RFbeam Microwave GmbH

data sheet

MR3003_RD

radar transceiver
with integrated signal processing

Features

- 76–81 GHz radar transceiver with digital signal processing
- Powerful control panel
- Based on NXP's MR3003/S32R274 chipset
- 3 TX and 4 RX channels
- Integrated PLL-based fast chirp generator
- Switchable wide and narrow TX beams
- Ethernet interface
- Detection distance 35 m (human) 130 m (cars)
- Compact size: 76 × 44 × 38.5 mm

Applications

- Traffic analysis and classification
- Collision avoidance sensors
- Intersection management
- Blind spot detection
- Speed measurement
- Adaptive cruise control

Description

The MR3003_RD is a reference design based on NXP's MR3003 chipset. This design builds a high-end 2D radar transceiver with 4 receiving channels and a low phase noise, PLL controlled transmitter. The integrated chirp generator allows creating very fast frequency sweeps. The target information from the 4 receive antennas is digitized and the high speed digital signal processing performs range and doppler FFTs with an update rate of 20 measurements per second. The high frequency bandwidth allows good distance resolution. Target information is sent out using the integrated ethernet interface.

The radar is delivered with a .NET control panel software and also the radar firmware in C-code. With the graphical user interface all radar modes can be selected and targets are visualized in 2D Range-Doppler maps, a Range-Range, a Range-Speed or a Range-Angle display.

Blockdiagram

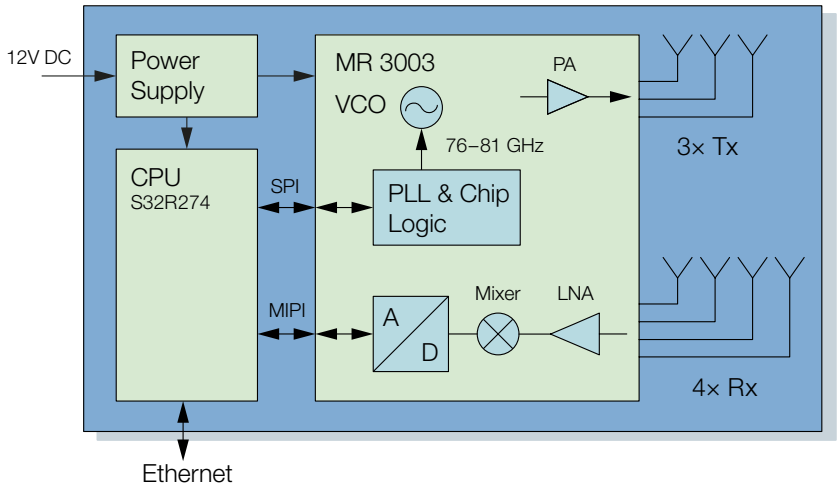


Figure 1: Blockdiagram

Characteristics

Parameter	Conditions/Notes	Symbol	Min	Typ	Max	Unit
Operating conditions						
Supply voltage		V_{cc}	10	12	14	V
Supply current		I_{cc}		280	500	mA
Connector type				Power Barrel 2.5 mm/5.5 mm		
Operating temperature		T_{op}	0		+60	°C
Storage temperature		T_{st}	-20		+85	°C
Transmitter						
Transmitter frequency		f_{TX}	76.000		81.000	GHz
Output power	EIRP	P_{TX}		+20		dBm
Output power deviation	f_{TX} = 76.000 .. 81.000 GHz	ΔP_{TX}		±2		dB
Maximum frequency error	V_{cc} = 12 V, 0 °C .. +60 °C	Δf_{Error}		50		ppm
Phase noise	@ 100 kHz	P_N			-73	dBc
Antenna						
TX1 antenna gain	f_{TX} = 76.500 GHz	G_{Ant}		15		dBi
Horizontal -3dB beamwidth	E-Plane	W_φ		30		°
Vertical -3dB beamwidth	H-Plane	W_θ		11		°
TX2,3 antenna gain	f_{TX} = 76.500 GHz	G_{Ant}		13		dBi
Horizontal -3dB beamwidth	E-Plane	W_φ		48		°
Vertical -3dB beamwidth	H-Plane	W_θ		11		°
RX 1,2,3,4 antenna gain	F_{RX} = 76.500 GHz	G_{Ant}		10		dBi
Horizontal -3dB beamwidth	E-Plane	W_φ		68		°
Vertical -3dB beamwidth	H-Plane	W_θ		11		°
Polarisation				Vertical		
Reciever						
Receiver sensitivity	f_s = 10MHz, 256/128Pt FFT, SNR = 10dB	P_{RX}		-124		dBm
Overall sensitivity	σ = 1 m², r = 35 m, S/N = 6dB	S		-144		dBc
Signal Processing						
Modulation				FMCW		
Range processing				256 point FFT		
Velocity processing				128 point FFT		
Update rate				50		ms
Output						
Ethernet output	RJ-45 connector		10		1000	MBit/s
Body						
Outline dimensions				76 × 44 × 38.5		mm
Weight				150		g

TABLE OF CONTENTS

ANTENNA DIAGRAM CHARACTERISTICS

These diagrams show the relative output power in both azimuth and elevation directions.

