MR 72 millimeter wave radar Communication protocol

Version history

Date	Version	Version description
2018-12-17	1.0	Initial draft of MR72 communication protocol
2019-05-29	1.1	Optimized table structure
2019-06-06	1.2	Added a data parsing example
2020-03-02	1.3	Added regional setting features
2020-04-15	1.4	Universal target protocol for merged serial port universal
2023-03-16	1.5	Optimized document layout

Catalog

1. Interface overview

MR72 emits radar signals to the surrounding environment, and the received signals undergo multi-step processing to obtain trajectory information of target clusters.

The MR72 radar UART three-sector and UART point target mode protocols are described separately in Section 8.

The sensor connects to the CAN network via a simplified software interface, providing radar-based environmental perception information to one or multiple evaluation units. Sensors can also be configured via CAN interface.

The CAN interface of MR72 is used to configure the sensor, output the sensor status information, and input and output the sensor data. The sensor ID can be configured and the output Message IDs can be changed.

The sensor ID is 0 to 7, and the message ID is calculated as follows:

MsgID= MsgID_0+SensorID*0x10

For example, if sensor ID = 0, the configuration message ID is 0x200, if sensor ID = 1, the configuration message is 0x210, and so on. Once the sensor ID is set, the sensor will only respond to configuration messages matching the new ID.

Table 1-1 Sensor CAN message (SensorID = 0)

In/Out	ID	Message Name	Content	Section
In	0x200	RadarCfg	Radar configuration message	4.1
In	0x401	Region configuration	Zone configuration	4.2
Out	0x201	RadarState	Radar status message	5.1
Out	0x700	SoftWareVersion	Contains software version and	5.2
Out	0x402	Region state	Locale status	5.3
Out	0x60A	Obj_0_Status	Object Target Status Message	6.1
Out	0x60B	Obj_1_General	Object Common Message	6.2

Among them, 0x201 and 0x700 are heartbeat signals, which are output once per second.

2. Introduction to radar

MR72 uses 77 GHz high-frequency electromagnetic waves to analyze the surrounding environment. Objects refer to the target position, speed, and signal strength information reflected by the radar, which are calculated and output in each cycle.

The Cartesian coordinates of the radar are shown in the following figure:

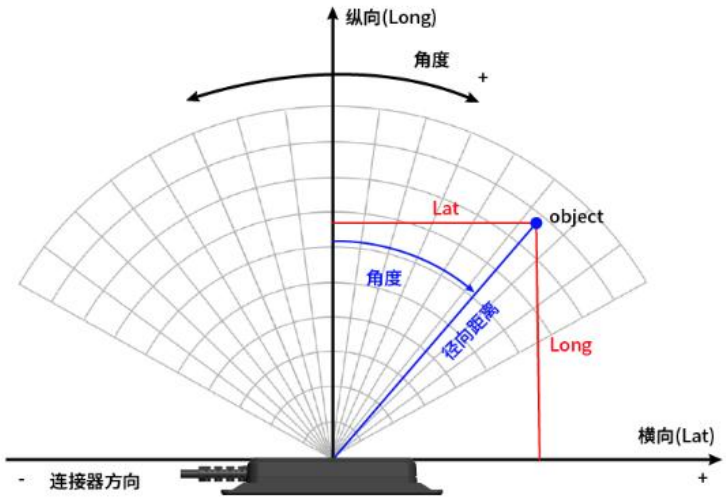


Figure 2-1 Radar coordinate diagram

Where the CAN interface direction remains unchanged in the negative direction.

The MR72 has a default power of 2W and a peak power of 2.5 W.

Be sure to use a 5 ~ 32 V DC power supply during operation. The current is greater than 0.2A at 12 V and greater than 0.5A at 5 V. When the current or voltage is too low, the radar cannot work normally.

When a target is approaching the radar, its speed is negative (-); when it is moving away from the radar, its speed is positive (+).

For a target moving laterally (lateral velocity), the lateral velocity is negative (-) when the target crosses from right to left, and positive (+) when crossing from left to right.

3. Introduction to Locales

To meet customer requirements, a zone setting function has been added to the existing MR72 general CAN protocol. The system defaults to output a rectangular frame (±3 × 50 meters), with targets output in order of radial distance from near to far.

The rectangular frame is set as shown in the figure below:

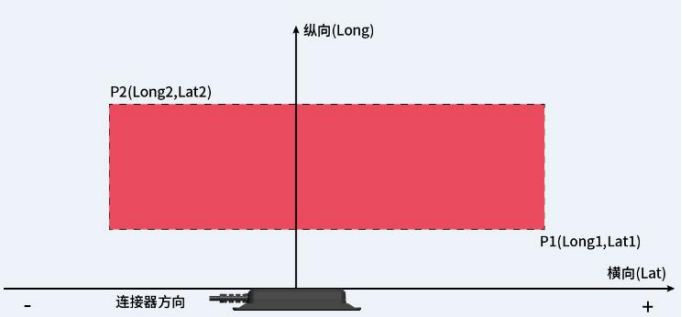


Figure 3-1 Schematic diagram of radar frame coordinates

At present, only a single input frame is allowed to be set, a rectangular frame is determined by two coordinate points P1 and P2, the number of output targets in the rectangular frame is set to be N, If N is greater than the number of actually detected targets within the rectangular frame, all detected targets are output; if N is less than the number of actually detected targets, the N nearest targets are output (sorted by distance from near to far).Where N is at most 63. In P1 (Long1, Lat1), Long1 is the ordinate and Lat1 is the abscissa.

