Instruction manual

MIT-SCAN-T3

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Liability

The manufacturer assumes no liability for any damages arising from

- failure to observe the instructions in this manual,
- use of the device for unintended purposes,
- non-compliance with the safety instructions.

The manufacturer assumes no liability for printing errors or other inaccuracies in the instruction manual.
Safety instructions

- Recharge the battery when the corresponding icon appears on the display. Do not leave the device unattended while charging.
- Power off the device before exchanging the battery.
- Do not use the device if the housing is damaged.
- Observe the operating conditions (e.g. operating temperature) specified under “Technical data” to prevent possible damage to the device.
- Though the housing seals have been tested extensively, it is possible that water may enter the device during heavy rainfall. If this happens, stop operating the device and ensure it is completely dry before using it again.
- When taking measurements on hot asphalt make sure only the sensor unit has contact to the asphalt. The electronics and the mechanical parts of the control unit are designed for use at temperatures from −10 °C to +50 °C only.
- Observe local safety regulations in effect when performing measurements.
1 Method and requirements

The MIT-SCAN-T3 enables accurate and nondestructive measurement of asphalt and concrete pavement layer thickness in accordance with the German standard **TP D-StB 12**.1

The device uses pulse induction, a further development of eddy current technology. It requires that aluminum or galvanized steel **reflectors** are installed at the base of each layer to be measured.

The measurement technique is based on the principles of magnetic induction tomography and analyzes the temporal and spatial course of eddy current fields generated in standardized reflectors.

The MIT-SCAN-T3 can be used on all layers of surfacing materials common in building and road construction such as bituminous composites, concrete or blast furnace slag. Areas of use include new road/road structure construction, sub-base construction as well as pavement inspection and rehabilitation of existing roads.

1 TP D-StB 12, “Technical specifications for determining pavement layer thicknesses in road construction”, issued by FGSV Verlag GmbH.
1.1 Measuring method

Electromagnetic layer thickness measurement with the MIT-SCAN-T3 is based on pulse induction technology. The method requires reflectors to act as antipoles at the base of the layer being measured (s. section 1.2, p. 7).

The MIT-SCAN-T3 measuring probe is equipped with an emission coil and four sensors (s. Fig. 2 Emission field).

The emission coil emits a magnetic field at regular intervals. This field induces a current in the installed antipole (s. Fig. 3 Induced current).

As it subsides temporally, a response field is generated (s. Fig. 4 Response field) which in turn is recorded by the four sensors and evaluated by the device.

During a measurement run over a reflector, 150 pulses are emitted and signals recorded. This data quantity ensures the high reliability of the measuring method.
# 1.2 Reflectors

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Max. depth²</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL RO 07</td>
<td>Circular plate</td>
<td></td>
</tr>
<tr>
<td>AL RO 12</td>
<td>Diameter: 7, 12, 30 cm</td>
<td>12 cm, 18 cm, 35 cm</td>
</tr>
<tr>
<td>AL RO 30</td>
<td>Diameter: 7, 12 and 30 cm</td>
<td></td>
</tr>
<tr>
<td>AL RO 12</td>
<td>Mat. thickness: 1 mm and 0.5 mm</td>
<td></td>
</tr>
<tr>
<td>AL RO 30</td>
<td>Mat. thickness: Aluminum</td>
<td></td>
</tr>
<tr>
<td>AL RE 30x50</td>
<td>Rectangle</td>
<td></td>
</tr>
<tr>
<td>AL RE 30x60</td>
<td>Width x Length: 30 x 50 cm</td>
<td>40 cm, 50 cm, 50 cm</td>
</tr>
<tr>
<td>AL RE 30x70</td>
<td>Mat. thickness: 0.1 mm</td>
<td></td>
</tr>
<tr>
<td>AL RE 30x100</td>
<td>Mat. thickness: 0.3 mm</td>
<td></td>
</tr>
<tr>
<td>AL RE 30x70</td>
<td>Material: Aluminum</td>
<td></td>
</tr>
<tr>
<td>AL RE 30x100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL SQ 16.5x16.5</td>
<td>Square</td>
<td></td>
</tr>
<tr>
<td>AL SQ 33x33</td>
<td>Width x Length: 16.5 x 16.5 cm or</td>
<td>30 cm, 40 cm</td>
</tr>
<tr>
<td>AL SQ 33x33</td>
<td>33 x 33 cm</td>
<td></td>
</tr>
<tr>
<td>ST RO 12</td>
<td>Mat. thickness: 0.1 mm and 0.3 mm</td>
<td></td>
</tr>
<tr>
<td>ST RO 30</td>
<td>Mat. thickness: Aluminum</td>
<td></td>
</tr>
<tr>
<td>ST SQ 14</td>
<td>Material: Aluminum</td>
<td></td>
</tr>
<tr>
<td>ST SQ 14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Antipole according to TP D-StB 12

² Information about the measuring range in imperial units in Table 2 Measuring ranged of the reflectors

**Special note:**

- Devices are validated/calibrated for use with specified reflectors
- Reflectors must be of verified quality
- MIT circular reflectors carry the MIT logo
- The packaging has a quality seal (s. Fig. 5) and also a label with the batch number.

