a module solution provider

MM5D91-00

60GHz mmWave Radar

Presence Detection Sensor Module

Command Manual

Revision 1.0

http://www.jorjin.com.tw

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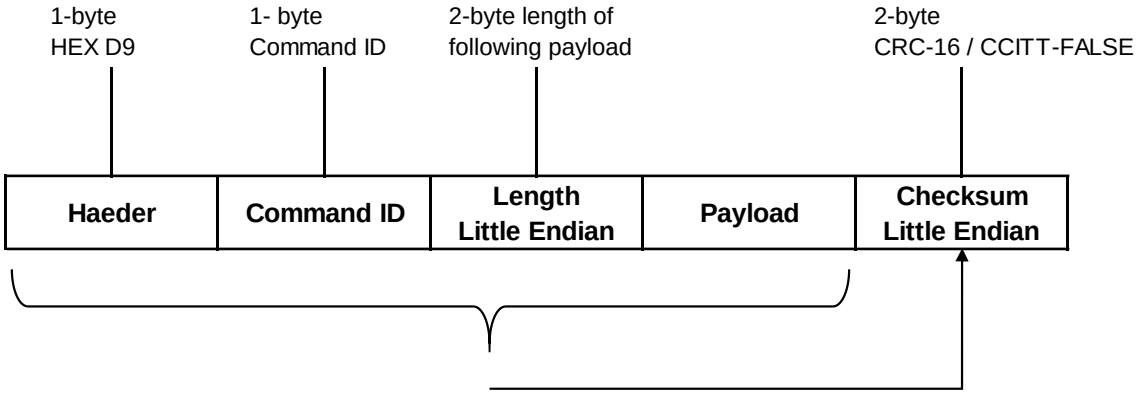
1. COMMAND STRUCTURE

The structure of a binary command is shown in following diagram.
Header is a fixed byte 0xD9.



Checksum: CRC16 of Header + Command ID + Length + Payload, in CRC-16/CCITT-FALSE format.
Example of C code implementation of the checksum is shown below.

The function will return a 16-bit checksum (in little endian) for the input array.

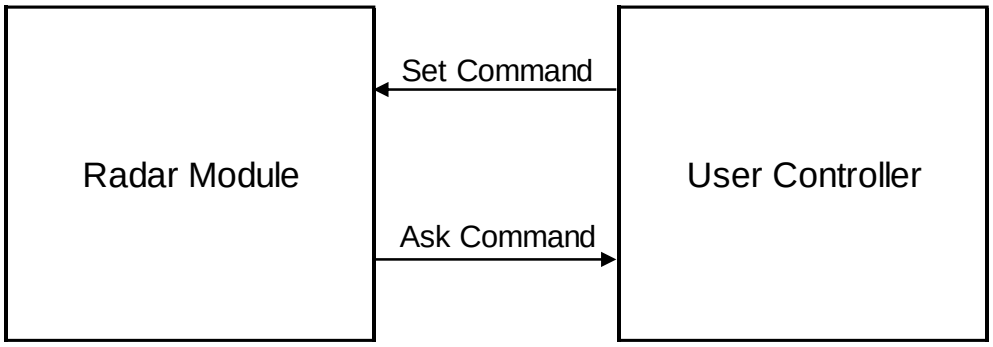
```
uint16_t crc16(uint8_t *src_data, uint32_t src_data_len)
{
uint16_t crc = 0xFFFF;
for (int i = 0; i < src_data_len; i++)
{
crc = ((uint8_t)(crc >> 8) | (crc << 8)) ^ src_data[i];
crc ^= (uint8_t)(crc & 0xFF) >> 4;
crc ^= (crc << 12);
crc ^= ((crc & 0xFF) << 5);
}
return (crc);
}
```

2. PROTOCOL MESSAGE FLOW

Command messages are being sent back and forth according to the following conditions.

