Programmer's Manual

ROTARY TABLES

RT340 device
RT360 device

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Document changes

Version	Date	Authors	Last changes
1.00.00	2015-03-23	SC	Initial version
1.01.00	2015-09-10	SC	Corrections and improvements
1.10.00	2015-10-02	SC	Added information about IP addresses, ports and firmware update procedure
1.20.00	2015-10-29	SC	Revision and additions: - Removed some unused services on TCP channel - Title and description
2.00.00	2018-07-10	SC	Format revision RT360 information
2.00.01	2018-11-16	SC	Updated for firmware version 1.22/04.00.20
2.01.00	2019-09-25	SC	New auto-scan feature and additional parameters

Content

1 Introduction

1.1 About this document

This document applies to all Triple-IN's Rotary Table versions.
It provides technical information on the device configuration and the communication between a control computer and the device firmware and is related to the models:

```
RT340
RT360
```

It is valid for the following firmware versions:

```
RT340 Firmware Version  1.22
RT360 Firmware Version  1.20 – 1.22, BSP: 04.00.18 - 04.00.20
```

This Programmer's Manual is part of a set of documents:

Manual	Targeted persons	Content
User's Manual	Technical personnel	Transport, mounting and installation Wiring and maintenance Operating means, system configuration Technical data
Programmer's Manual	Software developers	Data formats Commands and responses

Triple-IN's Rotary Tables are normally integrated with a Triple-IN's Laser Scanner, in order to provide a complete system able to perform 3D measurements.
For this reason, this document is strictly related to the documentation of the connected sensor, particularly the "Laser Scanner Programmer's Manual" or "Smart Sensor Programmer's Manual".
Every reference in this document to "sensor documentation" or "sensor commands" must be searched for in the Laser Scanner documentation.
If you or your colleagues have any comments on this manual, we would be grateful to hear from you. Please write to:


```
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Poppenbütteler Bogen 64
D-22399 Hamburg - Germany
Telefon +49(0)40 50091998
Mail info@triple-in.de
```

1.2 Web server with Documents and Firmware Updates

The latest version of this and other related documents and the latest firmware updates can be downloaded from Triple-IN's web server.

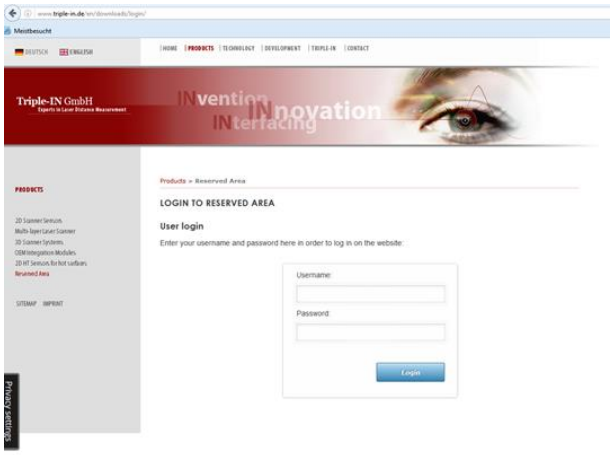

Figure 1: Triple-IN web server login

Please contact Triple-IN to get access to the reserved area of the web server:

```
info@triple-in.de
```

1.3 References to the Rotary Tables User's Manual

This document is a general description about the Rotary Table programming interface. All Triple-IN's devices use the same command/response structure.
However, some information is related to individual device models. The firmware may use different parameter identifiers, depending on the individual features. The complete list of parameters including a detailed description can be found at the end of this document, in *Appendix A*.

❖ Note

The parameter list can also be downloaded from the device itself by use of the binary commands.

2 Communication interfaces

The Rotary Table uses the Ethernet interface as the only communication channel.

2.1 UDP/IP transport protocol

The UDP transport protocol can be used to send commands to the device, receive responses and receive the online scan stream.

2.2 TCP/IP transport protocol

The TCP transport protocol can be used to send commands to the device and receive responses. It is possible but not recommended to use TCP/IP to receive online scan stream.

☞ Important

The TCP/IP transport channel is implemented in the RT360 only, starting from firmware 1.50/04.01.00.

2.3 Why choose UDP for scan data stream

TCP was designed to be reliable in data transmission. This means that, if a packet of data is not correctly (without errors) received by the destination, the sender will try to transmit it again until it is received correctly.
In a real-time system though it is more important to have always the most recent data available even if it means to have some previous data lost.
The UDP transport protocol has a lot of advantages for this purpose:

- It is stateless, suitable for very large numbers of clients. It is used for example in streaming media applications such as IPTV
- The lack of retransmission delays makes it suitable for real-time applications such as Voice over IP, online games, and many protocols built on top of the Real Time Streaming Protocol
- It works well in unidirectional communication and is suitable for broadcast information such as in many kinds of service discovery and shared information such as broadcast time or Routing Information Protocol

All these attributes (and more) made the UDP protocol the best choice to send the scan data stream to the requesting consumers.

2.3.1 Sensor IP address

In the described communication pattern, the device provides some functionalities accessible through the Ethernet. Each one of these functionalities is identified as a "Service", and the control computer is the "Client".
The device socket addresses are a combination of an IP address and a port (which is mapped to the application program process). Every available combination identifies a Service.
The device has two different IP addresses configured and exposed to the outside:

- Predefined. Is automatically calculated from the serial number and cannot be changed. The network mask is **255.255.0.0** and it is calculated this way:

```
IP = 10.255.(serial / 100).(serial % 100)
```

- Custom. This address can be modified by the user. It is initially set with a default value calculated similarly to the Predefined:

```
IP = 10.0.(serial / 100).(serial % 100)
```

  The custom IP address can be set as a DHCP address

❖ Information

The DHCP IP address mode is available from firmware 1.22/4.00.20.