![Fig. 5 Quality seal](image-url)
Reflectors supplied by MIT are always run through control tests. A certificate is issued for each batch. If required, this certificate may be viewed or requested at MIT by the user (s. Fig. 6). MIT plates are imprinted with the company logo to avoid confusion with any reflector imitations not validated for use with the measurement system.

Please ask MIT for a list with tested suppliers of circular plates in your country.

Fig. 6 Reflector quality validation certificate
1.2.1 Measuring range

The MIT-SCAN-T3 guarantees the correctness of the measurement results only for the specified measuring ranges and approved reflectors.

<table>
<thead>
<tr>
<th>Name</th>
<th>Standard measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL RO 07</td>
<td>1.5 - 12 cm</td>
</tr>
<tr>
<td>AL RO 12</td>
<td>1.5 - 18 cm</td>
</tr>
<tr>
<td>AL RO 30</td>
<td>4.0 - 35 cm</td>
</tr>
<tr>
<td>AL RE 30x50 (100 µm)</td>
<td>1.5 - 40 cm</td>
</tr>
<tr>
<td>AL RE 30x50 (300 µm)</td>
<td>2.0 - 40 cm</td>
</tr>
<tr>
<td>AL RE 30x60, 30x70, 30x100 (100 µm)</td>
<td>1.5 - 50 cm</td>
</tr>
<tr>
<td>AL RE 30x60, 30x70, 30x100 (300 µm)</td>
<td>2.0 – 50 cm</td>
</tr>
<tr>
<td>AL QU 16,5x16,5</td>
<td>1.5 - 30 cm</td>
</tr>
<tr>
<td>AL QU 33x33</td>
<td>1.5 - 40 cm</td>
</tr>
<tr>
<td>ST RO 30</td>
<td>4.0 - 35 cm</td>
</tr>
<tr>
<td>ST QU 14(^3)</td>
<td>2.0 – 50 cm</td>
</tr>
</tbody>
</table>

Table 2 Measuring ranged of the reflectors

\(^3\) ST QU 14 is a square reflector measuring 14 inches by 14 inches

Please note:
If other measuring ranges are required by the application, please contact the manufacturer.
1.3 Measurement environment

Metallic objects should not be present within a radius of one meter around a measurement point, such as e.g.:

- manhole covers, drains
- road restraint systems (crash barriers)
- other reflectors
- cars, construction machinery

Wearing safety footwear such as steel-toed boots has no influence on the measurement as long as they are not too close to the probe.

Conditions that have no impact on measurement are:

- wet roads
- hot asphalt
- slightly freezing temperatures
1.4 Device calibration

The German standard TP D-StB 12 stipulates annual recalibrations of the thickness measurement device. Depending on the country of use, there may be regulations from the authorities regarding the calibration.

The user commissions the calibration of relevant reflector formats for an application. A valid certificate of calibration with a tabular and graphical report of the test results is issued for the calibrated reflectors. Additionally, the next calibration due date is indicated on a calibration label on the device's probe (s. Fig. 8).

The user then cannot access uncalibrated reflector formats though all standard formats are preset in the device. If the area of application changes, formats can be reactivated with the next calibration.

The date of the last calibration will appear on the display when the device is switched on.

Please note:

The TP D-StB 12 standard stipulates the need for calibration of thickness measuring devices on an annual basis.
2 Thickness measuring device

The measuring device consists of two functional units (s. Fig. 9):

(1) control unit
(2) measuring probe

They are connected by a telescopic rod. The telescopic rod is secured with tube locks (4).

The control unit is equipped with:

(5) display
(6) directional pad (D-pad)
(7) search key
(8) interfaces for a USB stick, headphones and charger

Coils for emitting and receiving signals are integrated in the probe. The traversed measurement path is determined based on the front wheel's rotation.

Preparing the MIT-SCAN-T3 for operation:

- Remove the device from its case and loosen both tube locks by turning them counterclockwise.
- Extend the middle tube segment of the telescopic rod to the desired length and tighten the upper tube lock.
- Align control unit and probe by turning the lower tube segment by 90 degrees counterclockwise,
- Extend the lower segment and tighten the tube lock.

2.1 Interfaces

At the upper end of the control unit under a lid are three interface connections (s. Fig. 10):

1) battery charger
2) USB stick
3) headphones

2.1.1 Recharging the device

The integrated battery can be charged directly in the device. For this, connect the supplied power adapter or the 12 V car charger to the recharge port on the device. The battery charge level is shown on the display. A full recharge of the battery will take about 1.5 hours.

