

# Leica Captivate TS Survey Streaming Manual



Version 6.04  
English

- when it has to be **right**

**Leica**  
Geosystems

## 1. Introduction

### Description

The TS SurveyStreaming app is used for point measurement and additionally streaming out ASCII messages to different interfaces.

Angles and distances for points can be measured and the calculated coordinates stored using **Measure**, **Distance** and **Store** as described in the technical reference manual chapter 45.

One main difference to existing Auto points and GSI output functionality is that the trigger to send a message is not based on storing a point.

Time stamps of the streamed messages are based on the internal totalstation measurement time – the time of the operation system the app is running (remote or onboard) is synchronized with the internal measurement clock of the totalstation. Details will be in a separate chapter in this manual.

## 2. Meas & Stream Home

### Description

The standard pages and functionality of the TS Measure application are available within this app. Additionally a Streaming page is available on the first tab.

### Access

Select **Leica Captivate - Home: Meas & Stream**.

Leica Captivate -  
Home,  
 page

The fields shown are from a typical working style. An additional page is added to the standard measurement panel.

The fields shown are from a typical working style.



Key	Description
<b>Measure</b>	To measure and store distances and angles.
<b>Stop</b>	Available if <b>Measure distance: Continuously</b> and <b>Distance</b> was pressed. Stops the distance measurements. The key changes back to <b>Measure</b> .
<b>Distance</b>	To measure and display distances.
<b>Store</b>	To record data. If <b>Measure distance: Continuously</b> and/or <b>Automatically measure points</b> is checked, records measured point and continues tracking.
<b>Start / End</b>	To start / stop streaming data
<b>Page</b>	To change to another page on this panel.
Key	Description
<b>Fn Settings</b>	If Streaming page is active to configure stream format and interfaces. If other pages are active to configure the pages displayed and auto point measurements.

<b>Fn Display</b>	To configure what is displayed in the 3D viewer.
<b>Fn Init</b>	To initialize a new time synchronization
<b>Fn Tools</b>	Refer to "36 Apps - The Toolbox" technical reference manual.

Description of fields streaming page

Field	Option	Description
<b>Number of messages sent</b>	Display only	The number of messages sent out of the interface.
<b>Last message sent</b>	Display only	The time when the last messages was sent out of the interface.

### 3. Configure Streaming

**Streaming** The standard pages and functionality of the TS Measure application are available setting within this app. Additionally a Streaming page is available on the first tab.

**Access** Select **Fn Setting** when Streaming tab is active.

**Stream configuration** General stream configuration selections.

**Settings** Hz 0.0000 ° V 0.0000 ° @ 12:56

**Stream configuration** Interface

Automatically start streaming when ☐ starting the app

Stream new data after certain **Time** ▼

Stream data every **0.2 sec** ▼


Number of initial time synchronizations **20**

OK Page

Key	Description
<b>OK</b>	To store streaming settings and return to Meas & Stream
<b>Page</b>	To change to another page on this panel.

Description of fields

Field	Option	Description
<b>Automatically start streaming</b>	Check box	Activates the automatic streaming of messages each time the Meas & Stream app is started..

		 All other fields on the panel are active and can be edited.
<b>Stream new data after certain</b>	<b>Time</b>  <b>Distance</b>  <b>Difference in Height</b>  <b>Distance or Height</b>  <b>On Point Stored</b>	<p>Messages are streamed according to a time interval. If the application is running onboard the TS intervals up to 20 Hz are available. If the app is running remotely the highest streaming rate is 5 Hz.</p> <p>The difference in distance from the last position of a message that was sent, which must be reached before the next message is sent.</p> <p>The height difference from the position of the last message, which must be reached before the next message is sent.</p> <p>Before the next message is sent, either the difference in distance or the difference in height must be reached.</p> <p>Messages are streamed after a point has been stored in the application</p>
<b>Stream data every</b>	Editable field  From <b>0.2 sec</b> Remote From <b>0.01 sec</b> TS onboard  to <b>60.0 sec</b>	For <b>Stream new data after certain: Time</b> . The time interval before the next message is sent.
<b>When distance changed by</b>	Editable field	Available <b>Stream new data after certain: Distance, Difference in height or Distance or height</b> . The value for the difference in distance before the next message is sent.
<b>Or when height changed by</b>	Editable field	Available for <b>Stream new data after certain: Distance or height</b> . The value for the height difference before the next message is sent.
<b>Number of initial time synchronizations</b>	Editable field From <b>0</b> to <b>200</b>	The number of time synchronizations between the TS and operation system clock that will be executed when first start streaming or pressing the <b>Init</b> key. Details on the sync see chapter 4.