4. Configuration input

4.1. Parameter Configuration (0 x200)

Configure basic radar parameters through Message Radar Cfg 0x200. Configuration parameters do not need to be set periodically. If the RadarCfg_StoreInNVM bit is set to 1, the parameters will be stored in non-volatile memory and automatically enabled when the device is powered on. Care should be taken to minimize the number of writes to non-volatile memory to extend its service life.

0x200 can modify both or only one of the configuration parameters. Each parameter in the message has a valid bit. If the valid bit is set to 1, the corresponding modification takes effect; otherwise, it is invalid.

Signal	Start	Len	Min	Max	Res	Unit
RadarCfg_MaxDistance_Valid	0	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_SensorID_Valid	1	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_RadarPower_Valid	2	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_OutputType_Valid	3	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_SendQuality_Valid	4	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_SendExtInfo_Valid	5	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_SortIndex_Valid	6	1	0	1	1	0x0:Invalid 0x1:Valid

RadarCfg_StoreInNvm_Valid	7	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_MaxDistance	22	10	0	2048	2	40-80m
RadarCfg_SensorID	32	3	0	7	1	ID(0~7)
RadarCfg_OutputType	35	2	0	2	1	0x0:none 0x1:Objects 0x2:Clusters
RadarCfg_RadarPower	37	3	0	7	1	0x0:Standard 0x1:-3dB Tx gain 0x2: -6dB Tx gain
RadarCfg_SortIndex	44	3	0	7	1	0x0:No Sorting 0x1: Sorted by range 0x2: Sorted by RCS
RadarCfg_StoreNVM	47	1	0	1	1	0x0:Inactive 0x1: Active
RadarCfg_RCS_Threshold_Valid	48	1	0	1	1	0x0:Invalid 0x1:Valid
RadarCfg_RCS_Threshold	49	3	0	7	1	0x0:Standard 0x1:High Sensitivity

Remark

1. In the multi-target mode, the targets are output in the order of distance from near to far.

2. For example, when modifying the radar ID, first enable the RadarCfg _ SensorID _ Valid bit, the RadarCfg _ SensorID is the ID to be set, and the current

modification is successful. If a change needs to be saved to the NVM and the change is valid at the next boot, the RadarCfg _ StoreInNvm _ Valid bit needs to be enabled.

3. MR72 only supports Object mode. If the target mode is set to none, there will be no target data output from the radar, and the none mode is used internally by Naray.

4. Res means resolution. For example, if the maximum distance value is configured as 20 and the resolution is 2, it means that the maximum distance value is 40 meters.

5. Currently, MR72 radar only supports radar and baud rate setting.

4.2. Rectangular frame and target number setting command (0x401)

The collision detection region configuration (0x401) currently only supports the setting of one detection region. The setting command format is shown in the following figure:

Signal	Start	Len	Offset	Min	Max	Res	Description
Max_OutputNumber	0	6		0	63	1	Maximum number of output targets allowed
CollDetRegCfg_Activation	6	1		0	1	1	0x0:inactive 0x1:active
CollDetRegCfg_CoordinatesValid	7	1		0	1	1	0x0:invalid 0x1:valid
CollDetRegCfg_RegionID	8	3		0	7	1	Zone ID number, default is 1
CollDetRegCfg_Point1Long	27	13	-500	-500	1138.2	0.2	Unit m
CollDetRegCfg_Point1Lat	32	11	-204.6	-204.6	204.8	0.2	Unit m

CollDetRegCfg_Point2Long	51	13	-500	-500	1138.2	0.2	Unit m
CollDetRegCfg_Point2Lat	56	11	-204.6	-204.6	204.8	0.2	Unit m

The Max _ OutputNumber comprises the following steps of: setting the maximum number N of targets allowed to be output in the rectangular frame, wherein N is less than 64, and if the number n of actually detected targets in the rectangular frame is more than n, outputting N targets from near to far according to the radial distance; If the number n of the actually detected targets is less than N, the actually detected n targets are output.

CollDetRegCfg _ Activation: whether the collision detection function is activated, 0x0: inactive, 0x1: active. After the function is activated and the coordinates are valid, the subsequent rectangular frame settings will take effect, that is, the last set parameters are valid when the power is turned on again.

CollDetRegCfg _ CoordinatesValid: The coordinate point setting 0x0: invalid is invalid, and 0x1: active is valid. Only when the collision detection function is activated and the enabled coordinate is valid, the coordinate setting will take effect, otherwise it will not take effect.

CollDetRegCfg _ Point1 Long: longitudinal distance value of coordinate point 1;

CollDetRegCfg _ Point1Lat: horizontal distance value of coordinate point 1;

CollDetRegCfg _ Point2 Long: longitudinal distance value of coordinate point 2;

CollDetRegCfg _ Point2Lat: horizontal distance value of coordinate point 2;

Note for setting coordinate point: coordinate point 1 is the coordinate value of the lower right corner of the rectangular box, and coordinate point 2 is the coordinate value of the upper left corner of the rectangular box.

I.e. satisfied,

CollDetRegCfg_Point1Long < CollDetRegCfg_Point2Long

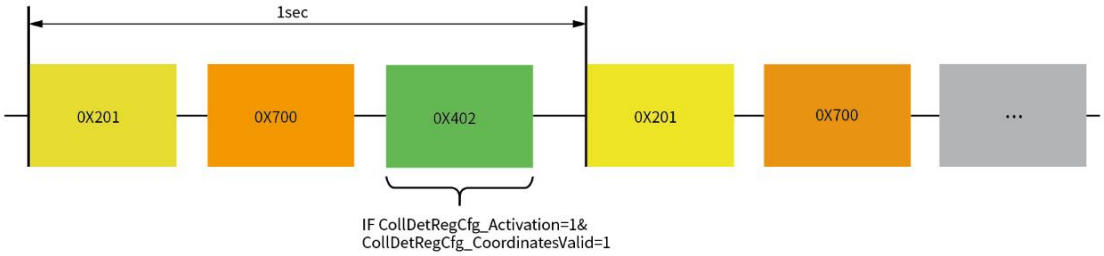
CollDetRegCfg_Point1Lat > CollDetRegCfg_Point2Lat

Otherwise, the set rectangle is invalid and is not saved in flash.

