GSI ONLINE for 3D Disto

January 2012

- when it has to be **right**

Leica Geosystems

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1 Introduction

The Leica Geosystems Serial Interface (GSI) is a general purpose, serial data interface for bi-directional communication between the instrument and the computer. GSI uses a simple command structure to read/write values from/to the sensor. Global and instrument specific Word Indexes (WI) are used to specify various data types. GSI provides specific sets of commands adapted to the functionality of the various instrument series.

The guide is designed as a simple command listing and therefore basic aspects of serial data communications will not be covered in depth. Chapter 2.5 features a very simple example written in VBA using Microsoft Excel™.

2 GSI Definition

2.1 GSI data format

GSI data is transmitted in blocks with each block ending with a terminator (CR or CR/LF). Every block consists of several data words (see the examples below). The data word begins with a two character Word Index, the WI code, specifying the data type within this block. The GSI-8 block has in total 16 characters, consisting of 7 information characters (e.g. WI, sign), followed by 8 data characters and by the blank character (ASCII code 32) at the end of the data word. The GSI-16 block is similar to the GSI-8 block but the block begins with "*" and the data word contains 16 characters for large values such as UTM coordinates, large alphanumeric codes, attributes or point IDs.

Example 1 shows a GSI-8 block sequence with the words for point ID (11), easting coordinate (81) and northing coordinate (82). Example 2 shows a GSI-16 block sequence with the words for point ID (11), horizontal (21) and vertical angle (22). **Note: 3D Disto does only support GSI16.**

Example 1: GSI-8

| <---- Word 1 ----> | <---- Word 2 ----> | <---- Word 3 ----> |

```
1234567890123456  (16 characters per word)

110001+0000A110 81..00+00005387 82..00-00000992
110002+0000A111 81..00+00007586 82..00-00003031
110003+0000A112 81..00+00007536 82..00-00003080
110004+0000A113 81..00+00003839 82..00-00003080
110005+0000A114 81..00+00001241 82..00-00001344
       |←8 ch. →|
```

GSI-8 data word structure:

Pos. 1-2:	Word Index (WI)	e.g. "11" (WI for PtID)
Pos. 3-6:	Information related to data	e.g. "0003" (block number in word 1)
Pos. 7:	Sign	e.g. "+" or "–"
Pos. 8-15:	Data (8 digits)	e.g. "0000A113" (PtID)
Pos. 16:	Blank (= separating character)	

Example 2: GSI-16

| <--------- Word 1 ------> | <-------- Word 2 --------> | <-------- Word 3 ------> |

```
 1234567890123456789012345678901234  (24 characters per word)

*110001+000000000PNC0055 21.002+0000000013384650 22.002+0000000005371500
*110002+000000000PNC0056 21.002+0000000012802530 22.002+0000000005255000
*110003+000000000PNC0057 21.002+0000000011222360 22.002+0000000005433800
*110004+000000000PNC0058 21.002+0000000010573550 22.002+0000000005817600
*110005+000000000PNC0059 21.002+0000000009983610 22.002+0000000005171400
        | <-- 16 char. -->|
```

GSI-16 data word structure:

Pos. 1-2:	Word Index (WI)	e.g. “11”; WI code
Pos. 3-6:	Information related to data	e.g. “002”
Pos. 7:	Sign	e.g. "+" or "-"
Pos. 8-23:	GSI-16 data (16 digits)	e.g. “000000000PNC0058”; PtID
Pos. 16/24:	Blank (= separating character)	

GSI word information

Position	*Explanation*	*Applicable for*
3	No significance	All words
4	**AUTOMATIC INDEX INFORMATION** 0: Automatic index OFF 1: Automatic index OPERATING 3: Automatic index OPERATING	All words containing angle information
5	**INPUT MODE** 0: Original measured values transferred from the instrument 1: Manual input from keyboard 2: Measured value, Hz-Correction ON 3: Measured value, Hz-Correction OFF 4: Result of special function	Measured data
6	**UNITS** 0: Meter (last digit: 1mm) 1: Feet (last digit: 1/1000ft) 2: 400 gon 3: 360° decimal 4: 360° sexagesimal 5: 6400 mil 6: Meter (last digit: 1/10mm) 7: Feet (last digit: 1/10‘000ft) 8: Meter (last digit: 1/100mm)	Measured data
7	**SIGN** +: Positive value -: Negative value	Measured data
8-15 (8-23)	**DATA** Data includes a sequence of 8(16) numerical or alphanumerical characters. Note that certain data blocks are allowed to carry more than 1 value (e.g. PPM/MM). Those data are automatically transferred with a sign before each single value.	Measured data
16 (24)	**SEPARATING CHARACTER** _: Blank	All words