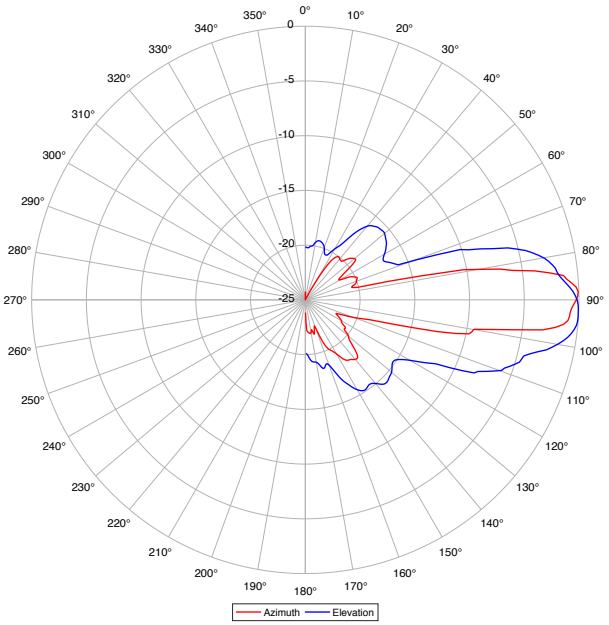


Figure 2: TX1 relative antenna pattern

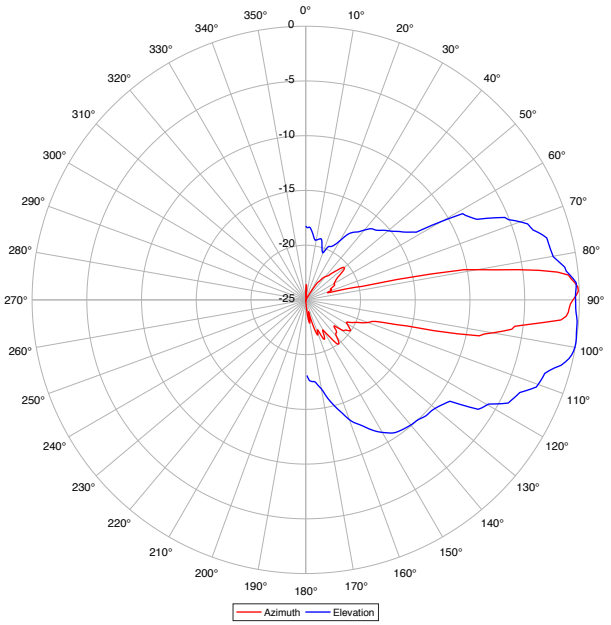


Figure 3: TX2 relative antenna pattern

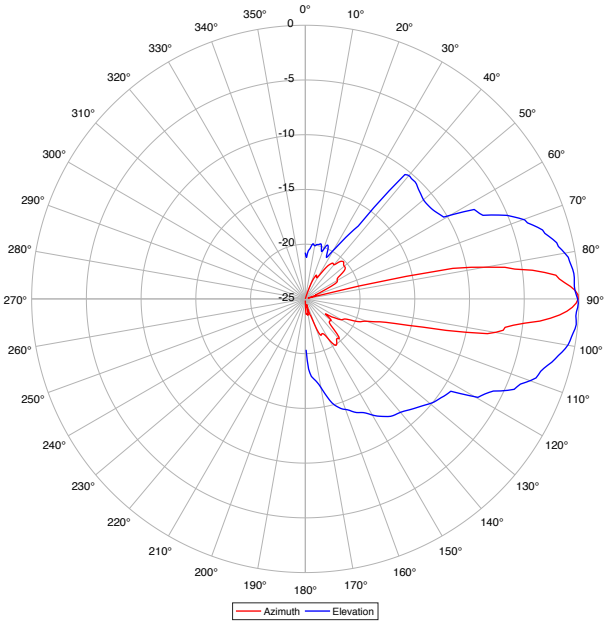


Figure 4: TX3 relative antenna pattern

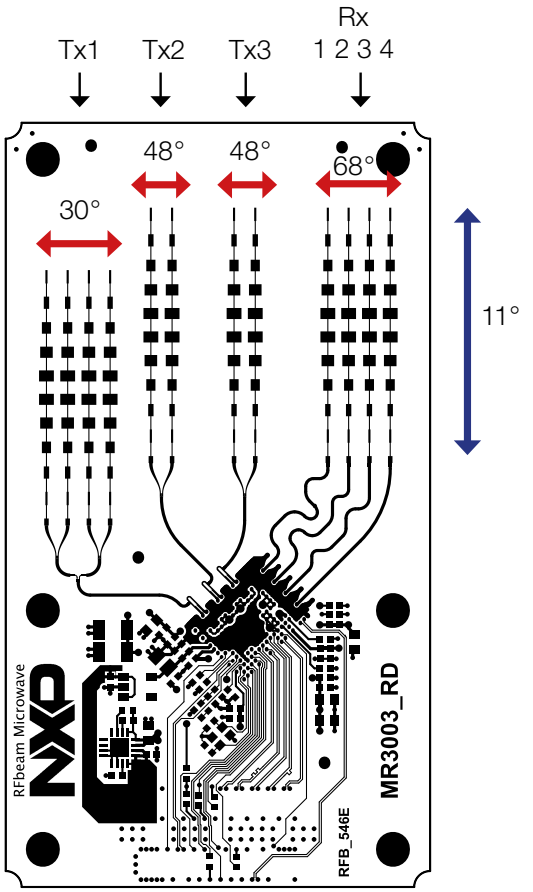


Figure 5: Beamwidth and antenna order

PIN CONFIGURATION AND FUNCTIONS

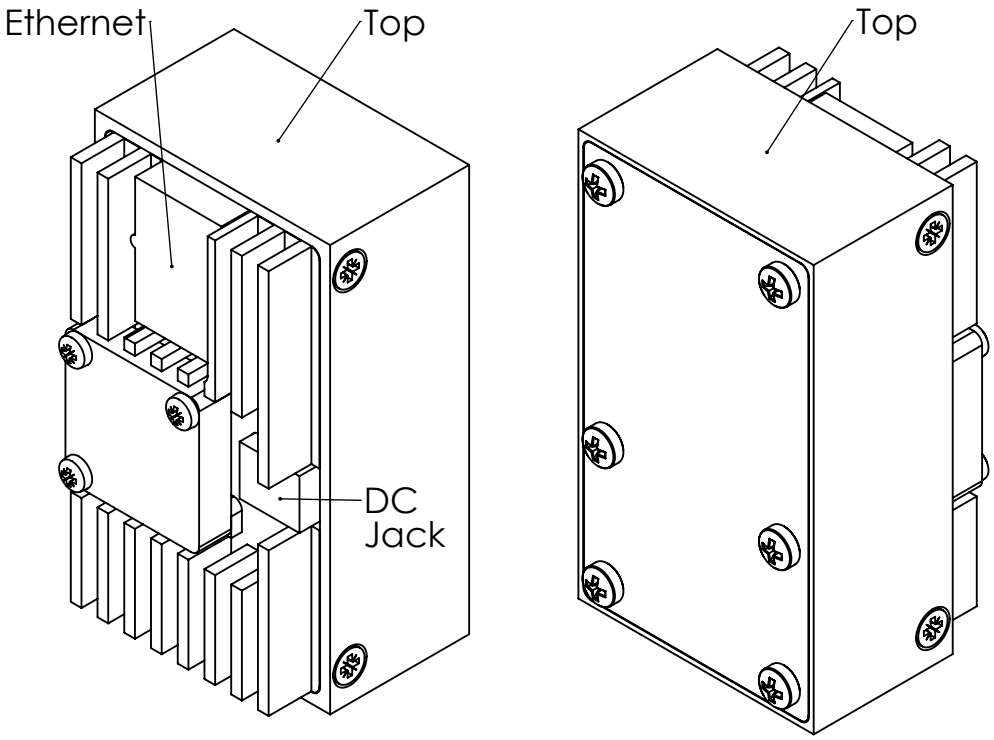


Figure 6: Pin Configuration

Figure 7: DC Jack polarity

THEORY OF OPERATION

The MR3003_RD is configured to perform **F**requency **M**odulated **C**ontinuous **W**ave (FMCW). With this modulation the radar receives information about static and moving objects.

The MR3003 chip is configured to perform 128 chirps per frame. For every chirp 256 ADC values will be sampled. All data for each frame is processed into one range-doppler for each RX antenna. The speed and the distance resolution changes depending on the chirp configuration.

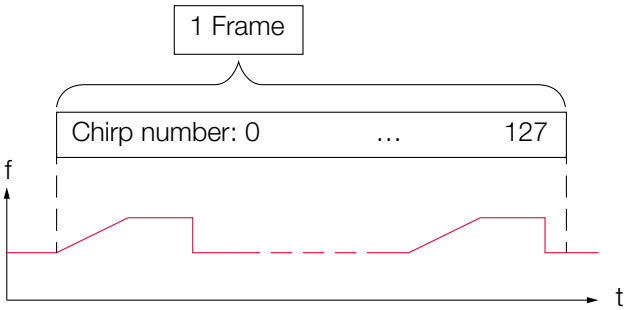
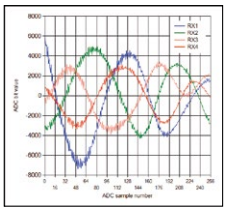
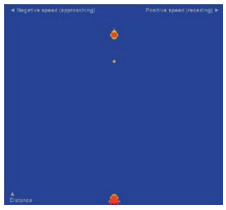


Figure 9: One frame



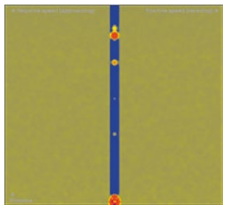
Raw ADC Data (RADC)

- Samples ADC data from all 4 RX antennas directly in MR3003 (1 Frame = 256 Samples x 128 Chirps)
- Sends data to CPU S32R274 over digital MIPI interface



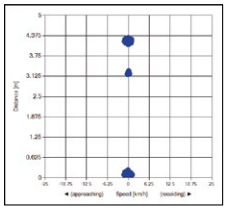
Raw Range-Doppler (RDDA)

- Calculates the raw range-doppler map for each RX antenna



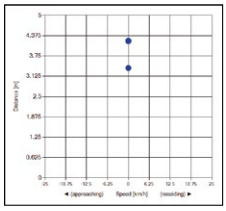
Adjusted Range-Doppler (RARD)

