

## RS900 / MRS900 communication protocol

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*Please notice that the communication protocol between device and host is **half-duplex** no matter what type of interface is using RS232, RS485, RS422 or USB VCP. Direction of data communication is controlled by the device. Host must wait at least 10ms after answer from the device before send new data. Device using 8 bit data, no parity, 1 stop bit (8-N-1) settings. Communication speed is varying. There is no flow control using.*

## Sonar's internal states

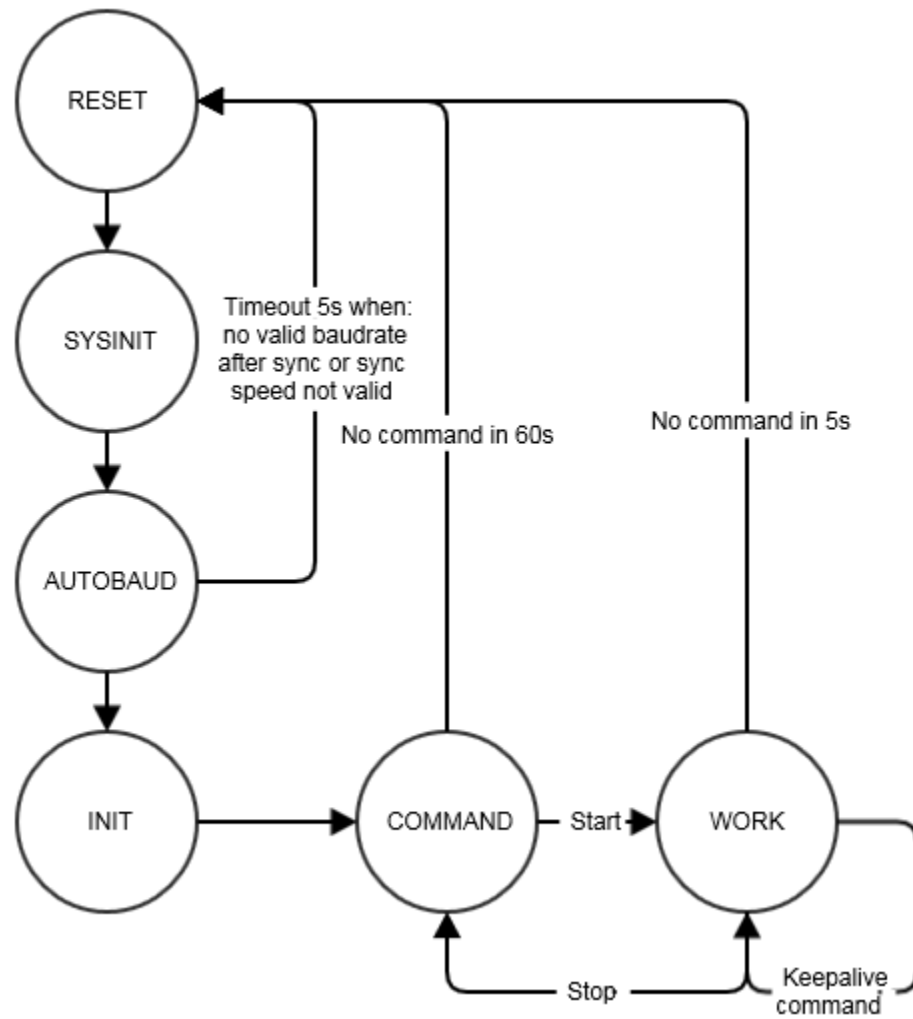


Fig. 1 Sonar internal states

*Please notice that device can send internal information at 115200 baud and then adjusting sonar head before entering auto baud mode. It is recommended to wait 5-10 second after power on before making auto baud procedure.*

## Auto baud mode

1. Host sends "@" character (0x64) at any speed from 115200 to 1000000 baud.
2. If device recognize symbol's speed it answer by "#SYNC<LF>" string at this speed. <CR> is carriage return symbol (0x13) and <LF> is line feed symbol (0x10). If device not recognize speed it waiting for new "@" character.
3. Host must send desirable speed by "<SPEED><CR>" string in five seconds. For example: "<921600><CR>". Otherwise device will go #1. Device supports follow serial speeds: 115200, 230400, 460800, 921600, 1000000 and 2000000 baud.
4. If device support this speed it answer "#OK<LF>" at current speed and then after 100ms switch to desirable speed and send "#OK<LF>" again. If speed is not supported it send "#ER<LF>" and go to #1.