5. Status output

The radar periodically transmits radar configuration and status information via Message 0x201 (every 1 second) and radar firmware information via Message 0x700.

If the region setting is enabled and the coordinate setting is valid, Message 0x402 is output. If either the region setting or the coordinate setting is invalid, the radar outputs target data in object mode, and Message 0x402 is not output.



5.1. Radar status information (0x201)

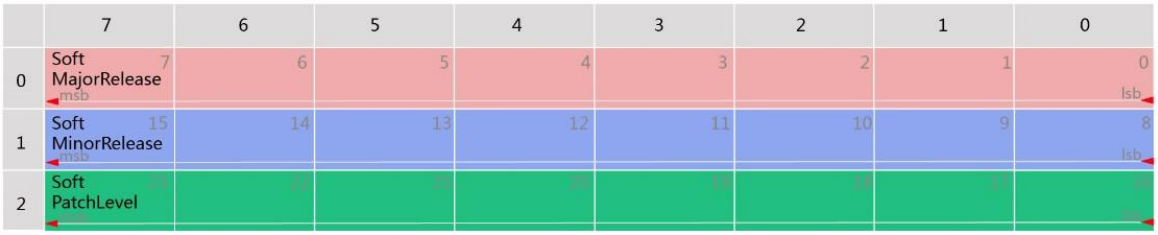
The radar sends status information periodically (every second). After the configured radar parameters come into effect, the radar status message immediately sends 0x201 command to prove that the configured parameters have come into effect.

	7	6	5	4	3	2	1	0
0	NVM-WriteStatus 7	NVM-ReadStatus 6	5	4	3	2	1	0
1	Max-DistanceCfg 15 msb	14	13	12	11	10	9	8
2	Max-DistanceCfg 23	22 lsb	21	20	19	18	17	16
3	31	30	29	28	27	26	RadarPower Cfg 25 msb	24
4	RadarPower Cfg 39 lsb	SortIndex 38 msb	37	36 lsb	35	SensorID 34 msb	33	32 lsb
5	47	46	45	44	OutputType-Cfg 43 msb	42 lsb	41	40
6	55	54	53	52	51	50	49	48
7	63	62	61	RCS threshold 60 msb	59	58 lsb	57	56

Signal	Start	Len	Min	Max	Res	Unit

RadarState_NVMReadStatus	6	1	0	1	1	0x0:failed 0x1:Successful
RadarState_NVMWriteStatus	7	1	0	1	1	0x0:failed 0x1:Successful
RadarState_MaxDistanceCfg	22	10	0	2046	2	m
RadarState_SensorID	32	3	0	7	1	Current radar ID (0 ~ 7)
RadarState_SortIndex	36	3	0	7	1	0x0:no sorting 0x1:sorted by range
RadarState_RadarPowerCfg	39	3	0	7	1	0x0:Standard
RadarState_OutputTypeCfg	42	2	0	3	1	0x0:none 0x1:Objects
RadarState_RCS_threshold	58	3	0	7	1	0x0:Standard 0x1:high sensitivity

5.2. Version information (0x700)



Signal	Start	Len	Min	Max	Res	Description
Soft_MajorRelease	0	8	0	255	1	Major version of
Soft _MinorRelease	8	8	0	255	1	Software minor
Soft _PatchLevel	16	8	0	255	1	Software patch

Soft _ MajorRelease: Major Software Version

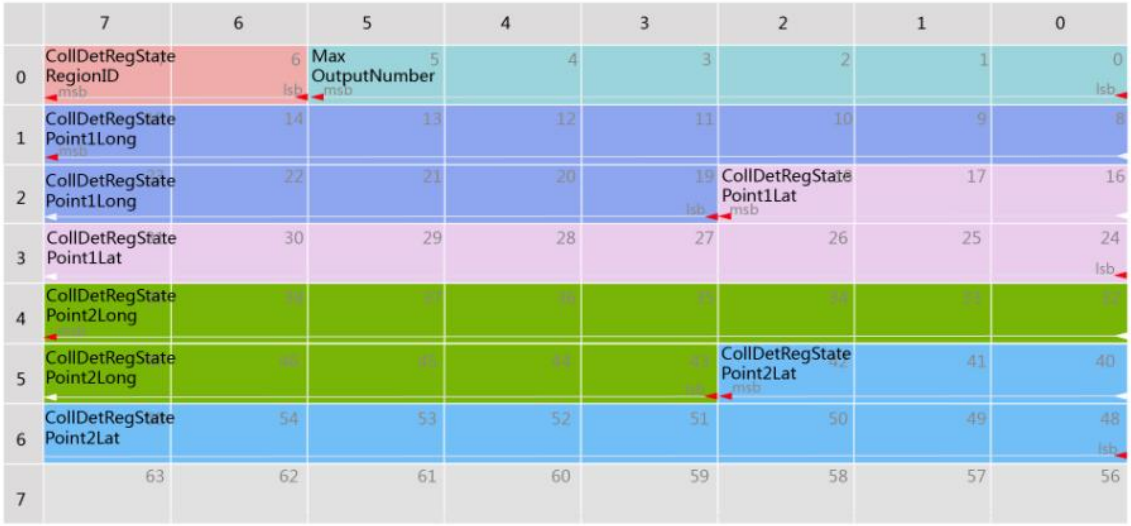
Soft _ Minor Release: Software Minor Release

Soft _ PatchLevel: Software Patch Version

5.3. Region setting state collision detection region state (0x402)

When the CollDetRegCfg _ Activation = 1 and the CollDetRegCfg _ CoordinatesValid = 1 in 0 × 401, the radar transmits the collision detection status message periodically (1 s).