2.2 Online command structure

GSI online commands represent a simple syntax structure consisting of four basic commands. To access a wide range of settings or values, commands can be enhanced with a limited sequence of word indexes (WI) and parameters. Following, a short summary explaining the meaning of the basic commands continued with some examples.

- SET Set instrument parameters
- CONF Read internal parameter settings
- PUT Write/change values within the Total station
- GET/I/… Get instant values from the Total Station (last valid value)
- GET/M/… Release measurement and get measured values from the Total Station
- POSIT Turn the instrument

Examples:

SET commands
SYNTAX: SET/<set spec>/<parameter><CR/LF>
EXAMPLE: SET/173/0
RESPONSE: ?

Instrument Compensator:	SET/173/0	OFF (disable)
	SET/173/1	ON (enable, sensitive)
	SET/173/2	ON (enable, standard)

CONF commands
SYNTAX: CONF/<conf spec><CR/LF>
EXAMPLE: CONF/173
RESPONSE: 0173/0000

Above CONF/173 reads the Compensator setting	0173/0000	Compensator OFF
	0173/0001	Compensator ON, sensitive
	0173/0002	Compensator ON, standard

PUT commands
SYNTAX: PUT/<put spec> <Value>_<CR/LF>
EXAMPLE: PUT/86…n+00045000
n[0..1]; distance unit must be specified
RESPONSE: ?
CONFIRMATION: <CR/LF>

Writes Station Elevation	PUT/86…0+00045000 ➔ puts Elevation=”45.000 m”

☞ Make sure you put a space (_), behind <Value>! (Space, not underscore)

GET commands
SYNTAX: GET/n/WI<get spec><CR/LF>
EXAMPLE: GET/M/WI21
RESPONSE: 21.102+12149400

Read Hz-Angle value	GET/I/WI21	➔ 21.104+12149400
Read Hz-,and V-Angles	GET/I/WI21/WI22;	➔ 21.104+12149400 ➔ 22.104+08832420

Note:
Unless the unit is not already specified in the command itself, the GSI interface returns values in the units that are set on the instrument. E.g.: GET/I/WI21 returns 21.104+12149400
has chosen to return 4 on position 6 because of the instrument unit setting 360° sexagesimal.

2.3 Online Commands 3D Disto

2.3.1 General

Supported Instruments:
- 3D Disto

Default RS232 parameter settings for virtual ComPort:
Baud: 115200
Parity: none
Databits: 8
Stopbit: 1

Low Level commands
SYNTAX: <command>CR/LF

<Command>:	a b	Enables 3D Disto software to send/receive GSI commands Closes the GSI Interface

See chapter 2.3.8 for interaction principles of 3D Disto software with 3rd party software.

Instead of command a, alternatively x can be used. However, using x closes open measurements on 3D Disto without asking. It must therefore be guaranteed by the 3rd party software that no data of importance are lost. It is safer to use a.

<Command>:	x	Enables 3D Disto software to send/receive GSI commands

The following command listing is split into separate sections for each basic command (SET, CONF, PUT, GET, POSIT).

2.3.2 SET

Syntax: SET/<SET SPEC>/<Parameter><CR/LF>

<SET SPEC>	***FUNCTION***	***<PARAMETER>***	***SETTING***
36	Laser Pointer + Viewfinder	0 1	OFF ON and locked
40	Angle UNIT	0 1	GON Degree decimal
41	Distance UNIT	0 1	Meter US Feet, decimal
70	RS232 - Baudrate	*0* 3 4 5 6 7 9 10 12	1200 Baud 2400 Baud 4800 Baud 9600 Baud 19200 Baud 38400 Baud 57600 Baud 115200 Baud (default) 14400 Baud
71	RS232 - Parity	0 1 2	None (default) Odd Even
76	Data recording device	0 1	Internal Memory Interface
173	Compensator	0 1 2	OFF ON (sensitive) ON (standard)

Note:
SET/40 and SET/41 do support fewer choices than the corresponding CONF/40 and CONF/41 commands. That's because the GSI output is restricted to decimal output, compare footnote in chapter 2.3.5.

