Instruction Manual

MIT-SCAN-T3

MIT Mess- und Prüftechnik GmbH

Version 12/2020

Table of contents

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 within this instruction manual.

Safety instructions

- Recharge the battery when the corresponding icon appears on 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 “9 Technical data” to prevent 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 contacts the asphalt. Electronics as well as mechanical parts of the control unit are designed for the use from +14 °F to +122 °F.
- Observe local safety regulations when performing measurements.
- Mechanical loads, such as permanent vibrations or impacts on a hard surface may cause damages and malfunctions such as measurement errors. In this case, the device has to be checked by the manufacturer and, if necessary, has to be recalibrated.

- The device may only be used or moved when the telescopic tube is locked.
- No structural changes may be made (replacement or additional attachment of objects).
- The device may only be used for thickness measurements according to ASTM E3209, AASHTO T-T359 or German Standard TP D-StB 12.
- Warranty service will only be accepted if only original accessories or reflector types have been used. The device is calibrated by the manufacturer with standardized reflectors (standard procedure). Differing material may cause wrong measurement results as the calibrations do not match with reflector types.

1 Method and requirements

MIT-SCAN-T3 provides the user with accurate and non-destructive measurement of asphalt and concrete pavement layer thickness in accordance with **ASTM E3209**[1], **AASHTO T-T359**[2] and German standard **TP D-StB 12**[3].

The device uses pulse induction, a further development of eddy current technology. It requires that aluminum or galvanized steel **reflectors** are installed under 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.

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.

Fig. 1 MIT-SCAN-T3

Attention!
Only install reflectors specified by MIT.

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[1] Issued by ASTM International.
[2] Issued by American Association of State and Highway Transportation Officials.
[3] TP D-StB 12, "Technical specifications for determining pavement layer thicknesses in road construction", issued by FGSV Verlag GmbH.

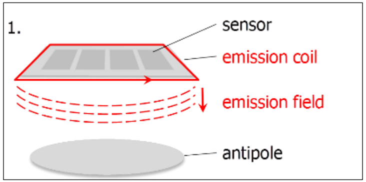


Fig. 2 Emission field

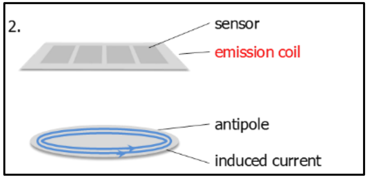


Fig. 3 Induced current

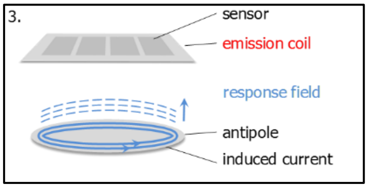


Fig. 4 Response field

1.1 Measuring method

Electromagnetic layer thickness measurement with **MIT-SCAN-T3** is based on pulse induction technology. This method requires reflectors to act as antipoles at the base of the layer being measured (s. section 1.2, p. 9).

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, up to 200 pulses are emitted and signals recorded. This data quantity ensures the high reliability of the measuring method.

1.2 Reflectors

Name	Description		Material thickness	Max. depth[4]
AL RO 07 AL RO 12 AL RO 30	Circular plate Diameter: Material:	 7, 12 and 30 cm Aluminum	1.0 mm 1.0 mm 0.5 mm	12 cm 18 cm 35 cm
AL RE 30x70 AL RE 30x100	Rectangle (foil/sheet) Width x Length Material:	 30 x 70/100 cm Aluminum	0.1/0.3 mm 0.1/0.3 mm	50 cm 50 cm
ST RO 12 ST RO 30	Circular plate Diameter: Material:	 12 and 30 cm Steel	1.00 mm 0.65 mm	18 cm 35 cm
ST SQ 14	Square sheet Width x Length Material:	 14 x 14 in Steel	0.65 mm	50 cm

Table 1 Description of the available antipoles

[4] Information about the measuring range: see Table 2 Measuring range of reflectors

Special note:

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

Fig. 5 Quality seal

Zertifikat Certificate Certificado Certifikat

ZERTIFIKAT

Das Firma
MIT Mess- und Prüftechnik GmbH
bescheinigt, dass die Ronden aus der Lieferung
mit der Chargennummer

20141023-223

als Gegenpol für das

Messsystem MIT-SCAN-T2

zugelassen sind.

Der Materiallieferant und der Hersteller der Ronden sind der MIT Mess-und Prüftechnik GmbH bekannt und von dieser zugelassen.

Die Eignung des Materials für den Einsatz mit dem Messsystem wurde durch den Lieferanten anhand eines Abnahmeprüfzeugnisses über die Materialzusammensetzung nachgewiesen.

Durch die Prüfung, Bericht-Nr. **B201423-223** wurde der Nachweis erbracht, dass die Ronden aus der oben genannten Charge die notwendigen Anforderungen erfüllen und in Kombination mit dem MIT-SCAN-T2 korrekte Messwerte erzeugen.

Dieses Zertifikat ist nur gültig für die Lieferungen mit der Kennzeichnung der oben aufgeführten Chargennummer, sichtbar auf der Verkaufsrechnung oder auf der Rondenverpackung.