When either of the CollDetRegCfg _ Activation and CollDetRegCfg _ CoordinatesValid in 0x401 is not 1, the radar outputs the objects mode target.



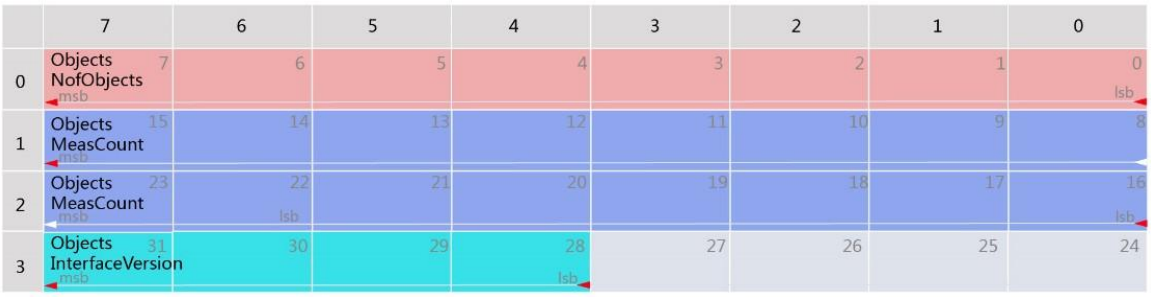
Signal	Start	Len	Offset	Min	Max	Res	Description
Max_OutputNumber	0	6		0	63	1	Maximum number of output targets allowed
CollDetRegState_RegionID	8	3		0	7	1	Zone ID number, default is 1
CollDetRegState_Point1Long	19	13	-500	-500	1138.2	0.2	Unit m
CollDetRegState_Point1Lat	34	11	-204.6	-204.6	204.8	0.2	Unit m
CollDetRegState_Point2Long	43	13	-500	-500	1138.2	0.2	Unit m
CollDetRegState_Point2Lat	48	11	-204.6	-204.6	204.8	0.2	Unit m

6. Object list

The object list includes two messages. Object_0_Status (0x60A) is the first list header message, containing the number of targets to be sent. Object_1_General (0x60B) is the second message, containing speed and distance information of targets. All tracked target information is transmitted periodically.

6.1. Object List Status(0x60A)

Object List Status (0x60A) contains the object list header message, and the 0x60A message is sent first in each measurement cycle.



Signal	Start	Len	Min	Max	Res	Description
Objects_NofObjects	0	8	0	255	1	Number of targets detected
Objects_MeasCount	8	16	0	65535	1	Cycle Count, Cycle Cycle + 1
Objects_InterfaceVersion	28	4	0	15	1	Target list can interface version, default is

6.2. Objects General Information(0x60B)

The message contains the distance and velocity information of the target, and all the tracking target information is sent periodically.

Signal	Start	Len	Min	Max	Res	Description
Objects_ID	0	8	0	255	1	Target ID
Objects _DistLong	19	13	-500	1138.2	0.2	m
Objects _Distlat	24	11	-204.6	+204.8	0.2	m
Objects _ VrelLong	46	10	-128.00	127.75	0.25	m/s
Objects _DynProp	48	3	0	7	1	0x0:moving 0x1:stationary 0x2:oncoming 0x3:stationary candidate 0x4:unknown 0x5:crossing stationary
Sector_Number	51	2	1	3	1	0x1:1Sector 0x2: 2Sector 0x3: 3Sector
Objects_VrelLat	53	9	-64	63.75	0.25	m/s
Objects _RCS	56	8	-64	63.5	0.5	dBm2

Objects _ ID: object ID;

Objects _ Dist Long: target longitudinal distance;

Objects _ Distlat: target lateral distance;

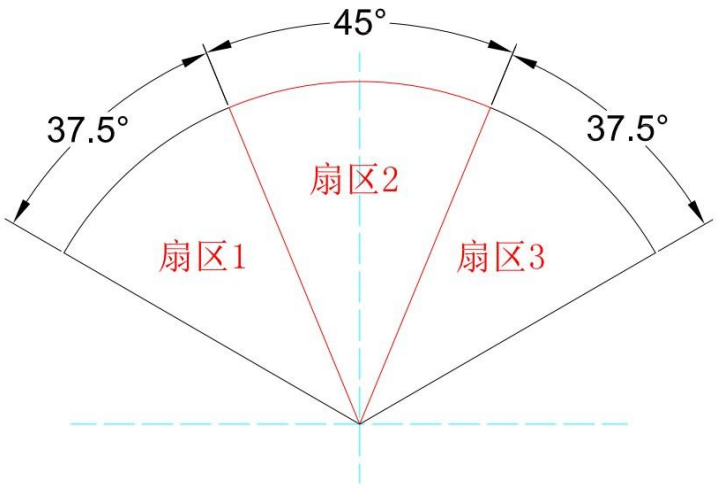
Objects _ VrelLong: target longitudinal velocity;

Objects _ DynProp: target dynamic attribute, which is not supported at present, and the current default values are all 0;

Objects _ VrelLat: target lateral velocity;

Objects _ RCS: The target RCS. The default is 0.

