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If there are major differences in using or handling the programs in one of the various OS (Operating Systems), then the appropriate part will be marked with one of the following icons.

This manual was produced using Microsoft Word.

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1 Introduction

1.1 Objective and the contents of the TRC05 Training Course

The objective of the TRC05 Training Course is to provide the basic guidelines how to operate the DCP05 software onboard a 3D Leica precision total station. The goal of the training is...

- to speed up the implementation process by providing the basic guiding information
- to use the powerful DCP05 program in performing real time dimensional control tasks on site and
- to save results in a file to be printed out.

Well-planned and documented function and training cases provide detailed procedure descriptions how different type of dimensional control tasks are performed.

The training manual is basically divided into the following subjects:

1.1.1 Introduction
This covers a brief introduction to the training contents and to Dimensional Control (DC), principles and implementation.

1.1.2 DCA System Description
Contains an introduction to the Dimensional Control and Analysis (DCA) System and its accessories.

1.1.3 Use cases
Describes how to use the basic functions and how to save results in 3D-files for further analysis and printouts. Separate training cases of each function are guided through on STEP by STEP principle.

1.1.4 3D Coordinate Measurement cases
The principles of the 3D coordinate measurement are described including the Object and the Instrument 3D Coordinate System (OCS and SCS) and the orientation methods (DOM and POM). Training cases are available to train the operator in performing the 3D coordinate measurements and calculations on STEP by STEP principle. Detailed instructions and documentation are provided for the cases.
1.2 Principles of Dimensional Control (DC)

1.2.1 Objective
To apply DC techniques in monitoring, controlling and analysing the production stages in order to continuously improve the design details and working methods to raise productivity.

1.2.2 Short term goal
To monitor the manufacturing accuracy of the critical working processes in order to minimise delays and rework during fabrication and parts assembly.

1.2.3 Long term goal
To implement an accuracy control and management system in order to continuously improve the design and manufacturing practises of the whole construction process to achieve drastic increase in productivity.

1.2.4 Method
DC is a cyclical and continuous working process as shown below. To achieve the long-term goal it might take years of hard work and requires commitment from all involved departments.
1.3 Dimensional Control Task (DCT)

The Dimensional Control Task (DCT) typically comprises the following major phases 1 to 5, each of them including the following sub tasks to be carried out:

1.3.1 Preplanning (office)
- DC goal setting,
- Definition of measurement stages,
- Definition of the design data to be used (vital points),
- Specifying the form of the reports,
- Planning the specific measurement procedures,
- Planning the specific actions needed,
- Planning the adjustment procedures for the instruments.

1.3.2 Measurement preparations (office)
- Producing (creating) the measurement worksheets (files),
- Extracting and downloading the design data, typically from point information from 3D CAD systems
- Transfer the worksheets (including the design data) to the measuring site, i.e. upload design data to the instrument

1.3.3 Measurement procedure (on site)
- Object point targeting,
- System set-up and instrument orientation to the object coordinate system,
- Point measurements (and data collection),
- Immediate measurement control based on Actual/Design differences.

1.3.4 Dimensional Analysis (office)
- Download the design/actual data from the instrument to PC,
- Numerical/Graphical analysis of the measured structure,
- Producing DC reports,
- Saving the design/Actual data for future use.

1.3.5 Process Analysis (office)
- Numerical/Graphical analysis and evaluation of the specific manufacturing processes, / stages, / object types or / process lines,
- Producing accuracy reports of the whole process,
- Planning of improvements in production/design processes.
1.4 About DC System Overall Implementation

1.4.1 Major Prerequisites
1. Use of the Product Oriented Work Breakdown Structure,
2. Well defined work processes and procedures,
3. System of Master (Building) Reference Lines, which define the Object Coordinate System.

1.4.2 One Time Investments
1. DC System implementation,
2. Development of Standard DC procedures,
3. Integration of the DC procedures into manufacturing processes,
4. Initial data collection and analysis,
5. Establishment of data bases of the critical work processes,
6. Expanding the use of the DC system.

1.4.3 How to get started
1. Commitment of the top management level,
2. Selection of the construction project / process stage,
3. Implementation plan,
4. Team definition:
   - Production engineering,
   - Design,
   - DC surveyor (operator),
   - Shop floor workers,
   - Outfitting,
   - Quality assurance.
5. Written definition of assembly and welding procedures,
6. Estimation of manufacturing tolerances,
7. Applied standards (or estimations) for overlength fabrication (excess material),
2 System Description of DCP05

2.1 System overview
The DCA-TPS5000 is a Dimensional Control and Analysis System comprising the A.M.S. dimensional control software and the Leica Geosystems 3D precision total stations. The DCA software includes several Dimensional Control Programs DCP. The Leica total stations offer a full range of precision total stations for different fields of accuracy:
- TPS1000
- TC/TCA2003
- TDM/TDA5005

The new remote control system RCS1100 in conjunction with TDA5005 allows to operate DCP05 from the point of interest.

![Figure 2-1: The fully remotely controlled system with TDA5005](image)

The DCA software products have been especially developed to meet the requirements of the real-time dimensional control tasks, analysis, simulation and reporting in large scale assembly processes such as shipbuilding, steel construction and similar industries. An operator performs fast and efficiently both basic and more demanding 3D measurements.

If more complex geometrical analysis is required, Leica’s software platform Axyz is an ideal add-on.

The onboard DCP05 has variety of measuring and control functions to process effectively the 3D coordinate information for on line surveying of parts and assemblies and for guiding the building and assembly processes based on comparison of Design and measured Actual 3D data.

DCP and Axyz training courses are tailored to the individual needs.
2.2 Real-time dimensional control

The various dimensional control tasks are performed based on measuring the position of a point in a specified 3D coordinate system. It is advantageous to use the Object Coordinate Systems (OCS) as the measurement basis, so that the actual/design comparison can be obtained instantly. The design values of the target points are imported using ASCII files.

It is important to know that the 3D measurement instruments (called total stations, 3D-sensors, tacheometers, etc.) are primarily measuring in their own Sensor Coordinate System (SCS). Thus, in real-time measurements there is the ultimate need to have versatile procedures (DOM, POM, Change Station) to align the 3D measurement instrument into OCS.

The onboard DCP05 and the handheld DCP10 measuring programs include special measuring functions such as to measure the 3D coordinate values of a hidden point with the aid of a hidden point bar. The XorYorZ function is advantageous, when measuring points of which only one or two coordinate values are important e.g. points laying on the edge of a thin plate. The setting out function combined with the pointing red laser permits to locate and visualise 3D object points for building and inspection of fabrication parts.

Additionally the circle measurement and analysis and the 3D-Front-Back point pair measurement with their support on 3D-file brings new aspects in effective use of total stations in large-scale assembly.

The DCP05 program comprises calculation features for real-time dimensional analysis. The position of a measured point can be compared to any other measured point, reference line or plane. The references are calculated from the set of measured points defined by the operator.

The SCS of a measuring instrument is based on following conditions

- **Stable mechanical construction** including the horizontal and vertical circles, which are perpendicular to each other, and a distance measurement unit integrated in the tilting unit.
- **Horizontal 0-direction** is given by the horizontal circle.
- **Horizontal plane and positive z-axis** defined by the dual-axis compensator (based on gravity).
- The **SCS origin** \((x=0,y=0,z=0)\) is defined by the intersection point of the tilting axis, standing axis and optical axis (= line of sight).
3 Measurements on training object

3.1 Principles of Coordinate measurements

3.1.1 Principle of 3D Point Measurement in Sensor Coordinate System

The location of a target point of an object is measured in terms of Polar coordinates:

- **Radial slope distance** from sensor to target point,
- **Horizontal angle** given by the horizontal circle,
- **Vertical angle** given by the vertical circle.

The results are calculated and shown in a Cartesian coordinate system (x,y,z) called **Sensor Coordinate System (SCS)**.

The origin of SCS is located in the center of a sensor at the intersecting point of the optical axis (= line of sight), vertical axis (= z-axis) and tilting axis.

![Figure 3-1: Sensor Coordinate System (SCS)](image)

- **Target point**
- **Z-axis**
- **Slope Distance = D**
- **Vertical angle = V**
- **Y-axis**
- **Horizontal angle = Hz**
- **X-axis (Hz = 0.0°)**
3.1.2 3D Cartesian Coordinate System - Definition
The spatial position of a target point \( P \) is defined relative to three mutually perpendicular planes of a reference coordinate system. These planes intersect at a point called origin producing three mutually perpendicular lines of intersection \( (x, y, z) \), to which coordinate dimensions are referred. The spatial position of the target point \( P \) is specified relative to the origin in terms of three ordered numbers \( (X_p, Y_p, Z_p) \) measured along the perpendicular axes.

Figure 3-2: Definition of a rectangular right handed Cartesian Coordinate System
3.1.3 *3D Cartesian Coordinate System – right handed vs- left handed*

The selected handedness of the coordinate system, as illustrated below, is used for all mathematical calculations, when defining

- the location of object points
- the sense of rotation and
- the measurement sequence of plane points (in DOM or USER DEFINed orientation).

![3D Cartesian Coordinate System](image)

**Figure 3-3: Definition coordinate systems and sense of rotation**

<table>
<thead>
<tr>
<th>Left handed system</th>
<th>Topic</th>
<th>Right handed system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clockwise = positive</td>
<td>sense of rotation</td>
<td>Counter clockwise = positive</td>
</tr>
<tr>
<td>Clockwise = positive if plane vector up</td>
<td>measurement sequence of plane points, see section 3.1.5 below</td>
<td>Counter clockwise = positive if plane vector up</td>
</tr>
</tbody>
</table>
3.1.4 Object and Sensor Coordinate Systems

Object Coordinate System (OCS) is a 3D co-ordinate system, where the object geometry is represented. The object is typically designed in a CAD providing the design 3D-coordinate values in OCS.

As defined in section 3.1.1 above the origin of the Sensor Coordinate System (SCS) is located at the centre of the sensor.

Orientation methods (DOM and POM) orient the sensor to the OCS, so that the measurement results are represented in OCS providing the immediate actual/design comparison of the results.

Figure 3-4: Relation of Sensor (SCS) vs. Object Coordinate System OCS
3.1.5 Principle of DOM orientation method

The Direction Orientation Method (DOM) is based on defining the direction of the axis of the Object Coordinate System (OCS).

2. REFERENCE AXIS
After the direction of the plane has been defined the direction of the corresponding axis on the plane is selected and defined.

Suppose that (x, y)-plane is selected and defined. Then select and define the direction of x- or y- axis. Measuring at least two reference points on the axis in SCS does the axis definition. The positive direction is from the first to second point.