Dresden, 28.08.2015

MIT Mess- und Prüftechnik GmbH – Gostritzer Straße 63 – 01127 Dresden - Germany

Fig. 6 Reflector quality validation certificate

Reflectors supplied by MIT are checked and verified thru control tests. A certificate is issued for each batch. If required, this certificate may be viewed or requested by the user (s. Fig. 6). MIT plates are imprinted with the MIT logo to avoid confusion with any reflector imitations not validated for the use of MIT-SCAN-T3.

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

Attention: Measuring device and reflectors are one unit. If unauthorized or damaged reflectors are used, the accuracy of the layer thickness measurement system can't be guaranteed. There may be significant variations between measured thickness and real thickness.

1.2.1 Measuring range

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

Name	Standard measuring range
AL RO 07 AL RO 12 AL RO 30	0.5 - 4.5 in 0.5 - 7.0 in 1.5 - 13.5 in
AL RE 30x70, 30x100 (100 µm) AL RE 30x70, 30x100 (300 µm)	0.5 - 19.5 in 0.8 - 19.5 in
ST RO 12 ST RO 30	0.5 - 7.0 in 1.5 - 13.5 in
ST SQ 14	0.8 - 19.5 in

Table 2 Measuring range of reflectors

Please note:
If other measuring ranges are required, please contact the manufacturer.

Fig. 7 Imprinted MIT plate

1.3 Measurement environment

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

- Manhole covers
- Drains
- Road restraint systems (crash barriers)
- Other reflectors
- Cars, construction machinery

Strong electromagnetic fields (caused for example by radar systems, radio masts, underground cables) in the environment of a measuring point can influence the measuring accuracy. The influence depends on the strength of the source and the distance to it. If it is suspected, that strong electromagnetic fields are located near to a measuring point, several measuring runs should be carried out at this measuring point. If the deviation of the individual results is higher than the specified device tolerance, this can be an indication of the influence of electromagnetic fields on the measurement signal.

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 the 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 calibration requirements.

In order to obtain accurate measurement results, the device should be serviced and calibrated at regular intervals even if it's not required by the authorities.

The user commissions the calibration of relevant reflector sizes. A valid certificate of calibration with a tabular and graphical report of the test results is issued for each calibrated reflector type.

Only calibrated reflectors are visible and selectable in the menu of the device. Uncalibrated and hidden formats can be reactivated with the next calibration, in case the area of application changes and additional reflectors are required.

Fig. 8 Calibration label

Please note:
In Germany, the TP D-StB 12 standard stipulates the need for calibration of thickness measuring devices on an annual basis.

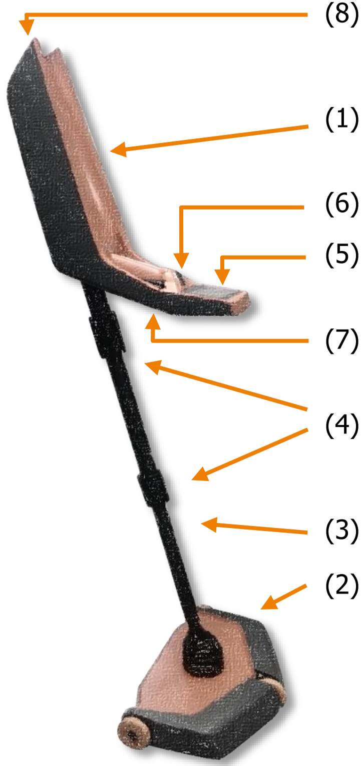


Fig. 9 MIT-SCAN-T3 design

The date of the last calibration will appear on the display when the device is switched on. Additionally, the next calibration due date is indicated on a calibration label on the device's probe (s. Fig. 8).

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 flash drive, 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 MIT-SCAN-T3 for operation:

- Remove the device from its transport box 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 flash drive
3) Headphones

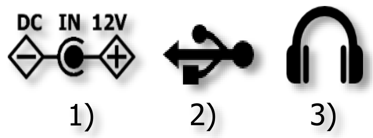


Fig. 10 Interfaces

2.1.1 Recharging the device

The integrated battery can be charged directly in device. 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

With USB interface, measurement data can be exchanged between device and PC. Connect a USB flash drive to device and opening the Main Menu starts the automatic synchronization of data between MIT-SCAN-T3 and USB flash drive. Remove the USB flash drive after having exchanged data successfully. Measurement data is stored in file “MIT-SCAN-T3_*device number*.T3”. Use MIT Project Software to import this file into a form sheet for further processing.

2.1.3 Headphone interface

This interface provides a connection for headphone with 3.5 mm audio jack. During a reflector search, acoustic signals are emitted depending on the received signal. Using headphones will make it easier to locate reflectors in high-noise environments.

2.1.4 Bluetooth interface

Bluetooth module allows wireless connection to mobile Apps.

2.2 Device number and firmware

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

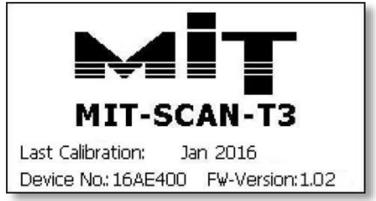


Fig. 11 Start screen

2.3 Carrying strap

The attachment of the carrying strap is 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 release 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.