## Initialization mode

Device set internal parameters. It is not host interaction mode.

## Command mode

1. Device sends "CMND<CR><LF>" string to host when it enter command mode and ready to receive command from host.
2. If device recognize command it sends "#OK<LF>" if it not it sends "#ER<LF>".
3. If there are no command in 1 minute device will reset to auto baud mode.

## Command format

The command from host has binary format and converted to **base64**-encoded string ending by <CR> character. Base-64 string is not line-formatted.

### *Command description*

Header	Payload data
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There are 4 types of command for setup sonar: COMMONSETTINGS : 0, SCANSETTINGS : 1, START(KEEPALIVE) : 6 and STOP : 7.

### *Command structure*

Field Size	Description	Data type	Comments	Value
4	magic	int32	command header's magic value	1145982275
4	command	int32	command	0,1,6,7
4	checksum	int32	CRC32 checksum of data	Any
4	size	int32	size of payload data	Any
1-28	data	uint32[]	payload data	Any

Fig. 2 Command structure

*“Common setting” command description*

Field Size	Description	Data type	Comments	Value
4	start_node	uint32	Reserved	1
4	data_format	uint32	Reserved	0
4	commandid	uint32	User's data	Any
4	central_frequency	uint32	Reserved	0
4	frequency_band	uint32	Reserved	0
4	chirp_tone	uint32	AFM(If supported), FM Chirp or CW	0- tone, 1 chirp FM, 2 - chirp AFM
4	pulse_length	uint32	Pulse length, us	10-200
4	ping_interval	uint32	Pulse interval, ms	
4	samples	uint32	Samples. Depend on range	240-8000
4	sample_frequency	uint32	Reserved	100000
4	gain	float32	Gain	-15 to +15db
4	tv_g_slope	float32	Reserved	0
4	tv_g_mode	uint32	Reserved	1
4	tv_g_time	uint32	Reserved	80
4	sync	uint32	Reserved	0
4	sync_timeout	uint32	Reserved	0
4	tx_power	float32	Reserved	0
4	rms_tx_power	float32	Reserved	0

Fig.3 Common setting command

### *“Scan settings” command description*

Field Size	Description	Data type	Comments	Value
2	sector_heading	uint16	Sector scan heading	0-28800
2	sector_width	uint16	Sector scan width, 0 - for 360° scan	0-28800
2	rotation_parameters	uint16	rotate direction CW/CCW	0,1
2	stepping_mode	uint16	Stepping mode	0,1,2,4,8,16 For stop, 0.1125, 0.225, 0.45, 0.9, 1.8 deg. step respectively
4	stepping_time	uint32	Same as ping interval	
4	stepping_angle	uint32	Reserved	0

Fig. 4 Scan setting command (Stepping motor settings)

### *Recommended ping intervals and number of samples*

Recommended ping interval (ms) and samples for 115200 baud

Range(m)	Samples	steps/0	steps/1	steps/2	steps/4	steps/8	steps/16
1.5	240	23	23	23	23	23	23
2.5	368	36	36	36	36	36	36
3	448	43	43	43	43	43	43
5	704	68	68	68	68	68	68
6	848	81	81	81	81	81	81
7.5	1040	100	100	100	100	100	100
10	1376	132	132	132	132	132	132
15	2048	196	196	196	196	196	196
20	2704	259	259	259	259	259	259
30	4048	387	387	387	387	387	387
45	6048	578	578	578	578	578	578
60	8000	764	764	764	764	764	764

Recommended ping interval (ms) and samples for 921600 baud

Range(m)	Samples	steps/0	steps/1	steps/2	steps/4	steps/8	steps/16
1.5	240	4	6	7	9	14	24
2.5	368	6	7	8	11	15	25
3	448	7	8	9	11	16	26
5	704	9	10	11	14	19	28
6	848	11	12	13	15	20	30
7.5	1040	13	14	15	17	22	32
10	1376	17	17	18	21	25	35
15	2048	25	25	25	27	32	42
20	2704	33	33	33	34	39	48
30	4048	49	49	49	49	52	62
45	6048	73	73	73	73	73	82
60	8000	96	96	96	96	96	101