2.3.3 CONF

Syntax: CONF/<CONF SPEC><CR/LF>

<CONF SPEC>	*FUNCTION*	*RESPONSE*	*CONFIGURATION*
36	Laser Pointer / Viewfinder	0036/0000 0036/0001	Off On
40	Angle UNIT	0040/0000 0040/0001 0040/0002	Gon Degree decimal Degree sexagesimal
41	Distance UNIT	0041/0000 0041/0001 0041/0007	Meter US Feet, decimal US Feet/Inch 1/16 Inch
70	RS232 - Baudrate	*0070/0000* *0070/0003* *0070/0004* *0070/0005* *0070/0006* *0070/0007* *0070/0008* *0070/0009* *0070/0010* *0070/0012*	1200 Baud 2400 Baud 4800 Baud 9600 Baud 19200 Baud 38400 Baud 56000 Baud 57600 Baud 115200 Baud (default) 14400 Baud
71	RS232 - Parity	0071/0000 0071/0001 0071/0002	NONE (default) ODD EVEN
73	Terminator	0073/0000 0073/0001	CR (3D Disto doesn't support) CR/LF (default)
76	Data recording device	0076/0000 0076/0001	Internal Memory Interface
90	Sensor Battery level	0090/00nn	n:[0..10] 0: Empty 10: Full
137	RS232 recording length	0137/0001	GSI-16 (default; GSI-8 not supported)
160	Validity of measured distance (retrospective)	0160/0000 0160/0001	Distance invalid Distance valid
170	Detect current face	0170/0000 0170/0001	Face I Face II
173	Compensator	0173/0000 0173/0001 0173/0002	OFF ON (sensitive) ON (standard)
174	Compensator Status	0174/0000 0174/0001 0174/0002 0174/0003 0174/0004	Off O.K. Tilt too big Old Fail

2.3.4 PUT

Syntax: PUT/<PUT SPEC>/<Parameter>_<CR/LF>

<PUT SPEC>	***FUNCTION***	***Access/Example***
21	Hz Angle (Orientation)	PUT/21…n+10000000_<CR/LF> n[2..3]; angle units must be specified ➔ for n=2; puts Hz=”100.0000 gon”
84	Station Easting	PUT/84…n+00100000_<CRLF> n[0..1]; distance unit must be specified ➔ for n=0; puts Easting=”100.000 m”
85	Station Northing	PUT/85…n+00100000_<CRLF> n[0..1]; distance unit must be specified ➔ for n=0; puts Northing=”100.000 m”
86	Station Elevation	PUT/86…n+00045000_<CRLF> n[0..1]; distance unit must be specified ➔ for n=0; puts Elevation=”45.000 m”

2.3.5 GET

Syntax: GET/n/WI<GET SPEC>/<Parameter><CR/LF>

<GET SPEC>	*FUNCTION*	*Access/Example*
11	Pointnumber	GET/M/WI11<CR/LF>; e.g. 11….+00000066 ➔ PtNo="66"
12	Serial number	GET/I/WI12<CR/LF>; e.g. 12....+00640054 ➔ S.No. "640054"
13	Instrument type	GET/I/WI13<CR/LF>; 13....+03DDISTO ➔ Instr. "3DDISTO"
21	Horizontal Angle	GET/M/WI21<CR/LF>; e.g. 21.102+17920860 ➔ Hz „179.086" gon
22	Vertical Angle	GET/M/WI22<CR/LF>; e.g. 22.102+07567500 ➔ V: „75.675" gon
31	Slope distance	GET/M/WI31<CR/LF>; e-g. 31..00+00003387 ➔ Sdist: „3.387" m
32	Horizontal distance	GET/M/WI32<CR/LF>; e.g. 32..00+00003198 ➔ Hdist: „3.198" m
33	Height difference	GET/M/WI33<CR/LF>; e.g. 33..00+00001119 ➔ Hdiff: „1.119" m
81	Target Easting (E)	GET/M/WI81; e.g. 81..00+01999507 ➔ E: "1999.507"m
82	Target Northing (N)	GET/M/WI82; e.g. 82..00+00213159 ➔ N: "2139.159"m
83	Target Elevation (H)	GET/M/WI83; e.g. 83..00-00032881 ➔ H: "32.881"m
84	Station Easting (E0)	GET/I/WI84; e.g. 84..11+00393700 ➔ E: "393.700"m
85	Station Northing (N0)	GET/I/WI85; e.g. 85..11+06561220 ➔ N: "6561.220"m
86	Station Height (H0)	GET/I/WI86; e.g. 86..11+00065618 ➔ H: "65.618"m
87	Reflector height (hr) (always zero)	GET/I/WI87; e.g. 87..11+00001700 ➔ hr: "1.700" m
88	Instrument height (hi) (always zero)	GET/I/WI88; e.g. 88..11+00001550 ➔ hi: "1.550" m
590	SW-Version: Application	GET/I/WI590; e.g. 590..6+00021000 ➔ "V2.10"