3. OFFSET POINT
After the direction of the axis of the OCS has been defined, you finally select and define the offset point. The values of the offset point are given in the OCS for x, y, z and it is measured in SCS respectively. The value in OCS may equal (0,0,0) or whatever is necessary.

4. ROTATION OF THE COORDINATE SYSTEM (OPTIONAL)
The OCS defined can be rotated around the plane -axis. If (x,y)-plane is selected, the system can be rotated around x and/or y-axis by the specified angle [decimal degrees]. The centre of rotation is the Offset Point. Refer to chapter 3.1.2 for the Sign of Rotation.
3.1.6 Principle of Change Station and POM orientation method

Change Station (CHST) and Point Orientation Method (POM) are based on defined points in the OCS and in the SCS.

Normally at least three points are needed to calculate the transformation. If a levelled plane is used as a reference plane in Change Station, then at least two points are needed for the calculation.

Change Station (CHST):
The measurement of a large object may need more than one sensor positions. The OCS has to be same from all sensor positions. OCS is maintained by measuring of the transfer points at Position 1 in OCS and at Position 2 in SCS.

![Common transfer points](image)

**Figure 3-5: Sample for distribution of transfer points**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal plane is selected in DOM and two points are selected or measured in CHST in OCS. • 1 point defines the location of the offset point, • ≥ 2 points define the axis direction and • instrument's compensator defines the horizontal plane.</td>
<td>Select the transfer points at the extreme edges of the object or even outside an object to get sufficient separation of the points.</td>
<td>1. Check the levelling. 2. Measure the transfer points in SCS. 3. Calculate the transformation. 4. Check the RMS-values and the residuals.</td>
</tr>
<tr>
<td>Horizontal plane is selected in DOM and three points selected or measured in CHST in OCS. • 1 point defines the location of the offset point, • 1st to 2nd point and 1st to 3rd point directions define the averaged direction • instrument's compensator defines the horizontal plane.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For mathematics refer to POM in case of 3 points or 4-20 points without horizontal plane.
Point orientation method (POM):
POM is used, if reliable points are available at the object for orientation.

Points within object coordinate system

![Diagram of POM points](image)

Figure 3-6: Sample for distribution of 5 POM points

<table>
<thead>
<tr>
<th>OCS-values (Design-values)</th>
<th>Which object points to select for POM?</th>
<th>Procedure for POM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using three points, the POM is defined as follows:</td>
<td>Select the object points at the extreme edges of the object. The points (so called HARD POINTS) need to have reliable x, y, z values.</td>
<td>1. Check the levelling.</td>
</tr>
<tr>
<td>• 1st point defines the location of the offset point, (all RMS = 0.0)</td>
<td></td>
<td>2. Define OCS points and values</td>
</tr>
<tr>
<td>• 1st and 2nd point define the axis direction and (two RMS = 0.0 if line defined by these 2 points is parallel to coordinate axis)</td>
<td></td>
<td>3. Measure the object points in SCS.</td>
</tr>
<tr>
<td>• all 3 points define the plane (single RMS = 0.0). Referring to the example in Figure 3-6:</td>
<td></td>
<td>4. Calculate the transformation.</td>
</tr>
<tr>
<td>RMS X RMS Y RMS Z</td>
<td></td>
<td>5. Check the RMS-values and the residuals.</td>
</tr>
<tr>
<td>P1 0.0 0.0 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2 ≠ 0.0 0.0 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3 ≠ 0.0 ≠ 0.0 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P4 and P5 are not included.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using four to twenty (4 –20) points, the POM is based on iterative least square method (= best-fit)
All RMS values typically ≠ 0.0 but should be within 1.0mm
3.1.7 Training object: Measurement procedure

<table>
<thead>
<tr>
<th>NAME: Test Object 3D Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBJECT: Basic 3D Coordinate Measurements, DOM, 3Dmeas, 3dfile, Change station, POM, Calc 2 points, Calc distances.</td>
</tr>
<tr>
<td>PURPOSE: Basic operator training to execute 3D measurements</td>
</tr>
<tr>
<td>SYSTEM SET-UP: Total station and accessories, DCP05</td>
</tr>
<tr>
<td>TEST OBJECT: Table surface</td>
</tr>
<tr>
<td>PLACE: Training room (indoor)</td>
</tr>
<tr>
<td>TEMPLATE: None</td>
</tr>
<tr>
<td>REFERENCES: DCP05 Quick Start</td>
</tr>
<tr>
<td>ILLUSTRATIONS: Figure 3-7: Proposed Set-up for Training Exercise</td>
</tr>
<tr>
<td>PARTICIPANTS: System operators, Max. 4 participants.</td>
</tr>
<tr>
<td>DURATION: Planned 3 – 8 hours</td>
</tr>
</tbody>
</table>

NOTES:
STEP 0: Training Object for 3D coordinate measurements in OCS

Figure 3-7: Proposed Set-up for Training Exercise
**STEP 1: Measurement Planning**

**Principle**
An Object Coordinate System (OCS) for a Test Object is established on a table illustrated on page 15. This table-OCS is used for indoor training purposes as follows:

- how to measure 3D coordinates,
- how to use DOM orientation of the instrument,
- how to use Change Station routine, when the instrument has to be moved from position 1 to position 2,
- how to aim object points having design coordinate values.

**Creation of a 3D-file in DCP05 : testobj1**
The 3D coordinate values \((x, y, z)\) are saved to the 3D-file on PCMCIA card.
To create a new file start from the DCP05 Main Menu as follows:

1. Select menu item *File*. The FILE - display is opened.
2. Select *3D-file* menu item. The 3D-FILE - display is opened.
3. Activating the NEW function creates a 3D-file.
4. Enter new filename by activating the \(\alpha\)NUM function.
5. Insert character by character and finally a number directly: *TESTOBJ1*. Accept with ENTER-key.
6. Enter first point ID (= point identification code, max 6 char. ): P1 is proposed, but in this case you should insert P10. Accept with ENTER-key and the 3D-FILE-display shows the basic information.
7. CONT-key returns to Main Menu.

**Open an existing 3D-file, e.g. created in DCP20 or Axyz-CDM**
A 3D-file can also be created using DCP20 or Axyz-CDM, then uploaded to PCMCIA card as described in section 5.4.

1. A 3D-FILE-display the Select file list is opened with OPEN function.
2. Search a file with scrolling HOME, END, PGUP, PGDN functions.
3. Accept with CONT or ENTER key and the 3D-FILE-display shows the basic information.

*Testobj1*, see the illustration of a 3D-file in on page 15.
STEP 2: Instrument Orientation using DOM method
See the DCP05 Operator’s Manual section “Principle of DOM orientation method” section 3.1, the HELP displays with Shift F1 keys and DCP05 Operator’s manual section 3.2 as a reference. Start the procedure from DCP05’s Main Menu:

1. Select Orientation menu item. The ORIENTATION menu is opened.
2. Select DOM menu item. The ORIENTATION \ DOM -display is opened.

Reference plane
1. Select reference Plane with PLANE function. The ORIE \ DOM \ PLANE -display is opened
2. Select either XY or ZX or YZ plane as a reference in OCSd. Select XY.
3. Select either the horizontally levelled instrument - HORIZ function or measuring of the points (3…20) or measure a minimum of 3 points via - MEAS function.
Select HORIZ, where positive z-direction is upwards and parallel to gravity.
4. If MEAS function is selected, the first three points (P1, P2, P3) define the positive direction from the plane as shown below:

![Diagram of measurement sequence to create plane vector parallel to required axis (here +z) in right handed coordinate system](image)

**Figure 3-8:** Measurement sequence to create plane vector parallel to required axis (here +z) in right handed coordinate system
5. If the instrument is not levelled the message pops up:
   Please check that instrument is levelled.
   Adjust the levelling and press OK. Return to ORIENTATION \ DOM -
   display.

6. Row 2 of ORIENTATION \ DOM -display should show Plane: xy(hz)+.

Reference line
1. Select reference Line with LINE function. The ORIE \ DOM \ LINE -display
   is opened.
2. Select X or Y line as a reference in OCSd. Select X.
3. Available only the measuring of the points (2…20) - select MEAS.
4. Measure the two line points in MEAS-display. The positive direction of the
   x-axis is from the first point to the second point. CONT-key returns to
   ORIENTATION \ DOM -display.

5. Row 3 of ORIENTATION \ DOM -display should show
   Line: x+.

Point Offset (i.e. controlling point)
1. Select reference Point Offset with OFFSV function. The ORIE \ DOM
   \ PNT\ OFFSV -display is opened.
2. Insert the x, y, z values in OCS and Point ID with EDIT function or pick
   them from a 3D-file with 3DF function. Insert x=0, y=0, z=0 at the first
   time.
3. Row 4 of ORIENTATION \ DOM -display should show
   Point Offset: + (showing -, if values x=y=z= 0.0).

Point Measure
1. Select MEASV function directly from ORIE \ DOM \ PNT\ OFFSV -display
   or from ORIENTATION \ DOM -display.
2. Measure the x, y, z coordinate values in SCS and return with CONT-key
   to ORIENTATION \ DOM -display.
3. Row 5 of ORIENTATION \ DOM -display should show
   Point Measure: +.

Calculation of DOM
1. Calculate the coordinate transformation with CALC function.
2. Row 7 of ORIENTATION \ DOM -display should show
   Calculation: +.
3. Proceed with STEP 4; 3D measurements.
STEP 3 (OPTIONAL): Instrument Orientation using DOM method with Plane and Line Rotation

Having completed measurements (coordinate values are saved in the 3D-file: testobj1), return to ORIENTATION \ DOM - display and continue with Rotate plane, then with Rotate line.

Rotate Plane
1. Select Rotate Plane with ROTPL function (Shift F3). The ORIE \DOM \ROTATE PLA -display is opened as above. Note the sign of the rotations as described in section 3.1.3.
2. Select rotation of Y-axis: 10.0° decimal degrees.
3. Row 5 of ORIENTATION \ DOM -display should show Rotate plane: +.

Rotate Line
4. Select Rotate Plane with ROTLI function (Shift F4). The ORIE \DOM \ROTATE LIN -display is opened as above. Note the sign of the rotations as described in section 3.1.3.
5. Select rotation of Z-axis: 10.0° decimal degrees.
6. Row 7 of ORIENTATION \ DOM -display should show Rotate line: +.

Important: The Offset Value of the Offset Point corresponds to the final OCS, i.e. they must be entered in the OCS, which is already rotated about the plane and the point.