2.1.2 Data exchange via USB interface

The USB interface is for the exchange of measurement data between the device and a PC. Connecting a USB stick to the device and opening
the Main Menu starts the automatic synchronization of data between MIT-SCAN-T3 and the USB stick. Remove the USB stick after successful data exchange. Measurement data is stored in the file “MIT-SCAN-T3\_device number.T3”. Use the MIT Project Software to import this file into a form sheet for further processing.

2.1.3 Headphone interface

This interface is for connecting a headphone with a 3.5 mm audio jack. During a reflector search, acoustic signals are emitted depending on the received signal. Using headphones will make searches easier in high-noise environments.

2.2 Device number and firmware

The number of the device can be found on a label below the USB, headphone and charger interfaces. Device number, firmware version and the last calibration date will also appear on the bottom line of the start screen after power-up (s. Fig. 11).

Fig. 11 Start screen
2.3 Carrying strap

The attachment of the carrying strap is as shown in Fig. 12. The carabiner of the belt is inserted into the eyebolt at the upper end of the control unit case. Open the loop at the other end of the belt, place it directly below the control unit case around the tube and close it using the snap button.

To release the snap button the knob (s. detail Fig. 12) must be pulled upwards. If the mechanism is sufficiently relieved, the two components are released from each other and the loop is opened. To lock the snap button, the ball head of the pin must be pressed into the buttonhole until both parts engage into each other.

Use of the device with the connected strap as shown in Fig. 1.

2.4 Operation

To switch on the device, simultaneously press the search button (s. Fig. 9 (7), p. 12) and the “—” key on the D-pad.

Navigate comfortably through the menu options via the D-pad (s. Fig. 13):
• Navigation: \(\leftarrow, \uparrow, \downarrow, \text{and} \uparrow\)
• Select or Confirm: \(\leftarrow\)
• Back/Power off: Press \(\downarrow\) for 3 seconds.

The respectively activated key is shown in the footer of the screen.

### 2.5 Main Menu

After startup, the Main Menu (s. Fig. 14) with the three sub-menu options is displayed automatically:

- “Measure” Start a measurement
- “Data” Saved measurement data
- “Settings” Set basic device settings

Besides the sub-menu options are displayed the date and time as well as the battery charge level.
2.5.1 Menu “Measure”

After selecting the measurement menu, first determine the construction project where measurements are to be taken (s. Fig. 15):

- “Preset Measuring Sites”:
  Measuring site plans set up with MIT's project management software (s. sec. 5.4, p. 43) can be displayed and executed under this menu item. The numbers in brackets indicate how many of the total number of measuring sites in the measuring site plan have already been measured.

- “Manual input”:
  Here new projects are set up or activated and implemented (s. sec. 3.1, p. 20).

- “Measuring without input”
  Under this menu item, measurement can be run directly without any site data. It is only necessary to set the installed reflector type.

![Fig. 15 Menu - Measure](image)

**Construction project selection:**

- “Preset measuring site”:
  Projects preset at the PC

- “Manual input”:
  Current project or preset new projects

- “Measuring without input”
  Measuring without construction project details
2.5.2 Menu “Data”

Under this menu item, all measured data are displayed sorted according to date and displayed as a file.

Already measured sites can be activated and measured again (s. Fig. 16). The measured value is displayed in the right area of the display. If more than one measurement result is available for a site the last three values are shown.

**Locate measuring sites via GPS data**

If a data set contains GPS information, the measuring site can be located later with the help of the GPS data and be remeasured. For this, first select the measurement date in the menu “Data”. After the data set is activated, the site can be remeasured by pressing on the ← key. The measuring site’s distance and direction (with a compass arrow) is then displayed on the right side of the screen (s. Fig. 17). This requires that current GPS data can be received.

**Relocate measuring site:**

1. Select measuring site
2. To “Remeasure” select ← button
3. Distance and direction are displayed
2.5.3 Menu “Settings”

Under this menu item, device specific settings can be made (s. Fig. 18):

- “Language”
- “Unit”
- “Light” (of display)
- “GPS”
- “Vibration”
- “Date, Time”

3 Performing a measurement

The MIT-SCAN-T3 is ready for use as soon as it is switched on. By selecting “Measure” in the Main Menu, the user changes to the measurement menu and can start with the measurements.

Please note:

If GPS is enabled, measuring site specific GPS data will be stored. A warning is displayed if there is no GPS reception. This warning function can be turned off in the settings menu.
3.1 Measuring sites set up on MIT-SCAN-T3

Projects can be preset at the PC with the MIT Project Software (s. sec. 5.4, p. 43). Alternatively, the projects can be set up directly on the device. For this, the item “Manual input” must be selected from the submenu “Definition of Measuring site”.

After activating the item “Project Data” in the menu “Current Measuring Site”, information about the current project can be entered by confirming with the ► key (s. Fig. 19). In this context, all project relevant parameters regarding the construction work can be entered (s. Fig. 20 below):

- “Project”
  Name of street or construction work (max. five characters)
- “Start Pos.” (Start position)
  Data on starting point of measurements
- “Distance”
  Distance between measuring sites
- “Layer”
  Information about layer structure (2- or 3-layer measurement)
- “Reflector”
  Preselection of installed reflectors
Enter data in each row by pressing the ← key. Press the ← key again to confirm the data input in the activated row. Entering information about measuring sites makes it easier to later identify them during evaluation with MIT Project Software. After input is completed, press the ▲ key for 3 seconds to go back to the measurement menu.