Note:

The n parameter in the string GET/n/ steers the system to make a distance measurement if set to 'M'. Otherwise, the measurement result transferred refers to a previously measured distance. Angle readings are always up-to-date, it doesn't matter if requested with 'M' or 'I'

Note:

Position 6 of 3D Disto GSI does not support sexagesimal degree and feet-inch. In case the HMI is set to sexagesimal degree, the GSI automatically refers to decimal degree.

Position 6	0: 1: 2: 3:	Meter (last digit: 1mm) Feet (last digit: 1/1000ft) 400 gon (3 digits) 360° decimal	Measured data, compare chapter 2.1

Distance unit settings in the HMI are simplified in the GSI to:

HMI Distance unit setting	**GSI GET commands uses**
0.000 m	0.000 m
0.0 cm	0.000 m
0 mm	0.000 m
0.000 ft	0.000 ft
0 in 1/32	0.000 ft
0’00” 1/16 ft	0.000 ft
0.000 yd	0.000 ft

with proper transformation.

2.3.6 POSIT/CFACE

Command	***Function***
CFACE	Turns the telescope to the opposite face
POSIT/<spec>Hz/V or POSIT/X/right/up	Turns the telescope to the given direction horizontally and vertically. Hz and V, and right and up are given in the unit set in the instruments.
List of <spec>	
A	Absolute positioning to the given values
R	Relative positioning from the current position
P	Turn the telescope to the direction of the last distance measurement
X	Relative positioning from the current position in metric units. This feature equals the comfort targeting feature

Example:

POSIT/A/123.4567/99.8754	Turns the telescope to the circle reading 123.4567 gon Hz and 99.8754 gon Vertical.
POSIT/R/20/0	Turns the telescope 20 gon clockwise.
POSIT/P/1/-1	Turns to the last position where a distance has been measured with 1 gon offset horizontal and vertical.
POSIT/X/0.55/-1	Starting from the current position, the telescope turns right 0.55m and down 1m from the current position, like it would do it in case of the comfort targeting function.

The unit of the parameters is chosen from the GSI command according to the units that are set on the instrument (HMI). 3D Disto GSI does not support sexagesimal degree and feet-inch. In case the HMI is set to feet-inch, the GSI automatically refers to decimal feet. In case the HMI is set to sexagesimal degree, the GSI automatically refers to decimal degree.

Note:
POSIT/X is specific to 3D Disto; POSIT/A, R, P and S are used on motorized TPS systems. POSIT/S is not used on 3D Disto