### *“Start” command description*

Field Size	Description	Data type	Comments	Value
4	start	uint32	Start	1

Fig. 5 Start / Keep-alive command

### *“Stop” Command description*

Field Size	Description	Data type	Comments	Value
4	stop	uint32	Stop	1

Fig. 6 Stop command

## Work mode

1. Device sends “**WORK**<CR><LF>” string to host when it enter work mode and ready to send data to host.
2. Because device use half-duplex protocol sending Keep-alive or stop commands are allowed in certain time intervals during 50ms after receive “Footer” with “826560069” as magic value. Command allowed sending after 3ms after received proper magic value. It is recommended to send keep-alive command not often than 1 second.

### *Work mode data format*

Data from the device has binary format. Command to device has format, similar to “command” mode.

### Work mode data flow

Header	DATA	Footer/ END0	Header	DATA	Footer/ END1	Receive command (50ms)	Header	DATA	Footer/ END0
Data transmitting to host						Command receiving from host	Data transmitting to host		

Fig. 7 Work mode data flow

### Sonar's transmitting format

Data consist of 3 parts: Header, data and footer

Header	DATA	Footer
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### Header data format

Field Size	Description	Data type	Comments	Value
4	magic	uint32	header's magic value	1096040772(DATA)
4	data offset	uint32	data offset from beginning of header	$\geq \text{sizeof(HEADER)}$
4	data size	uint32	samples size in bytes	1
4	samplesnum	uint32	number of data's samples	Vary
4	deviceid	uint32	device id	Reserved
4	angle	uint32	head current angle 0.00125° resolution	0-28800 (0-360°)
4	commandid	uint32	User's command id	Any

Fig.8 Header format

*Host's software must always check data offset value because header's size can be increased in the future. Actual current head's angle in degree can be calculated by formula  $\text{angle\_in\_degree} = \text{headangle} * 360 / 28800$ . Maximum physical motor steps per turn are 3600 or 3200 depending of step angle (0.1 or 0.1125). Now RS use 0.1125 degree minimum step angle.*



### *Sonar's data format*

Sonar data is linear amplitude values with sampling rate of 100 kHz (approx. 7.5mm resolution) and 12-bit precision of signal envelope encoded (companded) to 8 bit.

Field Size	Description	Data type	Comments	Value
1	data	uint8[]	Companded data value	0-255

Fig. 9 Data format

### *Footer data format*

Field Size	Description	Data type	Comments	Value
4	timestamp	uint32	timestamp value	Reserved
4	magic	uint32	footer's magic value	809782853(END0) or 826560069(END1)

Fig. 10 Footer format

### *Decoding data procedure*

```
unsigned short uncompond8to12(unsigned char b)
{
    unsigned short ret = (unsigned short) b ;

    ret = ( (b >> 5) == 7 ) ? ( (ret & 0x1F) << 6 ) | (1 << 11) | (1 << 5) :
    ( (b >> 5) == 6 ) ? ( (ret & 0x1F) << 5 ) | (1 << 10) | (1 << 4) :
    ( (b >> 5) == 5 ) ? ( (ret & 0x1F) << 4 ) | (1 << 9) | (1 << 3) :
    ( (b >> 5) == 4 ) ? ( (ret & 0x1F) << 3 ) | (1 << 8) | (1 << 2) :
    ( (b >> 5) == 3 ) ? ( (ret & 0x1F) << 2 ) | (1 << 7) | (1 << 1) :
    ( (b >> 5) == 2 ) ? ( (ret & 0x1F) << 1 ) | (1 << 6) | (1 << 0) :
    ( (b >> 5) == 1 ) ? ( (ret & 0x1F) << 0 ) | (1 << 5) :
    ( (ret & 0x1F) << 0 ) ;

    return ret ;
}
```

### *Work mode to command mode switching procedure*

When it is necessary to change device's parameter host must send a "stop" command and wait until sonar is switching to the command mode. Host must send "stop" command for each "END1" footer received until receive "CMND<CR><LF>" string from host.