The device with connected strap is shown in Fig. 1 (p. 7).

Fig. 12 Carrying strap

Fig. 13 External cradle

2.4 External charging cradle

The (replacement) battery can be charged outside device (e.g. in the office or car) with the charging cradle (accessory part). The charging cradle works with both charging cables, which are delivered with MIT-SCAN-T3.

The battery can be quickly removed or replaced without additional tools:

1. Loosen the screw
2. Remove the battery
3. Insert replacement battery
4. Tighten the screw

Fig. 14 Inserting the battery

2.5 Operation

To switch on the device, simultaneously press the search button (s. Fig. 9 (7), p. 14) **and** the "↵" key on the D-pad.

Navigate comfortably through the menu options via D-pad (s. Fig. 15):

Fig. 15 D-pad

- Navigation ◀, ▲, ▼ and ▶
- Select or confirm ↵
- Back/ Power off Press ◀ for 3 seconds.

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

2.6 Main Menu

After power-on, the Main Menu (s. Fig. 16) with the three sub-menu options is displayed:

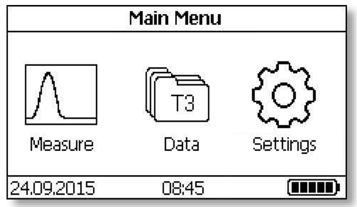


Fig. 16 Main Menu

- "Measure" Perform measurements
- "Data" Review of saved measurement data
- "Settings" Set basic device settings

The footer of the main menu contains date, time and battery charge level.

2.6.1 Menu “Measure”

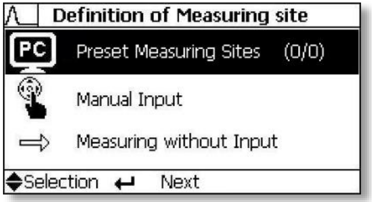


Fig. 17 Menu - Measure

After selecting the measurement menu, first determine the construction project (s. Fig. 17):

- “Preset Measuring Sites”:
  Measuring site plans set up with MIT's project management software (s. sec. 5.4, p. 47) can be displayed and executed in this menu. 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. 3.2, p. 24).
- “Measuring without input”
  In this menu item, the measurement can be run directly without any site data. Only installed reflector type has to be chosen correctly.

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

2.6.2 Menu "Data"

This menu item shows saved measurement results sorted according to date.

Already measured sites can be activated and measured again (s. Fig. 18). The measured value is displayed on the right hand site of the display. If more than one measurement result is available for a site, the last three values are shown.

Relocate measuring sites

After the data set is activated, the site can be measured again by pressing the ↵ key. The device will go to the measurement menu and take the site information of the saved data set. If a saved data set contains GPS information, the measuring site can be relocated with the help of this information. The distance and direction from the current position to the saved position will be displayed on the right side of the screen (s. Fig. 19). This requires that current GPS data can be received.

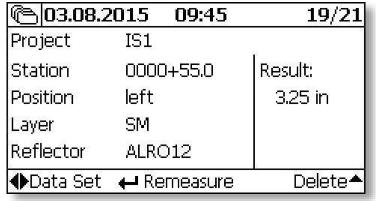


Fig. 18 Menu - Data

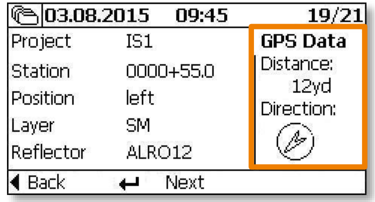


Fig. 19 Dataset display

Relocate measuring site:

1. Select measuring site
2. To "Remeasure" select ↵ button
3. Distance and direction are displayed

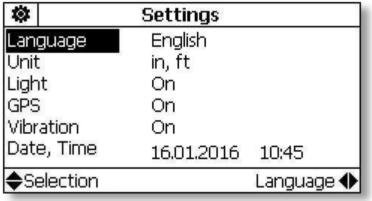


Fig. 20 Menu - Settings

Please note:
If GPS is enabled, measuring site specific GPS data will be stored. A warning is displayed if there is no GPS signal. This warning can be turned off in the settings menu.

2.6.3 Menu "Settings"

Under this menu item, device specific settings can be made (s. adjacent Fig. 20):

- "Language" German| English
- "Unit" mm | cm | in, mi | in, ft
- "Bluetooth" (if available) On | Off
- "GPS" On | On, no warnings| Off
- "Vibration" On | Off

"Date, Time" manual input of date and time

3 Performing a measurement

3.1 Before the measurement

It is recommended to check the mechanical condition and function of the device before the first measurement of the day. The device should be visually inspected for external damages. If damage has been discovered and it is uncertain if this affects the measurement, it is recommended to contact the manufacturer.

The wheel diameters are specified in the calibration certificates. The wheel diameter can wear because of abrasion and may affect the accuracy of measurements. The wheels should have the wheel diameter specified in the test report.

In addition, regular maintenance is recommended.