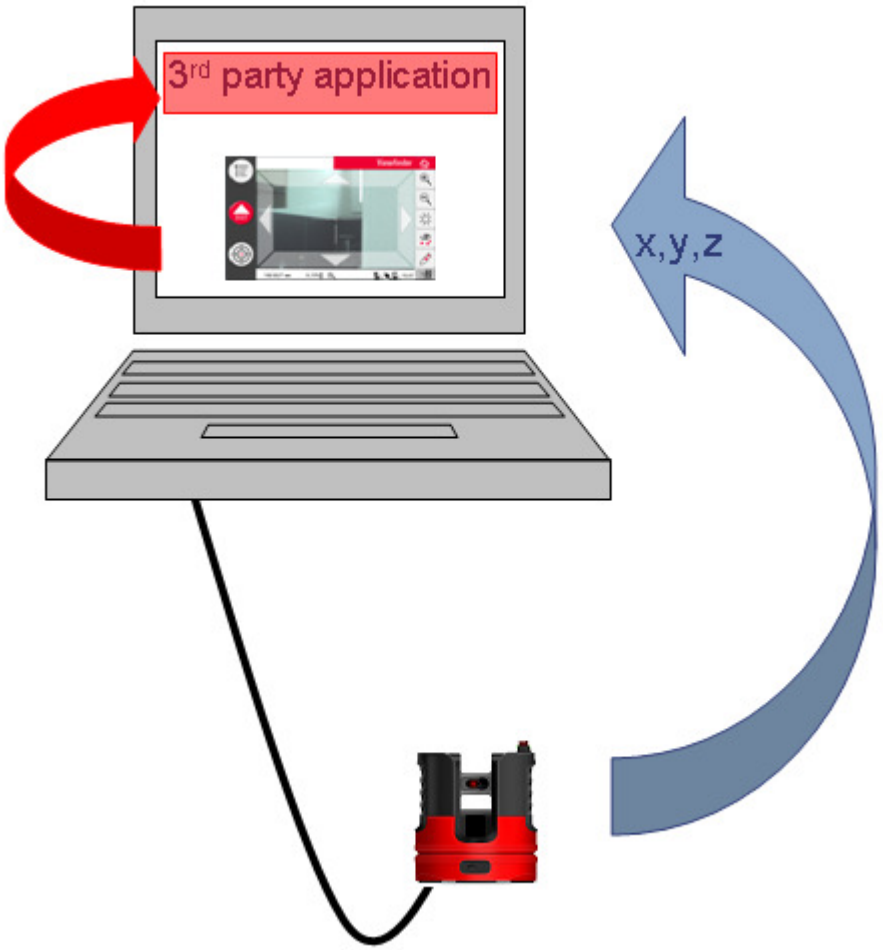
2.3.7 Warnings and Errors

Errors, initiated by an interface command are transferred to the interface. The warning will be sent and the 3D Disto will be ready to receive the next command. This is the list of potential errors and warnings; it might be the case that not all of them will occur at the 3D Disto.

Message ID	***Meaning***	***Possible reasons***
@W100	Instrument busy	Any other device is still interfacing the instrument; check interfacing priorities. This might also be the case if e.g. the compensator check blocks a command, or if the sensor is still turning while another command is already sent.
@W127	Invalid command	The string sent to the instrument could not be decoded properly or does not exist; check the syntax, or… Input buffer overflow (max. 100 characters)
@E112	Battery low	Low Battery; check voltage
@E117	Initialization error	Contact service
@E119	Temperature out of range	Refer to manual for temperature range
@E139	EDM error	The EDM could not proceed the requested measurement; no or weak signal; Check EDM mode and target
@E144	V or Hz collimation error	Check calibration data
@E150	Angle error	Call service
@E158	One of the instruments sensor corrections could not be assigned.	Instrument is not stable, not leveled or suffering of vibration; Tilt is out of range (e.g. when tilt sensor is out of range); Level instrument or switch off compensator
@E182	Telescope position out of range	Positioning timeout; Instrument could not position; Try again
@E190	General motorization Error	If frequently occurs call service
@E191	Data error	Check record mask
@E194	General error	If frequently occurs call service