☞ Important

For the RT340 with serial number between 130 and 255, the actual IP address is calculated as follows:

IP = 10.x.0.(serial)

2.4 Timeout

The command interface of the firmware has following timeouts:

- for measurement requests: **5** seconds
- for measured scans: **30** seconds
- for changing parameters: **60** seconds

The device sends an error (`ERR\0`) response if a timeout has occurred.

2.5 Services

The following services are available by default on a device. As an example, we list the IP addresses for a device with the serial number as `1234`:

Service IP/Port	Protocol	Service	Description
10.255.12.34 6969	TCP/IP	Scan and commands	Command communication line for configuration and online data stream
	UDP/IP	Scan and commands	Command communication line for configuration and online data stream
10.0.12.34 1024	TCP/IP	Scan and commands	Command communication line for configuration and online data stream
	UDP/IP	Scan and commands	Command communication line for configuration and online data stream
0.0.0.0 6996	UDP/IP	Announcement	A defined command sent to this channel will respond with the announcement message
0.0.0.0 3007	TCP/IP	Update	Used to send firmware updates to the device
0.0.0.0 22	TCP/IP	SSH	SSH access to the device
0.0.0.0 80	TCP/IP	Web interface	Access to the device web interface

Figure 2: Network services

2.6 Limitations

2.6.1 Concurrent connections

Update and Commands TCP/IP listening Services are limited to one connection at a time. This means that if a TCP/IP Service is connected to a client, no other Client can use that service.

2.6.2 Custom Service IP and Port

The IP address set by the user cannot be the same as the Predefined.
The Port set by the user cannot be one of: `22`, `80`, `3007`, `6969`, `6996` and `9996`.

3 Data Types and Data Format

3.1 Byte Order and Basic Data Types

The interface uses the Network Byte Order format in Big Endian.

Bit 31 Bit 0

Word at address A			
Half-word at address A		Half-word at address A + 1	
Byte at address A	Byte at address A + 1	Byte at address A + 2	Byte at address A + 3

The basic data types are shown in the next table.

Type definition	Size in bytes (bits)	Remark
Byte	1 (8)	A byte, unsigned, 0..255
Char	1 (8)	A byte, signed, -128..127
Word	4 (32)	Four-byte word, network byte order (big endian)
Bitfield	4 (32)	Four-byte word, network byte order (big endian)
String	Variable	A sequence of chars, zero terminated

Figure 3: Basic data types

3.2 Device specific data formats

Distances

Distance values are stored in a Word in units of 1/10 mm.
Two special values must be checked for to establish the validity of the distance value and the correctness of the measured distance must be validated.

Values	Description
-2147483648 (0x80000000)	In case the echo signal was too low
2147483647 (0x7FFFFFFF)	In case that the echo signal was noisy
< 0	Invalid measurement. Must be filtered
< Near field distance	Likely an invalid measurement. Should be filtered
> Maximum range	Likely an invalid measurement. Should be filtered

Echo Pulse Width

The echo pulse width can be used as representation of the Echo signal. Pulse widths are optionally provided as 3-byte values in picoseconds.

The echo signal and pulse width aren't necessarily proportional to each other, but the latter brings a meaningful information about the strength of the echoed pulse.
The pulse width in conjunction with the distance information provides the signal condition as summarized in the table below.

Pulse width	Distance value	Condition
0	-2147483648 (0x80000000)	No echo
> 0	-2147483648 (0x80000000)	Low Echo
> 0	-2147483648 < distance < 2147483647 0x80000000 < distance < 0x7FFFFFFF	Distance has a value
> 0	2147483647 (0x7FFFFFFF)	Noisy signal

❖ Note

If the pulse width field is read as Word, the highest byte will contain the echo number.

Target reflectivity

The Reflectivity of a target surface depends on various parameter, such as the color and the structure. Triple-IN's Laser Scanners provide an estimated information about the target reflectivity.
The reflectivity is provided as one-byte value from 0 to 255. It gives in conjunction with the distance value the measurement conditions described in the table below.

Reflectivity value	Distance value	Condition
0	-2147483648 (0x80000000)	No echo
> 0	-2147483648 (0x80000000)	Low Echo
> 0	-2147483648 < distance < 2147483647 0x80000000 < distance < 0x7FFFFFFF	Distance has a value
> 0	2147483647 (0x7FFFFFFF)	Noisy signal

Echo number and Master Echo

At measuring through rain, through protection windows, or in dusty surroundings several objects may reflect the laser beam.
Triple-IN's Smart Sensors can measure up to 4 echoes. Different data formats are provided to return the data measured. For the formats that provide only one echo, the user parameter 29 "Master Echo" must be set. Find more information about the Master Echo configuration in the connected sensor documentation.

Some data formats provide the number of echoes measured. Normally the echo number occupies 1 byte only and the value identifies the echoes in receiving order (echo 1 is the first echo).

Angular units

The angle unit depends on a circle with 360000 counts (millidegree). Scan start angle, scan angle and number of pulses must be used to calculate the scan direction of a single laser pulse:

```
dir = start_angle + (number-1) * scan_angle / number_of_pulses
```

Where

- dir: scan direction of a single laser pulse in degree
- start_angle: direction of the first laser pulse in the scan in degree
- number: number of the single laser pulse in the scan, starting from 1
- scan_angle: scan angle of the scan (field of view) in degree
- number_of_pulses: number of laser pulses of the scan.

