

77 GHz Automotive Safety Millimeter Wave Radar



I. Product introduce

Model No.: CAR-30

77 GHz Millimeter wave automotive safety radar, CAR-30 is the new generation short range wideband, high resolution automotive radar sensor built with customizable cutting edge radar technologies. It is built on Millimeter wave technology allowing for ultra low power consumption and low unit cost. The sensor's highly integrated hardware, advanced radar signal processing algorithms enable 360 surround high resolution detection when multiple units configured on the vehicle, and allow semi-autonomous or fully autonomous driving.

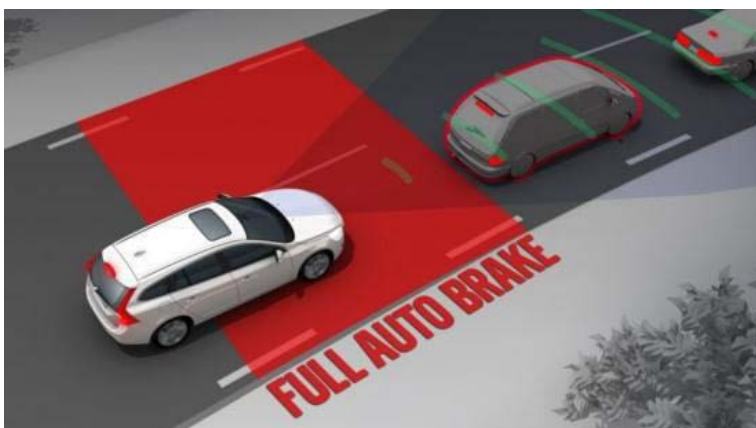
The ultra high range resolution, faster update rates, CAN-FD data link options make it a great solution to implement sensor fusion for ADAS and self-driving applications.

With the ruggedized design and the considerations for industrial and specialty vehicles, CAR-30 automotive radar sensors can be strategically placed on the exterior of the vehicle and deliver the superior performance in all tough working environment.

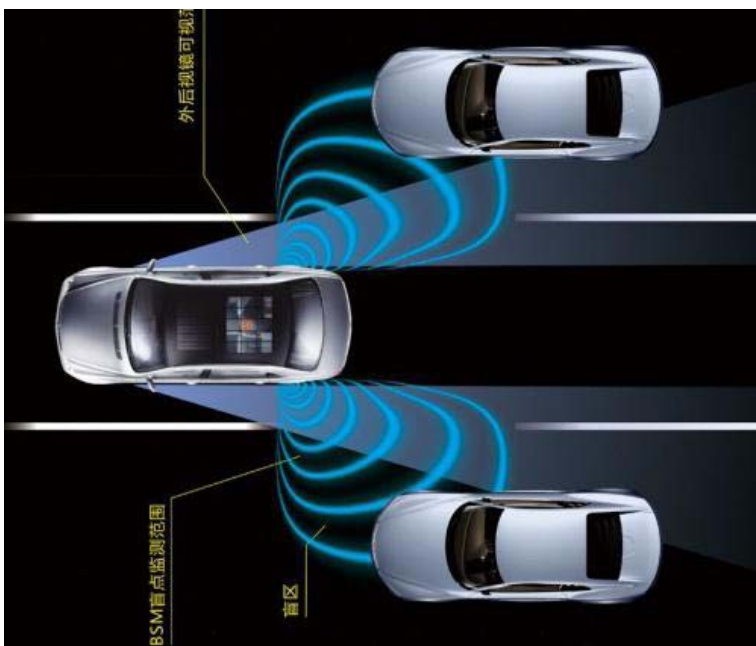
Applications:

- Large vehicle parking sensor
- Forward collision warning
- Headway monitoring warning
- Automatic emergency braking
- Pedestrian and cyclist collision
- Adaptive cruise control