Interface

Interface configuration

Settings

Stream configuration

Interface

Connect using

Device on any interface

Format

N,E,Ht,HZ,V,Sd,Ref,M,D,T

Device

RS232 1

OK

Page

Settings

Stream configuration

Interface

Connect using

Configured inte...

Interface

GSI output

Format

N,E,Ht,HZ,V,Sd,...

OK

Page

Key	Description
OK	To store streaming settings and return to Meas & Stream
Page	To change to another page on this panel.

#### Description of fields

Field	Option	Description
<b>Connect using</b>	<b>GSI Output</b>	Messages are defined and streamed according to GSI output configuration. See Chapter 17.14 technical reference manual.
	<b>Device on any interface</b>	Messages will be streamed to a specific defined device that is attached to a interface ( example RS232 device used on the CS Bluetooth port attached to the ASCII input interface ).
	<b>TCP port</b>	Messages will be streamed to TCP connection (client or server). Only available on CS35 or CS simulator.
	<b>UDP port</b>	Messages will be streamed to UDP connection.
	<b>Serial port on PC</b>	Messages will be streamed to a serial port on the PC. Only available on CS35 or CS simulator.
	<b>File stream</b>	Messages will be streamed to the configured file.
	<b>Configured Interface</b>	Interface configured in Captivate
<b>Device</b>	Editable field	For <b>Connect using: GSI Output, Device on any interface</b> . The device name used for the connection. Display only for GSI Output.
<b>Interface</b>	Configured ports	Device is not available, the configured interface defines the output

<b>Format</b>	<b>GeoCOM Msg 2167</b>	Message 2167 from ASCII GeoCOM protocol
	<b>GSI8 polar &amp; cartesian</b>	GSI Polar and Cartesian (8 data characters) (Point ID, Hz, V, SlopeDist, PPM, E, N,
	<b>GSI16 polar</b>	GSI Polar (16 data characters) (Point ID, Hz, V, SlopeDist, PPM, reflector height)
	<b>GSI16 cartesian</b>	GSI Cartesian (16 data characters) (E, N, Elev, Reflector Height)
	<b>Pt, N, E, Ht, Date</b>	Coordinate data (Northing BEFORE Easting)
	<b>Pt, E, N, Ht, Date</b>	Coordinate data (Easting BEFORE Northing)
	<b>NMEA GGA</b>	Based on NMEA (National Marine ElectAssociation), which is a standard for marine electronic devices. Coordinate system has to be linked to the measurement job to convert local coordinates to WGS84.
	<b>Pseudo NMEA GGA</b>	Based on NMEA (National Marine ElectAssociation), which is a standard for marine electronic devices.
	<b>GSI8 polar GSI16 polar 2</b>	GSI Polar (8 data characters) (Point ID, Hz, V, SlopeDist, PPM) GSI Polar (16 data characters) (Point ID, Hz, V, SlopeDist, PPM)
	<b>Pt, N, E, Ht, Date, Sensortime</b>	Coordinate data & SensorTime (Northing BEFORE Easting)
	<b>Pt, E, N, Ht, Date, Sensortime</b>	Coordinate data & SensorTime (Easting BEFORE Northing)
	<b>GeoCOM Msg 2003</b>	Message 2003 from ASCII GeoCOM protocol
	<b>N, E, Ht, Hz, V, Sd, Ref, M, D, T</b>	Coordinate & Measurements data & SensorTime (Northing, Easting, Height, Hz Angle, V Angle, Slope Distance, EDM Kind, EDM Mode, Date, Time, Sensortime)
	<b>E, N, Ht, Hz, V, Sd, Ref, M, D, T</b>	Coordinate & Measurements data & SensorTime (Easting, Northing, Height, Hz Angle, V Angle, Slope Distance, EDM Kind, EDM Mode, Date, Time, Sensortime)
	<b>NMEA Simrad HiPAP</b>	Based on NMEA Simrad HiPAP transponder telegram.