Calculation of rotated DOM
1. Calculate the coordinate transformation with CALC function.
2. Return to Main Menu with CONT-key.
Create a swapped 3D-file
1. First select File menu and then select 3D-file. The 3D-FILE display is opened.
2. Copy the 3D-file: testobj1 with COPY function to 3D-file: testobj2.
3. Convert the measured Actual values to Design values by using the SWAP function.
4. Return to Main Menu. Proceed with STEP 4; 3D Measurements
STEP 4: 3D Measurements

Start the 3D measurements from the Main Menu as follows:

1. Select Measurement menu item. The 3D-MEAS display is opened.
2. The 3D-file: testobj1 or testobj2 and Point ID: P10 are shown. No values in x,y,z fields.
3. Info area alternates between:
   - Additonal constant, (atmospheric) ppm-correction
   - OCSd length Units
   - User name
4. Measure the same point, which was measured as the Offset Point (x≅0, y≅0, z≅0). The measurement results are shown in the Actual fields.
5. Enter a point name with ADD function and measure the points of the TEST OBJECT. The values are automatically saved.
6. Check the values of the Reference Line points (x-line i.e. y-values ≅ same).
7. Check the values also in vertical direction (= z-values). All deviations should be rather small far within 1mm.
**STEP 5: 3D Design values with AIM function**

**Design values**
The design co-ordinate values (x, y, z) of the object points are available in a 3D-file or the values are inserted manually, then the values (x,y,z) are shown in the Design fields.

1. Check the 3D-file: *testobj1* and Point ID: *P10* are active. No values in x, y, z Design fields.

2. Insert the Design x, y, z values (0,0,0) with EDIT function: Numeric keys, Accept with ENTER-key.

3. The Deviation (dev) = Actual value – Design value. An example is shown below:

<table>
<thead>
<tr>
<th>actual</th>
<th>design</th>
<th>deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>x:</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>y:</td>
<td>-0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>z:</td>
<td>0.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>

4. EDIT the *Design* values in order to see the changes in Deviations. Check the Design values to be (0,0,0), before proceeding with the AIM function.

**Aim function = Setting out**
The instrument can be easily aimed on a particular object point based on the Design 3D coordinate values of the point in x, y, z fields. The instrument is pre-positioned by activating the AIM function.

1. Make sure that the instrument is not pointing towards point P10. For using the AIM function with design values the setting in Initialisation menu must be:

   *Design values in use: YES.*

2. The AIM function depends on the Instrument type as follows:

<table>
<thead>
<tr>
<th>Instrument Type</th>
<th>3D-MEAS -display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorised</td>
<td>AIM turns instrument automatically.</td>
</tr>
<tr>
<td>Manual</td>
<td>1. AIM opens the instrument’s TELESCOPE POSITION-display.</td>
</tr>
<tr>
<td></td>
<td>2. Set ΔHz and ΔV to zero with horizontal and vertical drive screws.</td>
</tr>
<tr>
<td></td>
<td>3. Return with OK to 3D-MEAS-display</td>
</tr>
</tbody>
</table>

3. Check the line of sight, which should be very close to the P10 target.

4. Adjust to the centre of target and measure with ALL function. The Deviations (dev) should be rather small.

5. Select POINT⇒ 3DF. Copy the 3D-file:*testobj1* to 3D-file: *testobj3* with COPY function. Make the Actual values to Design coordinates with SWAP function. Return to 3D-MEAS -display with CONT-key.
6. Measure and aim based on 3D-file:
   testobj3.

**STEP 6: Changing the station (position1->POSITION2)**

The routine guides the user when changing the station while keeping the results in the same object coordinate system (OCSd). Routine uses 3..20 transfer points. If Hz has been selected in DOM, then 2 points are sufficient. Point ID of transfer points guides the user. RMS & Residual values are shown after calculation.

1. Return to DCP05 \ MAIN MENU and select **Orientation**, which opens the ORIENTATION menu.

2. Select **Change Station (CHST)** from the list. The above display is opened.

3. Check that the OCS is active (and at first time without Rotate plane in DOM) and delete the old CHST values with DEL function.

4. Go through all the following cases: POS1 - FILE, POS1 - POINTS, POS1 - MEAS to clear up the alternatives with DEL.

5. Continue by either choosing FILE or POINT or MEAS.

**POS1 - FILE**

1. POSITION 1 (=POS1): Select file - FILE picks maximum 20 points (actual coordinates) from the top of the selected 3D-file testobj3 to Change Station point list. Select file: + is shown at row 3.

2. Accept with ENTER or CONT-key. The info is displayed:

   | Please, change the instrument position and measure the transfer points! |
   | Do not switch instrument Off. |

3. Transfer the instrument and level it, before proceeding with the measurements.

4. Accept with OK. The \POS2\MEAS -display is opened.

5. Select with Point ID:s the necessary points and measure the x,y,z values in SCS. Accept the points with CONT-key.

6. Check with RMS function the RMS-values for x, y, z coordinates. All RMS should be within 1 mm. If not, we recommend re-measuring the point from position 2.
7. Check with RESID function the residuals of x, y, z for each point. Press REJEC to inactivate or reactivate point(s), which exceed the tolerance. This will automatically restart the calculation.

8. Continue with CONT-key.

**POS1 - POINT**
1. POSITION 1 (=POS1): POINT opens Points-display to pick individual existing transfer points from the 3D-file testobj3. **Select points: +** is shown at row 4.

2. Continue as in POS1-FILE procedure, step 2.

**POS1 - MEAS**
1. POSITION 1 (=POS1): MEAS opens the MEAS display in order to measure additional transfer points in OCS. **Measure points: +** is shown at row 5.

2. Continue as in POS1-FILE procedure, step 2.

**POS2**
1. Re-measure individual point on position 2 if the RMS is out of tolerance and the point is necessary in the CHST procedure.
STEP 7: Instrument Orientation Using the POM Method
The principle of the method is described in the Section 3.1.6. Start the procedure from DCP05 \MAIN MENU:

1. Select Orientation menu item. The ORIENTATION menu is opened.
2. Select POM menu item. The ORIENTATION \ POM -display shown above is opened.
3. Check that the 3D-file testobj3 has OCS values and delete the old POM values with DEL function.
4. Go through the following cases: POM - FILE, POM - POINTS to clear up the alternatives with DEL.
5. Continue with either FILE or POINT

POM – FILE (OCS – file)
1. Select object points in OCS with FILE function, which picks 20 points from the top of the 3D-file: testobj3 to POM point list.
2. Accept with ENTER or CONT-key. POM display is opened and File: + is shown at row 3.
3. Select measure points in SCS with MEAS (SCS – points) function, which opens MEAS-display with Point IDs guiding the measurements in SCS. Accept the points with CONT-key. Meas: + is shown at row 6.
5. Check with RMS function the RMS-values for x, y, z (< 1 mm).
6. Check with RESID function the residuals of x, y, z for each point.
7. Continue with CONT-key.

POM – POINT (OCS – points)
1. Select object points in OCS with POINT function, which opens Points-display to pick individual transfer points from the 3D-file: testobj3 to POM point list. Points: + is shown at row 4.

Make sure to use design values (indicated by a/D*), not actual points.

2. Continue as in POM-FILE procedure, step 3
**STEP 8:  Real Time Dimensional Analysis - 2 points**

The real time dimensional analysis is performed with ...CALC\ 2 POINTS in 3D-MEAS or in 3D-FBS display. Calculation of axial (x, y, z) and of slope distance (t) between two selected points is available.

1. Check the 3D-file: testobj3 is active and select CALC function in 3D-MEAS or in 3D-FBS display.

2. The Select Points display of 3D-file is available. Two points can be selected. Accept with CONT-key.

3. After returning the selected Point IDs are shown in the Points field in row 2: P11 - P10.

4. The distances (x, y, z, t) are automatically calculated, if all the values are available:
   - Distance-actual (d-actual) = P11 − P10 (actual)
   - Distance-design (d-design) = P11 − P10 (design)

5. Also the distance deviations (d-dev) are calculated between the Actual and Design values:
   - Distance-deviation (d-dev) = d-actual − d-design.

6. To calculate other distances, press PICK to select another point pair.

7. Return to starting display with CONT-key.

- t = slope (= spatial) distance between points.
- The results of this calculation cannot be saved. In order to save calculated distances refer on page 27 below.
STEP 9: Real Time Dimensional Analysis - DISTANCES

The real time dimensional analysis is performed in Calculation menu with Distance menu item. The dimensional analysis is based on calculating the distance of a specified object point from a selected reference point, from a reference line or from a reference plane. Start the procedure from DCP05 \MAIN MENU:

1. Select Calculation menu item. The CALCULATION menu is opened.
2. Select Distance menu item. The CALCULATION \ DIST -display is opened.
3. Select the 3D-file: testobj3 with 3DF -function from the Select file list.
4. Create the DIST-file; testobj3 with DISTF function, which opens the DIST-FILE-display. Open the insert field with NEW function and accept with ENTER-key. Return with CONT.

Reference (= reference element)
1. Start with REF -function, which opens the Reference menu.
2. PLANE, LINE and POINT functions open the Select points list, where the points are picked from the 3D-file.

Target
1. Define a Target with TRG and pick a point from the 3D-file.
2. The distance from the reference to the target is calculated immediately.
   – slope distance: point to point
   – perpendicular distance: point – line, point plane

Save a distance
1. Check that the REF ID, dID and Note fields are correct.
2. The calculated distances are saved in the DIST-file by the SAVE function.
3. The DIST-file can be viewed with VIEW function.
4 How to use the specific measurement functions...

4.1 Tool Training (Target Thickness & Reflector Offset)

The TOOL function defines and/or applies a target thickness and reflector offset relative to the x, y, z-axes of the OCS = Object Co-ordinate System.

Tool info YES/NO (prior to each measurement with active tool) is selected in Initialisation display.

The tool list supports a maximum of 10 tools.

**STEP 0: Preparations**

System set-up/place: Total Station, DCP05, Tape or prism or CCR1.5” reflector / Indoor.

Training object: A Point in Object Co-ordinate System, which can be measured both directly and with a Tool applied.

**STEP 1: Tool and Translation definition**

1. Select TOOL function with Shift F4 in 3DMEAS or ROLLER measure displays. The TOOL display below is opened.

2. There are two ways of selecting a Tool:
   - Select a tool with Tool ID from the Tool list: Either with TID function or with NEXT/PREV functions. Verify the correct values! DEL deletes the active tool.
   - OR create a tool with ADD function opening the ADD TOOL display. Select the target/reflector type (prism/retro, additional constant), insert Tool ID, and x, y, z values of a tool in OCS. CONT-key accepts and returns ESC only returns without accepting the values.