Remark



1. The current Objects _ DynProp is 0.

2. Sector _ Number indicates the sector where the target is located, and the sector division is shown in the following figure:

3. If it is a three-sector program version, only the nearest three-sector distance target is output, and the output sequence is sector 1, sector 2, and sector 3. If there is no target in the sector, the distance speed value is assigned as 0.

4. If it is a multi-target version, the nearest target of three sectors will be output first in the order of sector 1, sector 2 and sector 3. No target will be output, and then the remaining targets will be output in the order of distance (from near to far).

5. Res: resolution. The data received from the radar is multiplied by this value as the actual value of the target. For example, the received value is 100 and the resolution is 0.2

The actual value is 100 * 0.2 = 20.

6. Min: offset. Some values may have a negative value (-). In order to ensure the output of a positive value (+) and facilitate the analysis, the offset is added at the radar end. When parsing radar data, an offset needs to be added. If the data sent by radar is Value1, the actual value is Value 2 = Value1 * Res + Min;

7. CAN protocol parsing example

Res: Resolution. The actual value of the target is obtained by multiplying the data received from the radar by this resolution. For example, if the received value is 100 and the resolution is 0.2, the actual value is 100 × 0.2 = 20.

Min: Offset. Some values may be negative (-). To ensure positive output values (+) and simplify analysis, an offset is added at the radar end. When parsing radar data, the offset must be included: if the data sent by the radar is Value1, the actual value is calculated as Value2 = Value1 × Res + Min.

7.1. Sample configuration message

The default radar _ outputType type of the program is Objects, the storage parameter is modified to NVM, the radar _ power is standard, SortIndex is classified by range, and the RCS _ Threshold is standard. SensorID is 0 and MaxDistance is 160 meters.

For example: Message ID Is 0 x200 and the message content is 0 xFF 0 x0A 0 x00 0 x00 0x09 0x90 0x00 0 x00

This message modifies the radar ID to 1 and saves the modified parameters to the NVM. When the radar is powered on next time, the ID is 1. The maximum distance is 80 meters, that is, (0 × 0A × 4 + (0 × 00 > > 6)) × 2. The resolution of this value is 2, so 0x28 = 40. 40 multiplied by the resolution of 2 is the maximum distance of 80 meters. Configuring this bit requires enabling bit0 of byte 0 with a maxdistance _ valid of 1. If the bit 0 maxdistance _ valid of byte 0 is 0, the configuration is invalid. When the modification is initiated, the corresponding Valid bit must be enabled for the configuration of that bit to take effect, otherwise the configuration will take effect.

7.2. Common configuration commands (CANMonitor)

The CAN interface of MR72 is used to configure the sensor, output the sensor status information, and input and output the sensor data. Up to 8 MR72 sensors can be

mounted on one CAN bus. After configuring the sensor ID, output the message ID (Message IDs) have also changed.

The sensor ID is 0 to 7, and the message ID is calculated as follows:

MsgID= MsgID_0+SensorID*0x10

In the following, the message ID is ignored, and the message content is mainly described.

1. Change the radar ID to 1 and save it. The command is as follows:

82 00 00 00 01 80 00 00

2. Change the radar ID to 2 and save it. The command is as follows:

82 00 00 00 02 80 00 00

3. Change the radar ID to 3 and save it. The command is as follows:

82 00 00 00 03 80 00 00

4. Modify the radar to high sensitivity (detect fine targets)

80 00 00 00 00 80 03 00

5. Modify the radar to low sensitivity

80 00 00 00 00 80 01 00

6. Change the radar to CAN port output

80 00 00 00 00 80 40 00

MR72 common configuration commands (NSM upper computer)

Refer to the NSM Upper Computer Application Manual for details.

7. 3. 0x60B Parsing example

As shown in the figure above, the current radar ID is 5.

The message is 0x570x4E 0xC4 0 x0C0x7F0x600x180x80

Namely:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x57	0x4E	0xC4	0x0C	0x7F	0x60	0x18	0x80

1. Target ID: 0x57 = 87, namely, the target ID is 87. The target is generated cyclically between 0 and 255. During stable tracking, the target ID remains unchanged;

2. Target longitudinal distance: (0 x4E * 32 + (0xC4 > > 3)) * 0.2-500 = 4 m;

3. Target lateral distance: ((0xC4 & 0x07) * 256 + 0x0C) * 0.2-204.6 = 2.6m;

4. Target longitudinal speed: (0x7F * 4 + (0x60 > > 6)) * 0.25-128 = -0.75m/s;

5. Target lateral speed: ((0x60 & 0x3F) * 8 + (0x18 > > 5)) * 0.25-64 = 0m/s;

6. Target dynamic attribute: 0x18 & 0 x07 = 0, 0 by default;

7. Sector No.: (0x18 > > 3) & 0x03 = 3, the target is in sector 3;

8. RCS: 0 X80 * 0.5-64 = 0, 0 by default.

7.4. Heartbeat (0x700)

The first three bytes of the message represent the software version number. If the returned message is 0x700, it indicates that the current radar ID is 0. If the returned message is 0x710, it indicates that the current radar ID is 1.

Example: The return message is 0 x01 0 x00 0 x15 0 x00

The current software version of the radar is V 1.0.21.