<b>Serial port</b>	Available serial ports on PC	Available for <b>Connect using: Serial port on PC</b> . Communication port settings ( <b>Baudrate, Parity, Data bits, Stop bit &amp; Flowcontrol</b> fields will be available for this port setting.
<b>Server</b>	Check box	Available for <b>Connect using: TCP port</b> . TCP server or client connection
<b>IP address</b>	Editable field	Available for <b>Connect using: TCP port &amp; UDP port</b> . IP address of the TCP / UDP client or server.
<b>Port</b>	Editable field	Available for <b>Connect using: TCP port &amp; UDP port</b> . IP port number of the TCP / UDP client or server.

Output format -

The GSI format specification could found in the Technical Reference Manual 17.14. **GSI-Formats** Values will be exported in the current used units.

Output format -  
GeoCOM Msg 2167

Format  
%R1P,0,0:0,HZ,V,0,0,C,L,0,0,SlopeDist,DistTime <CR/LF>

Description of fields

Field	Description
Header	Fix GeoCOM Suffix %R1P,0,0:0
Hz	Result of the horizontal angle measurement [rad].
V	Result of the vertical angle measurement [rad].
C	Result of the cross inclination measurement [rad].
L	Result of the length inclination measurement [rad].
SlopeDist	Result of the distance measurement [m].
DistTime	Time of the distance measurement [ms].
<CR/LF>	Carriage Return Line Feed



Output format -  
Pt, N, E, Ht,  
Date

Format  
Point ID, Northing, Easting, Elevation, Date, Time, DistTime <CR/LF>

Description of fields  
The format settings are defined in Regional.

Field	Description
Point ID	Text describing the point identification select in Survey panel.
Northing	The Northing coordinate of the target.
Easting	The Easting coordinate of the target.
Elevation	The height coordinate of the target.
Date	The measurement date [dd.mm.yyyy].
Time	The measurement time [hh:mm:ss.ss].
DistTime	Time of the distance measurement [ms].
<CR/LF>	Carriage Return Line Feed

Output format -  
Pt, E, N, Ht,  
Date

Format  
This output format is identical to the Pt,N,E,Ht,Date format except the order of the Easting and Northing variables are reversed.

Output format -  
Pt, N, E, Ht,  
Date, Sensortime

Format  
Point ID, Northing, Easting, Elevation, Date, DistTime <CR/LF>

Description of fields  
The format settings are defined in Regional.

Field	Description
Point ID	Text describing the point identification select in Survey panel.
Northing	The Northing coordinate of the target.
Easting	The Easting coordinate of the target.
Elevation	The height coordinate of the target.
Date	The measurement date [dd.mm.yyyy].
DistTime	Time of the distance measurement [ms].
<CR/LF>	Carriage Return Line Feed

Output format -  
Pt, E, N, Ht,  
Date, Sensortime

Format  
This output format is identical to the Pt,N,E,Ht,Date,Sensortime format except the order of the Easting and Northing variables are reversed.

Output format -  
GeoCOM Msg 2003

Format  
%R1P,0,0:0,HZ,V,0.0,DistTime,C,L,0.0,0,0 <CR/LF>

Description of fields

Field	Description
Header	Fix GeoCOM Suffix %R1P,0,0:0
Hz	Result of the horizontal angle measurement [rad].
V	Result of the vertical angle measurement [rad].
DistTime	Time of the distance measurement [ms].
C	Result of the cross inclination measurement [rad].
L	Result of the length inclination measurement [rad].
<CR/LF>	Carriage Return Line Feed

Output format -  
**N, E, Ht, Hz, V, Sd,  
Ref, M, D, T**

Format  
Point ID, Northing, Easting, Height, Hz Angle, V Angle, Slope Distance, EDM Kind,  
EDM Mode, Date, Time, Sensortime <CR/LF>

Description of fields  
The format settings are defined in Regional.