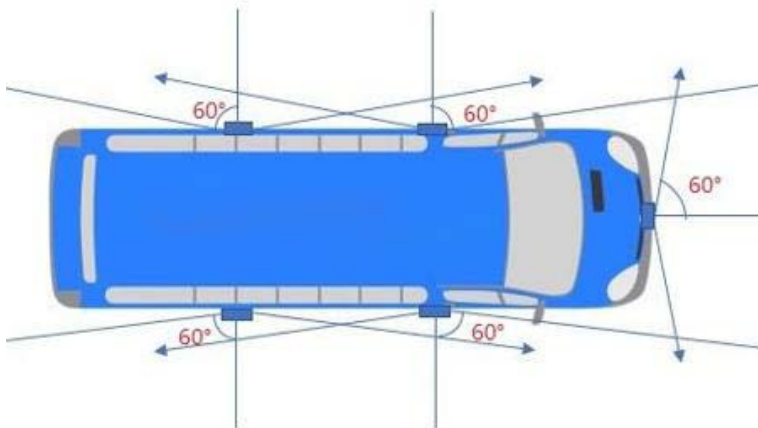
-Forward collision warning



-Passenger car blind spot detection



-Commercial vehicle blind spot detection



-Gate control



-Large vehicle survey radar ranging anti-collision

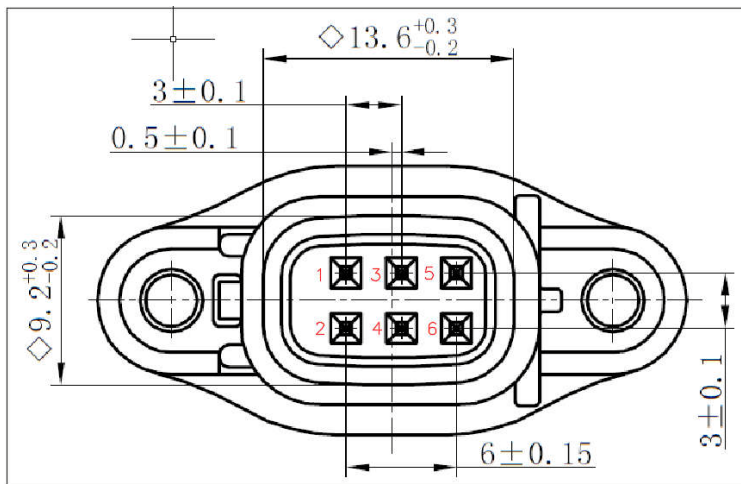


2. SPECIFICATIONS

2.1. Data Sheet:

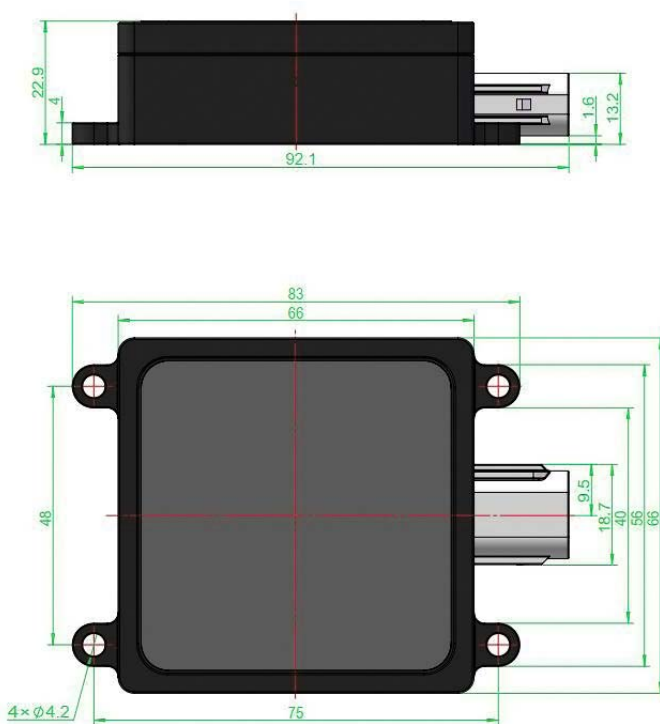
FEATURES	ITEMS	TECHNICAL DATA
System property	Working voltage	8-36VDC
	Working temperature	-40~85°C
	Power consumption	less than 2W
	Waterproof rating	IP67
	Working band	77-81GHz
	Refresh rate	20Hz
	Communication interface	CAN/UART
	Size	66mm x 66mm x 23mm
	Weight	133g
Antenna performance	Transceiver channels	2TX / 4RX
	Pitch beam width	+/- 10°
	Horizontal beam width	+/-60°
Detection performance	Distance resolution	0.18m
	Speed resolution	0.25m/s
	Speed range	90KM/H
	Ranging accuracy	Better than 0.18m
	Speed measurement accuracy	0.1m/s
	Angle measurement accuracy	0.1°
	Detect distance	0.5-30M
Upgrade/Debug	Firmware Upgrade	CAN/UART
	Data Calibration	CAN/UART