2.3.8 3rd party software and 3D Disto HMI interaction

- To use GSI interface, first install the 3D Disto HMI software from the file Leica_Geosystems_3D_Disto_1.1.0.6_setup.exe
  It is not possible to use the Control Unit to host GSI; 3D Disto must be connected to a Windows PC operating the above software installation. However, the infrared remote control RM100 works also if 3D Disto is in GSI mode and if the laser is turned on (SET/36/1).
- It uses a virtual COM port and listens to the port as long as the above mentioned interface software is running.
- The virtual port is provided by com0com software and is installed also from above exe file.
- The software needs connection to 3D Disto and is in a GSI 'sleep' mode until the command 'a' is sent by a 3rd party application software: Unless the command 'a' (chapter 2.3.1) isn't sent, the system does not answer to any other GSI command.
- If 'a' is sent, the HMI closes the current application, or it clears the screen if it is yet not cleared (in either case, the user has the option to save the data before the screen is cleared or the application closes). Finally, once the system is set back to the 3D Disto application with cleared screen, the GSI interface can be used. In case that the system is stuck because the user has to save his data first (pop-up is waiting for user decision), sending GSI command results in error @W100 (System busy). If the user has properly proceeded, the HMI shows the cleared 3D Disto screen AND is ready to receive GSI commands.
- To use the viewfinder, the user can use the viewfinder button in the HMI or the GSI SET/36/1 command. The GSI command always sets the viewfinder in the lock-mode. To close the view-finder with GSI, use SET/36/0
- If the HMI shows the viewfinder, and in case the viewfinder is not in lock-mode, a GET/M/ command closes the viewfinder.
- Per default, the system does *not* store any measurement executed through the GSI interface in a database (Data Recording Device = Interface, compare SET/76, GET/76). Thus, any GET/M/ command executing a distance measurement, does not shown the result in the HMI position sketch, and does not store any measurement in the measurement database of the 3D Disto itself. However, if the user uses the DIST button of the 3D Disto HMI, data are added as usual in the sketch as well as in the measurement database, and the system automatically sends a GSI string according to the GET request:
  GET/M/WI11/WI21/WI22/WI31/WI81/WI82/WI83/WI87;
  (PtId, Hz, V, Slope dist., E, N, h, hr)
  Using the red button on the RM100 infrared remote control has the same effect as executing DIST button.
- If Data Recording Device is set to Internal (SET/76/1), all GET/M commands executing a distance measurement return the corresponding GSI result AND act as if the user would have hit the DIST button. Manipulating (e.g. deleting) any data in the HMI has no influence on the GSI, but acts as usual in the HMI. If storage is set to 'internal', the GSI interface is only actively sending strings via the COM port on a request by one of the GSI commands. Any keystroke on the 3D Disto HMI does not actively send GSI strings; however, it might influence the result of GSI queries, e.g. if the distance unit setting is changed in the HMI, a future GET command might deliver a result in feet or meter, depending on the setting.
- GET/M/WI81 to 83 returns the coordinates based on the current station plus the offset given by measurements of Hz, V and Dist.
- GET/M/WI84 to 86 return the station (=sensor) coordinates.
- Only corrected angles are used in the GSI interface, no raw angles without tilt correction will be sent at any time.
- If the station is changed in the HMI, e.g. by relocation, it automatically affects the output of WI81 up to WI86.
- Changing the station and orientation with the GSI PUT commands, the sensor station will be changed in the same way the relocation feature would do it (however, the HMI would not show the used target marks since it doesn't know their position). It is up to the user to ensure that changing the station through the GSI interface doesn't negatively influence the work that he/she might be doing in parallel on the HMI and vice versa.