Field	Description
Point ID	Text describing the point identification select in Survey panel.
Northing	The Northing coordinate of the target.
Easting	The Easting coordinate of the target.
Elevation	The height coordinate of the target.
Hz	Result of the horizontal angle measurement [rad].
V	Result of the vertical angle measurement [rad].

SlopeDist	Result of the distance measurement [m].
EDM Kind	2 = Reflector, 3 = Reflectorless
EDM Mode	1 = Standard, 2= Fast, 3 = Tracking, 4 = Rapid Tracking, 5 = Averaging, 6 = Syncro Tracking, 7 = Prieicse
Date	The measurement date [dd.mm.yyyy].
DistTime	Time of the distance measurement [ms].
Time	The measurement time [hh:mm:ss.ss].
<CR/LF>	Carriage Return Line Feed

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Output format -  
**E, N, Ht, Hz, V, Sd,**  
**Ref, M, D, T**

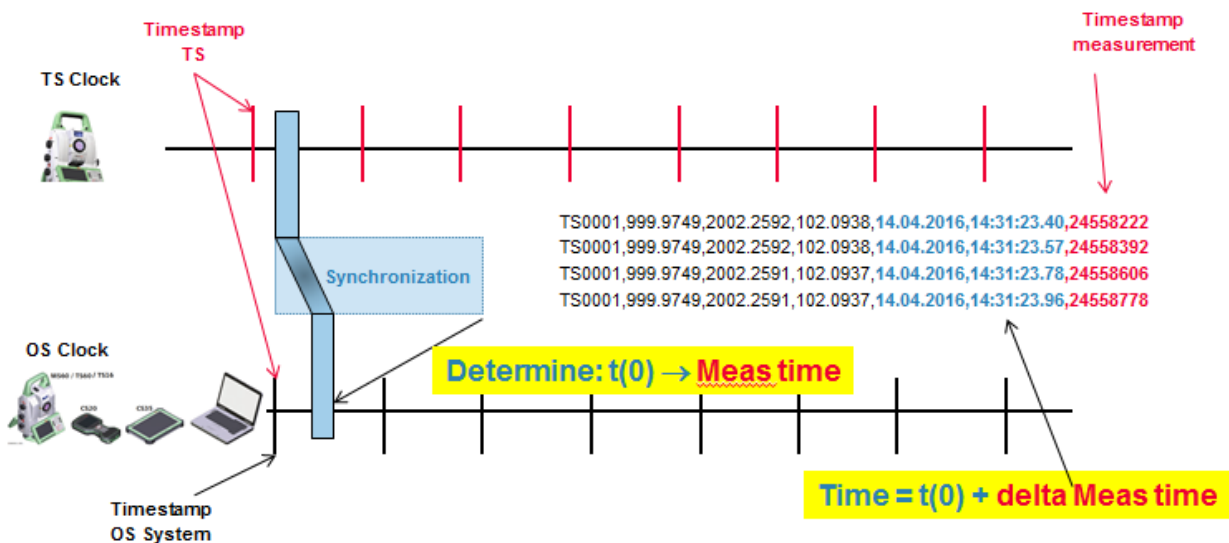
Format  
This output format is identical to the N, E, Ht, Hz, V, Sd, Ref, M, D, T format except the order of the Easting and Northing variables are reversed.

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## 4. Times and Synchronization

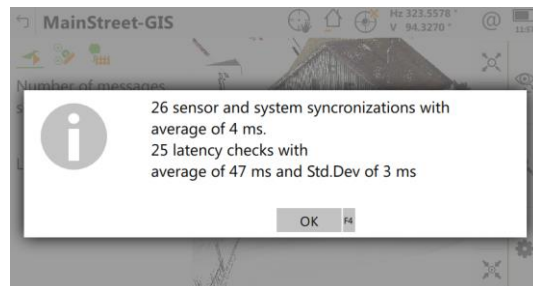
### Description

All time stamps in the TS SurveyStreaming app are related to the internal TS clock. This clock starts initial with 0 when turn the sensor is powered. To get local times format and also synchronize this clock with the clock where the app is running an initial time synchronization is needed. After this synchronization all time stamp will be computed based on the synchronization results and the TS clock. When entering the app an initial synchronization will be executed. The synchronization could be repeated all the time pressing **Fn Init** when streaming is not active.