3. EDIT key opens the input fields of the individual x, y, z translation.

4. Total values = tool values (= reflector offset) + translation values (= target thickness or adapter base). The Figure 4-1 illustrates a typical example.
Figure 4-1: Illustration of Tool example:
Tool value (= reflector offset) = 30mm in x, y, z
Translation (=thickness of base) = 10mm
target type = tape
for additional constant see individual certificate

The tool values are defined once and firmly assigned to the tool, whereas the translation can be modified prior to each measurement.

+ = target is off the point in positive direction of the axis
- = target is off the point in negative direction of the axis

5. CONT-key returns to measure display.

STEP 2: Measurement with Tool and Translation
1. Starting from 3DMEAS or ROLLER display, check that the OCS is active.
2. Measure a target point without any active tool. SWAP function turns the measured Actual values into Design points.

SWAP is possible only if the editing profile has been enabled. To check leave DCP05 and access the Main Menu, press CONF (F2) ⇒ Define Functionality (2) ⇒ Allow data editing = YES

3. Select TOOL function
4. Select a Tool and insert the translation values. Return with CONT-key to starting display.
5. Verify the active Tool ID and the Target constant in the Info area.

6. Verify from the Info area that the Object co-ordinate system is OCSd (created by DOM) or OCSp (created by POM) is active.

7. Trigger a measurement with ALL. The actual co-ordinates now show the result with the tool applied.

8. If Tool Info = YES, prior to each measurement with active tool, the tool display shows up. You can verify the translation values and edit if necessary, then continue with CONT.

9. The Dev fields show the deviation of x, y, z values measured with and without a tool.

**STEP 3: Measurement of Internal corner with retro target**
The example below refers to the measurement of a corner by using a square 20x20mm tape target. Both cases give the same result.

<table>
<thead>
<tr>
<th>Instrument Display</th>
<th>Measurement Targeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool (fix)</td>
<td>Translation (individual)</td>
</tr>
<tr>
<td>x: 0</td>
<td>+10</td>
</tr>
<tr>
<td>z: 0</td>
<td>0</td>
</tr>
<tr>
<td>y: 0</td>
<td>0</td>
</tr>
<tr>
<td>Internal corner: Design values</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4-2: Training example for a Tool with 10mm offset along +X**

The Tool function is not applicable for Hidden Point measurements.
4.2 Hidden Point Training

The x, y, z co-ordinate values of a hidden point are measured with a Hidden Point Bar (called HPB hereafter), which needs to be defined prior to the first use. The HPB-tip point is placed on the hidden point and HPB-points are measured.

The HPB definition requires a minimum of 2 and a maximum of 5 points. Definition/configuration means saving the distances from HPB-tip to the individual HPB-points.

![Figure 4-3: Leica Hidden Point Bar](image)

**STEP 0: Preparations**
- System set-up/place: Total Station, DCP05, Tape target / Indoor.
- Training object: A Point in Object Co-ordinate System, which can be measured with and without Hidden Point Bar.

**STEP 1: \SPECIAL FUNCTIONS\ HIDDEN POINT**
1. Select SPECIAL FUNCTIONS with SPECI -function (typically Shift F3). Starting display: …MEASV, 3DMEAS, ROLLER, MEAS -displays.
2. Select HIDDEN POINT from the list of SPECIAL FUNCTIONS. The HIDDEN POINT -display below is opened.

**STEP 2: Check target constant and HPB values**
1. Verify the additional constant of the current reflector type in the Info area and modify if necessary. Shift F4 = INIT provides direct access to Initialisation menu.
2. Check the Hidden Point Bar (HPB) values in Point No and Point Dist fields with NEXT/PREV which select next/previous points of the HPB.
3. If values to begin with are ok, proceed with step 4.
4. To configure the HPB, continue with step 3.

**STEP 3: Configuration of Hidden Point Bar - CONF**

1. Select CONF to open the HIDDEN POINT\CONF display below.

2. Select EDIT to input the distance of each HPB-point 1..5. Dist1 is the closest distance to the HPB-tip.

3. CONT-key accepts the configuration and returns to Hidden Point display. ESC returns without accepting.

**STEP 4: Measurement of Hidden Point Bar**

1. Start measuring the point, which is the nearest to the HPB-tip, typically, Point No.1.

2. Trigger measurement with ALL and the x, y, z co-ordinate values of Point No 1 are shown.

3. Select NEXT and the program suggests Point No 5. If Point no 2 or 3 or 4 are requested, select with PREV.

4. Trigger measurement with ALL and the x, y, z co-ordinate values of the measured point are shown. If more than 2 points are used, just select with NEXT or PREV and measure with ALL.

**STEP 5: Calculation of a Hidden point - CALC**

1. CALC calculates the HPB-tip point, once the HPB measurement is completed.

2. CLEAR clears the calculated x ,y ,z values.

3. CONT-key returns to the starting display.
4.3  X or Y or Z Training (i.e. measuring individual co-ordinates)

Each co-ordinate value x, y, z can be measured separately.

**STEP 0: Preparations**

System set-up/place: Total Station, DCP05, Tape or prism or CCR1.5" reflector / Indoor.

Training object: A rectangular corner in Object Co-ordinate System, so that the object sides are aligned to the XY, ZX and YZ planes.

![Figure 4-4: Training sample for measuring Y co-ordinate only](image)

**STEP 1; ... \ SPECIAL FUNCTIONS \ X or Y or Z**

1. Select SPECIAL FUNCTIONS with SPECI -function (typically Shift F3). Starting displays: ...MEASV, 3DMEAS, ROLLER, MEAS -displays.

2. Select X or Y or Z from the list of the SPECIAL FUNCTIONS. The XorYorZ display below is opened.

![Display](image)

**STEP 2; Check the measurement status**

1. Check the correct Point ID, if it has been defined in a starting display.

2. Verify the additional constant of the current reflector type in the Info area and modify if necessary.

   Shift F4 = INIT provides direct access to Initialisation menu.

   Verify from the Info area that the Object co-ordinate system OCSd (created by DOM) or OCSp (created by POM) is active.

   If necessary the TOOL function is applicable with Shift F4 as trained in section 4.1.
STEP 3: Measure X, Y, Z values separately
1. Trigger measurement with X or Y or Z or ALL. Position target at each plane and repeat separately until all the necessary co-ordinate values have been measured.
   - ALL  Measured x, y, z are saved.
   - X    Measured x-value is saved.
   - Y    Measured y-value is saved.
   - Z    Measured z-value is saved.
   DEL Deletes the x, y, z values.
2. Confirm and return to starting display with CONT-key.
3. The measured x, y, z values are automatically transferred into the Actual value fields of the starting display and are saved, if a 3D-file is open.
4. ESC returns without saving and transferring the x, y, z values.
4.4 Circle Training

Both co-ordinate values of a centre point and corresponding diameter/radius are calculated from three measured points. Sometimes the circle is so small, that the circle plane can not be defined accurately enough. Circle plane and circle points can be defined separately, if needed, as shown in table below:

<table>
<thead>
<tr>
<th>Co-ordinate system</th>
<th>PLANE definition separately</th>
<th>CIRCLE incl. PLANE definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY, YZ, ZX</td>
<td>MEAS</td>
<td>C-PNT</td>
</tr>
<tr>
<td>SCS</td>
<td>Not available.</td>
<td>Measure the plane points.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measure the points, which</td>
</tr>
<tr>
<td></td>
<td></td>
<td>define both the plane and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the circle.</td>
</tr>
<tr>
<td>OCS</td>
<td>Select the plane based on OCS.</td>
<td>Measure the plane points.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measure the points, which</td>
</tr>
<tr>
<td></td>
<td></td>
<td>define both the plane and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the circle.</td>
</tr>
</tbody>
</table>

STEP 0: PREPARATIONS

System set-up/place: Total Station, DCP05, Tape or prism or CCR1.5" reflector / Indoor.

Training object: Circle table (diameter < 0.5m) in Object Co-ordinate System.

STEP 1: \ SPECIAL FUNCTIONS \ CIRCLE

1. Select SPECIAL FUNCTIONS with SPECI-function (normally Shift F3).
   Starting displays: ...MEAV, 3DM EAS, ROLLER, MEAS-displays.

2. Select CIRCLE from the list of SPECIAL FUNCTIONS. The display below is opened.

STEP 2: Define circle plane - PLANE

1. PLANE opens the next display to select the circle plane by three methods.

2a. XY or ZX or YZ refer to OCS, i.e. circle plane is assumed strictly parallel to one of the co-ordinate system planes.

2b. MEAS opens the MEAS-display and allows measurement of the plane points, i.e. the circle diameter is rather small (e.g. 10cm), but the circle plane is much larger (e.g. as for a bolt hole).
2c. C-PNT uses the CIRCL-points, which are measured at STEP 4. Thus C-PNT applies to the general case.

3. The selected plane is shown in the row 3 of the Circle-display:

**Plane :xxxxxxxx**

**STEP 3: Tool radius - INSERT**
If necessary, input a tool offset with the appropriate sign:

- Tool inside circle (-),
- Tool outside circle (+).

**STEP 4: Measure circle points - CIRCL**
CIRCL opens the MEAS-display, in which CONT accepts the measured points.

**Important:**
The 3 points should be separated by at least 90° to calculate a reliable centre!

Correct Incorrect

**STEP 5: Circle results - ABORT or OK**

1. Check the following items:
   - **centre:** Calculated x, y, z values of the Centre point.
   - **radius:** Radius of calculated circle.
   - **diameter:** Diameter of the calculated circle.

2. Continue
   - **ABORT** Return without accepting the circle centre and radius.
   - **OK** Return with accepting
4.5 Application #1: Line Setting

See the DCP05 Operator’s Manual section 5.2 “Line Setting” and the HELP displays with Shift F1 key. Start the procedure from DCP05’s Main Menu:

**STEP 0: Preparations**

System set-up/place: Total Station, DCP05, Tape or prism or CCR1.5” reflector / Indoor.

Training object: A Point in Object Co-ordinate System.

**STEP 1: Define plane and reference line**

The DOM procedure is described in details on page 19.

1. Select *Initialisation* to define all parameters (units, reflectors)
2. Select *Orientation / DOM*.
3. Select *Plane* and set the Horizontal plane HORIZ.
4. Select *Line*; Measure line 1st point and 2nd point with MEAS.
5. Define and Measure any *Offset Point*
6. Activate calculation and return to DCP05 Main Menu.
7. Return to DCP05 Main Menu by pressing CONT.

