vertical angle. See section 2.2

Electrical Specification

Input Voltage Range	9 to 32 Vdc
Input Current (per sensor)	typ. 0.23A at 12Vdc / typ. 0.12A at 24Vdc
Power Supply Fusing	Dependent upon number of sensors in network. See section 4.10 for details
Vehicle Connections	System supplies positive & negative.
Host Connections	CAN High & CAN Low
Voltage Protection	ISO 16750 (over and reverse voltage protection)

Approvals

Product Types
Brigade Backsense Radar Obstacle Detection System
BS-9100, BS-9100T, BS-9100-U, BS-9100T-U, BS-9100-S, BS-9100T-S, BS-9100-U-S, BS-9100T-U-S

Manufacturer and Importer
Brigade Electronics Group PLC
Brigade House, The Mills, Station Road, South Darenth, DA4 9BD, UK

FCC
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.
Any change or modifications not expressly approved by the responsible party responsible for compliance could void the user's authority to operate the equipment.

Federal Communication Commission Interference Statement
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

IMPORTANT NOTE:
FCC Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

IC
IC Radiation Exposure Statement:
This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.
Cet appareil contient des émetteurs / récepteurs exempts de licence qui sont conformes au (x) RSS (s) exemptés de licence d'Innovation, Sciences et Développement économique Canada. L'opération est soumise aux deux conditions suivantes:
(1) Cet appareil ne doit pas provoquer d'interférences.
(2) Cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.

CE
Hereby, Brigade Electronics Group PLC declares that the radio equipment type BS-9100, BS-9100T, BS-9100-U, BS-9100T-U, BS-9100-S, BS-9100T-S, BS-9100-U-S, BS-9100T-U-S are in compliance with Directive 2014/53/EU and complies with EU radiation exposure limits set forth for an uncontrolled environment.

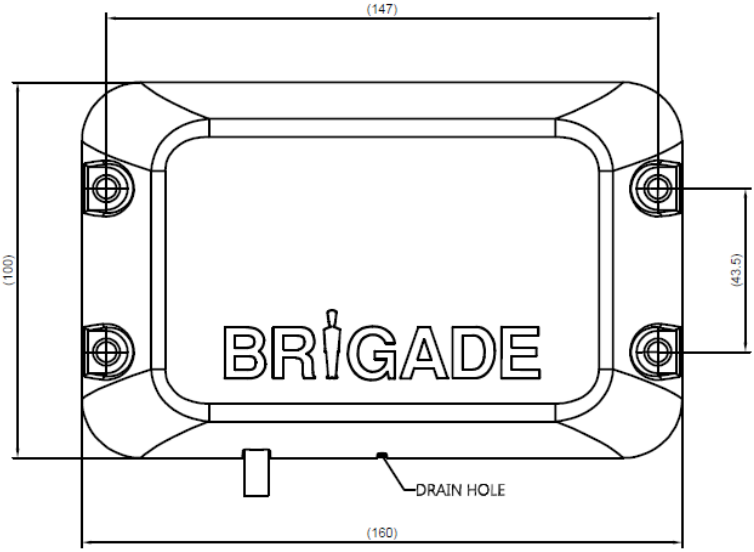
The full text of the EU declaration of conformity is available at the following internet address: www.brigade-electronics.com

This equipment should be installed and operated with minimum distance 20cm between the radar sensor and any human body.
The frequency and the maximum transmitted power in EU are: 76.175~76.925GHz: 15.61 dBm

UKCA
Hereby, Brigade Electronics Group PLC declares that the radio equipment type BS-9100, BS-9100T, BS-9100-U, BS-9100T-U, BS-9100-S, BS-9100T-S, BS-9100-U-S, BS-9100T-U-S are in compliance with Regulation SI 2017/1206 and complies with UK radiation exposure limits set forth for an uncontrolled environment.

The full text of the UK declaration of conformity is available at the following internet address: www.brigade-electronics.com
This equipment should be installed and operated with minimum distance 20cm between the radar sensor and any human body.

10 Mounting Dimensions



11 Disclaimer

English
Radar obstacle detection systems are an invaluable driver aid but do not exempt the driver from taking every normal precaution when conducting a manoeuvre.
It remains the driver's responsibility to ensure the proper and safe operation of the vehicle or machine.

Dutch
Radarobstakeldetectiesystemen zijn van onschatbare hulp voor de bestuurder, maar ontneem niet de plicht van de bestuurder om alle normale voorzorgsmaatregelen te nemen bij het uitvoeren van een manoeuvre.
Het blijft de verantwoordelijkheid van de bestuurder om te zorgen voor een juiste en veilige bediening van het voertuig of de machine.

French
Les systèmes radar de détection d'obstacles offrent une assistance précieuse au conducteur, mais ne remplacent en aucun cas la vigilance et les précautions nécessaires lors des manœuvres.
Il appartient au conducteur de s'assurer que le véhicule ou l'équipement est utilisé dans des conditions de sécurité optimales.

Polish
Radarowe systemy wykrywania przeszkód stanowią nieocenioną pomoc dla kierowcy, ale nie zwalniają go z obowiązku zachowania wszelkich normalnych środków ostrożności podczas wykonywania manewru.
Odpowiedzialność za prawidłowe i bezpieczne użytkowanie pojazdu lub maszyny spoczywa wyłącznie na kierowcy.

Spanish
Los sistemas de detección de obstáculos por radar son una ayuda inestimable para el conductor, pero no le eximen de tomar todas las precauciones normales al realizar una maniobra.
Sigue siendo responsabilidad del conductor garantizar el funcionamiento correcto y seguro del vehículo o máquina.

German
Radar-Hinderniserkennungssysteme sind eine unschätzbare Hilfe für den Fahrer, entbinden ihn aber nicht davon, bei der Durchführung eines Fahrmanövers alle üblichen Vorsichtsmaßnahmen zu treffen.
Es liegt in der Verantwortung des Fahrers, den ordnungsgemäßen und sicheren Betrieb des Fahrzeugs oder der Maschine zu gewährleisten.

Italian
I sistemi radar per il rilevamento degli ostacoli sono strumenti preziosi che assistono il conducente durante le manovre, ma non sostituiscono l'adozione delle normali precauzioni di sicurezza.
La responsabilità di garantire il corretto funzionamento e la sicurezza del veicolo o della macchina rimane interamente in capo al conducente.

Portuguese
Os sistemas de deteção de obstáculos por radar são uma ajuda inestimável para o condutor, mas não o dispensam de tomar todas as precauções normais ao efetuar uma manobra.
Continua a ser da responsabilidade do condutor assegurar o funcionamento correto e seguro do veículo ou da máquina.

Turkish
Radar engel tespit sistemleri paha biçilmez bir sürücü yardımcısıdır, ancak sürücüyü bir manevra yaparken her türlü normal önlemi almaktan muaf tutmaz.
Aracın veya makinenin düzgün ve güvenli çalışmasını sağlamak sürücünün sorumluluğundadır.

Specifications subject to change. Sous réserve de modifications techniques. Änderungen der technischen Daten vorbehalten. Specifiche soggette a variazioni. Las especificaciones están sujetas a cambios. Wijzigingen in specificaties voorbehouden. As especificações estão sujeitas a alterações. Спецификация может изменяться. Specyfikacja techniczna może ulec zmianie. Özellikler haber vermeksizin değiştirilebilir.

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