Temperature readings

The sensor handles the temperature readings in 0.1 degree Celsius. They are normally stored in a Word.
Example: a binary reading of “352” means "35.2° Celsius".

Time stamp

The real time clock counter gets a reset at startup and after receiving a SRTC command. The unit of the time stamp is milliseconds.
Note that the time stamp is stored in an unsigned 4-byte integer value. A clock counter overrun occurs after about 1193 hours, which are more than 49 days.
Smart Sensors support a “Pulse per second” PPS signal. Each rising edge of the PPS signal increases the full second of the real time clock while resetting the milliseconds to 0.

Strings

In some cases, strings are used by the device to send information to the control computer. If not otherwise stated, the strings are always a stream of Chars, zero terminated and 4 bytes aligned, padded with zeroes at the end if needed.

3.3 CRC32 Checksum

The Cyclical Redundancy Checking (CRC) field is four bytes, containing a 32–bit binary value. The CRC value is calculated by the transmitting control computer, which appends

the CRC to the message. The CRC covers the entire message excluding the CRC itself. The device firmware recalculates a CRC during receipt of the message and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error result is reported.
The CRC is started by first preloading a 32–bit register (initial reminder) to all 1's. Then a process begins, applying successive 8–bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits and the parity bit, do not apply to the CRC32.
The calculation of the CRC32 conforms to the CRC-32-IEEE 802.3 Standard with the following parameters:

```
int32_t CRC32_POLYNOMIAL = 0x04c11db7;
int32_t CRC32_INITIAL_REMAINDER = 0xFFFFFFFF;
int32_t CRC32_FINAL_XOR_VALUE = 0xFFFFFFFF;
int32_t CRC32_TOPBIT = 0x80000000;
```

Note that CRC Checksums sent by the device have a Big Endian byte order.
Example for tests: „1234567890"gives CRC32=0x261DAEE5

3.4 Error Codes

Error codes from -1 to -1999 correspond to the error codes defined in the "Standard C Library".
Error codes below -2000 are Triple-IN proprietary extensions to this.
A description of the Triple-IN proprietary error codes can be found in *Appendix B*.

3.5 Device Parameters

The device configuration is stored in a table of parameters.
Every parameter has, in addition to the value, a unique parameter identification code, a default value and a valid range. The user can edit the parameter value by use of the terminal mode and can change the value with the commands GPRM and SPRM.
Different models of Rotary Table may use different parameter identifiers, depending on the individual features. The complete list of device parameters including a detailed description can be found in *Appendix A*.
There are three special types of parameter:

- Constant parameters cannot be changed by the user. Parameters which do not change their value during normal device operation are typically defined to be constant. An example of constant parameter is the 100001 "Device serial number". The attempt to change a constant parameter returns an error.
- Read only parameters cannot be changed by the user. Read only parameters value may change during normal operation. An example of constant parameter is

the 100015 “Horizontal position in encoder steps”. The attempt to change a constant parameter returns an error.

- Temporary parameters depend on the current system status and are overwritten if the status changes. Temporary parameters will not be stored in the non-volatile memory.
  For example the parameter 100004 " Horizontal position in 1/1000th of degrees " may be used by a SPRM command to set the device to a particular position.
  Note that temporary parameters are typically updated by a self-test during the startup phase. It is recommended to set temporary parameters only once the self-test has been finished.

4 Message datagrams

The communication between the control computer and the device is performed using message datagrams. Three main types of Message datagrams can be identified:

- When the message datagram is sent by the control computer to the device, it is commonly called Command.
- When the message datagram is sent by the device to the control computer in response to a Command, it is called Response.
- When the message datagram is sent by the device to the control computer without a corresponding Command, it is simply called Message.

4.1 Binary Message Datagram Structure

The following section describes the main structure of the message datagram. All binary message datagrams have the following structure:

Function code	Length	[Data]	CRC
		← **Length** bytes →	
← Included in the **CRC** checksum →			

Where

- Function code: a sequence of ASCII **4** bytes to identify a command or a function.
- Length: the number of the following bytes as **4**-byte Word value (Big Endian), excluding the Function code, the Length and the CRC.
- Data: the data segment (optional). Data is transmitted as Big Endian **4** bytes Words and it is always **4** bytes aligned.
- CRC: a **32** bits CRC checksum. The checksum includes the function code, length bytes, and the data, but excludes the CRC itself. All integers are added as Big Endian.

☞ Important

Character "**0**" identifies a Char (**1** signed byte) of value **0**

5 List of Commands

The following Commands are supported.

Request	Response	Description
GVER	Version	Request the Firmware Version
GRTC	Get real time clock count	Request the real time clock counter. This command is sent directly to the connected sensor and is not described in this document
SRTC	Set real time clock count	Set the real time clock counter. This command is sent directly to the connected sensor and is not described in this document
GPRM	Read parameter	Get a single parameter value using the parameter identification code
SPRM	Write parameter	Set a single parameter value
SCAN	Start scan	Start the scanning mode
GSCN	Get next scan	Request the next measured scan
GPIN	Get parameter info	Request information about a parameter
REST	Perform special operations	Trigger specific operations on the device. This command is sent directly to the connected sensor and is not described in this document
GPOS	Get horizontal position	Request the horizontal angle referenced to parking position
SPOS	Set horizontal position	Set the horizontal position with different references
GS3D	Get next 3D scan	Requests the 3D scan. The message content is similar to the GSCN with slight differences. During normal 3D scan operation, scan data is sent continuously

Figure 4: List of Commands

In the following paragraphs every Command will be described in detail, with the corresponding expected Response.