7.5. Zone configuration commands

1) If it is necessary to set the rectangular frame to 6 X 20 meters and the maximum number of output targets to 63, it is necessary to enable the area setting and the coordinates to be valid. Assume that the coordinates of point 1 are (0, 3), the coordinates of point 2 are (20, -3), and the sending command is: 0 xFF 0x01 0 x4E 0x24 0 x0E 0x51 0 x43 0 xF0

CollDetRegState_Point1Long = (0+500)x5 = 2500 =(100111000100)b

CollDetRegState_Point1Lat = (3+204.6)x5 = 1038 =(10000001110)b

CollDetRegState_Point2Long = (20+500)x5 = 2600 =(101000101000)b

CollDetRegState_Point2Lat = (-3+204.6)x5 = 1008 =(1111110000)b

The specific analysis is as follows:

	7	6	5	4	3	2	1	0	Hex
0	1	1	1	1	1	1	1	1	0xFF
1	0	0	0	0	0	0	0	1	0x01
2	0	1	0	0	1	1	1	0	0x4E
3	0	0	1	0	0	1	0	0	0x24
4	0	0	0	0	1	1	1	0	0x0E
5	0	1	0	1	0	0	0	1	0x51
6	0	1	0	0	0	0	1	1	0x43
7	1	1	1	1	0	0	0	0	0xF0

2) If it is necessary to set the rectangular frame to be 10 X 50 meters and the

maximum number of output targets to be 63, it is necessary to enable the area setting and the coordinates to be valid. Assume that the coordinates of point 1 are (0, 5) and the coordinates of point 2 are (50, -5). The command to be sent is: 0 xFF 0x01 0 x4E 0x24 0 x18 0x55 0 xF3 0 xE6

CollDetRegState_Point1Long = (0+500)x5 = 2500 =(100111000100)b

CollDetRegState_Point1Lat = (5+204.6)x5 = 1048 =(10000011000)b

CollDetRegState_Point2Long = (50+500)x5 = 2750 =(101010111110)b

CollDetRegState_Point2Lat = (-5+204.6)x5 = 998 =(1111100110)b

The specific analysis is as follows:

	7	6	5	4	3	2	1	0	Hex
0	1	1	1	1	1	1	1	1	0xFF
1	0	0	0	0	0	0	0	1	0x01
2	0	1	0	0	1	1	1	0	0x4E
3	0	0	1	0	0	1	0	0	0x24
4	0	0	0	1	1	0	0	0	0x18
5	0	1	0	1	0	1	0	1	0x55
6	1	1	1	1	0	0	1	1	0xF3
7	1	1	1	0	0	1	1	0	0xE6

Locale considerations:

1) Only when coordinate point 1 and coordinate point 2 meet the condition ((point1Long < point2Long) & & (point1Lat > point2Lat)), the parameter will be saved, otherwise the parameter will not be saved;

2) As long as the coordinates meet the conditions, the parameters are saved to Flash regardless of whether the area setting is activated and the coordinates are valid;

3) However, only when the region setting and coordinates are valid, the rectangular frame will be drawn, and 0 x402 will be output periodically.

3) As long as one of the area settings and coordinates is invalid, the radar enters the objects multi-target mode to output all targets, that is, no frame, no 0x402 output.

8. UART protocol

At present, MR72 radar has two serial ports: sector mode and point target mode protocol. Both modes use the same upgrade method, utilizing the MR72 serial port for upgrading. The serial port mode does not support the picture frame function temporarily. When the radar is connected to the Nanoradar host computer, the sector

mode corresponds to MR72, and the point target mode protocol corresponds to MR72_C.

MR72 sector mode protocol outputs one packet of data per cycle.

The MR72 point target protocol supports a maximum of 8 targets output per cycle. If the number of detected targets is less than 8, all detected targets are output, sorted by distance from near to far.

8.1. UART sector mode protocol

The MR72 serial sector version supports 115200 baud rate, 8 data bits, 1stop bit, and a transmit cycle of 30 ms.

The protocol supports the open source flight control APM version below V3.6.0.

The UART outputs the targets of the three sectors detected, and the sectors are divided as shown in the following figure:

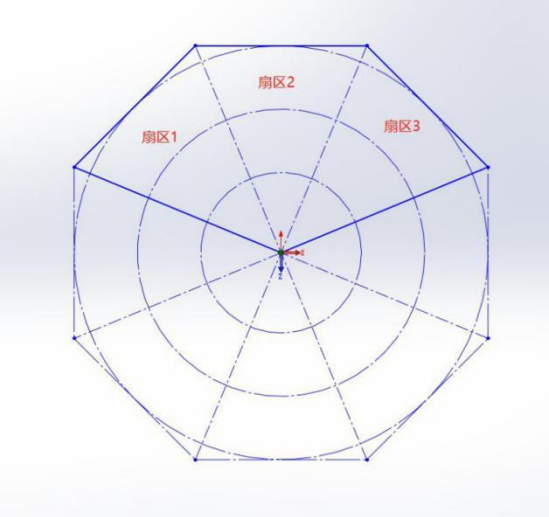


Figure 8-1 Schematic diagram of radar sector

At present, MR72 only outputs the nearest targets of sector 1, sector 2 and sector 3 within the detection range. The beam width of MR72 azimuth plane is ± 56 degrees, and the beam width of elevation plane is ± 7 degrees

Data transmission format (ASCII code):

Header Byte D1 D2 D3 D4 D5 D6 D7 D8 CRC8

The data protocol format is shown in the following table:

Table 8-1 Sector data format

	Number of bytes	Explain
Header Byte	2Btyes	Fixed, 'T' 'H' T ASCII is decimal 84 (0x54) H ASCII is decimal 72 (0x48)
D1	2Btyes	Closest distance target in sector 2, 0xFFFF for invalid data, high octet first, low octet last
D2	2Btyes	Closest distance target in sector 3, 0xFFFF for invalid data, high octet first, low octet last
D3	2Btyes	90-degree sector obstacle distance, 0xFFFF for invalid data, high octet in the front, low octet in the back
D4	2Btyes	135-degree sector obstacle distance, invalid data, fill in 0xFFFF, high octet in the front, low octet in the back
D5	2Btyes	180-degree sector obstacle distance, 0xFFFF for invalid data, high octet in the front, low octet in the back
D6	2Btyes	225-degree sector obstacle distance, 0xFFFF for invalid data, high octet in the front, low octet in the back
D7	2Btyes	270 degree sector obstacle distance, 0xFFFF is filled for invalid data, high octet is in the front, and low octet is in the back
D8	2Btyes	Closest distance target in sector 1, 0xFFFF for invalid data, high octet first, low octet last
CRC8	1Btyes	CRC8 verification, please refer to CRC8 verification procedure for verification algorithm

Where distance is in centimeter (cm).