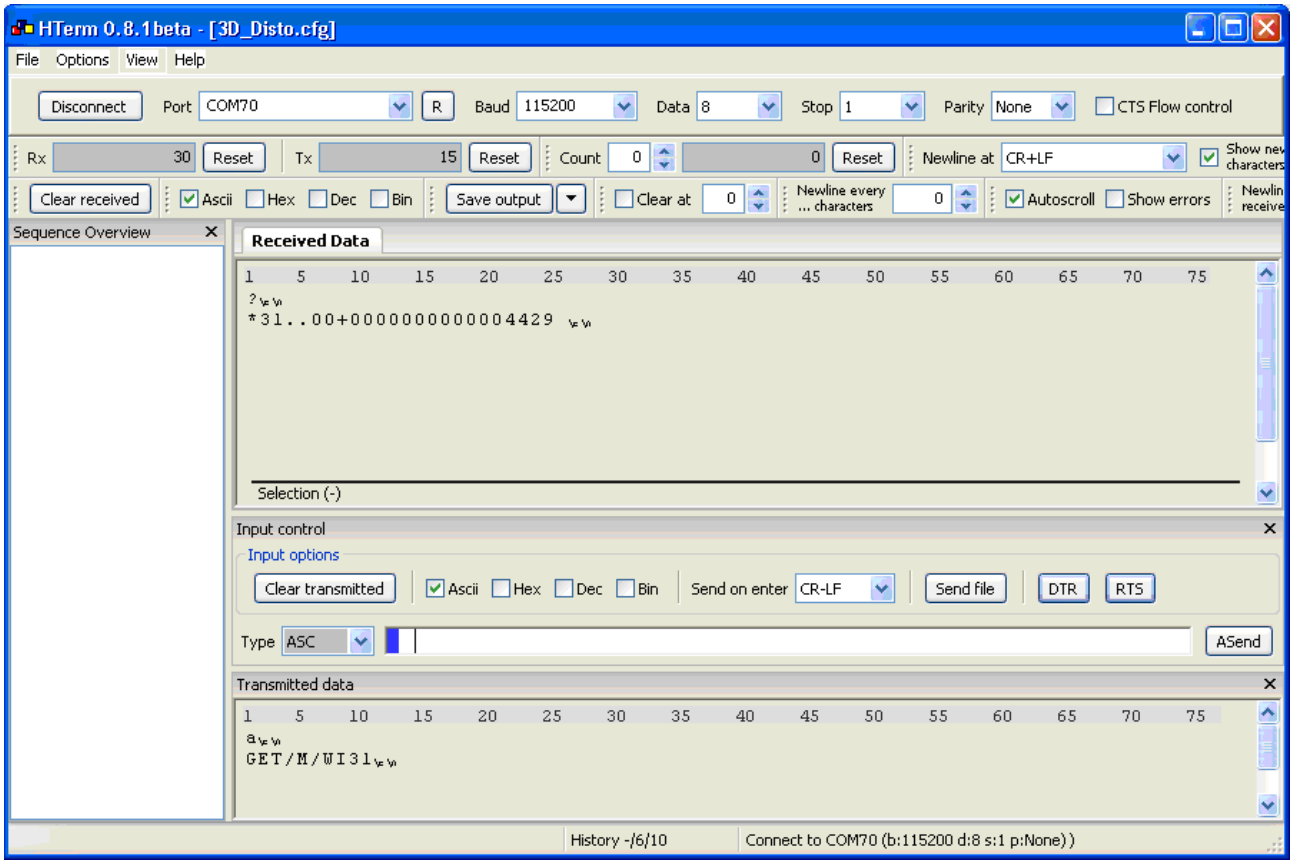

3rd party application
x,y,z

2.4 Testing GSI connection

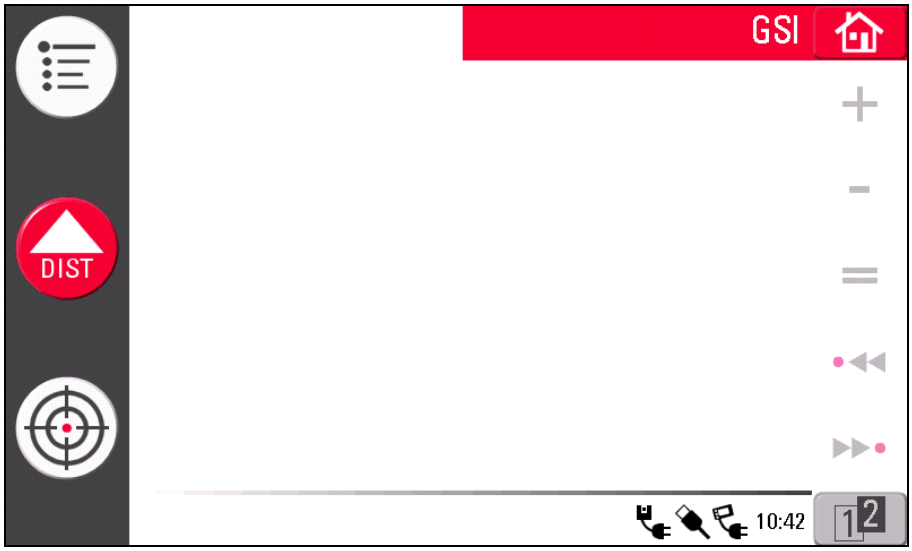
You can use a simple terminal program, such as HTerm, e.g. from here:

http://www.heise.de/software/download/hterm/53283

Run 3D Disto software. Connect on COM70 within HTerm. Setting for input option 'Send on Enter' is **CR-LF**, see picture. Simply type a command and press ENTER key on your PC keyboard (do not use the ASend button within HTerm)