MIT-SCAN-T3 is ready for use as soon as it is switched on. The user should check the prober function of the electronic by performing some test:

- In search mode (s. sec. 3.3.1), there must be four bars indicating a change when transitioned over a metallic object.
- Perform a function test with the MIT wheeled spacer (accessory part) as described in sec. 3.4.

3.2 Measuring sites set up on MIT-SCAN-T3

Projects can be preset at PC with MIT Project Software (s. sec. 5.4, p. 47). Alternatively, the projects can be set up directly on device on site. For this, the item "Manual input" has to be selected from the submenu "Definition of Measuring site".

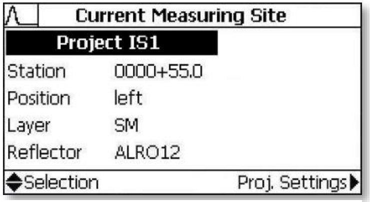


Fig. 21 "Manual input"

After activating the item "Project Data" in menu "Current Measuring Site", information about the current project can be entered by confirming the ▶ key (s. Fig. 21). In this context, all project relevant parameters regarding the construction work can be entered (s. Fig. 22 below):

- "Project"
  Name of road or construction work (maximum five characters)
- "Start Pos." (Start position)
  Data about starting point of the measurement
- "Distance"
  Distance between measuring sites (installed reflectors)
- "Layer"
  Information about layer structure (2- or 3-layer measurement)
- "Reflector"
  Preselection of installed reflectors

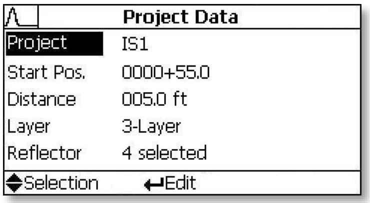


Fig. 22 Construction project data

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 identify measuring sites during evaluation with MIT Project Software. After the input is completed, press the ◀ key for about 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.

3.2.1 Layer system

MIT-SCAN-T3 is able to 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. 23).

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 ↵

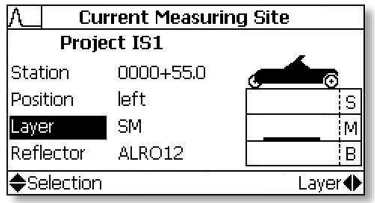


Fig. 23 Selection of layer to be measured

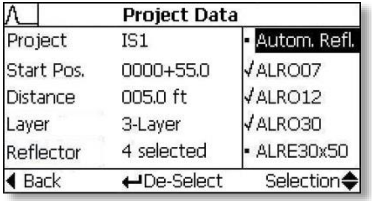


Fig. 24 Select reflectors

Automatic circular plate recognition:

1. Select reflector "Autom. Refl."
2. Search reflector and measure
3. Automatic recognition of MIT circular plates:
   - ALRO07
   - ALRO12
   - ALRO30
   - STRO12
   - STRO30
4. Calculation of layer thickness

3.2.2 Select reflectors

The correct selection of the reflector used is important because it influences the calculation of the result. A list of the calibrated reflectors is available to the user.

Since each separate construction project has its specific reflectors installed, the relevant reflector types can be selected or deselected (example s. Fig. 24):

- Switch to row "Reflector"
- Open reflector list with the ↵ key
- Navigate to specific reflector using the ▲ and ▼ keys
- Select or deselect reflector with ↵ key
- Switch to the measurement menu with ◀

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

3.2.3 Automatic circular plate recognition

The measuring device is offering an **automatic circular plate recognition** function. If "Autom. Refl." is activated, an extended 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 conduct a plausibility check of both: the identified reflector as well as the relatedly displayed layer thickness.

The automatic circular plate recognition is supporting an identification of the following reflectors (details in Table 1, p. 9):

- AL RO 07
- AL RO 12
- AL RO 30
- ST RO 12
- ST RO 30

Measuring procedure

1. Select measuring site
2. Set reflector type
3. Search reflector
4. Place probe centered 1 ft in front of reflector
5. Start measurement
6. Slowly run probe over the reflector
7. Process measurement result (optionally perform reflector test)

Hints regarding reflector search

- Sweep probe above the road surface in wide side-to-side motions
- Observe search bars
- Use horizontal search bar in the footer to determine reflector center

3.3 Measuring procedure

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

3.3.1 Reflector search

To start the search mode, press and hold down the search button (compare Fig. 9 MIT-SCAN-T3 design, (7), p. 14). The signals of the four sensors are pictured in display as four separate bars (s. Fig. 25 on next page).
The higher the bar, the stronger the received signal. The bar amplitude depends on the size of the reflector and its distance from the probe.

Reflector searching procedure:

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

The narrow, horizontal bar below the diagram supports operator to exactly determine the center of the reflector. The search bar (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. 26 on following page shows a graphic of the display with search bar and position of the probe for reflector type ALRO12.

Subsequently start the measurement:

- With search button pressed down, run measuring device back 1 ft; the measurement will start automatically, or
- Release search button
- Place the probe at the starting point of the measurement path which is about 1 ft in front of the located reflector.
- The option "↵ Measure" is displayed. Press the ↵ key to start measuring.