CRC8 verification procedure

Crc.cpp

static const uint8_t crc8_table[] = {

0x00, 0x07, 0x0e, 0x09, 0x1c, 0x1b, 0x12, 0x15, 0x38, 0x3f, 0x36, 0x31,0x24, 0x23, 0x2a, 0x2d, 0x70, 0x77, 0x7e, 0x79, 0x6c, 0x6b, 0x62, 0x65,0x48, 0x4f, 0x46, 0x41, 0x54, 0x53, 0x5a, 0x5d, 0xe0, 0xe7, 0xee, 0xe9, 0xfc, 0xfb, 0xf2, 0xf5, 0xd8, 0xdf, 0xd6, 0xd1, 0xc4, 0xc3, 0xca, 0xcd, 0x90, 0x97, 0x9e, 0x99, 0x8c, 0x8b, 0x82, 0x85, 0xa8, 0xaf, 0xa6, 0xa1, 0xb4, 0xb3, 0xba, 0xbd, 0xc7, 0xc0, 0xc9, 0xce, 0xdb, 0xdc, 0xd5, 0xd2, 0xff, 0xf8, 0xf1, 0xf6, 0xe3, 0xe4, 0xed, 0xea, 0xb7, 0xb0, 0xb9, 0xbe, 0xab, 0xac, 0xa5, 0xa2, 0x8f, 0x88, 0x81, 0x86, 0x93, 0x94, 0x9d, 0x9a, 0x27, 0x20, 0x29, 0x2e, 0x3b, 0x3c, 0x35, 0x32, 0x1f, 0x18, 0x11, 0x16,0x03, 0x04, 0x0d, 0x0a, 0x57, 0x50, 0x59, 0x5e, 0x4b, 0x4c, 0x45, 0x42,0x6f, 0x68, 0x61, 0x66,

```
0x73, 0x74, 0x7d, 0x7a, 0x89, 0x8e,      0x87, 0x80,0x95, 0x92, 0x9b, 0x9c,
0xb1, 0xb6, 0xbf, 0xb8, 0xad, 0xaa, 0xa3, 0xa4, 0xf9, 0xfe, 0xf7, 0xf0, 0xe5,
0xe2, 0xeb, 0xec, 0xc1, 0xc6, 0xcf, 0xc8,    0xdd, 0xda, 0xd3, 0xd4, 0x69,
0x6e, 0x67, 0x60, 0x75, 0x72, 0x7b, 0x7c, 0x51, 0x56, 0x5f, 0x58, 0x4d,
0x4a, 0x43, 0x44, 0x19, 0x1e,       0x17, 0x10,0x05, 0x02, 0x0b, 0x0c, 0x21,
0x26, 0x2f, 0x28, 0x3d, 0x3a,      0x33, 0x34,0x4e, 0x49, 0x40, 0x47, 0x52,
0x55, 0x5c, 0x5b, 0x76, 0x71, 0x78,      0x7f,0x6a, 0x6d, 0x64, 0x63, 0x3e,
0x39, 0x30, 0x37, 0x22, 0x25, 0x2c,      0x2b,
    0x06, 0x01, 0x08, 0x0f, 0x1a, 0x1d, 0x14, 0x13, 0xae, 0xa9, 0xa0,
0xa7, 0xb2, 0xb5, 0xbc, 0xbb, 0x96, 0x91, 0x98, 0x9f, 0x8a, 0x8d, 0x84,
0x83, 0xde, 0xd9, 0xd0, 0xd7, 0xc2, 0xc5, 0xcc, 0xcb, 0xe6, 0xe1, 0xe8,
0xef, 0xfa, 0xfd, 0xf4,    0xf3}
    /*crc8 from trone    driver by Luis Rodrigues*/
    uint8_t    crc_crc8(const uint8_t    *p, uint8_t len)
    {uint16_t i;
    uint16_t crc = 0x0;
    while    (len--) {
i = (crc ^ *p++) & 0xFF;
    crc = (crc8_table[i] ^ (crc << 8)) & 0xFF;
    }
    return crc & 0xFF;
    }
```

Calling method: crc8 = CRC _ crc8 (buffer, 18);//buffer is the data receiving cache array

8.2. Uart Point Target Mode Protocol

MR72 radar sensor Uart point target mode (with angular output) with preset default transfer rate of 115200 baud, 8 data bits, 1stop bit, no parity bit, no flow control. Each data message begins with a start sequence and ends with a stop sequence; In each data cycle (30 ms) of MR72, the system status and target output

status message of MR72 will be output. If the target is detected, that is, the number of targets detected in the target output status message is 1, the target output status message will be followed by the target information message, which contains the altitude parameters of the target.

The upper computer or peripheral equipment configures MR72 in the same message format, and the corresponding message MessageID is 0x200.