2.2. Pin definition and interface cable description



Pins	Labels	Cable Color	Definition
1	GND	Black	Negative power supply
2	VCC	Red	Positive power supply
3	Serial port RX	Green	Serial port TTL 3.3V level RX / CAN2_Low
4	CANL	Yellow	CAN1_Low
5	Serial port TX	White	Serial port TTL 3.3V level TX / CAN2_High
6	CANH	Blue	CAN1_High

2.3. Dimensions:



2.4. ASSEMBLY/INSTALL:

Screws:

Use 4 of M4 screws;

Installation direction:

The radar module antenna surface (flat surface) faces the detection area, with the heat sink side up, vertically horizontally mounted; the connector is on the right side;

Installation location:

It is recommended to install a height of 0.5~1.0m from the ground; if the installation height is less than 0.5m, the installation pitch angle should be adjusted appropriately;

Caution:

- ① When installing, try to position away from the frequently-powered high-power electrical equipment and motor with strong magnetic field interference position;
- ② There must be no obstructions in the radar beam range.

3. FUNCTION INTRODUCE:

3.1. Summary

- Multi-target tracking: 32 targets can be tracked simultaneously in the beam range;
- Communication interface: CAN interface rate 500K; serial port baud rate 115200;
- Data calibration: Data is calibrated by CAN and stored, and it takes effect after restarting the power supply;
- Firmware upgrade: free to disassemble, upgrade firmware through CAN interface, take effect after restarting power supply.

3.2. CAN transmission protocol:

The CAN bus interface supports target information output, data calibration, firmware upgrade; the CAN bus communication network conforms to the ISO11898-2 standard, and the transmission rate is 500K bits/second, frame type is 29-bit extended frame ID.

3.2.1. Bus message definition:

Frame Format	Base Message ID	Message Name	In/Out	Contents
Standard frame	0x5209	ObjectInfor	Out	Target information
Standard frame	0x200	ModeSelect	In	Mode selection
Standard frame	0x201	OnlineUpgr	Out	Online upgrade
Standard frame	0x520	OnlineUpgr	In	Online upgrade
Standard frame	0x521	OnlineUpgr	Out	Online upgrade
Standard frame	0x522	OnlineUpgr	In	Online upgrade
Standard frame	0x524	OnlineUpgr	In	Online upgrade
Standard frame	0x525	OnlineUpgr	Out	Online upgrade
Standard frame	0x700	DataCalibr	In	Data calibration
Standard frame	0x701	VersionInfor	Out	Version Information

3.2.2. Target Information:

The target information is sent through the ObjectInfor message frame, and the base message ID = 0x5209;

ObjectInfor message definition as:

Signal	Start bit	Length	Min	Max	Definition
Num	0	8	0	32	The number of targets detected in the current frame
Idx	8	8	0	32	The target series number of the current frame detection
X	16	16	0	65535	The horizontal X axis of the current target, the coordinate conversion formula $x = (N - 32768) * 0.01(m)$
Y	32	16	0	65535	The longitudinal Y axis of the current target, the coordinate conversion formula $y = (N - 32768) * 0.01(m)$
V	48	16	0	65535	Radial velocity of the current target, V conversion formula $V = (N - 32768) * 0.01(m/s)$

0	1	2	3	4	5	6	7
Current frame Total number of targets	Current frame target number	X High 8 bit	X Low 8 bit	Y High 8 bit	Y Low 8 bit	V High 8 bit	V Low 8 bit
		$((X[2] \ll 8) + X[3]) - 32768$ Unit:cm		$((Y[4] \ll 8) + Y[5]) - 32768$ Unit:cm		$((V[6] \ll 8) + V[7]) - 32768$ Unit:cm/s	

3.2.3. ID calculation:

Radars message ID = radar ID * 0x10 + base message ID;

CAN bus can mount up to 16 devices, each device has its own ID;

When the radar ID in the above table defaults to 0, the basic message ID is 0x40B, 0x200, 0x201, 0x700, 0x701;

If the radar ID is configured to 1, its message ID is 0x41B, 0x210, 0x211, 0x710, 0x711, and so on.