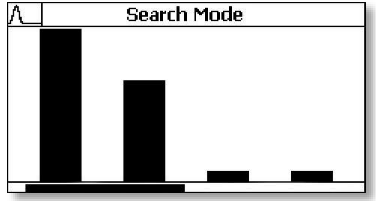


Fig. 25 Reflector search

Please note:

Measurement starts automatically

- Put down the probe above center of reflector
- With search button pressed down, run probe back about 1 ft

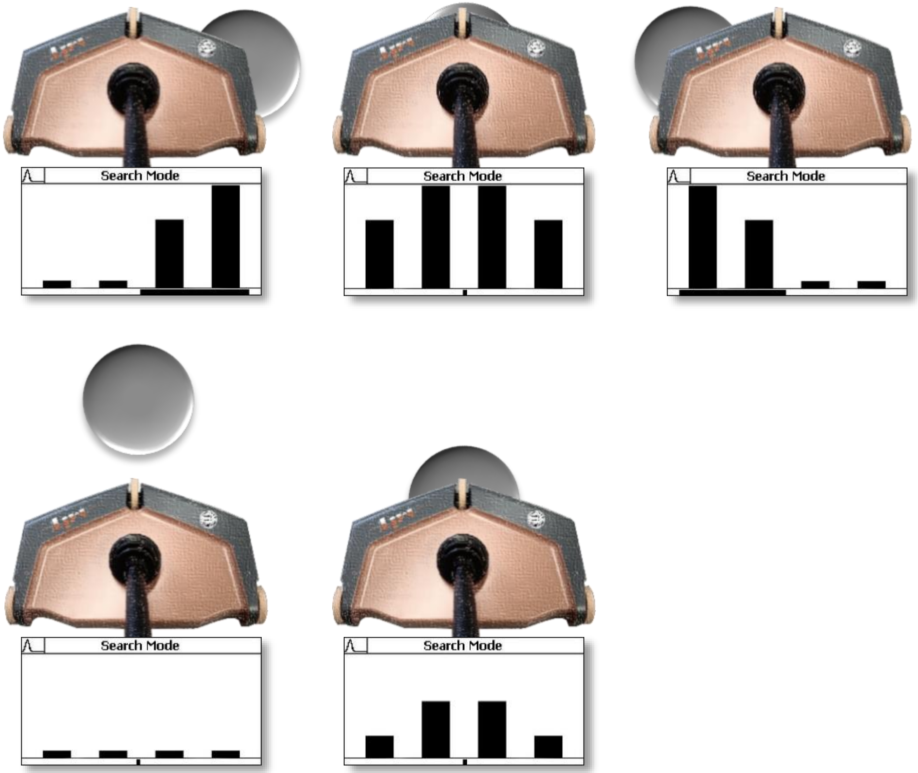


Fig. 26 Reflector search demonstrated for reflector type AL RO 12

3.3.2 Measurement

Starting a measurement, a graphic of the path is shown on the right hand side of the screen (s. Fig. 27). It is necessary to pass roughly over the reflector center, always starting along the short side in case of rectangular formats. All three wheels of device have to be in contact with the surface.

During run, please be aware of:

- 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.
- Curve maximum
  Maximum of the traversal curve has to be in the first half of the display (marked as dotted line).

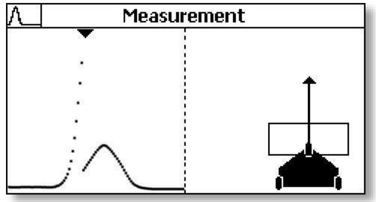


Fig. 27 Measurement

Notes:

- Jumps in measurement curve (s. Fig. 27) representing 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 last part of the measurement run gives the reference signal of the environment. This signal is subtracted from the curve. In this manner, materials with a homogenous distributed metallic content can also be measured (e.g. blast furnace slag). Signal peaks in the reference signal indicates additional metal in the ground which may cause wrong results

The measurement path depends on selected reflector:

- ≈ 4 ft for small reflectors like AL RO 07, AL RO 12, ST RO 12 and AL QU 16.5
- ≈ 5 ft for larger reflectors like AL RO 30, ST RO 30, AL RE 30x50, AL RE 30x60, AL RE 30x70, AL RE 30x100, AL QU 33 and automatic circular plate recognition

Measurement stops immediately when the complete traversed distance of the path has been covered.

The measurement is aborted, when the probe is moved backwards.

3.3.3 Results display

After completing the measurement run, the traverse path curve appears on display. In this graph the curve is scaled based on the display and the adaption of the amplification. The curve should show no irregularities. Irregularities are an indicator of disturbances during measurement (s. Fig. 28).

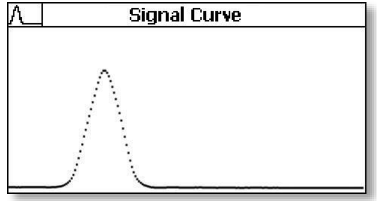


Fig. 28 Measurement curve

The result is subsequently displayed (s. Fig. 29). The following information is shown in display:

- Measured layer thickness
- Selected or automatically identified reflector
- Material quality coefficient

If GPS data have been received on site, this is shown at the right corner of display (s. highlighted area in Fig. 29).