### TimeStamp

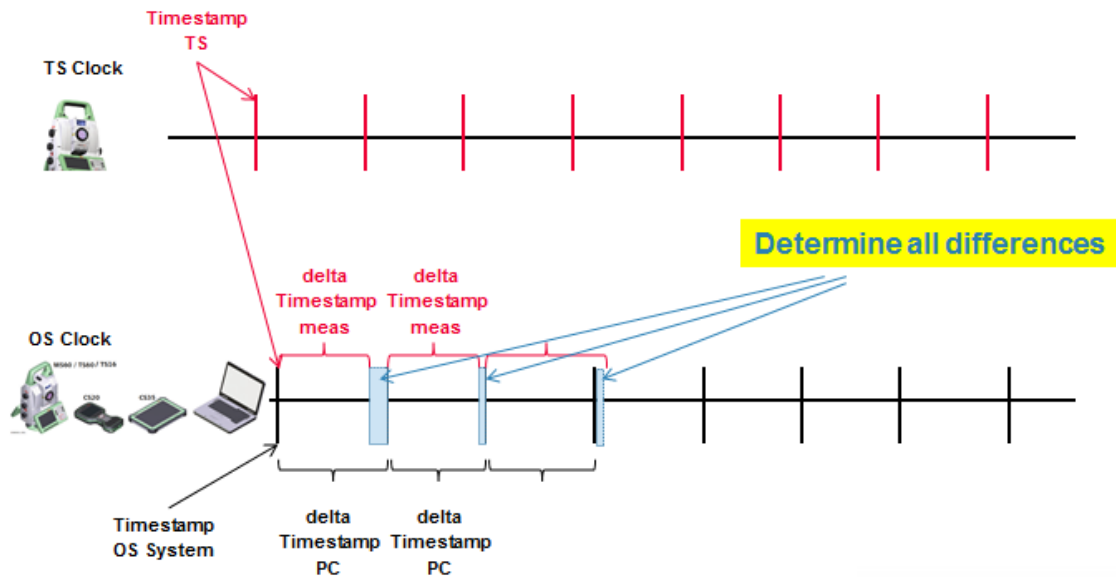
The timestamps of the messages streamed out of the app are based on this initial time  $t(0)$  of the OS clock and the TS clock. Possible different latencies in the communication during the application would not have any influences because all is based on this initial synchronization. The user will be notified about the quality of this synchronization process - the results will be shown in a message ( automatic close after 30 seconds ) and additionally stored in the database.



## 4.1 Times differences TS Clock and OS Clock

### Description

First step in the initialization process is to determine the time differences between the timestamps of the TS Clock and the timestamps of the OS the app is running. Running the app on the MS/TS then the number of this checks is defined in the settings of the app – for remote connections this checks are running in parallel with the synchronization tasks described in chapter 3.2.



## 4.2 Latency on remote connection

### Description

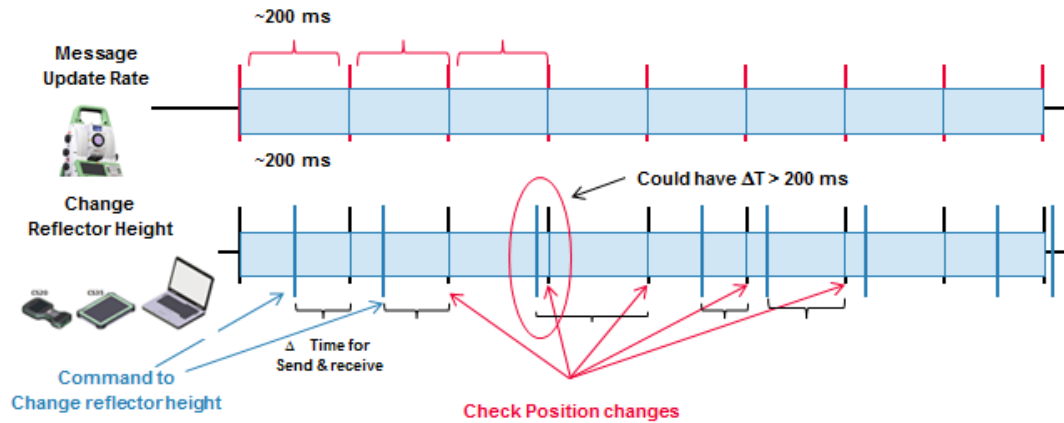
In this step of the synchronization the latency between the remote connection and the TS will be determined. Knowing the exact timing of a movement from the target will enable to match the raw measurements with its internal TS time.