3.2.4. ID Data calibration:

Step1: Enter the calibration mode through the ModeSelect message frame, the basic message ID = 0x200;

Signal	Start bit	Length	Min	Max	Definition
Mode	0	8	0	64	0 x A2: indicates entering data calibration mode

Step2: The radar ID is calibrated by the DataCalibr message frame, the base message ID = 0x700;

Signal	Start bit	Length	Min	Max	Definition
MagicWord	0	32	\	\	0x01090904
RadarID	32	8	0	-	29 bit any ID

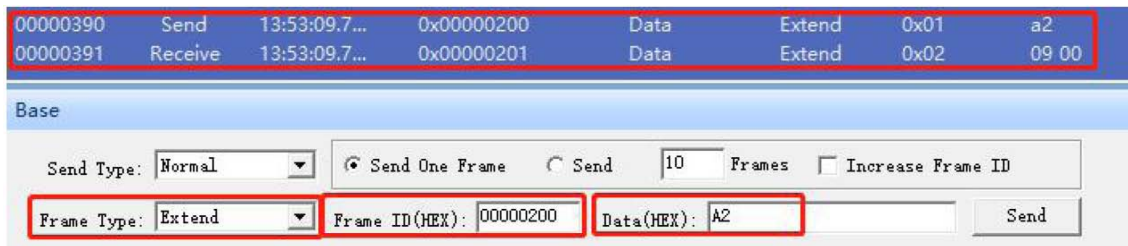
Step3: Repower up, new ID active.

3.2.5. 3.2.5. The example specific steps are as follows:

(1). Select the sending frame type as extended frame, baud rate: 500K

(2). Select send frame ID=0x200 DATA=0xA2

Send result: The radar stops transmitting and returns: frame ID=0x201 DATA=0x09 0x00 (0x09 =CANID & 0xff)



(3). Select send frame ID=0x700 DATA= 0x01 0x09 0x09 0x04 0x00 0x00 0x52 0x09

The last two digits are the modified ID. If modified to 0x5204, then send: 0x01 0x09 0x09 0x04 0x00 0x00 0x52 0x04

The result of the transmission returns: Frame ID=0x701 DATA=0x01 0x09 0x09 0x04 0x00 0x00 0x52 0x04

00000392	Send	13:54:43.3...	0x00000700	Data	Extend	0x08	01 09 09 04 00 00 52 04
00000393	Receive	13:54:43.8...	0x00000701	Data	Extend	0x08	01 09 09 04 00 00 52 04

Base

Send Type: Normal Send One Frame Send 10 Frames Increase Frame ID

Frame Type: Extend Frame ID(HEX): 00000700 Data(HEX): 01 09 09 04 00 00 52 04 Send

(4). Restart the radar

Index	Direction	Time Sta...	Frame ID	Format	Type	Data Leng...	Data(HEX)
00000457	Receive	13:55:59.6...	0x00005204	Data	Extend	0x08	01 00 80 16 80 eb 7f fd
00000458	Receive	13:55:59.6...	0x00005204	Data	Extend	0x08	01 00 80 18 80 e9 7f fc
00000459	Receive	13:55:59.7...	0x00005204	Data	Extend	0x08	01 00 80 19 80 e8 7f fc

3.3. Serial transmission protocol:

The radar module uses 3.3V TTL level output by default. It can be external TTL to 232 module or other communication interface compatible with the current host hardware. The baud rate is 115200, and the data is output by string.

- The first string represents the number of targets detected by the current frame.
- The second string represents the target number detected by the current frame.
- The third string represents the X-axis lateral coordinate (in m) of the current target.
- The fourth string represents the Y-axis longitudinal coordinate (in m) of the current target.
- The fifth string represents the Y-axis longitudinal velocity (in m/s) of the current target.