As long as a measurement has not yet been performed, layer and reflector data can be changed or corrected at any time.

### 3.1.1 Layer system

The MIT-SCAN-T3 can measure 2 and 3-layer systems. Switching between layered systems is done by pressing ← and subsequent selection with ▲ and ▼

- **2-layer system**: S, SB, B
- **3-layer system**: S, SM, SMB, M, MB, B

A schematic representation of the selected layer (S = Surface, M = Medium, B = Base) is shown in the right area of the screen (s. Fig. 21).

### Changing values:

1. Select parameters with ▲ or ▼ and confirm with ←
2. Change cursor position with ▼ or ▲
3. Change values with ▲ or ▼
4. Accept selection with ←

![Fig. 21 Selection of layer to be measured](image)
### Automatic Select reflectors

All reflectors for which the device has been calibrated are available to the user (s. Table 1, p. 7).

Since each separate construction project has its specific reflectors installed, the relevant reflectors for each respective project can be selected or deselected (example s. Fig. 22):

- Switch to row “reflector”
- Open the reflectors list with the ← key
- Navigate to your reflector using the ▲ and ▼ keys
- Select or deselect reflectors with the ← key
- Switch to the measurement menu with ▲

In the measurement menu, the reflector to be measured is then quickly selected using the keys ◀ and ▶.

### Automatic circular plate recognition

The measuring device has an **automatic circular plate recognition** function. If “Autom. Refl.” is activated, a second analysis of the measurement signal will be performed at the end of the measurement. By means of the signal characteristics, the reflector is determined and
the layer thickness calculated.

In the results representation, the identified reflector is displayed in addition to layer thickness. The user is recommended to do a plausibility check of both the identified reflector and the relatedly displayed layer thickness.

The automatic circular plate recognition can identify the following reflectors (s. Table 1, p. 7):

- ALRO07
- ALRO12
- ALRO30
- STRO12
- STRO30
3.2 Measuring procedure

The measurement can be performed once all necessary settings have been made.

3.2.1 Reflector search

To start the search mode, press and hold down the search button (compare Fig. 9 MIT-SCAN-T3 design, (7), p. 12). The signals from the four sensors are shown in the display as separate bars (s. Fig. 23 on next page).

The higher the bar, the stronger the signal received. The bar amplitude also depends on the size of the reflector and its distance from the probe.

Reflector searching procedure:

- Sweep probe above the road lane in wide side-to-side motions
- Observe the four search bars
- When bar amplitudes or a vibration indicate detection, perform shorter sweeping motions for exact localization
- Determine reflector center and put down the probe

Hints regarding reflector search

- Sweep probe above the road lane in wide side-to-side motions
- Observe search bars
- Use horizontal search bar in the footer to determine reflector center
The narrow, horizontal band under the diagram helps the user to exactly determine the center of the reflector. The search band (illustrated in the adjacent graphic) clearly shows in which direction, based on the center of the display, the probe needs to be moved to locate the reflector center.

Fig. 24 on the following page shows a graphic of the display with the search band and the position of the probe for an ALRO12 reflector.

Subsequently start the measurement:

- With the search button pressed down, run measuring device back by 30 cm; the measurement will start automatically, or
- Release the search button
- The option “Measure” is displayed
- Position the probe at the starting point of the measurement path (about 30 cm before the located reflector) and press the key to start measuring.

Please note:
Measurement starts automatically

- Put the probe down above the reflector center
- With the search button pressed down run probe back by 30 cm
Fig. 24 Reflector search demonstrated for a ALRO12 reflector
3.2.2 Measurement

At the start of the measurement, a graphic of the path is shown on the right side of the screen (s. Fig. 25). It is necessary to pass roughly over the reflector center, always starting along the short sides with rectangular formats. All three wheels must have contact to the lane surface.

Please note the following during run:

- **Pace**
  The measurement pace must be slow, otherwise measurement data will be lost. If the device traverses a measuring site too quickly, one of the following warnings will appear on the display:
  "Move slower!" – Evaluation was still possible. Yet, a slower pace is recommended.
  "Movement too fast!" – Calculation of layer thickness failed. Repeat measurement run.

- **Traversal curve maximum**
  The maximum of the traversal curve must be in the first half of the display (marked as dotted line).

**Notes:**

- Jumps in the measurement curve (s. Fig. 25) show the signal amplifications of the device. The amplification is thereby adjusted to the measurement signal.
- Signals displayed during the reference run indicate metallic objects in the surrounding environment. These can negatively impact measurements.
• Reference measurement
  The reference measurement is taken during the last part of the measurement run. It is required for the evaluation of the baseline signal of the measurement surrounding. In this manner, materials with a homogenous distributed metallic content can also be measured (e.g. blast furnace slag).