- Averages the raw range-doppler map of all four RX antennas
- Normalises and adjusts the averaged range-doppler map
- Calculates automatically a threshold to detect targets



Raw Target (PDAT)

- Finds targets over threshold
- Decides which target is reported in neighbourhood
- Filters targets (e.g. Clutter)



Tracking (TDAT)

- Clusters raw target clouds to objects
- Assigns objects to tracking channels
- Predicts momentary lost objects

Figure 8: Signal processing workflow

APPLICATION INFORMATION

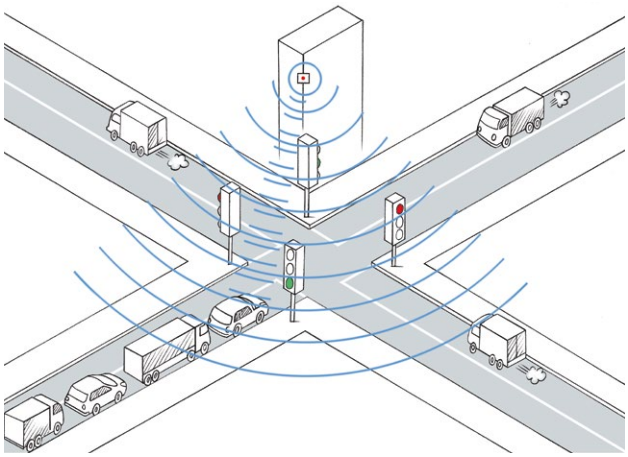
The intended use of the MR3003_RD is evaluation and research. Therefore it is delivered with a powerful GUI.

> Depending on the country the 76–81 GHz band is limited to some specific applications.

Radar type (RTYP)

The parameter «Radar type» may be set to «Static» or «Moving» depending on the application.

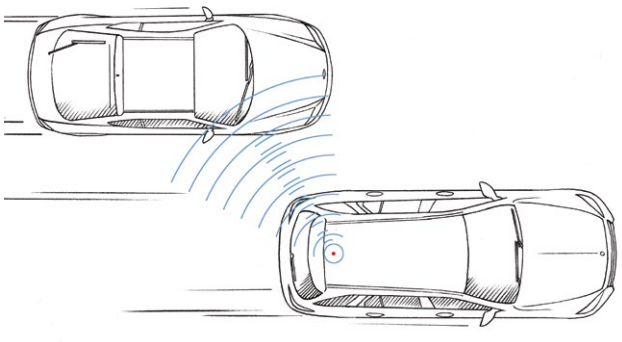
Static



The «Radar type» «Static» is intended for traffic observation. Static objects may be filtered in this mode, which will lead to target lists only containing moving objects, like cars, bicycles and humans.

Possible use in:
- Traffic management systems
- Adaptive street light control
- Vehicle classification
- Speed control
- etc.

Moving



The «Radar type» «Moving» was developed to reduce the number of clutter targets. Due to limited resources in processing, not all detected targets may be tracked. Therefore a parameterizable clutter filter is included, limiting the clutter to a minimum. This ensures the ability to track the targets of interest.

Based on the MR3003_RD multiple uses on board may be developed:
- Blind spot detection
- Automatic cruise control
- Break assists
- Collision avoidance for heavy machines
- etc.

Speed and Range Settings

It's possible to configure the MR3003 radar to a set of different speed and range settings (command RSSR). Depending on the chosen setting the MR3003 chip generates the chirp ramp with the corresponding bandwidth and time.

Range parameter:

Max. range [m]	Resolution [m]	Sampling bandwidth [MHz]	Middle frequency [MHz]
5	0.0390625	3840	79000
10	0.078125	1920	80000
20	0.15625	960	76500
50	0.390625	384	76500
100	0.78125	192	76500
200	1.5625	96	76500

Speed parameter:

Max. speed [km/h]	Resolution [km/h]	Chirp time [us]	Frame time [s]
25.04955428	0.391399286	139.975	0.0179168
50.07227934	0.782379365	70.025	0.0089632
100.037414	1.563084594	35.05	0.0044864
185.0296232	2.891087863	18.95	0.0024256

Target Detection

With a set of parameters the number of raw targets can be influenced. It can be decided how a peak over threshold is reported. Usually an object results not only as one peak in the range-doppler map but rather as some peaks side by side. With the following parameters a neighbourhood around a peak can be defined in which only the strongest peak is reported as a raw target.

Range neighbour delta (PRND)

The bigger, the less range peaks are seen as raw target. This makes the object in the raw target view appear shorter, as the following comparison shows.

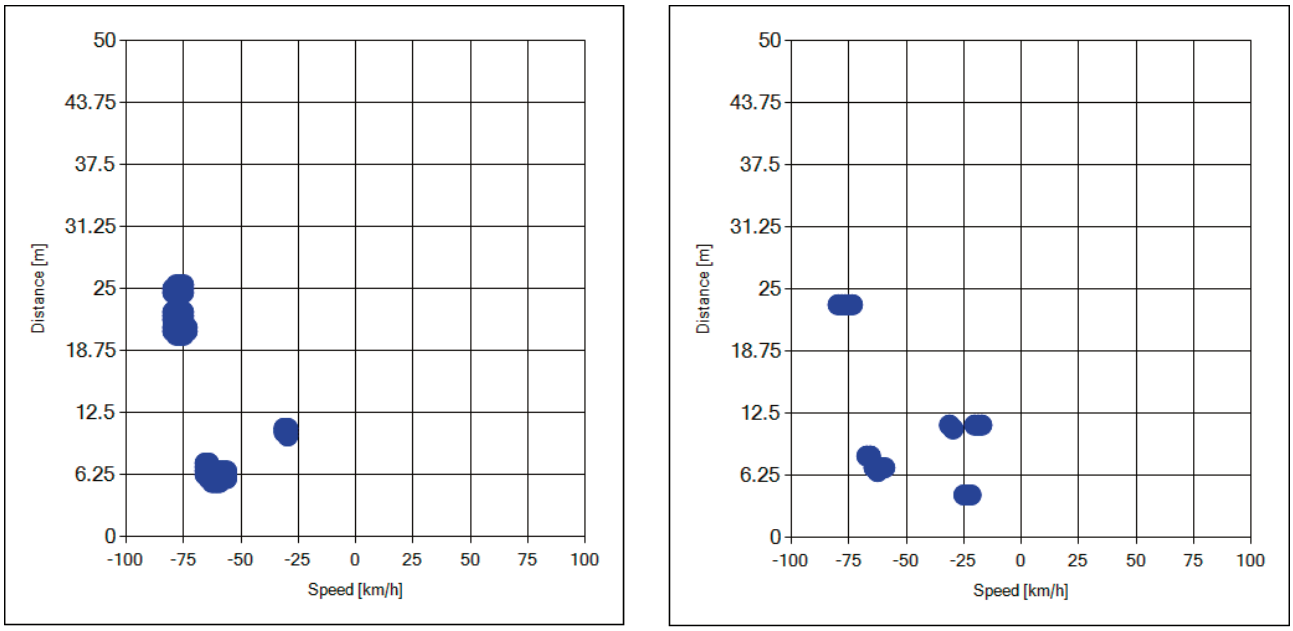


Figure 10: Range neighbour delta = 0 on the left and delta = 5 on the right

Speed neighbour delta (PSND)

The bigger, the less speed peaks are seen as raw target. This makes the object in the raw target view appear slimmer, as the following comparison shows.