**STEP 2: Select Line Setting – application**

1. Select *Application* menu item.
2. Select *Line Setting*. The LINE SETTING display is opened.

**STEP 3: Align the sensor to direction of 0°, 90°, 180°, 270° or a user specific angle**

<table>
<thead>
<tr>
<th>Instrument Type</th>
<th>Procedure</th>
</tr>
</thead>
</table>
| Motorised       | 1. Press SET  
|                 | 2. Select 0, 90, 180, 270 or a specific direction and the sensor turns to the selected angle automatically.  
|                 | 3. Check the final tuning. |
| Manual          | 1. Turn the sensor accurately to the angle. |
Reference line (x-axis)

Angle = 90°

1st datum point

Angle = 180°

Leveled sensor

Angle = 270°

2nd datum point

Figure 4-5: Line setting in relation to a horizontal reference line, which is defined by DOM
4.6 Application #2: 3D- Roller Alignment - measurement

The DCP05 is automatically supporting the Roller Alignment by measurement of point pairs. See schematic

Figure 4-6 (top view). The main field of application is the alignment of rollers in paper machines and primary metal mills.

See the DCP05 Operator's Manual section 5.3 “3D Front –back - single” and the HELP displays with Shift F1 key. Start the procedure from DCP05’s Main Menu:

**STEP 0: Preparations**
System set-up/place: Total Station, DCP05, Tape or CCR1.5” reflector / Indoor.

Training object: A Cylinder in Object Co-ordinate System.

**STEP 1: Define plane and reference line**
The DOM procedure is described in details on page 19.

8. Select *Initialisation* to define all parameters (units, reflectors)
9. Select *Orientation / DOM*.
10. Select *Plane* and set the Horizontal plane HORIZ.
11. Select *Line*; Measure line 1\(^{st}\) point and 2\(^{nd}\) point with MEAS.
12. Define and Measure an *Offset Point*
13. Activate calculation and return to DCP05 Main Menu.
14. Return to DCP05 Main Menu by pressing CONT.

**STEP 2: Select 3D Roller Alignment – application.**
1. Select *Application* menu item.
2. Select *3D Roller Alignment*. The ROLLER display is opened.
3. Select the 3D-file having Point-IDs with last character either f/F or b/B or create a new file and insert point ID P10F. The point ID P10B is automatically created.
4. Press DSP to enter the ROLLER\|BACK display.
5. Measure point ID P10B in the ROLLER\|BACK display, press DSP
6. Measure point ID P10F in the ROLLER\|FRONT display, then immediately F-B –display pops up, showing the deviations between the Front and the Back point.
7. Press DSP to switch to **ROLLER\|BACK** display. Insert design-values of point ID *P10B*, press DSP

8. Insert design-values also to point ID *P10F*. The deviation is immediately calculated.

9. Select the **FRONT-\|BACK** - F-B – displays with DSP function. The A<>D key toggles between Actual and Design differences.

---

**Figure 4-6: Roller alignment**
5 Data exchange

TPS1000/2000/5000 offer 2 possibilities of data transfer via memory cards, which are compatible to PCMCIA standards. These card (SRAM memory cards 2MB for up to 18’000 measurement sets, Art. No. 639 949) are accessible as separate drives. The data are stored in ASCII format and require conversion for the appropriate post-processing software. Thus the data exchange is handled in two steps:

- The file types relevant for DCP05 are:
  - *.ADF actual – design coordinate files
  - *.CDF calculated distance file
  - *.AGF calculated angle file
- The file name should not exceed 8 characters.

Import (typically: actual co-ordinate values)
1. Transfer from PCMCIA-card to PC
   - “Off-line” via PCMCIA card reader or PCMCIA drive (see section 5.1)
   - “On-line” via cable connection (see section 5.2)
2. Import into post-processing software such as
   - Axyz-CDM (see section 5.3.1 below for preparation)
   - DCP15, an EXCEL based application (see DCP15 operator’s manual) or other DCP products
   - Microsoft EXCEL (see section 5.3.3 below) or other SW (see appropriate documentation)

Export (typically: design co-ordinate values)
1. Export from post-processing software such as
   - Axyz-CDM (see section 5.4.1 and 0 for preparation)
   - Microsoft EXCEL (see section 0 below) or other SW (see appropriate documentation)
2. Data conversion using DCPcom software (© by A.M.S.)
3. Transfer from PC to PCMCIA-card
   - “Off-line” via PCMCIA card reader or PCMCIA drive (see section 5.1)
   - “On-line” via cable connection (see section 5.2)
5.1 via Memory card reader or PCMCIA slot

There are two different possibilities to read the contents of these cards, depending on the operating system you use.

**Caution:**
In case it becomes necessary we recommend formatting the memory card onboard the instrument. Avoid formatting the cards via Windows (see section 1.11 “Memory Card” of DCP05 Operator’s manual).

![Data Transfer via PCMCIA card](image)

**Figure 5-1: Data Transfer via PCMCIA card (Additional Disk Drive)**

5.1.1 External card Reader OmniDrive Professional (667’072)

Typically applies to Desktop PCs. Please refer to the corresponding manual for hardware set-up.

5.1.2 Internal PCMCIA slot

Typically applies to Notebook PCs. However as the corresponding Windows drivers are not available, the file C:\CONFIG.SYS needs to call two DOS-drivers.

```
device=c:\{Windows}\system\csmapper.sys
device=c:\{Windows}\system\carddrv.exe /slot=x
```

where {Windows} = current Windows95/98 directory and x = amount of PCMCIA slots.

If you cannot see CONFIG.SYS in the root directory C:\ by using the Explorer, click on the Explorer’s menu item View ⇒
Options ⇒ File Types tab and click the radio button **Show all files**.

After you have modified C:\CONFIG.SYS simply reboot your Notebook PC, start the Explorer and access the SRAM card via standard Windows operations like Drag & Drop, Copy, Cut & Paste.
5.2 via cable connection

The PCMCIA card remains plugged in the instrument and the data are transferred via serial communication.

![Data Transfer via connection cable](image)

**Figure 5-2: Data Transfer via connection cable**

5.2.1 Data Exchange Manager (located in Leica Survey Office)

The Data Exchange Manager is automatically set-up during the Leica Survey Office installation.

1. Attach the cable PC (RS232, 9 pin) – instrument (Lemo 0), 2 m, Art. No. 563 625 to the TPS instrument and the COM1 port of your PC.

2. Activate the GeoCom mode via instrument’s Main Menu ⇒ Extra (F1) ⇒ On-line Mode (GeoCom) (1)

3. Click the Windows Start button, select from Programs the program Leica SurveyOffice\Data Exchange manager which will start the data transfer session. Once the GeoCom is initialised you may drag and drop the necessary files to the target directory.
• For Leica SurveyOffice installation see section 8.4.
• All DCP05 related data MUST be stored in the root directory of the PCMCIA Memory Card.
• If necessary modify the communication settings with Options \(\Rightarrow\) Port Settings.
5.3 Data Import

Axyz supports a lean DCP05 Export/Import from 1.4.0 onwards.

5.3.1 Import into Axyz-CDM
1. Start Axyz-CDM
2. Click the Import icon
3. Select the source location and specify the file type **DCP05-10 Actual (*.adf)**. For conversion settings press the Advanced button and refer to the Axyz manual.

4. Press Open button and the Points (Point ID, x, y, z) are saved as Entered Points in the specified Workpiece (e.g. **DCP05**).

5.3.2 Import into other DCP software

Please refer to the specific DCP manuals:
- DCP15 Operator’s manual, section 3.
5.3.3 Import into EXCEL

The procedure applies to Microsoft EXCEL 97 onwards. For further help or older EXCEL versions please refer to EXCEL manual.

1. Start EXCEL
2. Click File ⇒ Open, select the source location and specify type All files (*.*)

Press Open. As the *.ADF file format is different from *.XLS the EXCEL Import Wizard will automatically show up and guide you through the necessary steps.
5.4 Data Export

5.4.1 Export from Axyz-CDM
1. Start Axyz-CDM
2. Open the Reference/Workpiece tree in the Data Manager and select the reference points to be exported (Point ID, x, y, z).
3. Click the Export Icon
4. Chose that target location and specify the file type DCP05-10 Design (*.dsg). For conversion setting press the Advanced button and refer to the Axyz manual.
5. Press Save button and the Points (Point ID, x, y, z) are saved under the specified file name.
6. Proceed with transfer via Memory card reader or PCMCIA slot (section 5.1 above) or via cable connection (section 5.2 above).

5.4.2 Export from other DCP software
Please refer to the specific DCP manuals:
- DCP15 Operator’s manual, section 3.

5.4.3 Export from EXCEL
The procedure applies to Microsoft EXCEL 97 onwards. For further help or older EXCEL versions please refer to EXCEL manual.

The Export requires the conversion program DCPcom in order to properly convert the appropriate data files into the required *.ADF format.

Preparation of DCPcom Installation
1. Create an appropriate directory on drive C:\, e.g. C:\DCP05\Transfer
2. Insert the DCP05 data carrier into the corresponding drive
3. Copy the file `DCPCOM.EXE` into the directory, which you have created in step 1 above

Step 1 to 3 need to be performed only once for setup.

Export procedure
1. Have the design data ready in an EXCEL Worksheet. The four columns on the left must contain Point ID, x, y, z. No more columns should contain values.
2. Click `File ⇒ Save As`, enter the file name and save as type `Formatted text (Space delimited) (*.prn)`.

3. Exit EXCEL.
5. Start DCPcom
6. Click the DCPcom menu item *File ⇒ Convert*, which opens the dialog below.

7. Set the source location (CONVERT A FILE FROM) and the target location (CONVERT A FILE TO).

8. Specify the file type FROM on the left (source file *.dsg*), so do with the file type TO on the right (target file *.adf*) and enter the file name. Optionally set the conversion options. To convert and save the new file, press the *Convert* button.

9. Press *Close* and exit DCPcom when all conversions are completed.

10. Proceed with transfer via Memory card reader or PCMCIA slot (section 5.1 above) or via cable connection (section 5.2 above).
6 Service, checking and adjustment TPS family

6.1 General items

It is important that the instruments are checked periodically and specifically after a long transport, after shocks or if large temperature variations occur. In case of doubts please contact a Leica specialist to advise you in correct handling your instrument.

- Correction values are measured and stored in the instrument when it was delivered. The measurements are corrected accordingly.