Do not move the telescope of the TS during this initialization process.

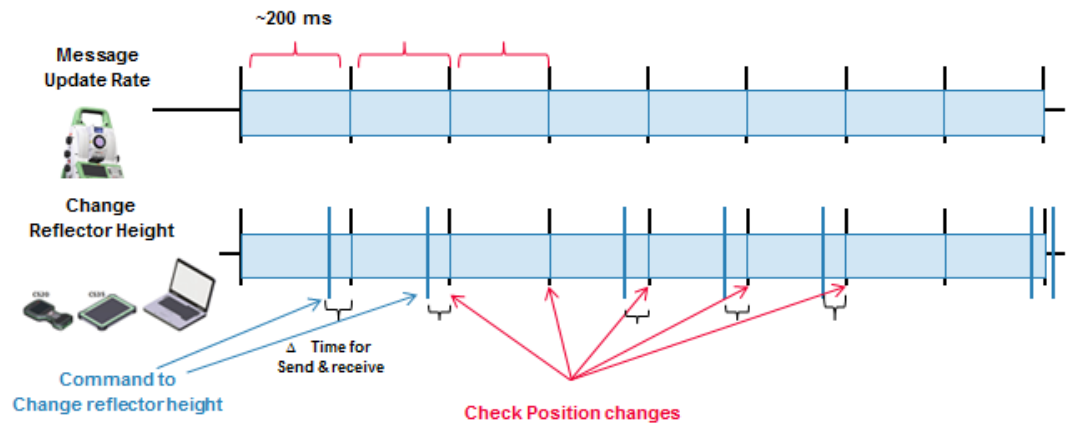
### Simulate Movement

In most setups the targets are fixed and could not be moved. To simulate a movement the reflector height will be changed and an observer will detect the time when this change is mirrored in the target height.



Detect  
Outliers

Captivate receive the TS measurements with an update rate of 5Hz. If the command to change the reflector height was send too close to the next available measurements this could end up with resulting time  $> 5$ Hz. The timing for sending the command has been optimized to get the best available latency for this update rates. Higher update rates in the future would determine the latency more accurately

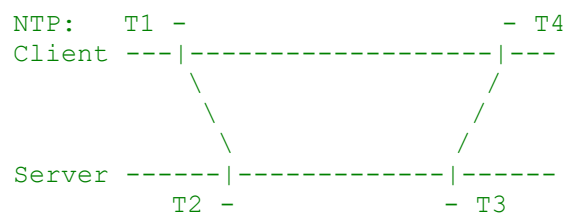


## 4.3 Remote Operating System clock synchronization

Description

In order to be able to synchronize the measurement raw data with the operating system clock on a remote device, a network time protocol implementation exists in the app. This enables the usage of unordered network transport protocols like UDP and post process synchronization.

The Network Time Protocol consists of four timestamps, two on client and two on server site.



With this information, the time on the client (Tx) referenced to the server clock (EDM\_Measurement timestamps) can be calculated using the following formula:

Time on client with local clock offset (RFC2030)

$$T_{\text{client}} = ((T2 - T1) + (T3 - T4)) / 2 + T_x$$

Which is based on RFC 2030 (<https://datatracker.ietf.org/doc/html/rfc2030>)

To be able to reference the time on the clients operating system (os) to the measurements on the server (TPS), the timestamps of the measurements are required. Therefore, in this case, T2 is the EDM-time of the last measurement when received the request. T3 is the EDM-time of the next valid measurement before sending the reply. Valid means the time difference between EDM-time and operating system time (TPS) is less than 50ms. If the latency shown in the Message described in 4. Is higher, the command will not succeed.