The strings are separated by spaces, and the data between different target numbers is distinguished by the line feed \n;

Examples of receiving data are as follows:

Total: 2,id: 0,X: -1.33,Y: 7.11,V: 0.01

Total: 2,id: 1, X: -0.06,Y: 1.92, V: 0.00

This part of the data indicates:

2 targets were detected,

No. 0 The target is located at -1.33m in the horizontal direction, 7.11m in the longitudinal direction, and the longitudinal velocity is 0.01m/s;

No. 1 The target is located at -0.06m in the horizontal direction, 1.92m in the longitudinal direction, and the longitudinal velocity is 0.00m/s.

Note:

CAR-30 shipment default configuration CAN output, if you need to configure serial output: the steps are as follows:

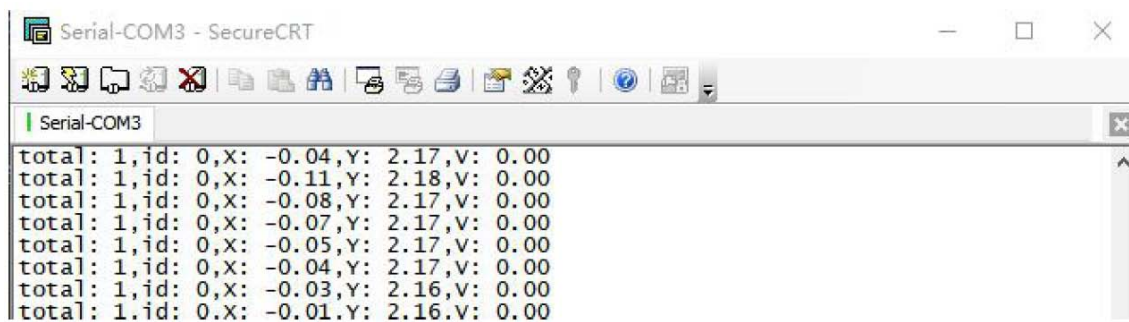
1. Serial port module wiring, the green line is the RX of the radar, and the white line is the TX of the radar;



- Using the serial port tool, the baud rate is set to 115200, and the string is sent: clioutput 1;



- Restart the radar and the radar output information on the serial port.



4. PARAMETER SETTING:

4.1. CFAR distance dimension modification

The value range is 8~30dB. Restart the power after the setup is complete.

1. Serial port calibration

Using the serial port tool, the baud rate is set to 115200.

Set the threshold to 15dB, then the string is sent: setparam 01 15 (decimal);

```

Serial-COM3
cfar:14
doppler:13
Please Sign the device First!

setparam 01 15
cfar:15
Done
    
```

4.2. CAN calibration

(1). Select the sending frame type as extended frame, baud rate: 500K

(2). Select send frame ID=0x200 DATA=0xA2

Send result: The radar stops transmitting and returns: frame ID=0x201 DATA=0x09 0x00 (0x09 =CANID & 0xff)

(3). Select Send Frame

ID=0x300 DATA= 0x01 0x09 0x09 0x04 0x00 0x00 0x01 0x09

The last digit is the modified value. If it is modified to 12dB (hexadecimal), then send: 0x01 0x09 0x09 0x04 0x00 0x00 0x01 0x0b

The result of the transmission returns: Frame ID=0x301 DATA=0x01 0x09 0x09 0x04 0x00 0x00 0x01 0x0b

The screenshot shows a USBCAN software interface with a list of frames and an 'Advance' table. The main table lists frames with columns: Index, Direction, Time Sta..., Frame ID, Format, Type, Data Leng..., and Data(HEX). The 'Advance' table has columns: Type, Format, Frame ID, and Data(HEX). Red arrows point from the 'Advance' table to the corresponding rows in the main table.