- When working in single face measurements, it is necessary to periodically check and adjust the most important errors such as vertical collimation error => daily basis
  Line-of-sight error => monthly basis

- Two-face measurements practically eliminate residual instrument errors and therefore provide a better accuracy. However the most important errors, i.e. vertical and line-of-sight error, should be periodically checked, especially if only one-face measurements are carried out. These errors are caused by angular deviations between the optical axis and the reading system defined by the mechanical sighting axis of the telescope. They influence the vertical and horizontal angular readings.

- Leave the handle mounted when checking and adjusting. It does not obstruct the plunging of the telescope when changing to second face. Generally the checking and adjustment set-up should be carried out with the same instrument configuration. For description see TPS System 1000 manual, section “Checking and Adjusting”.

- For checking the instrument within an industrial environment select a target at working distance. The target must be well visible, e.g. a tooling ball or a distinct mark. It also should have a good contrast to its background. Make sure that neither the instrument nor the target moves or vibrates during the adjustment measurement.

- If differences to the previous settings are found, the new values may be set in the instrument. We recommend replacing the old values if the difference between old and new exceeds 2 to 3 times the specified accuracy or $0.5 \text{ mgon}/1.5$''.

- Repeat the measurement with a second target and check the difference to the previous adjustment.
6.1.1 Types of instrument residual errors
In general, the instrument exhibits the following residual mechanical errors as listed in the function $F_2$ of the instrument's Main Menu.

F1 Determine the compensator index errors ($l$, $t$) on page 54 on simultaneous adjustment of the electronic level.

F2 Determine the index error ($I$) for the vertical circle (V-index error) on page 56.

F3 Determine the lines of-sight ($c$) and, if required, tilting axis error ($k$) on page 58.

F4 Joint determination of the V-index- ($i$), Line-of-sight ($c$) and, if required, tilting axis error ($k$) on page 61.

F5 Determine the Collimation error ($ATR$) of the Automatic Target Recognition (for TCA/TDA total stations only) on page 63.

The determination of the instrument errors can be started in any telescope face.

The instrument errors reported are displayed in the sense of an error. When correcting measurements, they are used in the sense of corrections and have the opposite sign to the error.
6.1.2 Adjustment periods
All residual errors can change over time and with temperature. They should, therefore, be re-determined in the order shown below:

<table>
<thead>
<tr>
<th>Period</th>
<th>Index error</th>
<th>Index error</th>
<th>Line-of-sight</th>
<th>Tilting axis</th>
<th>ATR coll.</th>
<th>ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changing prism or CCR type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Monthly</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Monthly (specific cases)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>before the first use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>after long distance transport</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>after temperature change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;20°Celsius</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regular general inspection in an authorised Leica service centre. Your Leica Geosystems partner is looking forward for supplying a Hardware Maintenance contract, which is tailored to your needs.

Before determining the residual errors, level the instrument using the electronic level. The instrument should be secure and firm, free from vibrations, and should be protected from direct sunlight in order to avoid thermal warming on one side only.

6.1.3 Cleaning the optics
Use blower to remove large debris and dust first. The lenses on the eyepiece are coated optics and the objective lens is clear glass. Never touch the coated optics with your fingers. The oils on your fingers will etch the coating on the lens. To clean any lens, put a few drops of pure grain alcohol on a piece of lens tissue and draw it down the lens. At the same time, roll the tissue away from the lens. The rolling motion will pull away any dirt on the lens surface. Never flood the lens surface with the alcohol, as the alcohol can eventually attack the cement holding the lenses in place.
6.2 Compensator (l, t)

The determination of the index error for the longitudinal and transverse axes of the compensator (l, t) corresponds to the determination of the centre of the bubble used in the level.

The compensator only takes care of angle measurements corrections, NOT of distance measurements. In order to obtain precision distance measurements either, level the instrument within ±0.01 gon

The index error for the longitudinal and transverse axes is determined at the factory and adjusted to zero before delivery.

F1 Activate the adjustment procedure as described in section 6.1.1. The longitudinal and transverse axes (l, t) are displayed afterwards in the following dialog.

F3 Initiate the measurement of the longitudinal and transverse tilt (l, t). Motorised instruments will automatically complete the determination of l and t without any other assistance.

If the tilt cannot be measured, e.g. due to an unstable instrument, the error message ERROR: 557 is displayed and the following keys are defined:

F1 Abort measurement.
F5 Repeat measurement.

If the difference between the horizontal and vertical angles lie within ±4°30’ (±5 gon), the menu can be exited with F5.

The user is made aware of this by an acoustic signal that the F5-key is redefined as “OK”.

F5 Activates the second tilt measurement.
F1 Terminates the determination of the compensator indexes.
The following dialog shows the two newly determined values for the longitudinal and transverse compensator index errors.

F1 Repeats the complete adjustment procedure.
F3 Leaves the previous values unchanged.
F5 Stores the new values.

If the values for the index errors (l, t) exceed 5' 24" (0.1 gon), the complete adjustment procedure should be repeated, but not before checking that the instrument is correctly levelled and is free of vibration. If these values are exceeded repeatedly, please notify service.
6.3 V-Index (i)

The V-Index error is the zero-point error of the vertical - encoding circle in relation to the vertical axis of the instrument.

The V-Index error is set to zero before delivery. All vertical angles are corrected with the V-index error.

To determine the V-index error, aim the telescope at a target within object distance. The target must be positioned within ±9° (± 10 gon) of the horizontal plane.

**Figure 6-2: Set-up for error determination**

**F2** Activate the adjustment procedure as described in section 6.1.1. The two-axis compensator is turned off automatically when determining the V-index error. This fact is shown by the symbol.

To determine the V-index error, aim the telescope at a target within object distance. The target must be positioned within ±9° (± 10 gon) of the horizontal plane.

**Figure 6-3: Index error (i)**

**F3** Starts the measurement. Afterwards, the display shows a message asking to turn the telescope to the other face. Motorised instruments automatically change face immediately after the first measurement.
has been completed (see Figure 6-3). The user must only perform the fine adjustment before proceeding. If the differences between the horizontal and vertical angles do not exceed ± 27’ (± 0.5 gon), the display shows that the instrument is ready to measure. The user is made aware of this by an acoustic signal that the F5-key is redefined as "OK".

![Image](image.png)

Sight the target accurately again.

**F3** Start the second measurement.

After the measurements are complete the older and newly-determined V-index errors are displayed.

![Image](image.png)

**F1** Repeats the complete V-index error determination procedure.

**F3** Leaves the old values unchanged.

**F5** Stores the new values.

If the value of the V-index error (i) exceeds 54’ (1 gon) you should repeat the measurement procedure. If this value is exceeded repeatedly, please contact service.
6.4 Line-of-sight (c)

The Line-of-sight error (c) is the divergence of the line of sight from a line perpendicular to the tilting axis. The Line-of-sight error is adjusted and reduced to zero before delivery from the factory.

Horizontal angles are only corrected by this Line-of-sight error when the correction is turned “ON”.

This correction can be selected after pressing the aF... key (Refer to section “Compensator! Hz-corrections” in “TPS1000 System” manual).

To determine the Line-of-sight error, aim the telescope at a target within object distance. The target must lie within ±9° (± 10 gon) of the horizontal plane, see Figure 6-2.

The procedure is identical to that of determining the V-index error.

**F3** Activate the adjustment procedure as described in section 6.1.1. The two-axis compensator is turned off automatically when determining the Line-of-sight error. This fact is shown by the symbol.

![Figure 6-4: Line-of-sight error (c)](image)

**F3** Perform the measurement. Afterwards, a message in the display prompts you to change telescope face. Motorised instruments automatically change face directly after the first measurement has been completed (see Figure 6-4). The user must only perform the fine adjustment before proceeding.

If the differences between the horizontal and vertical angles do not exceed ± 27' (± 0.5 gon), the display shows that it is ready to measure. The user is made aware of this by an acoustic signal that the F5-key is redefined as “OK”.


Sight the target accurately.

F3 Perform the second measurement. After successful completion of the second measurement, the older and the newly-determined Line-of-sight error is displayed.

F1 Repeats the complete Line-of-sight error determination procedure
F3 Leaves the old values unchanged
F5 Stores the new values

If the value of the Line-of-sight error (c) exceeds 5’ 24” (0.1 gon) the measurements are to be repeated. If this occurs repeatedly, please notify service.
Afterwards, the tilting axis error of the instruments can be determined.

F5 Confirms that the tilt axis error should also be determined.
F3 Ends the function and returns to the adjustment dialog.
6.5 Tilting axis (k)

The tilting axis error (k) is the deviation of the tilting axis from the perpendicular of the vertical axis.

The tilting axis error is adjusted to zero at the factory and before delivery. The horizontal angles are only corrected by the tilting axis error when the Hz-correction is turned "ON".

This correction can be selected after pressing the aF... key (Refer to section "Compensator! Hz-corrections" in "TPS1000 System" manual).

To determine the tilting axis error, aim the telescope at a target within object distance. The target must be positioned at least ± 27° (± 30 gon) above or beneath the horizontal plane.

The two-axis compensator is turned off automatically when determining the tilting axis error. This fact is shown by the symbol.

F3 Start measurement. Afterwards, a message in the display prompts the user to change telescope face. Motorised instruments automatically change face directly after performing the initial measurement. The user needs only to perform fine aiming.

If the differences between the horizontal and vertical angles do not exceed ± 27' (± 0.5 gon), the display shows that it is ready to measure. The user is made aware of this by an acoustic signal that the F5-key is redefined as "OK".

F5 Confirms readiness to measure and the display changes as follows.
Sight the target accurately.

**F3** Performs the second measurement of the horizontal angle. After completing the second measurement, the old and newly determined tilt-axis error ($k$) are displayed.

If the value of the tilting axis error ($k$) exceeds 5°24" (0.1 gon) the measurements are to be repeated. If this occurs repeatedly, please notify service.
6.6 ATR1 collimation (ATR)

The ATR1 collimation error is the combined horizontal and vertical angular divergence of the line-of-sight from the axis of the CCD camera.

The collimation procedure includes, optionally, the determination of the CCD line-of-sight error (c) and the vertical-index error (i).

The correction for the ATR1 collimation errors is always applied regardless of the “ON/OFF” status of the Hz-correction setting.

To define the ATR1 collimation error, a prism can be accurately targeted at an average working distance. The target must lie within ±9° (± 10 gon) of the horizontal plane, see Figure 6-2.

The procedure is identical to that of determining the V-index error.

F5 Activate the adjustment procedure as described in section 6.1.1.

The ATR1 target recognition is automatically switched on. This fact is shown by the symbol. The display shows the current horizontal and vertical ATR1 collimation errors.