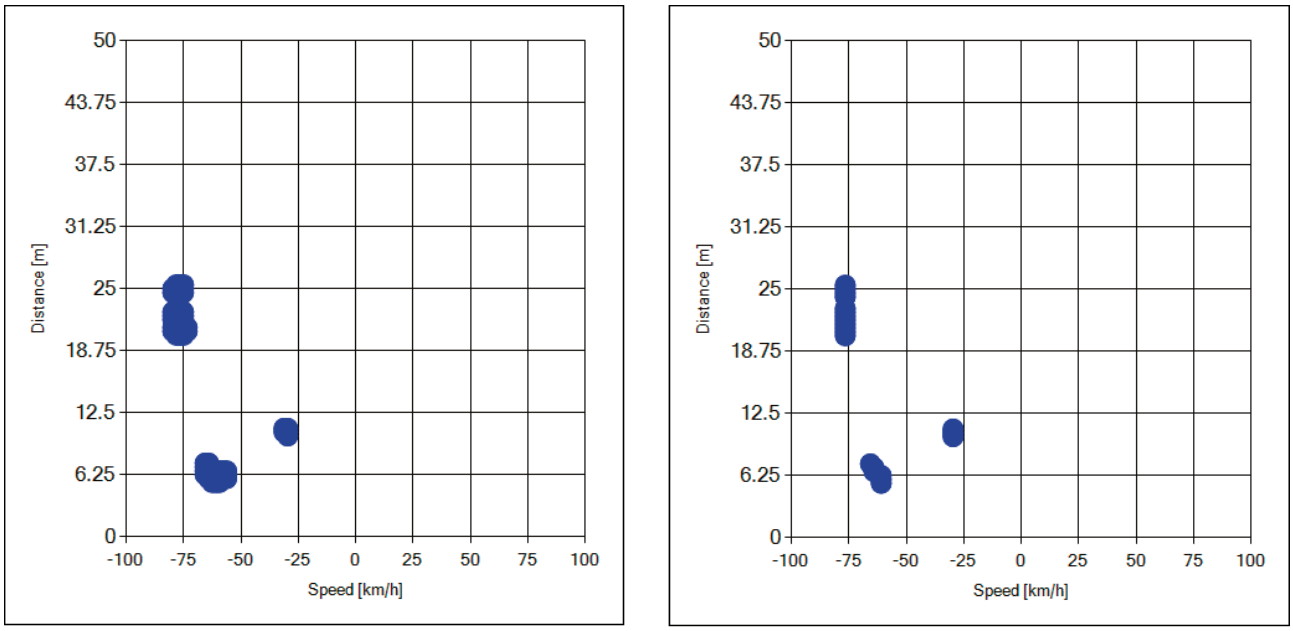


Figure 11: Speed neighbour delta = 0 on the left and delta = 5 on the right

Clutter Filter

When the radar is on a moving vehicle (RTYP = 0x01) all non-moving objects are seen as objects with the same speed as the radar itself. These objects are called «clutter» and want to be filtered in most applications.

Collision Time (PCOT)

Suppress targets too close to react. This also suppresses the clutter of static objects, which characteristically is going towards the point 0,0 of the range-doppler.

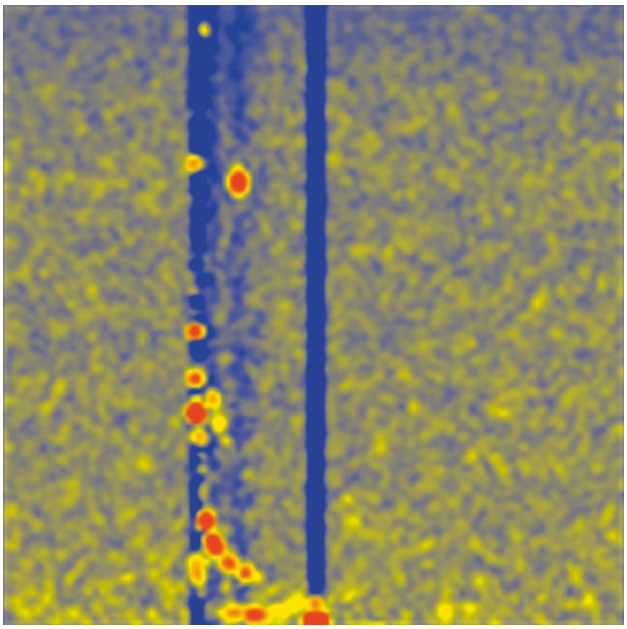


Figure 12: Filter effect of collision time

Clutter Band Factor (CLBF)

The radar estimates his driving speed on the basis of detected clutter. The clutter factor filters targets around the own speed of the radar.

The clutter band speed will be calculated as:

$C_{BS} = O_S \pm C_{BF} \cdot S_R$

C_{BS} → *clutter band speed;* O_S → *own speed;* C_{BF} → *clutter band factor;* S_R → *speed resolution*

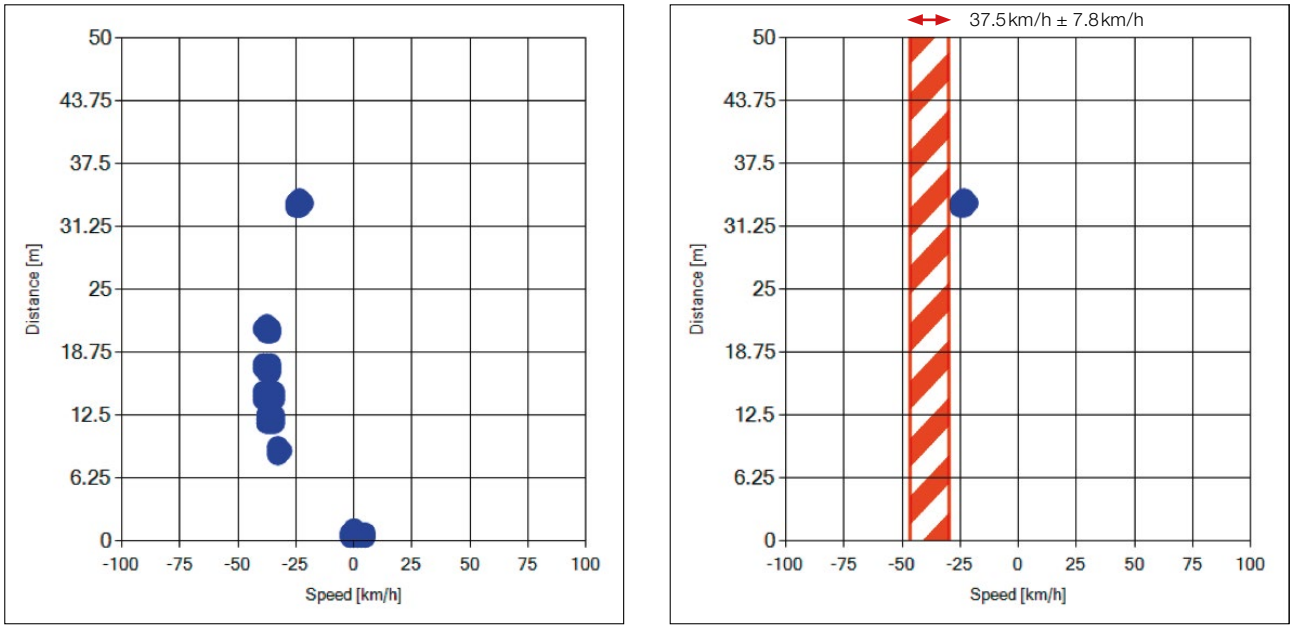


Figure 13: Clutter band factor = 0 on the left and Clutter band factor = 5 on the right

Angle Calibration (ACAL)

Due to hardware variances of the MR3003 and the antenna board it is necessary to calibrate the angle. For that purpose a strong target (e.g. a corner reflector) is placed in front of the radar with an angle of zero degree. With this procedure the angle offsets between the four RX antennas will be saved and subtracted henceforward. The devices are shipped with a factory calibrated angle.