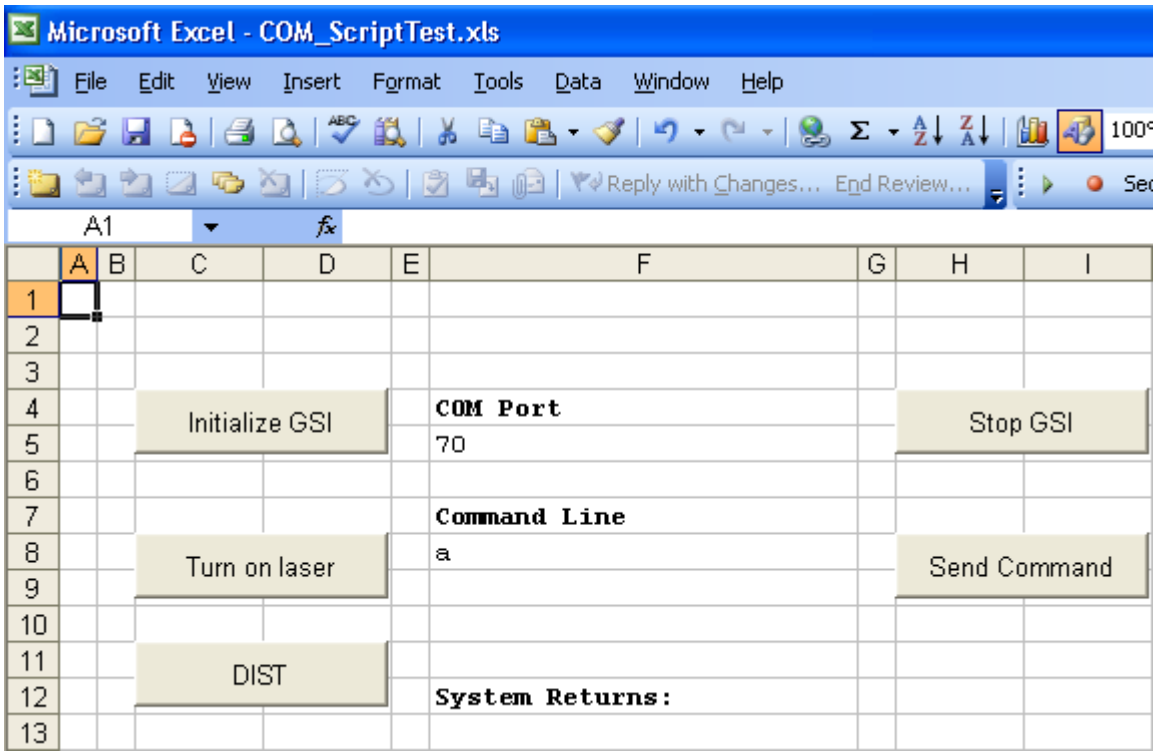


With a successful connection running, the header line should say 'GSI':



2.5 VBA Script COM_ScriptTest.xls

There is a file COM_ScriptTest.xls part of the scope of this software delivery opening in Microsoft Excel™. Purpose of the COM_ScriptTest.xls is only for being an example GSI usage, it is not generally required to operate with 3D Disto and GSI interface.



This file contains VBA scripts that allow to test GSI interface as well as having a look how to use Microsoft Windows™ API functions to handle serial ports. To see the source code, open the VBA editor of Microsoft Excel™.

```
' Open COM port
lngStatus = CommOpen(intPortID, portname, _
    "baud=115200 parity=N data=8 stop=1")

If (lngStatus) Then
    MsgBox "Can not open port", vbCritical
Else
    ' Send GSI Command a
    Call Write_GSI("a")
    Call Read_GSI_Buffer
End If
```

To operate the COM_ScriptTest.xls, run 3D Disto software. Open the COM_ScriptTest.xls and press the ‘Initialize GSI’ button. With a successful connection running, the header line of 3D Disto software should say ‘GSI’ (compare chapter 2.4). Now you can send a command using the command line (cell F8) and the ‘Send Command’ button, or you use the preconfigured commands ‘Turn on laser’ or ‘DIST’. All system output is automatically pasted in line 13 and beyond. Once finished, close GSI connection using the ‘Stop GSI’ button.

Of course, the usage of GSI in this simple script is very limited; normally, the reading and writing to the serial port should be handled in a multitasking environment, using separate threads for reading and writing to the port and a proper event handling.