## 5.0 Commands and ASCII protocol

**Description** The functionality to send some commands to the TS SurveyStreaming app is available version 3.02 and higher. Turn telescope was added with version 3.04, Start/Stop Stream with 3.07.

### ASCII Syntax

Syntax of an ASCII Survey Stream request:

```
[<LF>] %R8Q, <RPC> [, <TrId>] : [<P0>] [, <P1>, ...] <Term>
```

<LF>	An initial line feed clears the receiver buffer.
%R8Q	Survey Streaming request
<RPC>	Remote Procedure Call identification number in between 0 to 65535.
<TrId>	Optional transaction ID: normally incremented from 1 to 7. Same value in reply.
:	between protocol header and following parameters.
<P0>, <P1>, ...	Parameter 0, Parameter 1, ...
<Term>	Terminator string CR/LF

Syntax of an ASCII Survey Stream response:

```
[<LF>] %R8P, <RPC> [, <TrId>] : [<P0>] [, <P1>, ...] <Term>
```

<LF>	An initial line feed clears the receiver buffer.
%R8P	Survey Streaming response
<RPC>	Remote Procedure Call identification number in between 0 to 65535.
<TrId>	Optional transaction ID: normally incremented from 1 to 7. Same value in reply.
:	between protocol header and following parameters.
<P0>, <P1>, ...	Parameter 0, Parameter 1, ...
<Term>	Terminator string CR/LF

### Return codes

GRC_COM_CANT_DECODE_REQ	3080	Can't decode request
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GRC_COM_PROC_UNAVAIL	3081	The requested procedure is unavailable
GRC_COM_CONS_REQ	3107	Another request still pending

## 1. Start Distance

Description Start the distance procurement.

ASCII Request

*%R8Q,1:*

ASCII Response

*%R8P,0,0:RC*

Parameters

No parameter required

Return codes

GRC_OK	0	Distance measurement started
GRC_DIST_ERR	26	Unable measure the distance

## 2. Stop Distance

Description Stop the distance procedure if it is running.

ASCII Request

*%R8Q,2:*

ASCII Response

*%R8P,0,0:RC*

Parameters

No parameter required

Return codes

GRC_OK	0	Function successfully completed
GRC_STOP_DIST_FAILED	29	Unable stop the measurement process



### 3. Store Point

Description Store the current point to the database. The same as an user press Store in the instrument.

ASCII Request

*%R8Q,3:*

ASCII Response

*%R8P,0,0:RC*

Parameters

No parameter required

Return codes

GRC_OK	0	Function successfully completed
GRC_DIST_MANDATORY	27	A distance measurement is required

### 4. Start Stream

Description Start the streaming to the configured interface.

ASCII Request

*%R8Q,4:*

ASCII Response

*%R8P,0,0:RC*

Parameters

No parameter required

Return codes

GRC_OK	0	Function successfully completed
GRC_START_FAILED	50	Start streaming failed
GRC_STREAM_ACTIVE	51	Streaming is already active

## 5. Stop Stream

Description Stop the streaming from the configured interface.

ASCII Request

*%R8Q,5:*

ASCII Response

*%R8P,0,0:RC*

Parameters

No parameter required

Return codes

GRC_OK	0	Function successfully completed
GRC_STOP_FAILED	52	Stop streaming failed
GRC_STREAM__NOT_ACITVE	53	Streaming is not active

## 6. Search Reflector

Description Start the searching procedure to find the reflector

ASCII Request

*%R8Q,6: SearchKind*

ASCII Response

*%R8P,0,0:RC*

Parameters

SearchKind	integer	in	
------------	---------	----	--

Search Kind value	Description
1	ATR Window Static
2	Power Search 360 Degree ClockWise
3	Power Search 360 Degree CounterClockWise
4	Power Serach Windows Static
5	ATR Window Dynamic

Return codes

GRC_OK	0	Reflector found
GRC_NOT_OK	30	Unable to start the reflector search procedure
GRC_ReflectorNotFound	31	Reflector not found