The measurement path depends on the selected reflector:

• ≈ 1 m for small reflectors ALRO07, ALRO12, STRO12 and ALQU16.5

• ≈ 1.5 m for larger reflectors ALRO30, STRO30, ALRE30x50, ALRE30x60, ALRE30x70, ALRE30x100, ALQU33 and automatic circular plate recognition

Measurement stops immediately when the complete traversed distance of the path has been covered at an appropriate pace. The measurement is interrupted, when the probe is moved backwards.
3.2.3 Results display

After completing the measurement run, the traverse path curve appears on the display for a moment. In this graph the curve is scaled based on the display and change-over points taken into account. The curve should show no irregularities. Irregularities are an indicator of disturbances during measurement (s. Fig. 26).

The result is subsequently displayed (s. Fig. 27). The following information are shown in the display:

- Measured layer thickness
- Preset or automatically identified reflector
- Reflector value

If GPS data were received for the measuring site, this is shown on the upper right of the display (s. highlighted area in Fig. 27).

3.2.4 Calculated layer thickness

The calculated layer thickness is displayed in the selected unit of measurement. The measured value equals the distance between reflector bottom side and the contact surface of the probe.
Layer thickness too low

The measuring range depends on the selected reflector. If the calculation gives a layer thickness less than the lower measuring range of the reflector, this is shown in the display (s. Fig. 28). In this case, the setting and the measurement should be considered critically:

- Reflector set correctly?
- Is the expected measured value within the measuring range of the reflector?

Note: If the measuring range is not reached, a layer thickness can still be determined. In this case, a measurement with the MIT wheeled spacer is possible. It increases the distance to the reflector, so a valid measurement result can be calculated.
3.2.5 Measured reflector

On the left, above the measurement result, the reflector selected for the measurement is displayed. If automatic circular plate recognition was activated, here is shown which reflector was identified. This is then indicated by an “(A)” next to the name of the reflector.

3.2.6 Material quality coefficient

On the right area of the display is a graphic view of the material quality coefficient (s. adjacent Fig. 29).

This provides useful information for assessing the intactness of a measuring site, i.e. of the reflector. The coefficient should be within the range of −1.0 to +1.0. The scale on the right side of the display demonstrates this clearly. The calculated value is found left next to the scale.
Evaluation of measuring site via material coefficient:

- Reflector selection correct?
- Reflector of verified quality used?
- Reflector damaged?
- Only robust reflectors of verified quality ensure reliable measurement results

If the quality coefficient is outside of the valid range, the measurement result is questionable:

- Was the correct reflector selected and set up for the measurement? If not, the result is wrong.
- Were the installed foils too thin?
  If yes, the calculated coefficient is well below −1.0.
- Was the reflector possibly damaged or destroyed?
  Sometimes, foils can be damaged or destroyed during placement by the construction machines. Depending on the extent of damage, the reason for measurement failures can be foils with bent ends, torn foils or perforated foils. Therefore, whenever possible, always use robust reflectors for electromagnetic thickness measurements.
- Have MIT-SCAN-T3 validated reflectors not been used?
  In this case, the result of the calculated layer thickness is not warranted.
3.2.7 Reflector test

After a reflector foil is measured (ALQU16.5, ALQU33, ALRE30x50, ALRE30x60, ALRE30x70 and ALRE30x100), the results menu optionally offers a “Reflector test” (s. Fig. 29, p. 31). The reflector test helps to:

- determine reflector foil/plate size
- assess the condition of the reflector

To perform a reflector test, a second run over the reflector is necessary: This run must be conducted along the long side of the reflector (change measurement direction by 90 degrees). Press search button to determine reflector position. Once the edge of the foil/plate is determined, measurement can be started and the probe moved slowly over the reflector.

Directly after completing the measurement the following parameters are displayed (s. adjacent Fig. 30):

- “Coefficient” (material quality): repeated calculation of material quality (s. sec. 3.2.6, p. 31) from the data of a run along the long and short side of the reflector
- “Calc. size” (calculated size); calculated width and length of reflector

Reflector test

1. Change measurement direction by 90 degrees
2. Press search button to find edge of reflector
3. Start measurement and move probe slowly over the reflector

<table>
<thead>
<tr>
<th>Result of reflector test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient: 0.0</td>
</tr>
<tr>
<td>Calc. size: 30 x 70 cm</td>
</tr>
<tr>
<td>sel. Refl.: ALRE30x70</td>
</tr>
<tr>
<td>Rating: Reflectortype correct</td>
</tr>
<tr>
<td>Condition: Reflector Good</td>
</tr>
</tbody>
</table>

Fig. 30 Reflector test result
“Sel. Reflector” (selected reflector):
Display of set up reflector

“Rating”: The calculated reflector format provides a check of the conformity between measured reflector and set antipole.