☞ Important

The message datagram structure will not be replicated, so the Command description will not contain the Length and CRC that are calculated from the Message contents.

Command handling flowchart

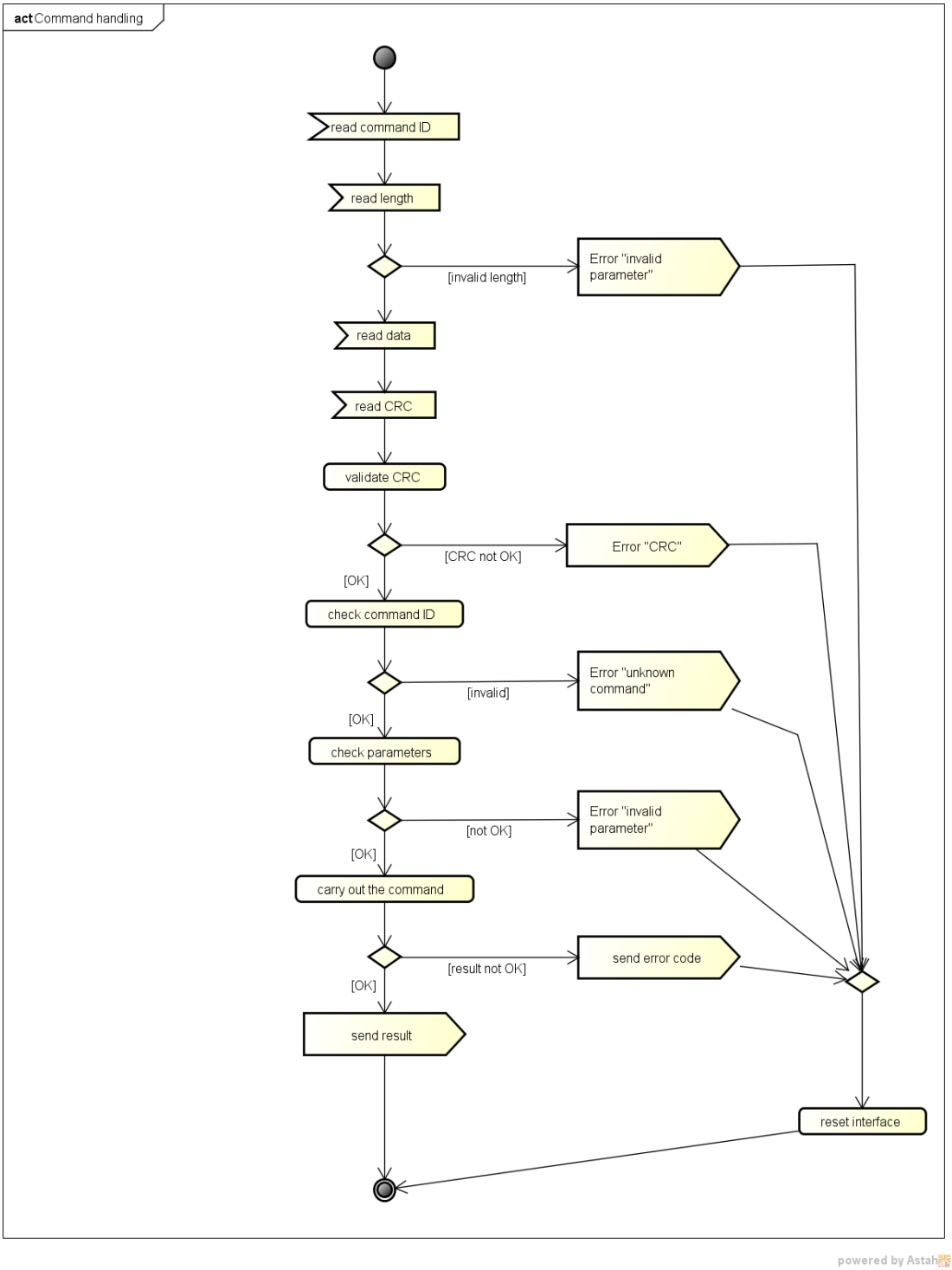

Figure 5: Command handling by the firmware

5.1 Error Response

In case some error occurs on the device during the processing of a Command request, an error Response is sent instead of the Command Response.

Error Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"ERR\0"	The Error Response function code
1st required	Word	4	-2005	The error code (see *Paragraph 3.5* for details)

Example

```
 Func.Code    Length       Data         CRC
45 52 52 00 00 00 00 04 FF FF F8 2B AB E2 32 36
```

5.2 Getting the Firmware Version

Requests the firmware versions of different components of the Rotary Table and the connected Laser Scanner.
The GVER command contains a parameter which defines the requested hardware component. Common components are the Measurement Processing Unit (MPU) of the sensor, the Application Processing Unit (APU) of the sensor and the Rotary Table itself. The resulting version code might contain several text lines, each separated by a "line feed" character '\n' (ASCII code 10).