Index	Direction	Time Sta...	Frame ID	Format	Type	Data Leng...	Data(HEX)
00009980	Receive	14:31:31.1...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 7f ff
00009981	Receive	14:31:31.1...	0x00005209	Data	Extend	0x08	01 00 80 20 80 e4 7f ff
00009982	Receive	14:31:31.2...	0x00005209	Data	Extend	0x08	01 00 80 20 80 e3 7f fe
00009983	Receive	14:31:31.2...	0x00005209	Data	Extend	0x08	01 00 80 21 80 e3 7f fe
00009984	Receive	14:31:31.3...	0x00005209	Data	Extend	0x08	01 00 80 21 80 e3 7f fe
00009985	Receive	14:31:31.3...	0x00005209	Data	Extend	0x08	01 00 80 22 80 e3 7f fe
00009986	Receive	14:31:31.4...	0x00005209	Data	Extend	0x08	01 00 80 23 80 e3 7f fe
00009987	Receive	14:31:31.4...	0x00005209	Data	Extend	0x08	01 00 80 23 80 e3 7f fe
00009988	Receive	14:31:31.5...	0x00005209	Data	Extend	0x08	01 00 80 23 80 e3 7f fe
00009989	Receive	14:31:31.5...	0x00005209	Data	Extend	0x08	01 00 80 24 80 e3 7f fe
00009990	Receive	14:31:31.6...	0x00005209	Data	Extend	0x08	01 00 80 24 80 e3 7f fe
00009991	Receive	14:31:31.6...	0x00005209	Data	Extend	0x08	01 00 80 25 80 e3 7f fe
00009992	Receive	14:31:31.7...	0x00005209	Data	Extend	0x08	01 00 80 25 80 e3 7f ff
00009993	Receive	14:31:31.7...	0x00005209	Data	Extend	0x08	01 00 80 25 80 e2 7f ff
00009994	Receive	14:31:31.8...	0x00005209	Data	Extend	0x08	01 00 80 25 80 e2 7f ff
00009995	Send	14:31:31.8...	0x00000200	Data	Extend	0x01	a2
00009996	Receive	14:31:31.8...	0x00005209	Data	Extend	0x08	01 00 80 25 80 e2 7f ff
00009997	Receive	14:31:31.8...	0x00000201	Data	Extend	0x02	09 00
00009998	Send	14:31:36.9...	0x00000300	Data	Extend	0x08	01 09 09 04 00 00 01 0b
00009999	Receive	14:31:37.4...	0x00000301	Data	Extend	0x08	01 09 09 04 00 00 01 0b

Type	Format	Frame ID	Data(HEX)	
0	Extend	Data	00000200	A2
1	Extend	Data	00000300	01 09 09 04 00 00 01 0B

4.3. CFAR doppler dimension modification

The value range is 8~30dB. Restart the power after the setup is complete.

I. Serial port calibration

Using the serial port tool, the baud rate is set to 115200.

Set the threshold to 14dB, then the string is sent: setparam 02 14 (decimal);

```

Serial-COM3 - SecureCRT
Serial-COM3
cfar:15
doppler:13
Please sign the device First!

setparam 02 14
doppler:14,Done
    
```

4.4. CAN calibration

1. Select the sending frame type as extended frame, baud rate: 500K

2. Select send frame ID=0x200 DATA=0xA2

Send result: The radar stops transmitting and returns: frame ID=0x201 DATA=0x09 0x00 (0x09 =CANID & 0xff)

3. Select send frame ID=0x300 DATA= 0x01 0x09 0x09 0x04 0x00 0x00 0x02 0x09

The last digit is the modified value. If it is modified to 15dB (hexadecimal), then send: 0x01 0x09 0x09 0x04 0x00 0x00 0x02 0x0F

The result of the transmission returns: Frame ID=0x301 DATA=0x01 0x09 0x09 0x04 0x00 0x00 0x02 0x0F

The screenshot shows the CANTest software interface. The main window displays a list of CAN bus messages. A red box highlights a specific send operation and its subsequent receive responses. Red arrows point from the send operation to the corresponding receive messages.