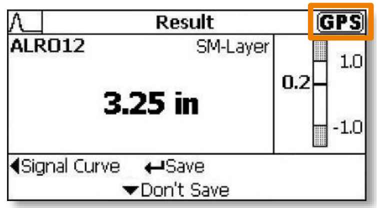


Fig. 29 Display of results with GPS icon

3.3.4 Calculated layer thickness

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

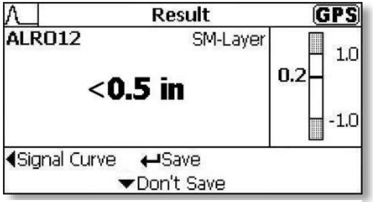


Fig. 30 Display of too low layer thickness result

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 displayed (s. Fig. 30). In this case, the setting and the measurement should be considered critically:

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

Please note: If the measuring range has not been reached, a layer thickness can still be determined by use of the MIT wheeled spacer. The wheeled spacer increases the distance to the reflector, so that a valid measurement result can be calculated.

3.3.5 Measured reflector

On the left hand side of the screen, the selected reflector chosen for the measurement is displayed. If automatic circular plate recognition was activated, the reflector which has been identified will be displayed. This mode will be indicated by an "(A)" next to the name of reflector.

3.3.6 Material quality coefficient

On the right side of display a graphic diagram of material quality coefficient is shown (s. adjacent Fig. 31).

This provides some useful information for assessing the intactness of the measuring site, i.e. of the quality of the reflector. The coefficient has to be within the range of −1.0 to +1.0 to secure a reliable result.

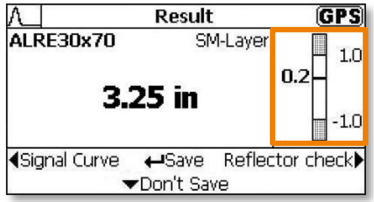


Fig. 31 Display of results

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 should be outside of the recommended valid range, the measurement result is questionable:

- Was the input of the reflector type correct? If not, the result will be wrong.
- Has reflector possibly been damaged or destroyed?
  Foil may be damaged or destroyed during placement by the construction machines. Depending on the extent of damage, the reason for measurement failures could be foils with bent ends, torn foils or perforated foils. Therefore, whenever possible, always use robust reflectors for electromagnetic thickness measurements!
- Is the installed reflector certified for use with MIT-SCAN-T3? If not, the signal may not match with MIT-SCAN-T3 calibration files.
  In this case, the result of the calculated layer thickness cannot be guaranteed.

3.3.7 Reflector test

After a reflector foil is measured (AL QU 16.5, AL QU 33, AL RE 30x50, AL RE 30x60, AL RE 30x70 and AL RE 30x100), the results menu optionally offers the "Reflector test" (s. Fig. 31, p. 35). 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 reflector is necessary: This run must be conducted along the long side of 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 has to be moved slowly over reflector.

Directly after completing the measurement the following parameters are displayed (s. Fig. 32):

- "Coefficient" (material quality): Repeated calculation of material quality (s. sec. 3.3.6, p. 35) from the data of a run along the long and short side of the reflector
- "Calc. size" (calculated size):
  Calculated width and length of the 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 reflector

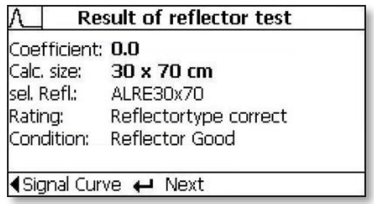


Fig. 32 Reflector test result

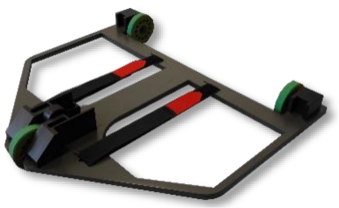


Fig. 33 MIT wheeled spacer

Functionality check:

1. Perform measurement
2. Fit MIT wheeled spacer to device
3. Remeasure measuring site
4. Subtract the defined amount of 1.38 in from second measurement result
5. First and second measurement end values should not differ by more than 0.04 in.

- "Sel. Reflector" (selected reflector): Display of set up reflector
- "Rating": The calculated reflector format provides a check of the conformity between measured reflector and selected antipole
- "Condition": With the calculated coefficient, it is possible to assess whether a reflector is damaged (but still measurable) or destroyed (not measurable)

3.4 Functionality check according to TP D-StB 12

"*Before starting the day's first measurement, the thickness measuring device's functionality must be tested."*[5]

The German standard TP D-StB 12 requires that the first measurement has to be a check of the correct device function. For this, with the device traverse the measuring site and perform a measurement. Use the MIT wheeled spacer (s. Fig. 33) and fix it to the probe. Repeat the measurement with a mobile spacer. The MIT wheeled spacer increases the distance between probe and road surface by 35 mm (**~ 1.38 in**).

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

The functionality test according to TP D-StB 12 is considered as passed if the difference between layer thickness measurement result without wheeled spacer and the result of the measurement with spacer, subtracted by the spacer distance of 1.38 in, is not more than the specified accuracy of the device plus 1 mm (0.04 in).[6]

It is important to note that the device itself has a measurement tolerance of ± (0.5 % of the measured value + 0.04 in).