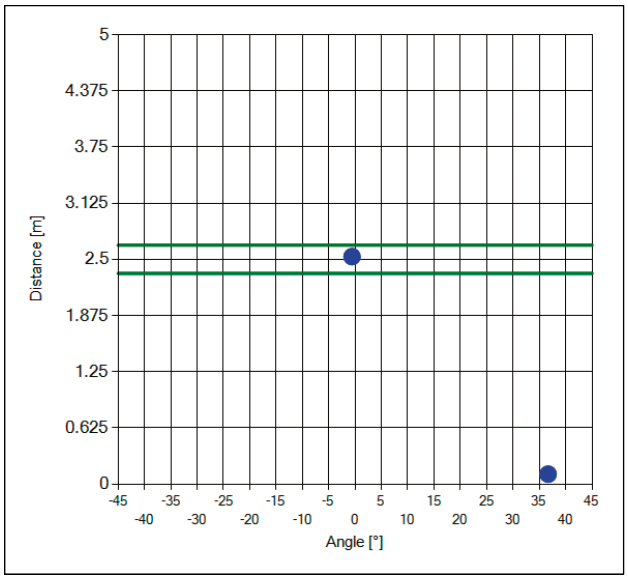


Figure 14: Angle calibration

Interpretation Example

The direct output of the radar processing is the adjusted range-doppler. It is the result of multiple FFT over all ranges and all speeds.

To begin with it needs some time to interpret range-doppler maps correctly. The following example explains a road situation.

In Fig. 15, the range-doppler map on the left side shows the speed and the distance of the objects. Zero speed is placed in the middle of the x-axis. The distance is increasing on the y-axis. Negative speeds (approaching objects) are shown to the left of zero speed and positive speeds (receding objects) are shown to the right of zero speed.

All non-moving objects are visible as clutter. In some applications (e.g. automated cruise control) the clutter do not hold any useful information and must be filtered. The objects of interest are the remaining targets.

In this case there are three cars. The position in the mean range-doppler map and the one in the corresponding video image are connected with the arrows.

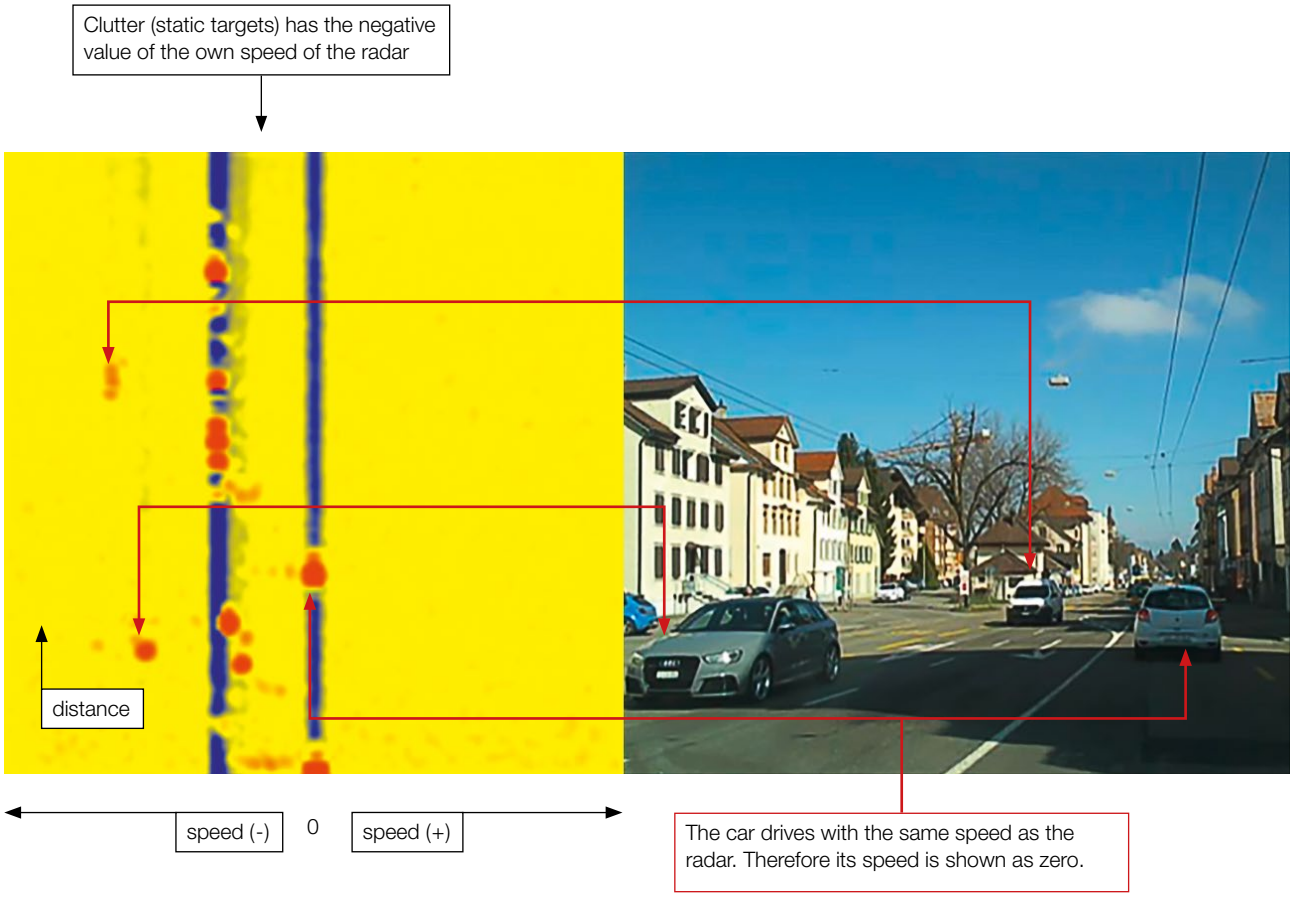


Figure 15: Interpretation example of a road situation

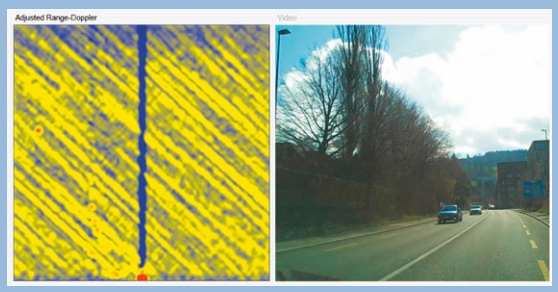
Known Issues

Issue: Control Panel freezes during driving tests

Caused by	Light sensitivity of MR3003 Version 1.x
Leads to	Frozen Control Panel
Notes	Use a black tape to cover the MR3003 Chip. Do not tape over the antenna section of the MR3003_RD.

Issue: Disturbance of other FMCW radar

Caused by	Other cars with FMCW
Leads to	Interferences, which can make frames unusable
Notes	The tracking filter does handle this issue well. If the number of cars with 77GHz radar at the back increases, this will be a problem.



Issue: Clutter filter filters targets instead of clutter

Caused by	The own speed of the radar is estimated with the help of the clutter. Depending on the environment the real clutter can be nearly 0 and a column of cars which drives the same speed, looks the same as real clutter would.
Leads to	Filtering out real targets
Notes	The clutter filter is developed to minimize the number of uninteresting targets. In systems with the speed information of the car itself, such situations would not occur.

Issue: Tracking filter cannot track folded targets

Caused by	When the max. speed is less than the double of the own speed, or vehicles on other lanes are much faster, folding of targets from the left to the right or vice versa is possible
Leads to	If there is only one target, the tracking filter can easily filter it out. If there are multiple such targets, the tracking filter will try to track them and a trace of points will appear
Notes	To filter them out, increase the min. life time

Table 1: Known issues

Application Layer

Client-Server

The communication is based on a client-server model. There are two types of packets transmitted. Commands are sent from client to server and messages are sent from server to client.