5.2.1 GVER variant with hardware component

Part	Type	Length	Value	Description
Function code	Word	4	"GVER"	The Command function code
1st required	Word	4	1	Hardware component ID

1st required – Hardware component ID

Value	Description
0	Returns the version string of the sensor MPU firmware. Managed by the connected sensor
1	Returns the version string of the sensor APU firmware. Managed by the connected sensor
2	Returns the version string of the Rotary Table firmware
3	Returns the short version string of the sensor MPU firmware
4	Returns the short version string of the Rotary Table firmware
5	Returns the sensor model
6	Returns the Rotary Table model

Example

```
Func.Code   Length      Data        CRC
47 56 45 52 00 00 00 04 00 00 00 01 09 95 BC 35
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GVER"	The Response function code
1st required	Word	4		The requested hardware component
2nd required	String	Variable		The version string of the component's firmware

Example

```
Func.Code   Length      Data                        CRC
47 56 45 52 00 00 00 68 00 00 00 01 42 42 … 36 00 00 00 A9 73 65 CC
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the parameter has an invalid value

5.2.2 Deprecated GVER variant without parameter

This variant of the GVER command needs no parameter in the Command request. The device will return the firmware version of the connected Laser Scanner MPU.
This variant is intended for backward compatibility to older firmware versions.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"GVER"	The Command function code. Managed by the connected sensor

Example

```
 Func.Code    Length      CRC
47 56 45 52 00 00 00 00 1B 39 CF 64
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GVER"	The Response function code
1st required	String	Variable		The requested version string

Example

```
 Func.Code    Length      Data          CRC
47 56 45 52 00 00 00 94 50 53 32 … 4E 0D 0A 00 00 1B 39 CF 64
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB

5.3 Reading the Real Time Clock Counter

The GRTC remote command is used to read the millisecond counter of the sensor system timer.
The real time clock starts with 0 when the sensor is powered up and has a millisecond resolution.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"GRTC"	The Command function code

Example

```
Func.Code   Length      CRC
47 52 54 43 00 00 00 00 7A 7C 84 7B
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GRTC"	The Response function code
1st required	Word	4	1527856598	The actual Real Time Counter

Example

```
Func.Code   Length      Data        CRC
47 52 54 43 00 00 00 04 5B 11 3D D6 B9 2C 3D 7E
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB

5.4 Setting the Real Time Clock Counter

The SRTC remote command allows to set the connected sensor real time clock counter.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"SRTC"	The Command function code
1st required	Word	4	0	The number of milliseconds to assign to the sensor RTC. The value will be used as a starting point for the next increments

Example

```
Func.Code   Length      Data        CRC
53 52 54 43 00 00 00 04 00 00 00 00 B2 82 95 46
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"SRTC"	The Response function code

Part	Type	Length	Value	Description
1st required	Word	4	0	The actual Real Time Counter

Example

```
 Func.Code   Length      Data       CRC
53 52 54 43 00 00 00 04 00 00 00 00 B2 82 95 46
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB

5.5 Getting 2D Scans

The GSCN command requests measured scans to the connected sensor.
A typical scan record contains a time stamp, a scan number, distances, and pulse widths.
The scan number starts with 1 after the measurement system is turned on.
Using the GSCN command with scan number 0 will return the latest scan measured (the most typical use case).
The command response is built by two sections:

- The parameters section contains all information related to the scan. A typical parameters section contains a time stamp, the scan number and system status information. It also contains information about the size and content of the following data section.
- The data section is built by a sequence of measurement results, such as distance and pulse widths.

❖ Information

For further information about the GSCN response please check the documentation related to the connected sensor.

5.6 Getting 3D Scans

The GS3D command requests measured scans like the GSCN command, adding an extra parameter in the parameters section containing the horizontal angle value in 1/1000th of degree.

Parameters section

The parameters section contains the scan number, a time stamp, the layout of the scan area, the current system temperature, a system health status and information about the content and the size of the following data section.
The scan number starts with 1 after a SCAN command has been received. Using the GS3D command with scan number 0 always returns the latest scan measured.
Unit of the time stamp is always milliseconds starting from the last SCAN command.
Scan starting angle, scan angle and number of pulses must be used to calculate the vertical direction for each distance (see below).
Each GS3D response contains the operating temperature in 0.1 degree Celsius. An additional system health bit field informs about possible device faults.
The scan can be associated with a horizontal position that bases on an external trigger signal. The unit of the horizontal position information depends on the signal provided to the sensor.

Data section

Please refer to the manual of the connected sensor for information about the data section.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"GS3D"	The Command function code
1st required	Word	4	0	The required scan line

Example

```
 Func.Code   Length     Data      CRC
47 53 33 44 00 00 00 04 00 00 00 00 __ __ __ __
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GS3D"	The Response function code
1st required	Word	4	?	Number of parameters
2nd optional	Word	4	?	Scan number
…	Word	4		Other parameters
nth parameter	Word	4	1	The number of extra parameters following

Part	Type	Length	Value	Description
n+1st required	Word	4	?	Horizontal angle in 1/1000th of degree
n+2th required	Word	4	0	Number of points in scan 0
…	Data	Variable		Data table as provided by the connected sensor

5.7 Reading a User Parameter

The GPRM remote command is used to read user parameters from the device. A parameter identification code specifies the desired parameter.
Different models of Triple-IN's Rotary Tables and Laser Scanners may use different parameter identifiers, depending on the individual features. The complete list of Rotary Table parameters including a detailed description can be found in *Appendix A*.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"GPRM"	The Command function code
1st required	Word	4	3	The parameter identifier

Example

```
Func.Code   Length      Data        CRC
47 50 52 4D 00 00 00 04 00 00 00 03 B9 25 00 6B
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GPRM"	The Response function code
1st required	Word	4	3	The requested parameter identifier
2nd required	Word	4	1	The actual value stored in the requested parameter