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

4 Warnings and error messages

MIT-SCAN-T3 is equipped with a comprehensive error detection function. During measurement, the measurement signal is checked for possible deficiencies and influences. If an error will be detected, this is displayed subsequently to the measurement (s. example in adjacent Fig. 34 and Fig. 35).

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

[6] 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.

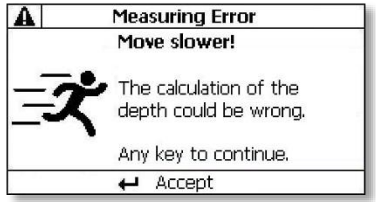


Fig. 34 Example for single warning

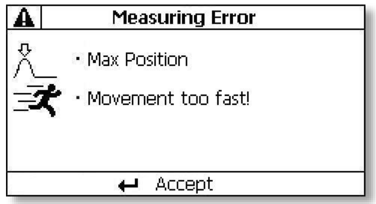
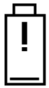
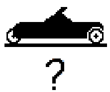


Fig. 35 Several warnings

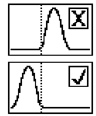


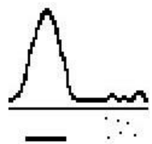




Error message	What to do?
Low battery!	Reload battery promptly.
Empty battery!	Measurements cannot be performed. Reload or exchange battery.
No GPS signal!	Continue measurement and save data without GPS signal. Alternatively wait until device will receive a GPS signal.
Data memory full!	Measurements cannot be saved.
Move slower!	Evaluation was still possible. However, a slower pace is recommended.
Movement too fast.	Calculation of layer thickness failed. Repeat measurement run.
No reflector found!	Analysis of measurement signal was not able to find a reflector. Repeat search and measurement of reflector.

Error message	What to do?
Max. position wrong	Repeat measurement at measuring site. Place probe about 1 ft in front of reflector.
Measurement aborted	Movement of probe must be forward.
Electromagnetic interfer.	Measurement signal was influenced by electromagnetic interferences, e.g. by: - High-voltage lines - Underground cables - Transformers, generators or other construction machinery
Zero meas. invalid	Reference signal was influenced by extraneous metal. If possible remove extraneous metal. Alternatively, pass over reflector in other direction.
Incorrect measurement	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.





Error message	What to do?
Side shift of reflector	The error message appears when user has passed the reflector too close to the edge. The reflector should be re-searched and passed over its center.

Table 3 Overview of warnings and error messages

5 MIT Project Software

The MIT Project Software offers the following functions:

- Set up of construction site data by 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 according to TP D-StB 12

Please note:

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

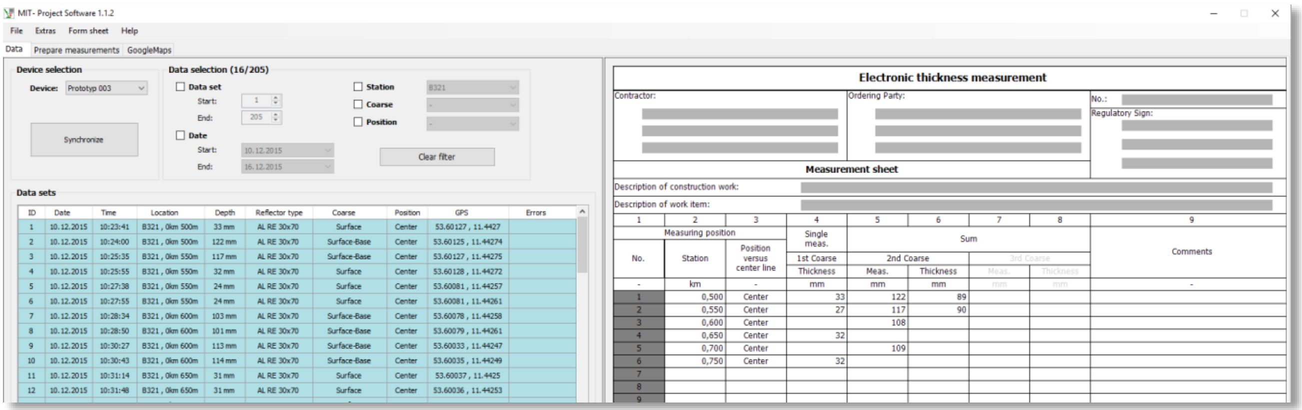


Fig. 36 MIT Project Software - Program screen shot

With the MIT Project Software, new projects can also be set up prior operation at the construction site.

Data synchronization between measuring device and MIT Project Software is performed by at first connecting the USB flash drive to 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 operating device-dependently. Only measurement data of corresponding device can be processed. The synchronization of measured data using the MIT Project Software is activated with the license key included in the delivery. It can be found in inlay of the installation medium. In order to evaluate data from other MIT-SCAN-T3 devices, the corresponding license key for the respective device has to be entered. The software can be installed on various computers.

5.2 Program settings

In menu item “Extras”, different settings can be made (s. Fig. 37):

- “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 result display (form sheet).
- “Multiple measurements”
  It is possible to average the results from several measurements at the same measuring site or alternatively use the last result 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, a simultaneous calculation of values is performed in the form sheet.