Set command

1. User send a Set Command to radar module
2. Module reply a ACK Command to imply set success or fail



Example: set maximum detection range to 1.0m

User send:

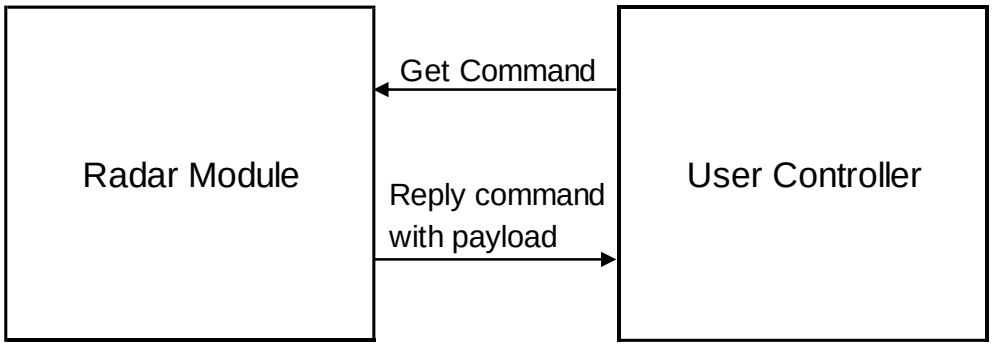
D9 03 04 00 00 00 80 3F D5 5C

Module reply:

D9 02 02 00 03 01 DF 0E

Get command

1. User send a get command to radar module to poll certain status,
2. Module reply a command with the same command ID and payload. The get command is similar to set command except that it has no payload inside.



Example: get maximum detection range

User send:

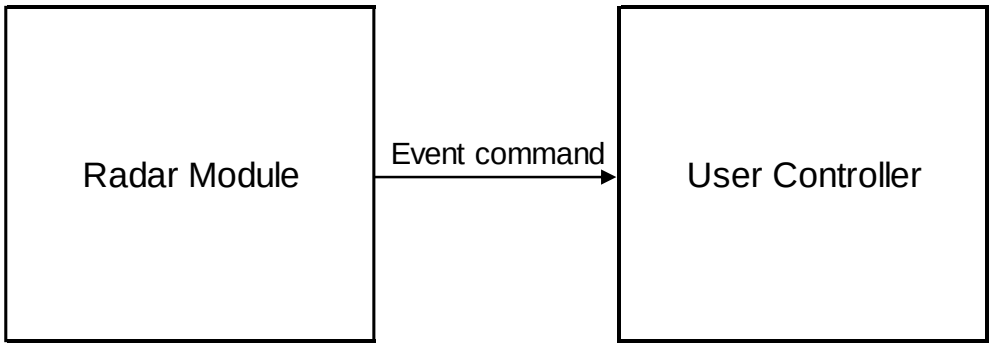
D9 03 00 00 E4 86

Module reply, detection range is 1.0m:

D9 03 04 00 00 00 80 3F D5 5C

Event command

1. Module will actively send out command to user to indicate an event change, such as presence in or out event.



Example: presence IN event

Time: 528578ms / Distance: 0.49m / Accuracy: 0.163

Module send:

D9 06 10 00 8F A7 50 00 00 00 00 00 F2 42 FA 3E 4D D7 26 3E 25 9E

3. COMMAND LIST

The supported command is shown below.

3.1. Version (0x00)

Packet	Firmware Version				
Command Type	Get				
Comment	This command is used to get the version of the firmware.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x00	N	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	string	version	Firmware version in string format		

3.2. ACK (0x02)

Packet	Acknowledge command				
Command Type	Get				
Comment	This command is acknowledgement from radar module.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x02	2	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	ID	Set command ID to be acknowledged		
1	uint8_t	set_result	Set command result 0: fail 1: success		

3.3. Maximum detection range (0x03)

Packet	Maximum detection range of presence detection				
Command Type	Set / Get				
Comment	Valid range is 1.0-10.0. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x03	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	max_range	Maximum detection range		

3.4. Sensitivity (0x04)

Packet	Detection sensitivity of presence detection				
Command Type	Set / Get				
Comment	Higher sensitivity means the presence detection is more sensitive to small motion. The change will be saved in flash. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x04	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	sensitivity	Detection sensitivity 0: low 1: medium 2: high 3: customize, only available at get, indicating macro/micro threshold value is manually changed by command.		