![Figure 6-6: ATR1 collimation error (ATR)](image)

F1 Activates the adjustment procedure.

The two-axis compensator is turned off automatically when determining the Line-of-sight error. This fact is shown by the symbol. Sight the prism accurately with the crosshair.

F3 Starts the measuring procedure.

F6 Toggles between simple and combined error determination:
YES Simultaneous determination of ATR1 collimation error, line-of-sight error (c) and vertical-index error (i)

NO Only determination of ATR1-collimation

It is advisable to determine the ATR1-collimation error, the line-of-sight error and the vertical-index error at the same time.

It is important to perform the procedure for determining the instrument errors very carefully and with highest precision.

Changes face automatically directly after completing the initial measurement.

Sight the prism accurately with the crosshair.

F3 Performs the second-face measurement of the collimation errors.

When the second measurement has been taken, the accuracy of ATR1 and, if previously selected, the accuracy of the index and the line-of-sight errors are displayed.

F1 The adjustment process is interrupted. The old values will be left intact.

F3 No further repeat measurements are required. The old and the newly defined ATR 1 collimation errors become optional, and are displayed together with the line-of-sight error (c) and the V-index error (i).

F5 The adjustment can be repeated as often as necessary until the required level of accuracy is obtained. The result is the mean of all the measurements taken. It is recommended that at least 2 measuring sequences be carried out.
**F1**  Repeats the ATR 1 error determination procedure.

**F3**  Leaves the old values unchanged.

**F5**  Stores the new values.

If the differences between the horizontal and vertical angles exceed ±27 (±0.5 gon), the display gives an error message. The user is made aware of this by an acoustic signal and the **F5**-key is redefined as "OK". The measurement procedure can be repeated.

If the value of the ATR1 horizontal and vertical collimation errors exceeds 2’ 42” (0.05 gon), repeat the measurement procedure.

Similarly, if the value of the V-index error (i) exceeds 54’ (1 gon) or if the value of the line-of-sight error (c) exceeds 5’24” (0.1 gon), the measurements are to be repeated. If these values are exceeded repeatedly, please contact service.
7 Hints for practical measurements

7.1 Pre-requisites for precision measurements

We highly recommend following these recommendations for precision measurements

General
- Correct for residual instrument errors within typical working distance (see section 6 above, page 51)
- Apply the distance offset as stated in the Producer/Service Inspection Certificate M.
- Correct TDM/TDA measurements for temperature and pressure.
- Level the instrument within 0.01gon as the compensator corrects for angle measurements, however not for distance measurements

Use of “swoxed” (black surface) Corner Cube 1.5”
- Align the CCR1.5” within the acceptance angle of $\pm 10^\circ$ (£z), $\pm 20^\circ$ (£V) (Note that the acceptance angles are instrument related and may vary. If the angles are exceeded, distance measurement may slow down and distance deviations $> 0.5$mm may occur. See also section 7.2 below.

Figure 7-1: Acceptance angle for “swoxed” Corner Cube 1.5”
- Apply the aperture to the front lens

Use of Reflective Tape Targets
- Align the target within the acceptance angle of $\pm 45^\circ$ (£z & £V). See also section 7.2 below.
- When the acceptance angle is at its limits, we recommend to use the auto-reverse measurements, i.e. angle & distance in face I and distance in face II (see DCP05 operator manual)
- Apply the front lens GDV3 for close range measurements < 10m
7.2 Reflector types and their major characteristics

Each TDM5005 and TDA5005 has its Producer Inspection Certificate, which states the corresponding addition constant. The user has the possibility to enter various reflector types and to set their additional constant.

Please refer to section 2.3.1 of the DCP05 Operator’s manual. In order to define a reflector ID, the reflector type and its additional constant.

See below table for available certificates:

<table>
<thead>
<tr>
<th>Art.No.</th>
<th>Denomination</th>
<th>TDM5005</th>
<th>TDA5005</th>
</tr>
</thead>
<tbody>
<tr>
<td>632 253</td>
<td>Producer Certificate IMS (O).</td>
<td>option</td>
<td>option</td>
</tr>
<tr>
<td>575 668</td>
<td>Producer inspection certificate (M), for angles.</td>
<td>option</td>
<td>option</td>
</tr>
<tr>
<td>575 863</td>
<td>Producer Inspection Certificate M TPS5000 (M) for distance measurements on Corner-Cube Reflector CCR1.5&quot;</td>
<td>option</td>
<td>standard</td>
</tr>
<tr>
<td>575 876</td>
<td>Producer Inspection Certificate M TPS5000 (M) for distance measurements on tape targets.</td>
<td>standard</td>
<td>option</td>
</tr>
<tr>
<td>632 252</td>
<td>Producer inspection certificate M TPS5000 (M) for distance measurement to surveying prisms</td>
<td>standard</td>
<td>standard</td>
</tr>
</tbody>
</table>

Figure 7-2: Applicable reflector types for distance measurements

- If retro-reflective targets are used, make sure that they are neither dirty, nor damaged nor partly covered. Otherwise the reflective properties may be changed which may result
in distance errors.

- The ATR1 is primarily designed for prisms and cannot be used on retro-reflective targets.

- When measuring through glass windows, or if other reflecting objects are within the field of view, measuring errors may occur.

<table>
<thead>
<tr>
<th>Type</th>
<th>1) Reflective tape target</th>
<th>2) Prism reflector</th>
<th>3) Corner cube reflector</th>
<th>4) 360° prism reflector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size/applicable distance</td>
<td>20*20mm/2-40m (requires front lens GDV3 up to 10m only)</td>
<td>GMP101/ &lt; 1000m GPR1, GPH1P/ 2500m with single prism</td>
<td>1.5 inch diam. / 2-600m</td>
<td>GRZ121/ &lt; 1300m</td>
</tr>
<tr>
<td></td>
<td>40*40mm/20-100m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60*60mm/60-180m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Additional constant tilt</td>
<td>± 42°</td>
<td>± 30°</td>
<td>Hz ±10° V ±20°</td>
<td>Hz 360° V ±27°</td>
</tr>
<tr>
<td></td>
<td>default: 34.4mm individual: see certificate</td>
<td>default: 0mm (GPR1, GPH1P) default: 17.5mm (GMP101) individual: calculation via field check</td>
<td>default: 34.9mm (old type with collar) 35.5mm (&quot;swoxed&quot; type &amp; AP31) individual: see certificate</td>
<td>default: 23.1mm individual: calculation via field check</td>
</tr>
<tr>
<td>Critical points</td>
<td>• large tilt angles effect length of distance path (an inclination of 35° may cause deviations of more than ±2mm or 1/100”), thus 2 face measurements are highly recommended</td>
<td>• large tilt angles effect length of distance path depending on size of prism (less than 0.3mm at 2.5cm / 1” free diameter).</td>
<td>• individual determination of add. constant is highly recommended for precision measurements</td>
<td></td>
</tr>
</tbody>
</table>

If ATR is used, the ATR collimation needs be determined for each individual prism.
7.3 Limitation of the horizontal and vertical theodolite movements

There are cases where the motorised movement of the instrument should be restricted because of attached accessories, such as diode laser, elbow eyepiece etc. If a restriction is defined the theodolite or the telescope will not change face via the objective or eyepiece side or it will not pass or enter a certain horizontal sector in case cables are attached to the moving part.

The procedure is as follows:

See also TPS System 1000 manual, section: “Operating Concept”, Function of the FIX keys, Additional Functions aF... For the setting follow the path:

aF... ⇒ Accessories (8)

↑↓ Move to respective item

In case of TDM/TDA5005 the default setting for eyepiece, lens and horizontal limits is NO. (i.e. no accessories attached). Use the key F6 for alternating YES/NO.

7.3.1 Example:
If a DL2/3 is used the settings could be like follows:

Limitation of vertical movement:

Accessories are attached:

Eyepiece YES
Lens NO
Define:
Eyepiece V begin 60 gon
Eyepiece V end 340 gon

Figure 7-3: Vertical restriction of the telescope

In this case the objective lens does not move closer than 60 gon to the zenith (closest position of the DL2 on the eyepiece to the base of the theodolite). The viewing angle is restricted at 160 (240) gon due to the base of the theodolite. With these settings the eyepiece does not move in or through the lower position 160 to 240 gon, also when the theodolite moves in its second face.
Limitation of horizontal movement:

Accessories are attached:
Eyepiece YES
Lens NO
Define: Eyepiece Hz begin 190 gon
        Eyepiece Hz end 170 gon

Figure 7-4: Horizontal restriction of the telescope

The theodolite will not move into or through the sector between 170 and 190 gon.

If the total station is positioned at e.g. 192 gon it turns clockwise to face II (392 gon) and counter-clockwise back to its previous position in face.

If the total station is positioned at e.g. 168 gon it turns counter-clockwise to face II (368 gon) and clockwise back to its previous position in face I. Due to this alternating movement the cable between DL2 and intensity regulator will not wind up.


8 Installation of System Firmware and DCP05

8.1 Software, Programs

A Theodolite System needs various software (=programs) to perfectly match an application.

8.1.1 The System Software (= “operating system”, “Firmware”)

The TPS System Software is a program comprising the “operating concept” of the Hardware (also called the “man-machine-interface MMI), for the Theodolite or Total Station.

The operating concept defines all Instrument related functions and is purely hardware depending. This is the instrument’s operating system.

8.1.2 The Application program (= “onboard software”)

DCP05 is an executable program, which allows more functionality than the built-in the system software.
8.2 Contents of CD-ROM “TPS-Series” (Art.No. 713’765)

The System Firmware files are also available via Internet on the Leica Geosystems Service & Support page http://www.leica-geosystems.com/ims/product/download/index.htm and select the corresponding instrument type. Please note that the language files are compatible for all different types of TPS.

The meaning of System Firmware equals System Software.

8.2.1 Leica SurveyOffice 2.0

The Leica SurveyOffice utility programs in all currently available languages can be found under the following directory on the CD-ROM: \Osw\SOffice\. To install Leica SurveyOffice in the desired language run the program “setup.exe” from ..\[Language]\disk1\. For further information on Leica SurveyOffice refer to the Leica SurveyOffice on-line help.

8.2.2 TPS1000/2000/5000 Software

The TPS1000/2000/5000 on-board software in all currently available languages can be found under the following directories:

1 [CD directory]\Tp1000\Tp1000_Software\TPS_Firmware\System_Firmware
   …includes the TPS1000/2000/5000 system software. The system software includes also all English texts.