“Condition”: With the calculated coefficient, it is possible to assess whether a reflector is damaged (but still measurable) or destroyed (not measurable).

3.3 Functionality check acc. to TP D-StB 12

“Before starting the day’s first measurement, the thickness measuring device’s functionality must be tested.”

The TP D-StB 12 stipulates that the first measurement must be a device function test. For this, with the device traverse the measuring site and perform a measurement. Then repeat the measurement with a mobile spacer. For this, use the MIT wheeled spacer (s. Fig. 31) and fix it to the probe. The MIT wheeled spacer increases the distance between probe and road surface by 35 mm.

The functionality test acc. to TP D-StB 12 is considered passed if after the subtraction of the surplus amount (35 mm) from the second

4 Source: TP D-StB 12, sec. 2.2.6
measurement “the difference between layer thickness measurement results with and without the spacer is not more than the specified accuracy of the device plus 1 mm”.

It is important to note that the thickness measuring device itself has a measurement tolerance of ± (0.5 % of the measured value + 1 mm).

If the device does not pass the functionality check, it must be sent to the manufacturer for validation.

4 Warnings and error messages

The MIT-SCAN-T3 is equipped with a comprehensive error detection function. During measurements, the measurement signal is checked for possible deficiencies and influences. If an error is detected, this is displayed subsequently to the measurement (s. example in adjacent Fig. 32 and Fig. 33).

The following error messages may occur (table on the next pages):

5 Source: TP D-StB 12, sec. 2.2.6 Measurement

**Hint:**
Perform the functionality test on thinner layers to decrease the influence of measurement tolerance.

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring Error</td>
<td>Move slower!</td>
</tr>
<tr>
<td>Measuring Error</td>
<td>The calculation of the depth could be wrong.</td>
</tr>
<tr>
<td>Measuring Error</td>
<td>Any key to continue.</td>
</tr>
<tr>
<td>Measuring Error</td>
<td>Max Position</td>
</tr>
<tr>
<td>Measuring Error</td>
<td>Movement too fast!</td>
</tr>
</tbody>
</table>

---

Fig. 32 Example for single warning

Fig. 33 Several warnings
<table>
<thead>
<tr>
<th>Error message</th>
<th>What to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low battery!</td>
<td>Reload the battery promptly</td>
</tr>
<tr>
<td>Empty battery!</td>
<td>Measurements cannot be performed. Reload or exchange battery.</td>
</tr>
<tr>
<td>No GPS signal!</td>
<td>Continue measurement and save data without GPS signal or</td>
</tr>
<tr>
<td></td>
<td>Wait until the device has a GPS signal.</td>
</tr>
<tr>
<td>Data memory full!</td>
<td>Measurements cannot be saved.</td>
</tr>
<tr>
<td>Move slower!</td>
<td>Evaluation was still possible. However, a slower pace is recommended.</td>
</tr>
<tr>
<td>Movement too fast.</td>
<td>Calculation of layer thickness failed. Repeat measurement run.</td>
</tr>
<tr>
<td>No reflector found!</td>
<td>Analysis of measurement signal found no reflector. Repeat search and measurement of reflector</td>
</tr>
<tr>
<td>Error message</td>
<td>What to do?</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Max. position wrong</td>
<td>Repeat measurement at measuring site. Place probe about 30 cm before the reflector.</td>
</tr>
<tr>
<td>Measurement aborted</td>
<td>Measurement must be run at a constant pace.</td>
</tr>
<tr>
<td>Electromagnetic interfer.</td>
<td>Measurement signal was influenced by electromagnetic interferences, e.g. by:</td>
</tr>
<tr>
<td></td>
<td>- High-voltage lines</td>
</tr>
<tr>
<td></td>
<td>- Underground cables</td>
</tr>
<tr>
<td></td>
<td>- Transformers, generators or other construction machinery</td>
</tr>
<tr>
<td>Zero meas. invalid</td>
<td>Reference run was influenced by extraneous metals. If possible remove extraneous metal. Alternatively, pass over the reflector in the other direction.</td>
</tr>
<tr>
<td>Incorrect measurement</td>
<td>This error message appears if the course of the measurement signal indicates that a rectangular foil was not passed over along its long side. Repeat run over rectangular foil along the long side.</td>
</tr>
</tbody>
</table>
Error message | What to do?
--- | ---
Side shift of reflector | The error message appears when the user has passed the reflector too close to the edge. The reflector should be re-searched and passed over in the middle

Table 3 Overview of warnings and error messages
5 MIT Project Software

The MIT Project Software offers the following functions:

- Set up of construction sites using the measuring site plan (= predetermined grid points of measurement for a construction project)
- Display and storage of measured data
- Evaluation of measured data and generation of form sheets acc. to TP D-StB 12

Please note:

When using a new USB stick, first connect it to the MIT-SCAN-T3 and then synchronize with the PC.

Fig. 34 MIT project software - Program screen shot
With the MIT Project Software, new projects can also be set up during operation at the construction site.