## 7 Turn Telescope

Description Turn the telescope to the specified position

ASCII Request

*%R8Q,7: PosMode, Hz or North, V or East, Elevation(only for TgtMode)*

ASCII Response

*%R8P,0,0:RC*

Parameters

PosMode	integer	in	
---------	---------	----	--

Pos Mode value	Description
0	Hz and V specified position
1	Target Position with coordinates

Hz or North	double	in	Horizontal angle [rad] or Target Northing [m]
V or Easting	double	in	Vertical angle [rad] or Target Easting [m]
Elevation	double	in	Target Elevation [m] only for Pos Mode = 1

Return codes

GRC_OK	0	Reflector found
GRC_NOT_OK	40	Unable to start the positioning procedure
GRC_PositioningFailed	41	Positioning failed

## 8. Ntp – Network time protocol

Description

Get timestamps from the EDM (telescope).  
For this command it is highly recommend to use the Transaction Identifier (<TrId>) to be able to identify the reply of the send request.  
A distance measurement is required to be able to receive the EDM-Timestamps.

## ASCII Request

*%R8Q,8:ClientTimeT1*

## ASCII Response

*%R8P,0,0:RC,ClientTimeT1,EDMTimeT2,EDMTimeT3*

## Parameters

ClientTimeT1	long	in	Unix timestamp when message is sent
ClientTimeT1	long	out	Unix timestamp received from client
EDMTimeT2	long	out	Unix timestamp of measurement when received request (uptime of EDM)
EDMTimeT3	long	out	Unix timestamp of measurement before send reply (uptime of EDM)

## Return codes

GRC_OK	0	Timestamps valid
GRC_DistMandatory	27	No distance available. Start distance measurement procedure
GRC_NtpClientTimestampNotValid	54	Timestamp received from client not valid (T1 < 0)
GRC_TMC_DIST_ERROR	1992	Distance measurement not achieved, timestamps not valid
GRC_COM_CANT_DECODE_REQ	3080	Failed to decode request. Request not in valid format
GRC_COM_CANT_ENCODE_REP	3082	Failed to encode reply message
GRC_COM_CONS_REQ	3107	Request send before reply to previous request is send. Consider using transaction identifier

## Example

*%R8Q,8,1:1603889027*

*%R8P,0,1:0,1603889027,1208781603,1208781718*

T1: 1603889027

Ntp command send time from client

T2: 1208781603

EDM-Meas time when Ntp command is received

T3: 1208781603

EDM-Meas time when Ntp command is send back

T4: 1603889137

Client time when Ntp command is received

Calculate time T at client, related to the EDM of the TPS instrument

Local Clock offset :

$$t = ((T2 - T1) + (T3 - T4)) / 2 = -395107534$$

Local time (T4) related to EDM-Measurement:

$$T = t + T4 = 1208781603$$

## 9. Set Point ID

Description This is the point ID which will be set in the TPS-Streaming application.

ASCII Request

*%R8Q,9:PointId*

ASCII Response

*%R8P,0,0:RC*

Parameters

PointId	string	in	The point id to be used
---------	--------	----	-------------------------

Return codes

GRC_OK	0	Success
GRC_SetPointIdFailed	55	Failed to apply the point id

## 10. Store new point

Description This will create a new point and store it to the currently active database with the given parameter.

ASCII Request

*%R8Q,10:PointId,CrsSystem,Ordinate1,Ordinate2,Ordinate3*

ASCII Response

*%R8P,0,0:RC*

Parameters

PointId	string	in	The point id to be used
CrsSystem	int	in	Define which Coordinate reference system to be used: 0: WGS84 1: Local Grid
Ordinate1	double	in	This is the Latitude [rad] or Northing [m] part of the point
Ordinate2	double	in	This is the Longitude [rad] or Easting [m] part of the point
Ordinate3	double	in	This is the height [m] part of the point

Return codes

GRC_OK	0	Timestamps valid
--------	---	------------------

GRC_StorePointFailed	56	Failed to store the point to the database
----------------------	----	-------------------------------------------

---

#### Example

```
%R8Q,10,P1,0,-0.827434893015844175,0.167894822001353936,451.123
%R8P,0,0:0
```

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