Example

```
Func.Code   Length      Data                    CRC
47 50 52 4D 00 00 00 08 00 00 00 03 00 00 00 01 06 1E B7 53
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the parameter ID is unknown or hidden

Error	Case
	If the parameter value is out of range

5.8 Getting Parameter Information

The GPIN remote command is used to get information about user parameter. The command returns human-readable information about the parameter's name and the minimum and the maximum values allowed to be set.
GPIN can also be used to get a readable error message of an error code. Send GPIN with the negative error code ID to get the corresponding error message.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"GPIN"	The Command function code
1st required	Word	4	3	The parameter identifier

Example

```
 Func.Code   Length     Data      CRC
47 50 49 4E 00 00 00 04 00 00 00 03 5F E6 46 B1
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GPIN"	The Response function code
1st required	Word	4	3	The requested parameter identifier
2nd required	Word	4	3	The number of parameter information words following
3rd optional	Word	4	1	The actual value stored in the requested parameter
4th optional	Word	4	1	The minimum value which can be set on the parameter
5th optional	Word	4	4	The maximum value which can be set on the parameter
6th required	Word	4	48	The length of the following description string, including the terminating 0
7th required	String	Variable		The zero-terminated text string giving a human-readable parameter description. The same description is visible in the Terminal mode. The data is aligned to a 4 bytes Word. Unused bytes are filled with zero

Example

```
 Func.Code   Length    Data                    CRC
47 50 49 4E 00 00 00 48 00 00 00 03 … 65 64 00 53 F1 F8 9D
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the parameter ID is unknown or hidden

❖ Information

When the requested parameter is the one after the last parameter ID, the system will return a valid response with **0** as parameter ID. For parameter ID bigger than this, an error will be returned.

5.9 Setting a User parameter

The SPRM remote command is used to write a single parameter to a register in the remote device. The parameter identification code specifies the parameter to be written. The parameter value is checked, and non-temporary parameters are stored in the non-volatile memory of the device.
The normal response is a copy of the request, returned after the parameter content has been written. The SPRM command has a prolonged timeout of **30** seconds.
The flash device is specified with a limited lifetime of **100000** program/erase cycles.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"SPRM"	The Command function code
1st required	Word	4	8	The parameter identifier
2nd required	Word	4	1	The new value to store into the parameter

Example

```
Func.Code   Length    Data                    CRC
53 50 52 4D 00 00 00 08 00 00 00 08 00 00 00 01 43 D8 F4 5B
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"SPRM"	The Response function code
1st required	Word	4	8	The requested parameter identifier
2nd required	Word	4	1	The actual value stored in the requested parameter

Example

```
Func.Code   Length    Data                    CRC
53 50 52 4D 00 00 00 08 00 00 00 08 00 00 00 01 43 D8 F4 5B
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing If the flash cannot be written
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds If the flash writing procedure do not return within 60 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the parameter ID is unknown or hidden If the parameter value is out of range

5.10 Special operations

The REST remote command is used to instruct the device to perform some special operations.
This command uses a value as a bitmask in which every bit is assigned with a special meaning.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"REST"	The Command function code
1st required	Word	4	?	The operations bit mask
2nd required	Word	4	0x446F4974	A fixed magic number used to confirm the operation

Bits definition

Bit n°	Operation
0	If this bit is set, the sensor MPU is restarted
1	If this bit is set, the sensor APU is restarted
23	If this bit is set, the sensor **dev** password is reset to the factory value
Others	All the other bits are reserved for future use and must be set to 0.

If not otherwise stated, the operation bits can be combined safely.

☞ Important

The REST command is implemented only in the RT360, starting from firmware 04.01.00.

Example

```
 Func.Code    Length     Data                      CRC
52 45 53 54 00 00 00 08 00 00 00 01 44 6F 49 74 __ __ __ __
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"REST"	The Response function code
1st required	Word	4	?	The operations bit mask
2nd required	Word	4	0x446F4974	A fixed magic number used to confirm the operation

Example

```
 Func.Code    Length     Data                      CRC
52 45 53 54 00 00 00 08 00 00 00 01 44 6F 49 74 __ __ __ __
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing If the flash cannot be written
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds If the flash writing procedure do not return within 60 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the parameter ID is unknown or hidden If the parameter value is out of range

5.11 Get horizontal position

The GPOS remote command is used to read the Rotary Table rotation angle. The measurement unit is 1/1000th of degree and the reference is the homing position.

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"GPOS"	The Command function code

Example

```
 Func.Code   Length      CRC
47 50 4F 53 00 00 00 00 __ __ __ __
```

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"GPOS"	The Response function code
1st required	Word	4	?	Position value in 1/1000th of degree
2nd required	Word	4	?	Status bit mask

Example

```
 Func.Code   Length      Data                    CRC
47 50 4F 53 00 00 00 08 00 00 00 00 00 00 00 01 __ __ __ __
```

Status bit mask definition

Bit n°	Operation
0	If this bit is set, the device is rotating. If not set, the device is still
Others	All the other bits are reserved for future use and their value is undetermined

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing If the flash cannot be written
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds If the flash writing procedure do not return within 60 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the parameter ID is unknown or hidden If the parameter value is out of range

5.12 Set horizontal position

The SPOS remote command is used to position the Rotary Table at a specific rotation angle. The measurement unit is 1/1000th of degree and the reference is selected by the reference parameter described on the next table (1st required).

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"SPOS"	The Command function code
1st required	Word	4	?	Reference from which to calculate the movement
2nd required	Word	4	?	Rotation angle: the amount of degrees to rotate from the reference position. A positive value means a clockwise rotation, in 1/1000th of degrees

Example