A complete data message of UART-TTL communication consists of 14 bytes, and the data of each byte is unsigned8bit type. The data range is 0 ~ 255 (0 ~ 0 xFF), and the format is shown in the following table. Each data message contains a message ID, which is used to distinguish different types of messages.

Table 8-2 Data message format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Start Sequence (2 x Uint8)							
1								
2	Message ID (2 x Uint8)							
3								
4	Data Payload (8 x Uint8)							
5								
6								
7								
8								
9								
10								
11								
12	End Sequence (2 x Uint8)							
13								

The Start Sequence is set to 0xAAAA, the Message ID is defined as shown in the table below, the Data Payload is defined according to the Message ID (see the next section for details), and the End Sequence is set to 0x5555.

Table 8-3 Message ID definition

Num	Message ID	Message Name	Comment
1	0x200	Sensor Configuration	MR72 configuration
2	0x201	Sensor Back	MR72 return
3	0x60A	Sensor Status	MR72 System Status
4	0x70B	Target Status	Target output status
5	0x70C	Target Info	Target output

			information

Note：

The Message ID is represented by 2 bytes, Byte2 for the low byte and Byte3 for the high byte. For example, the MR72 message output is: 0 xAA 0 xAA | 0x0A 0x06 | Data Payload | 0x55 0x55, which indicates that the Message ID is 0x60A (MR72 system status), and the Data Payload is the content of MR72 system status.

The configuration and status return data bits of the UART point target mode are the same as those of the CAN protocol, and only the two-byte frame header and frame trailer of the serial port protocol are added.

8.3. Target Output Status

The format of MR72 system target output status data message is shown in the following table, in which the start sequence (0xAAAA) and stop sequence (0x5555) have been omitted. Where the value of RollCount cycles continuously between 0-1-2-3-0-1-2-3 ·. When the upper computer or the external MCU cannot process the output data of the MR72 sensor in time, the received RollCount value will be discontinuous. At this time, we should find a faster moving method to solve this problem.

Table 8-4 MR72 Target Output Status Message Format

Message ID 0x70B					
Signal Name	Bit	Resolution	Interval	Type	Comment
NoOfTarget	0..7	1	0…255	u8	Number of targets detected
RollCount	8..9	1	0…3	u2	Cycle count 0-1-2-3 per 1 change per cycle
Rsvd1	10..63	1	-	u54	-

8.4. Target output information (Target Info)

The format of MR72 target output information message is shown in the following table, in which the start sequence (0xAAAA) and the stop sequence (0x5555) have been omitted. When the radar sensor works normally and detects a target, it outputs MR72 system status message first, then target output status message, and finally target output information message.

Table 8-5 MR72 Target Output Information Format

Message ID 0x70C					
Signal Name	Bit	Resolution	Interval	Type	Comment
Index	0..7	1	0…255	u8	Target ID
AzimuthH	8..15	1	0…255	u8	High 8 bits of target azimuth
RangeH	16..23	1m	0…255	u8	Target Range High 8 bits
RangeL	24..31	1m	0…255	u8	Lower 8 bits of target distance
AzimuthL	32..39	-	0…255	u8	Lower 8 bits of target azimuth
VrelH	40..42	1m/s	0..7	u3	Target speed 3 bits higher
Rsvd1	43..45	-	0	u3	-
RollCount	46..47	1	-	u2	Cycle count 0-1-2-3 per 1 change per cycle
VrelL	48..55	1m/s	0..255	u8	Target speed lower 8 bits-
Rcs	56..63	1m/s	0..255	u8	Target cross section area

Note:

The value of each field in the table is not the true value of the target information, and the true value of the target information shall be calculated according to the following relationship:

Index = Index Value//Target ID, obtained from Track information

Range = (RangeHValue * 256 + RangeLValue) * 0.01//The original data output by the radar is in cm, and the converted target distance is in meter

Azimuth = (AzimuthH * 256 + AzimuthL) * 0.01-90//target azimuth

Vrel = (VrelH * 256 + VrelL) * 0.05-35//Target speed in m/s

RollCount = RollCountValue//count bit

Rcs = RcsValue * 0.5 – 50//The value is reserved in the factory test and will not be output. The current default value is 0

Through these calculations, the target cross section Rcs, the target Range, the target Azimuth, and the target velocity Vrel can be obtained, so that the target can be detected accurately.

8.5. Uart Point Target Mode Data Parsing Example

Take Message ID as the target output information (Target Info) as an example, there is a Target Info data message as follows:

Target Info Data:

0xAA 0xAA 0x0C 0x07 0x01 0x28 0x07 0xD0 0x46 0x02 0xD0 0x96 0x55 0x55

Description:

Start Sequence Message ID Data Payload End Sequence

Interpretation：

Start Sequence = 0xAAAA
Message ID = 0x0C + 0x07*0x100 = 0x70C
Data Payload = 0x01 0x28 0x07 0xD0 0x46 0x02 0xD0 0x96
End Sequence = 0x5555
Data Payload fields are parsed as follows:
Index = 1//Target ID
Range = (0x07 * 0 x100 + 0xD0) * 0.01 = 20//units, m
Azimuth = (0x28 * 0 x100 + 0 x46) * 0.01-90 = 13.1 degrees
Vrel = ((0x02 & 0x07) * 0x100 + 0xD0) * 0.05-35 = 1//unit, m/s
RollCount = (0x02 >> 6) = 0
Note:
The user needs to program and interpret the sensor output data (hexadecimal).
Data is hexadecimal before parsing and decimal after parsing. 0x2AF5 XVI
Base 10:10997 = 5 * 16 ^ 0 + F * 16 ^ 1 + A * 16 ^ 2 + 2 * 16 ^ 3