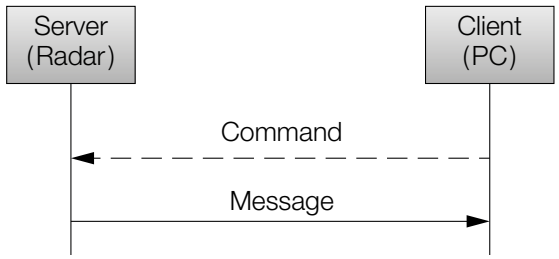


Figure 16: Client-Server model

Handshaking

To start and end a communication in the application there is a client/server handshake. The timeline to the left shows this behaviour

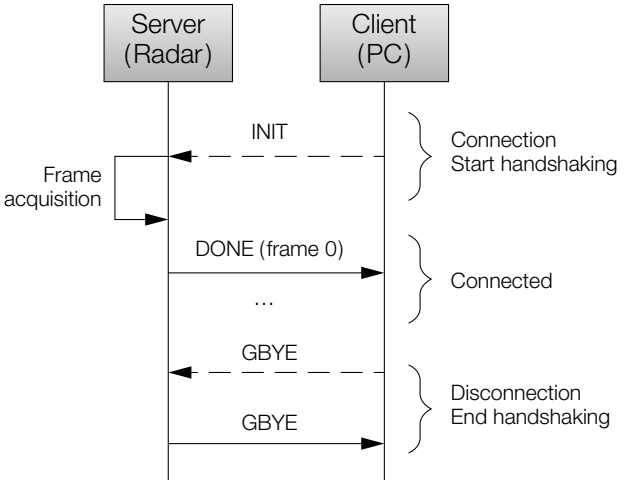


Figure 17: Application handshaking

Presentation Layer

All commands and messages sent have the format described in table 2.

Description	Datatype	Length
Header The header describes the command or message type (e.g. RADC, RSRG, …)	ASCII character	4
Payload Length The payload length is always sent even if the payload is zero. It is sent as big endian (MSB first).	UINT32	4
Payload The payload is message and command dependent. If the payload includes datatypes (e.g. UINT16, INT32, …) then they are sent as big endian (MSB first).	Binary data	0–1438

Table 2: Packet format

Overview Messages and Commands

The server acquires frames in a fixed cycle of 50 ms. After every frame cycle it outputs all enabled messages. The messages DONE, PDAT and TDAT are enabled by default.

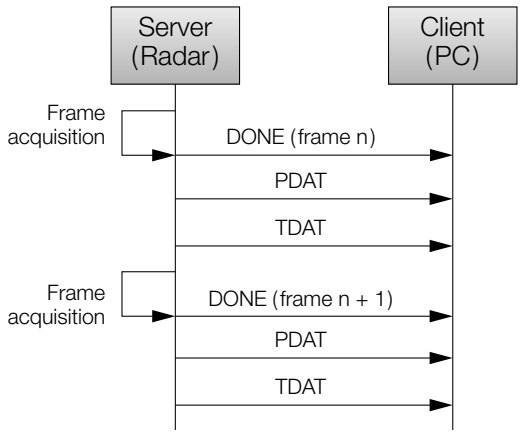


Figure 18: Cyclic message output

Header	Payload Length	Description
DONE	4	Frame done
RADC	262144	ADC values of one frame with 256 samples per chirp and 128 chirps per frame.
RDDA	131072	Raw range-doppler magnitude map
RARD	32770	Adjusted range-doppler magnitude map
PDAT	0–1280	The array of detected raw targets
TDAT	0–320	The array of tracked targets
RPRM	53	Status structure of radar
GBYE	0	End of handshaking

Table 3: Application messages

The table 3 shows the possible messages, see the chapter Messages for details

The table Application commands shows the possible application commands, see the chapter Commands for details.

Header	Payload Length	Description	Default values
INIT	0	Start handshaking (reset frame number)	–
RSRG	4	Radar receiver gain [dB]	26 dB
RSSR	4	Speed and range setting	5 m/25 km/h
DSF0	4	Disable messages with given header	–
DSF1	4	Enable messages with given header	–
TXAN	4	Transmit antenna	TX3
RMOD	4	Modulation mode	FMCW
RCWF	4	CW Frequency [MHz]	76500 MHz
TXPW	4	Transmit power	+15 dBm
PRND	4	Range neighbour delta [Bin]	1
PSND	4	Speed neighbour delta [Bin]	1
RTYP	4	Radar type	Static
PCOT	4	Collision time [s]	4s
PMOS	4	Minimum own speed [km/h]	10 km/h
PMRD	4	Minimum range [bin]	4
CLBF	4	Clutter band factor	3.5
STOB	4	Static objects	On
TVLT	4	Tracking minimum life time	10
TDLT	4	Tracking maximum life time	15
ACAL	4	Start angle calibration	–
GBYE	0	End handshaking	–

Table 4: Application commands

Messages

This chapter provides detailed information about the messages of the MR3003_RD.