Data synchronization between measuring device and the MIT Project Software is performed by first connecting the USB stick to the device, subsequently to the PC and then again to the measuring device.

### 5.1 License key and copy protection

The MIT Project Software is protected by a license key. It is device-dependent. Only measurement data from the corresponding device can be processed. The synchronization of measured data using the MIT Project Software is activated with the license key included in delivery. It can be found in the CD cover inlay on the last page. To be able to evaluate data from other MIT-SCAN-T3 type measurement devices, the corresponding license key for the respective device must be entered. The software can be installed on various computers.
5.2 Program settings

Under the menu item “Extras”, different settings can be made in the program (s. Fig. 35).

- “Language”
  German or English
- “Units”
  international (mm/cm for depth, m for step size) or Anglo-American (inch for depth, foot/mile for step size) and the unit for results display (form sheet).
- “Multiple measurements”
  It is possible to have the average from several measurements for a measuring site or alternatively the last value entered in the form sheet.
- “Plausibility of measurements”
  The program checks whether the measured value is within the measurement range of a respective reflector.
- “Form sheet preview”
  With the selection of a data set, simultaneous calculation of the values in the form sheet is performed.
5.3 Selection of devices

The MIT Project Software can be used to read-out the measured data on the USB stick. As soon as the program is opened after connecting the USB stick, or if a USB stick is connected while the program is running, the USB ports are queried for device files (*.T3). The result of the query is shown in Fig. 36 below.

![Fig. 36 File query for T3 data](image)

The T3 data can be linked to each respective device by assignment of a name or number. This is especially helpful when several devices are in use and another designation than the internal device number is preferred. It is possible to activate and load several files. The respective file is selected in the program under “device” (s. Fig. 37).
5.4 Set up of measuring sites at the PC

Measuring sites can conveniently be set up at the PC. The interface is under the second tab “Prepare measurements” (s. Fig. 39).

With the software, optionally the measuring sites for all devices can be set up, which since installation exchanged data via the USB stick with the software. If measurements from several layer thickness measuring devices are to be processed, the relevant device has to selected (s. highlighted area in Fig. 38).
The following construction project information is required:

- Construction ex.: A14
- Start ex.: 3 km 500 m
- Distance ex.: 50 m
- End ex.: 5 km 550 m
- Pos. of measuring sites left, middle, right
- Select layer and corresponding reflector

After data input, the measuring site plan is generated automatically under “Generate measurement plan” s. Fig. 40). Individual data sets can be processed or deleted there.

Fig. 40 Generated measuring site plan with USB stick data
Once the measuring site plan has been generated, the data can be “Transferred to the USB stick”. The set up measuring sites are shown in the table (s. Fig. 40, p. 44) and are saved as a file to the USB stick. In the table, the storage site for data can be changed from “PC” to “USB”; the data can then be transferred to the layer thickness measuring device. It is possible to sort the data in the table according to the position. This can be done in ascending or descending order. As a result, measuring stations that are subsequently added can be sorted into the desired grid easily.

Fig. 41 Transfer the generated measuring point plan to a USB stick
5.5 Selection of measured values

Data transferred from the device can be selected under the tab “Data”.

One option is to filter the measurement data using the filter function (s. Fig. 42). Several criteria can be queried at the same time.

Another option is to select data sets directly in the table:

- To select all data sets:
  Left-click with the mouse in the table, then use the key combination “Ctrl + a”.
- To select related data sets:
  Click on first data set, then hold shift key pressed and click on last marked data set.
• To select isolated data sets:
  Hold Ctrl key pressed and select single rows
• To select single data set:
  Left click with the mouse on the desired data set

**Error message during measurement**

Error messages which were displayed during the measurement are displayed in the table (s. Fig. 34) in the “Error” column by their abbreviation. By moving the mouse over the respective cell, all error messages are displayed completely.

**5.6 Correct and delete data**

Information about layer type and position can be corrected also at a later time. For this right-click with the mouse on the relevant row and then correct the data (s. Fig. 43).

To delete single data sets first mark the relevant row. Then press the “Del” key and the selected row is deleted.
5.7 Synchronize and save data

From time to time, the data sets on the USB stick and the measuring device must be synchronized. For this there are two options:

“Synchronization” button
Press this button to synchronize data with the active file on the USB stick. In Fig. 44 a synchronization of data sets e.g. with the device “Prototype 003” is shown.

Menu Tools - “Synchronize USB stick”:
Select the device whose data are to be synchronized with the USB stick.

All data sets can be stored on the PC. The following file formats are available:

MIT format:
In this format the data are encrypted before saving and can be loaded into the software any time via “Import”. MIT files can also be evaluated using the software ElmaDick.

Please note:
The form sheet cannot be reloaded later with the program. It is therefore recommended to save the used data sets in the MIT format (*.mit).
Excel format:
By pressing the button “Export selected data sets” (s. Fig. 45), the data sets are saved as a table to an XLSX file.