3.5. Presence detection output (0x05)

Packet	Presence detection event command output status				
Command Type	Set / Get				
Comment	This status controls whether an event command will send out for a change in presence event. The change will be saved in flash. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x05	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	output_status	Event command output status 0: disabled 1: enabled		

3.6. Presence detection IN event (0x06)

Packet	Presence detection IN event command				
Command Type	Event				
Comment	This event command will send out once for a change in IN presence event.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x06	16	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint64_t	event_time	Event time, in ms		
8	float	distance	Detected object distance, in meter		
12	float	accuracy	Detected object distance accuracy, in meter		

3.7. Presence detection OUT event (0x07)

Packet	Presence detection OUT event command				
Command Type	Event				
Comment	This event command will send out once for a change in OUT presence event.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x07	8	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint64_t	event_time	Event time, in ms.		

3.8. Reset configuration (0x08)

Packet	Reset all configuration to default command				
Command Type	Set				
Comment	This command will reset the setting saved in flash to default, and perform a system reset.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x08	0	N/A	CRC16

3.9. Get present detection status (0x09)

Packet	Poll presence detection result				
Command Type	Get				
Comment	This command is used to get the current presence detection result. Reply will be IN (0x06) or OUT (0x07) event command.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x09	0	N/A	CRC16

3.10. Presence detect enable (0x0A)

Packet	Enable/Disable presence detection				
Command Type	Set				
Comment	This command is used to enable/disable presence detection. Make sure to disable RFCW mode before enabling presence detection. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0A	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	status	Presence detection enable status 0: disable 1: enable		

3.11. RFCW mode (0x0B)

Packet	Set the radar to send out RF continuous wave				
Command Type	Set				
Comment	This command is used to enable the RF test mode for FCC test. Make sure to disable presence detection before entering this mode.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0B	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	mode	Radar enable status 0: disable RFCW mode 1: RFCW output at 61.02GHz 2: RFCW output at 61.25GHz 3: RFCW output at 61.48GHz 4: RFCW test at 61.02GHz with TX off 5: RFCW test at 61.25GHz with TX off 6: RFCW test at 61.48GHz with TX off		

3.12. Radar chip temperature (0x0D)

Packet	Temperature in radar chip				
Command Type	Get				
Comment	This command is used to get the temperature in radar chip, to check for overheat condition.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0D	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	temperature	Temperature of radar chip, in ºC		

3.13. Sleep mode (0x0E)

Packet	Set module into sleep mode				
Command Type	Set				
Comment	This command is used set the module into sleep mode to save power consumption. Module will wakeup when up coming command received. A preamble byte such as 0x00 is needed to add in the next command to have the command correctly received at the module (to compensate wakeup delay time).				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0E	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	sleep_mode	1: deep sleep		

3.14. Calibration mode (0x0F)

Packet	Enable/disable calibration mode				
Command Type	Set				
Comment	This command is used enable/disable calibration mode. Calibration message indicating the activity level will output periodically when enabled. Default is 0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x0F	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	status	0: disable 1: enable		

3.15. Calibration message (0x10)

Packet	Calibration message				
Command Type	Get				
Comment	This command will output periodically when calibration mode enabled.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x10	N	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	string	calibrate_msg	Calibration message string		

3.16. Calibration message output rate (0x11)

Packet	Calibration message output rate				
Command Type	Set				
Comment	This command is used to set the calibration message output rate. Default is 1.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x11	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	output_rate	1: message rate at 1 per second, 1s 2: message rate at 2 per second, 0.5s 3: message rate at 3 per second, 0.33s 4: message rate at 4 per second, 0.25s		

3.17. Minimum detection range (0x30)

Packet	Minimum detection range of presence detection				
Command Type	Set / Get				
Comment	Valid range is 0.0-1.0 less than maximum range. User needs to ensure this value is smaller than maximum detection range. The change will be saved in flash. Default is 0.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x30	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	min_range	Minimum detection range		

3.18. Macro threshold (0x31)

Packet	Macro movement threshold value				
Command Type	Set / Get				
Comment	Threshold value used for detecting macro movement. After changing this value, Sensitivity will become customize. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x31	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	macro_threshold	Macro movement threshold value		