<table>
<tr><th>Header</th><th>Payload Length</th><th>Description</th><th>Payload</th></tr>
<tr><td>DONE</td><td>4</td><td>Frame done</td><td>
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>Actual frame number</td><td>UINT32</td><td>4</td></tr>
</table>
</td></tr>
<tr><td>RADC</td><td>262144</td><td>ADC values of one frame with 256 samples per chirp and 128 chirps per frame.</td><td>
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>RX1:
Chirp 0: Samples 0–255
… to
Chirp 127: Samples 0–255</td><td>INT16</td><td>65536</td></tr>
<tr><td>RX2:
Chirp 0: Samples 0–255
… to
Chirp 127: Samples 0–255</td><td>INT16</td><td>65536</td></tr>
<tr><td>RX3:
Chirp 0: Samples 0–255
… to
Chirp 127: Samples 0–255</td><td>INT16</td><td>65536</td></tr>
<tr><td>RX4:
Chirp 0: Samples 0–255
… to
Chirp 127: Samples 0–255</td><td>INT16</td><td>65536</td></tr>
</table>
</td></tr>
<tr><td>RDDA</td><td>131072</td><td>Raw range-doppler magnitude map</td><td>
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>RX1:
Chirp 0: Samples 0–127
… to
Chirp 127: Samples 0–127</td><td>UNT16</td><td>32768</td></tr>
<tr><td>RX2:
Chirp 0: Samples 0–127
… to
Chirp 127: Samples 0–127</td><td>UNT16</td><td>32768</td></tr>
<tr><td>RX3:
Chirp 0: Samples 0–127
… to
Chirp 127: Samples 0–127</td><td>UNT16</td><td>32768</td></tr>
<tr><td>RX4:
Chirp 0: Samples 0–127
… to
Chirp 127: Samples 0–127</td><td>UNT16</td><td>32768</td></tr>
</table>
</td></tr>
<tr><td>RARD</td><td>32770</td><td>Adjusted range-doppler magnitude map</td><td>
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>Automatically calculated threshold for this frame</td><td>UINT16</td><td>2</td></tr>
<tr><td>Range 0: Speed 0–127
… to
Range 127: Speed 0–127</td><td>UINT16</td><td>32768</td></tr>
</table>
</td></tr>
<tr><td>PDAT</td><td>0-1280</td><td>The array of detected raw targets</td><td>Maximum of 128 raw targets possible. One raw target structure consists of:
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>Range [cm]</td><td>UINT16</td><td>2</td></tr>
<tr><td>Speed [km/h × 100]</td><td>INT16</td><td>2</td></tr>
<tr><td>Azimuth angle [Radian × 100]</td><td>INT16</td><td>2</td></tr>
<tr><td>Elevation angle [Radian × 100] (not used, zero)</td><td>INT16</td><td>2</td></tr>
<tr><td>Magnitude of peak</td><td>UINT16</td><td>2</td></tr>
</table>
</td></tr>
<tr><td>TDAT</td><td>0-320</td><td>The array of tracked targets</td><td>Maximum of 32 tracked targets possible. One tracked target structure consists of:
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>Range [cm]</td><td>UINT16</td><td>2</td></tr>
<tr><td>Speed [km/h × 100]</td><td>INT16</td><td>2</td></tr>
<tr><td>Azimuth angle [Radian × 100]</td><td>INT16</td><td>2</td></tr>
<tr><td>Elevation angle [Radian × 100] (not used, zero)</td><td>INT16</td><td>2</td></tr>
<tr><td>Magnitude of peak</td><td>UINT16</td><td>2</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Header</th><th>Payload Length</th><th>Description</th><th>Payload</th></tr>
<tr><td>RPRM</td><td>53</td><td>Status structure of radar</td><td>The status structure consists the following data:
<table>
<tr><th>Description:</th><th>Datatype</th><th>Length</th></tr>
<tr><td>Firmware version string
(e.g. MR3003_APP-NXP-0106)</td><td>ASCII-String</td><td>20</td></tr>
<tr><td>MR3003 chip revision
0x00 = Unknown 0x01 = ES1.0 0x06 = ES1.1
0x0C = ES1.2 0x0D = ES1.2b 0x15 = ES2.0
0x1E = ES2.0+RF 0x29 = ES3.1</td><td>UINT16</td><td>2</td></tr>
<tr><td>Messages active
0x01 = RADC 0x02 = RDDA 0x04 = RARD
0x08 = PDAT 0x10 = DONE 0x20 = TDAT
0x40 = RPRM 0x29 = ES3.1
Can be «OR» bit coded</td><td>4</td><td>2</td></tr>
<tr><td>Actual frame number</td><td>UINT32</td><td>4</td></tr>
<tr><td>Modulation mode
0x00 = FMCW 0x01 = CW</td><td>UINT8</td><td>1</td></tr>
<tr><td>Speed and range settings
0x00 = 5m/25km/h 0x01 = 10m/25km/h
0x02 = 20m/25km/h 0x03 = 50m/25km/h
0x04 = 100m/25km/h 0x05 = 200m/25km/h
0x06 = 10m/50km/h 0x07 = 20m/50km/h
0x08 = 50m/50km/h 0x09 = 100m/50km/h
0x0A = 200m/50km/h 0x0B = 50m/100km/h
0x0C = 100m/100km/h 0x0D = 200m/100km/h
0x0E = 200m/185km/h (not for ES1.x chip revision)</td><td>UINT16</td><td>2</td></tr>
<tr><td>CW frequency [MHz]
76000–81000</td><td>UINT32</td><td>4</td></tr>
<tr><td>RX VGA [dB]
2, 8, 14, 20, 26, 32, 38, 44</td><td>UINT8</td><td>1</td></tr>
<tr><td>TX antenna
0x00 = TX1 0x01 = TX2 0x02 = TX3</td><td>UINT8</td><td>1</td></tr>
<tr><td>TX power
0x00 = -45dBm 0x01 = -25dBm 0x02 = -15dBm
0x04 = -10dBm 0x07 = -5dBm 0x0B = 0dBm
0x14 = +5dBm 0x25 = +10dBm 0x3F = +15dBm</td><td>UINT8</td><td>1</td></tr>
<tr><td>Range neighbour delta [Bin]
0–63</td><td>UINT8</td><td>1</td></tr>
<tr><td>Speed neighbour delta [Bin]
0–63</td><td>UINT8</td><td>1</td></tr>
<tr><td>Minimum range [bin]
0–63</td><td>UINT8</td><td>1</td></tr>
<tr><td>Radar type
0x00 = Static 0x01 = Moving</td><td>UINT8</td><td>1</td></tr>
<tr><td>Static objects
0x00 = Off 0x01 = On</td><td>UINT8</td><td>1</td></tr>
<tr><td>Minimum own speed [km/h x 100]</td><td>INT16</td><td>2</td></tr>
<tr><td>Collision time [s]
0.00–100.00, factorized with 100</td><td>UINT16</td><td>2</td></tr>
<tr><td>Clutter band factor
0.00–100.00, factorized with 100</td><td>UINT16</td><td>2</td></tr>
<tr><td>Tracking minimum life time [frame]</td><td>UINT8</td><td>2</td></tr>
<tr><td>Tracking maximum life time [frame]</td><td>UINT8</td><td>2</td></tr>
</table></td></tr>
<tr><td>GBYE</td><td>0</td><td>End of handshaking</td><td>–</td></tr>
</table>

Table 5: Application messages

Commands

The commands are sent to the radar to set configurations. The payload length may be zero or four bytes. This chapter provides detailed information about the commands of the MR3003_RD.

Header	Description	Datatype	Length
INIT	Start handshaking (reset frame number)	–	0
RSRG	RX VGA [dB] 2, 8, 14, 20, 26, 32, 38, 44	UINT8	4
RSSR	Speed and range settings 0x00 = 5m/25km/h 0x01 = 10m/25km/h 0x02 = 20m/25km/h 0x03 = 50m/25km/h 0x04 = 100m/25km/h 0x05 = 200m/25km/h 0x06 = 10m/50km/h 0x07 = 20m/50km/h 0x08 = 50m/50km/h 0x09 = 100m/50km/h 0x0A = 200m/50km/h 0x0B = 50m/100km/h 0x0C = 100m/100km/h 0x0D = 200m/100km/h 0x0E = 200m/185km/h (not for ES1.x chip revision)	UINT16	4
DSF0	Disable messages with given header (e.g. RADC, PDAT,…)	ASCII character	4
DSF1	Enable messages with given header (e.g. RADC, PDAT,…)	ASCII character	4
TXAN	TX antenna 0x00 = TX1 0x01 = TX2 0x02 = TX3 See chapter «Antenna Diagram Characteristics» for the antenna order.	UINT8	4
RMOD	Modulation mode 0x00 = FMCW 0x01 = CW CW mode is only for frequency tests. Due to MR3003 internal filters, there will be no doppler signal visible in the ADC values!	UINT8	4
RCWF	CW frequency [MHz] 76000–81000	UINT32	4
TXPW	TX power 0x00 = -45dBm 0x01 = -25dBm 0x02 = -15dBm 0x04 = -10dBm 0x07 = -5dBm 0x0B = 0dBm 0x14 = +5dBm 0x25 = +10dBm 0x3F = +15dBm	UINT8	4
PRND	Range neighbour delta [Bin] 0–63 See chapter «Range Neighbour Delta» for more information.	UINT8	4
PSND	Speed neighbour delta [Bin] 0–63 See chapter «Speed Neighbour Delta» for more information.	UINT8	4
RTYP	Radar type 0x00 = Static 0x01 = Moving See chapter «Radar type» for more information.	UINT8	4
PCOT	Collision time [s] 0.00–100.00, multiplied with 100 See chapter «Collision Time» for more information.	UINT16	4
PMOS	Minimum own speed [km/h × 100]	INT16	4
PMRD	Minimum range [bin] 0–63	UINT8	4
CLBF	Clutter band factor 0.00–100.00, multiplied with 100 See chapter «Clutter Band Factor» for more information.	UINT16	4
STOB	Static objects 0x00 = Off 0x01 = On	UINT8	4
TVLT	Tracking minimum life time [frame]	UINT8	4
TDLT	Tracking maximum life time [frame]	UINT8	4
ACAL	Start angle calibration. The target at zero degree must be between the range of the following two parameter: Maximum range [Bin] of calibration Minimum range [Bin] of calibration See chapter «Angle Calibration» more information.	UINT16 UINT16	4
GBYE	End handshaking	–	0

Table 6: Application commands

TCP

The NXP MR3003 uses the standard TCP/IP communication protocol to transceive data between the control panel and the radar.