Index	Direction	Time Sta...	Frame ID	Format	Type	Data Leng...	Data(HEX)
00009980	Receive	14:33:42.3...	0x00005209	Data	Extend	0x08	01 00 80 1f 80 e4 80 00
00009981	Receive	14:33:42.4...	0x00005209	Data	Extend	0x08	01 00 80 1f 80 e4 80 00
00009982	Receive	14:33:42.4...	0x00005209	Data	Extend	0x08	01 00 80 1f 80 e4 80 00
00009983	Receive	14:33:42.5...	0x00005209	Data	Extend	0x08	01 00 80 1f 80 e4 80 00
00009984	Receive	14:33:42.5...	0x00005209	Data	Extend	0x08	01 00 80 1f 80 e4 80 00
00009985	Receive	14:33:42.6...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009986	Receive	14:33:42.6...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009987	Receive	14:33:42.7...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009988	Receive	14:33:42.7...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009989	Receive	14:33:42.8...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009990	Receive	14:33:42.8...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009991	Receive	14:33:42.9...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009992	Receive	14:33:42.9...	0x00005209	Data	Extend	0x08	01 00 80 1e 80 e4 80 00
00009993	Receive	14:33:43.0...	0x00005209	Data	Extend	0x08	01 00 80 1d 80 e4 80 00
00009994	Receive	14:33:43.0...	0x00005209	Data	Extend	0x08	01 00 80 1d 80 e4 80 00
00009995	Send	14:33:43.1...	0x00000200	Data	Extend	0x01	a2
00009996	Receive	14:33:43.1...	0x00005209	Data	Extend	0x08	01 00 80 1d 80 e4 80 00
00009997	Receive	14:33:43.1...	0x00000201	Data	Extend	0x02	09 00
00009998	Send	14:33:43.2...	0x00000300	Data	Extend	0x08	01 09 09 04 00 00 02 0f
00009999	Receive	14:33:43.6...	0x00000301	Data	Extend	0x08	01 09 09 04 00 00 02 0f

The 'Advance' section at the bottom shows the configuration for the send operation:

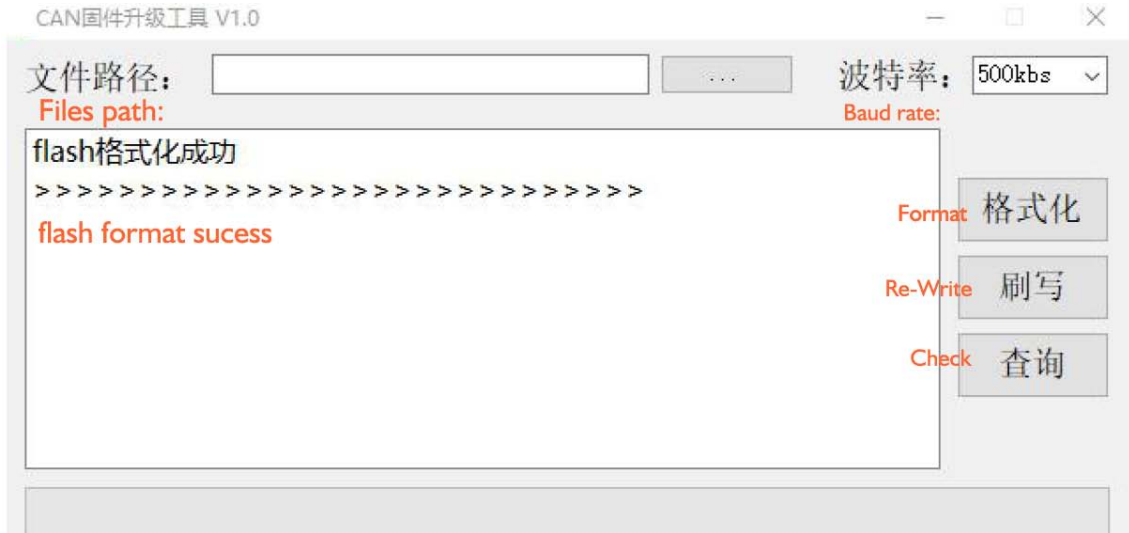
<input checked="" type="checkbox"/>	Type	Format	Frame ID	Data(HEX)	
<input checked="" type="checkbox"/>	0	Extend	Data	00000200	A2
<input checked="" type="checkbox"/>	1	Extend	Data	00000300	01 09 09 04 00 00 02 0F

Additional settings: Send Type: Normal, Send Times: 1

5. FIRMWARE UPGRADE

The radar can be upgraded using the CAN firmware upgrade tool;

The upgrade tool supports USB_CAN_2E_U and USBCAN (CANalyst-II) two USB to CAN devices.



Firmware upgrades to the radar using the serial firmware upgrade tool.



6. Windows Test Graphic Display Interface

Use the medium and long range radar test tool to parse the CAN protocol and graphialize the target

The interface is displayed, and an external USB camera can be connected to capture the radar data and video data synchronously, which can help users to quickly test and evaluate. The graphic display interface supports USB_CAN_2E_U and USBCAN (CANalyst-II) two USB to CAN devices.