```
 Func.Code   Length    Data                    CRC
53 50 4F 53 00 00 00 08 00 00 00 04 00 00 00 00 __ __ __ __
```

Reference value definition

Bit n°	Operation
0	Absolute reference. The angle is calculated from the homing (zero) position
1	The angle is calculated from the user defined parking position
2	Relative reference. The angle is calculated from the current position
3	The angle is calculated from the left limit position
4	The angle is calculated from the right limit position

Response from the device

Part	Type	Length	Value	Description
Function code	Word	4	"SPOS"	The Command function code
1st required	Word	4	?	Reference from which the movement was calculated
2nd required	Word	4	?	Rotation angle: the amount of degrees to rotate from the reference position

Example

```
 Func.Code   Length    Data                    CRC
47 50 4F 53 00 00 00 08 00 00 00 00 00 00 00 01 __ __ __ __
```

❖ Note

The response gives only confirmation that the command has been accepted, not that the requested movement has been completed.
The movement completion can be checked using the GPOS command.

6 Scan stream management

6.1 Command/Response pattern

A GSCN or a GS3D command can be requested whenever the measurement laser is on. Format of commands and responses are described in detail in *Paragraph 5.5* and *Paragraph 5.6*.

6.2 AutoScan

To avoid the timing issues that a user can incur using the Command/Response pattern, the Plus sensors have the possibility to be instructed to send continuous flow of scan data. This function is called AutoScan.
To start the AutoScan function a Client sends a special version of the SCAN command (described later in this chapter). The AutoScan function will not be limited to one destination at a time, so more Clients can use this function at the same time with the constraint that the Clients must be connected to different Service.

☞ Important

The AutoScan feature is implemented in the RT360 only, starting from firmware 04.01.06.00.

6.3 Using the SCAN command

The SCAN command is used to enable or disable the measurement process on the connected sensor.

6.3.1 Command format

Command from the control program

Part	Type	Length	Value	Description
Function code	Word	4	"SCAN"	The Command function code
1st required	Word	4	0	Enables (1) or disables (0) the measurement process on the connected sensor
2nd optional	Word	4	1	Enables or disables the AutoScan feature

Example

```
Func.Code   Length    Data        CRC
53 43 41 4E 00 00 00 08 00 00 00 01 81 AE 3F D5
```

Response from the sensor

Part	Type	Length	Value	Description
Function code	Word	4	"SCAN"	The Response function code
1st required	Word	4	0	The measurement process on the sensor was disabled
2nd optional	Word	4	1	The actual state of the AutoScan feature

Example

```
Func.Code   Length    Data        CRC
53 43 41 4E 00 00 00 08 00 00 00 01 81 AE 3F D5
```

Possible errors

Error	Case
-2001	If the streaming device has reported a hardware failure on reading
-2002	If the streaming device has reported a hardware failure on writing
-2003	If the first 8 characters (function code and length) are not completed within 5 seconds
-2007	If the number of bytes to be received is bigger than 8 kB If the number of parameters passed is invalid
-2009	If the requested feature is not supported by the device
-2021	If the system is not ready

6.3.2 Command description

First parameter: Measurement enable

The first parameter is used to control the measurement process.

- If the parameter is 0, the measurement process will be stopped.
- If the parameter is 1, the measurement process will be activated.

Second optional parameter: AutoScan

The second parameter is used to modify the AutoScan status on the contacted Service.

- If the value of the parameter is 0, the AutoScan function will be disabled.
- If the value is 1, the AutoScan function will be enabled and a GSCN packet will be sent continuously.

- If the value is 2, the AutoScan function will be enabled and a GS3D packet will be sent continuously.

Some examples

`SCAN,1,2`

```
 Func.Code   Length    Data        CRC
53 43 41 4E 00 00 00 08 00 00 00 01 00 00 00 02 81 AE 3F D5
```

This command will enable the AutoScan function and it will clear the Scan&Store buffer.

`SCAN,1`

```
 Func.Code   Length    Data        CRC
53 43 41 4E 00 00 00 08 00 00 00 0F 7D 8D 3E 27
```

This command will enable the measurement process. The AutoScan function status will not be modified.

`SCAN,0,0`