IP address of server (radar):	192.168.100.5
Socket number:	6172
MSS (maximum segment size):	1446 Bytes

The TCP protocol allows a maximum of 1446 data bytes per frame. If a message or a command includes more than 1446 bytes the packet will be segmented into several frames. Every frame must be acknowledged by the receiver. Therefore, depending on the count of payload and the speed of the client, it is possible that the frame rate will be increased by the server to ensure all data is received by the client.

Boot Loader

With the boot loader programmed, it is possible to update the application firmware over Ethernet. After power on, the boot loader starts up. If it receives an INIT command within three seconds it stays in the boot loader code and is ready for firmware update. If no INIT command is received within three seconds it jumps to application code. In TCP mode a connection is only possible after the link LED of the ethernet connector lights up.

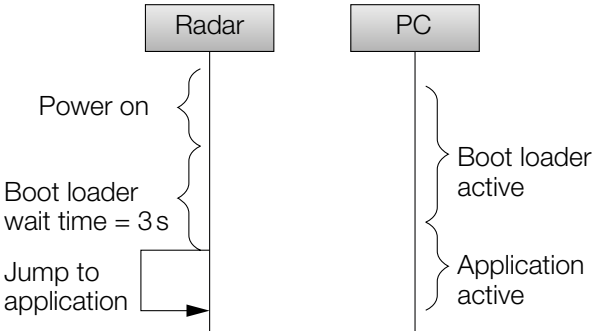


Figure 19: Normal start-up with boot loader and application

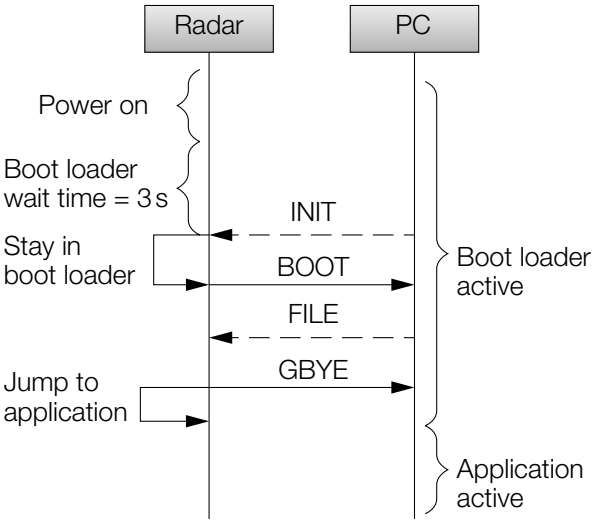


Figure 20: Successful firmware update

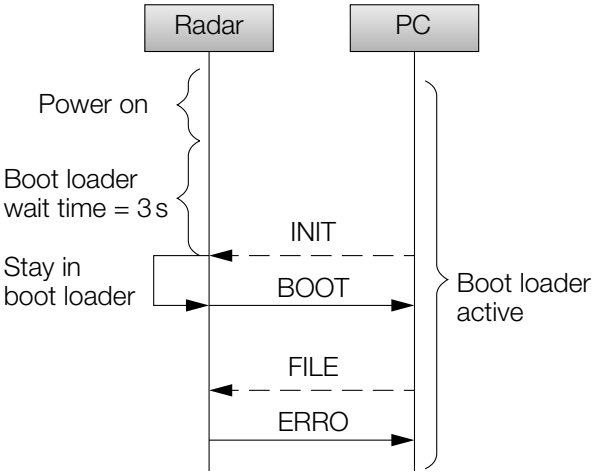


Figure 21: Unsuccessful firmware update

Commands

Header	Length	Description	Payload
INIT	0	Start handshaking. Stay in boot loader.	–
FILE	Max. 600KB	Firmware file in “Intel Hex” format. It can include the boot loader as well but the boot loader won’t be updated.	Complete hex file e.g. MR3003_FWR-NXP-0102

Table 7: Boot loader commands

Messages

Header	Length	Description	Payload
BOOT	21	Boot loader start message	20 Byte: Boot loader version string (e.g. MR3003_BTL-NXP-0102)
ERRO	4	Error message	0x00 = No error 0x01 = Hex file check sum error 0x02 = Hex file record error 0x03 = No memory for hex file
GBYE	0	File successfully received. End of handshaking.	–

Table 8: Boot loader messages

OUTLINE DIMENSIONS

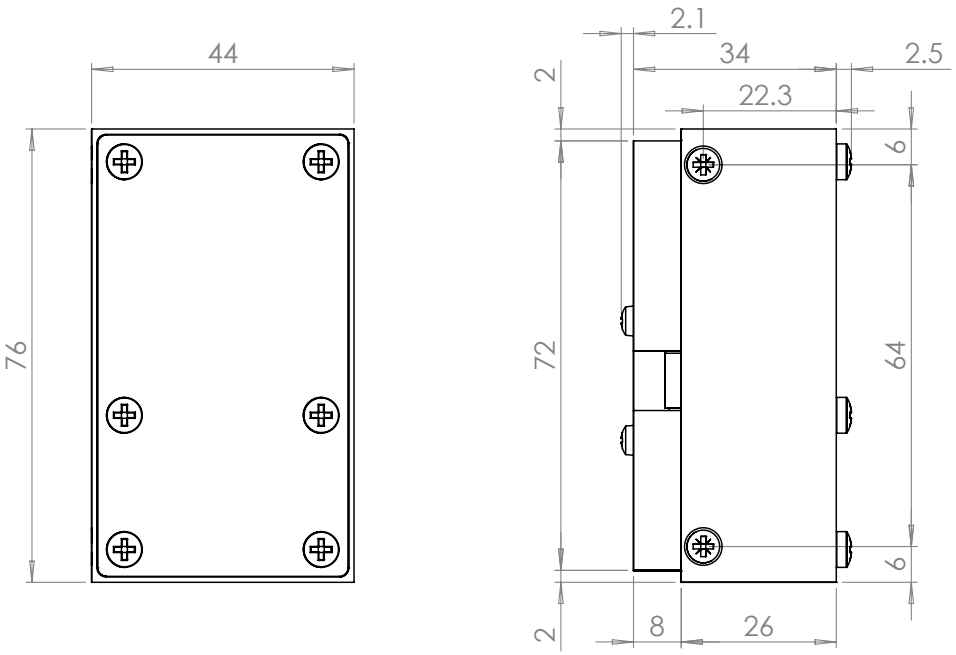


Figure 23: Outline dimensions in milimeter

ORDER INFORMATION

The ordering number consists of different parts with the structure below.

Product	–	Customer	–	HW variant	Supply	–	SW variant
= MR3003_RD		**= NXP** for standard products		**= 01** for standard variant	**= F** for 12 V version		**= 01** for standard variant

Figure 22: Ordering number structure

Ordering number	Description
MR3003_RD-NXP-01F-01	Standard MR3003_RD evaluation kit

Table 9: Available ordering numbers

DELIVERY CONTENT

- MR3003_RD
- Power supply
- Ethernet cable
- Memory stick containing:
  - Installer for «MR3003 Control Panel»
  - Source code of MR3003_RD
    as NXP S32 Studio project
  - Source code of control panel available
    as Microsoft Visual Studio 2017 project.

VERSIONING

There are different version descriptions for software and firmware:

MR3003_APP-NXP-01xx.hex	→ Application firmware
MR3003_BTL-NXP-01xx.hex	→ Bootloader firmware
MR3003_FWR-NXP-01xx.hex	→ Application and bootloader firmware combined
MR3003_CTP-NXP-01xx.exe	→ PC control panel software

REVISION HISTORY

03/2018 – Revision A: Initial Version