2 [CD directory]\Tp1000\Tp1000_Software\TPS_Firmware\ATr_Firmware
   …includes ATR firmware for TDA- and TCA-type instruments.

3 [CD directory]\Tp1000\Tp1000_Software\TPS_Firmware\Edm_Firmware
   …includes the EDM firmware.

4 [CD directory]\Tp1000\Tp1000_Software\[Language]\n   …includes the “language” (e.g. ..\German\.) text files for the system and applications. The ..\English\ directory already contains the application language files and therefore need not to be uploaded.
8.3 Preparing the instruments for software upload

It is recommended to start as follows:

1. Set up the instrument and, by using the bubble level, level-up the instrument
2. Switch on
   The display shows for a short moment:
   - The instrument type (e.g. TDA5005)
   - The firmware version (e.g. GSI Version 2.28a)
   - The release date (e.g. 1994 - 99)
3. Afterwards, either the DCP05 dialogue or the main Menu with the program list will show up.
4. The version number of the firmware is displayed when the instrument is started up or may be indicated in the Main Menu by pressing the following keys:
   CONF (F3)
   INFO (F1)
5. Insert the CD-ROM TPSSeries into the CD drive and close the Notepad file which gives an overview of the CD’s contents. The required Firmware is located
   - TDM5000, TDA5000, TPS1000
     [CD directory]\Tps1000\Tps1000_Software\TPS_Firmware\System_Firmware\SYSA_228.TPS
   - TDM5005, TDA5005, TC2003, TCA2003
     [CD directory]\Tps1000\Tps1000_Software\TPS_Firmware\System_Firmware\SYSS_228.TPS
   - Language other than English:
     [CD directory]\Tps1000\Tps1000_Software[Language]\

8.3.1 When to upload?

Only needed in following cases:

- The Main Menu\Programs display does not contain DCP05
- A new version (either any System Firmware and/or DCP05) is available
- Your installed system Firmware does not comply with the DCP05 version:

<table>
<thead>
<tr>
<th>TDM5000, TDA5000, TPS1000-series total stations</th>
<th>System software</th>
<th>DCP05</th>
</tr>
</thead>
<tbody>
<tr>
<td>System software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2.20</td>
<td>Not tested and thus not guaranteed</td>
<td></td>
</tr>
<tr>
<td>2.22 onwards</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>2.28</td>
<td>2.26</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TDM5005, TDA5005, TC2003, TCA2003</th>
<th>System software</th>
<th>DCP05</th>
</tr>
</thead>
</table>
### 8.3.2 Set-up for Software upload

*We recommend using built-in Com-port 1 or 2!*

**Direct connection with Instrument powered by battery**

1. Connect the instrument to the computer, Com 1 or Com 2, with cable 563'625 (2m) or 574'948 (10m).
2. Start instrument and switch to the Main Menu!

   - Make sure the battery is loaded at least ¾ of full charge (process to load System Firmware program takes approx. 35 Minutes for one instrument).

3. Set Baud rate to 19200:
   - Press `CONF` (F3) in the Main Menu
   - Select `GeoCom communication param.` with Up/Down cursor
   - Press `ENTER`

   **To change Baud rate (recommended if neither communication nor data transfer possible):**
   - Select Baud rate other than 19200 with Up/Down cursor
   - Press `ENTER`
   - Press `CONT` to return to Main Menu

4. Start Computer and have Windows running
8.4 Installation of the Survey Office 2.0 onwards

Please uninstall existing Survey Office version prior to installing Version 2.0.

Make sure that the source directories for Firmware, DCP05 program have no blanks in the name.

The procedure is as follows:

1. Insert the CD-ROM **TPS-Series** into the CD drive and close the Notepad file which gives an overview of the CD’s contents.

2. Use RUN function (or start installation from within Explorer) and double click at \[CD-Drive]\:\OSW\Soffice\[Language]\Disk1\Setup.exe

3. Confirm selection with OK to start the installation.

4. Specify the folder where the Leica Survey Office is installed. The Leica Survey Office will be placed in a subdirectory \C:\Program Files\Leica Geosystems\Survey Office\Leica Survey Office. Change the target directory if needed.
5. Setup type: typically select **Custom Installation**. Proceed with **Next >**

![Setup Type Screen]

6. Select Components: typically select **Leica Survey Office** and **TPS1000 Tools**. All other programs are not needed for the standard industrial application. Proceed with **Next >**.

![Select Components Screen]

7. After completion of the installation, start up dialogue is showing the downloaded programs.

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8. Click the Windows Start button, select from Programs the program Leica SurveyOffice\Leica SurveyOffice which will start the “Leica SurveyOffice” session.

9. Press the Settings/Communication Settings menu in order to specify the communication settings for upload and data transfer. The example below refers to the standard settings of the GeoCom mode. Press Ok to confirm for TPS1000 (equivalent to setting for TPS5000-series) and save.
8.5 Installation of the Firmware

Fulfil the requirements as described in section 8.3.2:

- The instrument must be switched ON (Battery at least ¾ full charged)
- Change to the Main Menu
- The instrument is set to GeoCom mode
  Select EXTRA (F1)
  Select on-line mode (GeoCom), press ENTER
  Switch to on-line mode (Yes, F5)

The procedure is now as follows:

1. Click the Windows Start button, select from Programs the program Leica SurveyOffice\Software Upload that will start the “Software Upload” session.

![TPS 1000 - Software Upload](image)

For Help, press F1

2. Select Menu item “Utilities” and click Transfer Files

![Software Upload Utilities](image)

- This will open the installation wizard: Select radio button “System Firmware” for Firmware installation. Proceed with Next >
3. Select the appropriate directory, which contains the Firmware type. Proceed with Next >

4. Confirm selection (e.g. “System Software for TPS class 2003, 5005 or 5100 (V2.28)” (= System Firmware 2.28a for TC/A2003, TM/TDM/TDA5005 and TM5100(A)) and press the Finish button.
   The transfer of the program is now in progress.
CAUTION
From the activation of the Finish button till the moment the process is completed, NEITHER INTERFERE with the Computer NOR the Instrument. If for one or the other reason the process is interrupted, simply retry. If this does not help the System Firmware can only be loaded again by an authorised Leica workshop!

8.5.1 Installation of the local language
This applies only for official TPS languages other than English. The system language can be loaded once the System Firmware installation has been completed successfully.

1. Click the Windows Start button, select from Programs the program Leica SurveyOffice\Software Upload that will start the “Software Upload” session.

2. Select Menu item “Utilities” and click Transfer Files.
3. Select radio button “Other Sensor Software”. Proceed with Next

4. Select check box “System Language”. Proceed with Next
5. Select the appropriate directory, which contains the language (e.g. German). Proceed with Next >

5. Confirm selection and press the Finish button
   The transfer of the language files is now in progress.

6. After completion, proceed with DCP05 upload as described in section 8.6.
8.6 Installation of DCP05

Fulfil the requirements as described in section 8.3.2:

- The instrument must be switched ON (Battery at least ¾ full charged)
- Change to the Main Menu
- The instrument is set to GeoCom mode
  Select EXTRA (F1)
  Select on-line mode (GeoCom), press ENTER
  Switch to on-line mode (Yes, F5)

The procedure is as follows:

1. Insert the DCP05 diskette into drive A:
2. Click the Windows Start button, select from Programs the program Leica SurveyOffice\Software Upload which will start the “Software upload” session.

3. Select Menu item “Utilities” and click Delete Application in order to delete any existing version of DCP05
4. Select Menu item “Utilities” and click Transfer Files
7. Select radio button “Other Sensor Software”. Proceed with Next >

5. Select check box “Application”. Proceed with Next >
6. Select the appropriate directory, which contains the DCP05 program and the appropriate language. Proceed with Next >

8. Confirm selection and press the Finish button.
   The transfer of the program is now in progress. It takes about 20 minutes with a communication speed of 19200 Baud.

7. Proceed as described in section 8.7
8.7 Setting the instrument parameters after upload

Once the installation of System Firmware, language version and on-board application is finished the instrument must be re-initialised, i.e. all settings necessary for DCP05 must be verified.

Any adjustment parameters are unaffected from System Firmware upload. However we recommend verifying them prior to the first use of the instrument.

Two different possibilities apply:

1. The most convenient way is the use of the *TPS1000/2000/5000 configuration utility*.
2. Manually set the appropriate instrument parameters.

**CAUTION**
If the System Firmware and the DCP05 are of different language, the instrument display might bring up XXXX-characters.
Countermeasure:
- Select common local language for both system and DCP05.
- If DCP05 is not available in your local language, simply install English version for DCP05 and chose the local language.

- Switch on the instrument and switch to its Main Menu.
- Verify the adjustment parameters in *CAL (F2)*.
- You must specify the start-up application of the instrument which is accessible via the *CONF (F3)* menu, list item *Autoexec application* (6); i.e. set the Autoexec application to *DCP05*
- To change to local language, access in the *CONF (F3)* menu, list item *User Template* (8)
- Prior to first measurements please verify the communication parameters onboard the TPS and modify as follows if necessary. Access these settings from the Main Menu with *CONF (F3)*, list item *GSI communication param.* (3).

**RCS1100:**
- 19200Bd,
- 8 data bits,
- 1 stop bit,
- Parity None,
- Protocol = None,
- Terminator = CR LF;

- The additional function menu *aF… contains a list item Accessories* (8), which allows you to specify what kind of hardware accessories are
attached in order to avoid damaging the telescope or cable wind-up during instrument rotations (e.g. change face or Build/Inspect). Set and enable the \textit{Hz and/or V limits} in the corresponding list as described in section 7.3

- If you upload DCP05 the very first you will be prompted to enter the license code for this application. Type in the code, which you have received from Leica and enter with the \textit{CONT} key.

This code number is specific to the serial number of the instrument and can not be used for any other instrument number.

\textbf{Tip}

If the menu at \textit{CONF} (F3) does not show any other topics except no 1 and 2 (and 9 for theodolites only), the menus are locked. Unlock the menu in the following way:

a) call the instrument’s Main Menu
b) press \textit{CONF} (F3) \textit{Define functionality}, item 2 at System Config.

c) press \textit{CONT}
d) change to YES for the following item:
   \begin{itemize}
   \item \textit{Show all menus & keys} (YES, F6)
   \item \textit{Enable user configuration} (YES, F6)
   \end{itemize}

e) press \textit{CONT}

If you want to avoid that the operator can manipulate the parameter setting by accident, reset the above-mentioned items to NO once you have defined all necessary settings for DCP05. If you want even to go further, you can password protect them via \textit{System protection}, item 7 at \textit{System Config}.,