5.8 Form sheet

The MIT Project Software transfers measurement data from a construction site to a measurement sheet analogous to TP D-StB 12. For this, the relevant measurement data must be selected (s. sec. 5.5, from p. 46).

5.8.1 Form sheet settings

Under the menu item “Form sheet” several settings can be made (s. Fig. 46):

- “Update”: Calculations in the form sheet are updated (only possible, if result preview is deactivated).
- “Zoom”: With this control the width of the form sheet can be changed within the program (50–200%).
- “Show/hide company logo”: A company logo can be inserted top right of the form sheet. The inserted logo can be hidden at any time.
- “Save”: The form sheet can be saved as a pdf or excel file.
After it is saved it opens automatically and can be printed out.

5.8.2 Data transfer for site measuring

Simultaneously with the selection of measurement data, if the preview setting is activated, data are taken over into the form sheet and individual layer thicknesses calculated (s. Fig. 35, p. 41). If the results preview is deactivated, the update is performed under the menu item “Form sheet” - “Update” (s. Fig. 46, p. 49).

To take over data into the form sheet, the following information is mandatory:

- Kilometer indication
- Type of layer (surface, binder or aggregate)
- Position of reflector to axis (left, center or right)

These settings can be made with the MIT-SCAN-T3 or at the PC using the prepared measuring site plan.
5.8.3 Calculations in the measurement sheet

The form sheet shows the measured layer thickness for each layer in separate columns (s. Fig. 34, p. 39). If layer thickness determination of several layers is performed over the same measurement point, the program automatically calculates individual layer thicknesses for the following layer systems (s. Fig. 47):

- Two-layer construction
- Three-layer construction

The MIT Project Software averages the measured values available for one layer type taken at the same measurement point. This presetting can be made under the menu item “Extras” (s. sec. 5.2, p. 41).

By clicking on a measurement value or determined layer thickness the values in the form sheet used for calculation are marked green in the table.

Fig. 47 Calculation of layer construction
5.8.4 Setting up a form sheet

The upper part of the form sheet is utilized to provide information about the contractee, contractor and description of the performed construction work.

In the footer (s. Fig. 48) the user must enter the results of the functionality test acc. to TP D-StB 12 (s. sec. 3.3, from p. 34). If not confirmed or is even negated, the functionality test is considered failed. To complete the form sheet, additional information can be added in the footer regarding the device used and measured antipoles.

Fig. 48 Footer of form sheet
5.9 GPS data and Google Maps

In the third tab in the MIT Project Software, the highlighted measurement data are displayed as markers in Google Maps (s. Fig. 49).

Fig. 49 Measurement data display in the tab Google Maps
The display of single measurements can be selected and deselected by the marker in the legend above the map.

Several measurement points are shown in the map if they are marked by the filter or selected manually. The graphic display of measurement points facilitates reliable allocation of measurement values to a certain measuring site. It may also reveal incorrect measuring site information.

If the mouse cursor is positioned above a marker in the map, the data measured at this point are displayed. The map can be moved using the mouse cursor. For this, position the mouse cursor on the map and then with the right mouse key pressed move it in the desired direction.
## 6 Technical data

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement data</strong></td>
<td>150 measurement points/receiver coil</td>
</tr>
<tr>
<td><strong>High measurement accuracy</strong></td>
<td>±(0.5 % of measured value + 1 mm)</td>
</tr>
<tr>
<td><strong>Measurement range</strong></td>
<td>15 – 500 mm depth&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Asphalt temperature</strong></td>
<td>up to 110 °C</td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>-10 °C to +50 °C</td>
</tr>
<tr>
<td><strong>Battery life</strong></td>
<td>8 hours or about 1000 measurements</td>
</tr>
<tr>
<td><strong>Charging time</strong></td>
<td>1.5 hours</td>
</tr>
<tr>
<td><strong>Memory capacity</strong></td>
<td>up to 5000 data sets</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>USB stick</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>Net weight 4 kg, 18 kg incl. packaging</td>
</tr>
</tbody>
</table>

Table 4 Technical data

<sup>6</sup> The measuring range depends on the respective reflector
7 Scope of delivery

- Basic device
- NiMh (12 V/2 Ah) battery
- Calibration for aluminum circular plates (diameter: 7, 12, 30 cm)
- Test certificate
- GPS inside
- Battery charger
- Car charger
- Shoulder strap
- Instruction manual
- USB stick for data transfer
- MIT Project Software incl. license key
- Device case

Accessories:
- MIT control trolley
- Headphones
- Further customer-requested calibrations
- Consumables (reflectors)
MIT Mess- und Prüftechnik GmbH
Gostritzer Str. 63
01217 Dresden
Telephone: +49 (0) 351/871 81 25
Fax: +49 (0) 351/871 81 27
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Internet: www.mit-dresden.de

Device support:
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Email: info@mit-dresden.de

Software support
Telephone: +49 (0) 351/871 81 22
Email: info@mit-dresden.de