3.19. Micro threshold (0x32)

Packet	Micro movement threshold value				
Command Type	Set / Get				
Comment	Threshold value used for detecting micro movement. After changing this value, Sensitivity will become customize. The change will be saved in flash. Default is 25.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x32	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	micro_threshold	Micro movement threshold value		

3.20. Macro valid (0x33)

Packet	Macro movement detection timeout value				
Command Type	Set / Get				
Comment	Valid range is 0.5-30. Timeout value (second) used for judging the motion is no longer macro movement. For example, if value is 1, it means detected value below macro threshold for continuous 1 second will be treated as no macro movement. The change will be saved in flash. Default is 1.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x33	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	macro_valid	Macro movement detection timeout value		

3.21. Micro valid (0x34)

Packet	Micro movement detection timeout value				
Command Type	Set / Get				
Comment	Valid range is 1.5-30. Timeout value (second) used for judging the motion is no longer macro movement. Judging criteria is same as in Macro valid value. The change will be saved in flash. Default is 4.0.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x34	4	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	float	micro_valid	Micro movement detection timeout value		

3.22. Detection mode (0x35)

Packet	Presence detection detect mode				
Command Type	Set / Get				
Comment	This command is used to set or get the detect mode of presence detection. The change will be saved in flash. Default is Macro then micro.				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x35	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	detect_mode	0: Macro then micro mode. Radar will first detect macro motion for presence, and enter micro motion detect mode when the object movement becomes small. 1: Macro only mode. Radar will only detect macro movement. 2: Micro only mode. Radar will only detect micro movement. 3: Macro and micro mode. Radar will always detect both macro and micro movement, either one kind of motion exceeding the threshold will be treated as presence.		

3.23. Macro detection trigger range (0x36)

Packet	Macro detection trigger range				
Comment	Valid range is 1-64. This command is used to set or get the trigger range for macro movement detection. Setting a higher value, user need to enter the detection zone inner to trigger presence. Value is multiple of 0.33m. The change will be saved in flash. Default is 1.				
Command Type	Set				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x36	2	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	trigger_range	Macro detection trigger range		
1	uint8_t	N/A	N/A		

Command Type	Get				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x36	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	trigger_range	Macro detection trigger range		

3.24. Macro detection trigger delay (0x37)

Packet	Macro detection trigger delay				
Comment	Valid range is 0-255. This command is used to set or get the trigger delay for macro movement detection. Setting a higher value, radar will need a longer continuous macro movement to trigger presence. Value is multiple of 0.25s. This parameter can be used to filter false trigger such as sudden short vibration object in the detection zone. The change will be saved in flash. Default is 0.				
Command Type	Set				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x37	2	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	trigger_delay	Macro detection trigger delay		
1	uint8_t	N/A	N/A		

Command Type	Get				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x37	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	trigger_delay	Macro detection trigger delay		

3.25. Presence chirp per frame (0x38)

Packet	Chirp per frame of presence detection				
Comment	Valid range is 1-4. This command is used to set or get the number of chirps per frame for coherent integration. Setting a higher value, radar will send out more chirps in a frame and use for coherent integration and interference checking, resulting in a better signal to noise ratio. Notice that power consumption will also increase for setting higher value, as the RF active time will also increase.The change will be saved in flash. Default is 1.				
Command Type	Set				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x38	2	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	chirp_num	Number of chirp per frame (1-4)		
1	uint8_t	N/A	N/A		

Command Type	Get				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0x38	1	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t	chirp_num	Number of chirp per frame (1-4)		

3.26. Unique ID (0xF7)

Packet	Get the unique ID of the module				
Command Type	Get				
Comment	This command is used to get the unique ID of the module				
Packet Structure	Header	ID	Length (Bytes)	Payload	Checksum
	0xD9	0xF7	8	See below	CRC16
Payload Contents					
Byte Offset	Format	Name	Description		
0	uint8_t x 8	unique_id	Module unique ID		

4. HISTORY CHANGE

Revision	Date	Description
D01	2021-02-26	Draft version.
D02	2021-12-14	Correct length of payload in section 3.23 to 3.25.
D03	2022-01-26	1. Update default value for command. 2. Update chirp per frame setting description.
R01	2022-03-07	Update the setting range of value.