```
 Func.Code   Length    Data        CRC
53 43 41 4E 00 00 00 08 00 00 00 00 00 00 00 00 F6 A9 0F 43
```

This command will disable the AutoScan function and will stop the measurement process.

A User parameters

This appendix contains a reference and a description of all User parameters defined on the Rotary Table.

❖ Information

This chapter describes only the User parameters defined by the Rotary Table device.
For an extensive description of the parameters defined by the connected sensor see the Laser Scanner Programmer's Manual.

100000 Release date *Const*

Contains the firmware release date.

100001 Serial number *Const*

Contains the Rotary Table serial number.

100002 Home position *Const*

The home position defined in encoder steps. This value is set in Triple-IN factory and cannot be modified.
It defines the position to which the device will move after the initialization process and from which all the absolute angle values refer to.

100003 Parking position

A parking position defined by the user. It is a helper parameter which allow the user to make movement referred to this position.
The value is expressed in 1000th of degree.

Dev. model	Minimum	Maximum	Default value
RT340	-170000	+170000	0
RT360	-180000	+180000	0

100004 Horizontal position *Temp*

Defines the absolute angular position of the device, referred to the Home position, in 1000th of degree.
Setting this parameter will make the device rotate to the defined value.

Dev. model	Minimum	Maximum	Default value
RT340	-170000	+170000	0
RT360	-180000	+180000	0

100005 Moving speed

This User parameter can be set to the speed to apply on every movement.
The relation between the value of this parameter and the actual speed is defined by the next table.

Value	Default value
0	Default speed. It is set as Positioning speed
1	Normal speed: calculated depending on the scan speed of the connected sensor's Pulse Repetition Frequency. 40KHz PRF: 1.8° per second 60KHz PRF: 2.7° per second
2	Fast speed: calculated depending on the scan speed of the connected sensor's Pulse Repetition Frequency. 40KHz PRF: 7.2° per second 60KHz PRF: 10.8° per second
3	Fine speed: calculated depending on the scan speed of the connected sensor's Pulse Repetition Frequency. 40KHz PRF: 0.1125° per second 60KHz PRF: 0.16875° per second
4	Positioning speed: 16° per second
5	Calibration speed: 0.03125° per second
10..50000	Specific value of speed in millidegree per second

100006 Device IP address AAA.xxx.xxx.xxx

The first byte of the Rotary Table IP address.

100007 Device IP address xxx.BBB.xxx.xxx

The second byte of the Rotary Table IP address.

100008 Device IP address xxx.xxx.CCC.xxx

The third byte of the Rotary Table IP address.

100009 Device IP address xxx.xxx.xxx.DDD

The last byte of the Rotary Table IP address.

100010 Device service port

Contains the Rotary Table service port.

Minimum	Maximum	Default value
0	65535	1024

100011 Device IP subnet mask AAA.xxx.xxx.xxx

The first byte of the Rotary Table IP subnet mask.

100012 Device IP subnet mask xxx.BBB.xxx.xxx

The second byte of the Rotary Table IP subnet mask.

100013 Device IP subnet mask xxx.xxx.CCC.xxx

The third byte of the Rotary Table IP subnet mask.

100014 Device IP subnet mask xxx.xxx.xxx.DDD

The last byte of the Rotary Table IP subnet mask.

100015 Horizontal position in encoder steps

Read only

Defines the absolute angular position of the device, referred to the Home position, in encoder steps.

Dev. model	Minimum	Maximum	Default value
RT340	-15111	+15111	0
RT360	-16000	+16000	0

100019 Sensor tilt angle

Const

Tilt angle of the connected sensor from the vertical.
This parameter is set at factory when the Rotary Table and the Laser Scanner are provided as an integrated system.

100020 Sensor base offset

Const

Distance between foot point and height of the measurement point of origin on the Rotary Table axis of rotation.
This parameter is set at factory when the Rotary Table and the Laser Scanner are provided as an integrated system.

100023 Sensor longitudinal offset *Const*

Longitudinal distance between the measurement point of origin and rotation axis of the Rotary Table.
This parameter is set at factory when the Rotary Table and the Laser Scanner are provided as an integrated system.

100024 Sensor transversal offset *Const*

Transversal distance between the measurement point of origin and rotation axis of the Rotary Table.
This parameter is set at factory when the Rotary Table and the Laser Scanner are provided as an integrated system.

100025 Custom parameters

The parameters from **100025** to **100040** are reserved for storing user defined parameters.

100042 Extra power line enable

This parameter is used to enable (1) or disable (0) the extra power line available on the rotating side of the Rotary Table.

Minimum	Maximum	Default value
0	1	0

Important

This parameter is available only on RT360 with customized connectors.

100043 Device IP default gateway address AAA.xxx.xxx.xxx

The first byte of the Rotary Table IP default gateway address.

100044 Device IP default gateway address xxx.BBB.xxx.xxx

The second byte of the Rotary Table IP default gateway address.

100045 Device IP default gateway address xxx.xxx.CCC.xxx

The third byte of the Rotary Table IP default gateway address.

100046 Device IP default gateway address xxx.xxx.xxx.DDD

The last byte of the Rotary Table IP default gateway address.

100047 Device IP acquired via DHCP

If set to 1, the IP address will be acquired through DHCP.
If enabled, Device IP address, Device service port and Device IP default gateway parameters will be ignored.

☞ Important

Parameters from 100043 to 100047 are available only from version 1.22/040020.

100049 Hi torque mode

If set to 1, a specific hi-torque mode will be enabled.
The motor will be put under higher stress in this mode, so it is recommended to use it only when it is needed.

100050 System version

If set to 1, a specific hi-torque mode will be enabled.

☞ Important

Parameters 100049 and 100050 are available only from version 04.01.06.00.

B Error Codes

Error codes table

Code	Description
-2000	Physical device I/O error
-2001	I/O read error
-2002	I/O write error
-2003	Timeout expired
-2004	User break
-2005	CRC checksum error
-2006	Unknown command
-2007	Parameter is out of range
-2008	Access denied / Permission denied
-2009	Unsupported function
-2010	Invalid handle / Bad address
-2011	Division by zero
-2012	Array index is out of bounds
-2013	Internal buffer overflow
-2014	Fatal system error
-2015	System configuration error
-2016	Error in serialization
-2017	KEM Unit error / Measurement clock failure
-2018	Angle encoder failure / Motor failure
-2019	Temperature out of operating range
-2020	Front screen not clear
-2021	System not ready
-2022	Empty buffer

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