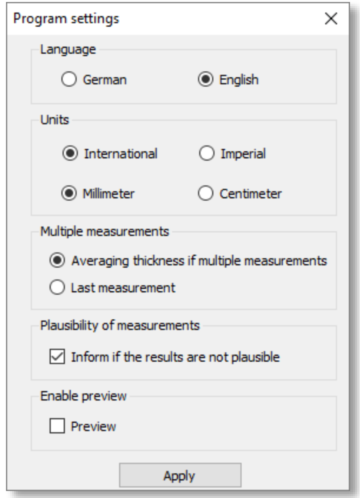


Fig. 37 Program settings

5.3 Selection of devices

The MIT Project Software can be used to read-out the measured data from USB flash drive. If a USB flash drive with data files (*.T3) is connected while the program is running, the program shows a message.

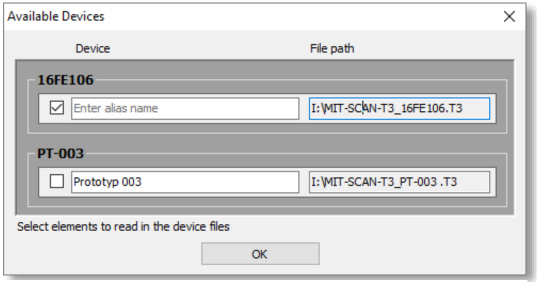


Fig. 38 File query for MIT-SCAN-T3 data

The MIT-SCAN-T3 data can be linked to each respective device by assignment of a name or number. This is 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 menu "device" (s. Fig. 39).

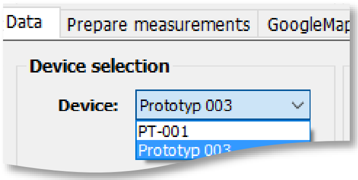


Fig. 39 Program screen shot device selection

5.4 Set up of measuring sites at the PC

Measuring sites can conveniently be prepared at the PC. The interface is in the second tab “Prepare measurements” (s. Fig. 41).

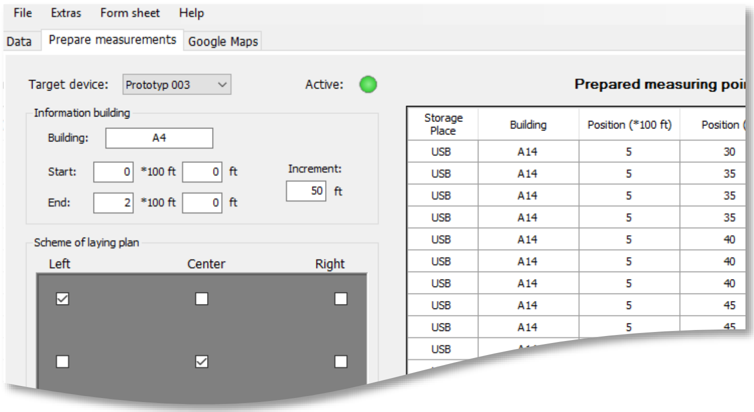


Fig. 41 Measurement set up with the MIT Project Software

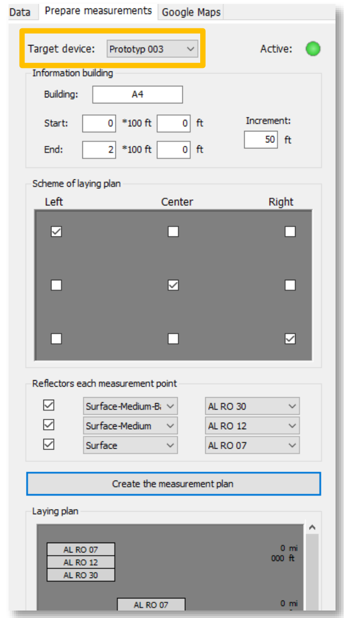


Fig. 40 Device specific measuring site set up

If measurements for several layer thickness measuring devices are processed, the relevant device has to selected (s. highlighted area in Fig. 40). The list of target devices contains all by license key registered devices.

Hint:

If large changes to a measurement plan are required, it is recommended to set up a new plan with the necessary corrections!

The following construction project information is required:

- Construction ex.: A4
- Start ex.: 0000+00.0
- Distance ex.: 50 ft
- End ex.: 1000+00.0
- 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. 42). Individual data sets can be processed or deleted there.

Prepared measuring points on the computer (18 / 304)

Storage Place	Building	Position (*100 ft)	Position (ft)	Reflector	Coarse	Axis
USB	A14	5	55	AL RO 30	Surface-Me...	Right
USB	A14	5	55	AL RO 12	Surface-Me...	Right
USB	A14	5	55	AL RO 07	Surface	Right
PC	A4	0	0	AL RO 30	Surface-Me...	Left
PC	A4	0	0	AL RO 12	Surface-Me...	Left
PC	A4	0	0	AL RO 07	Surface	Left
PC	A4	0	50	AL RO 30		
PC	A4	0				

Fig. 42 Generated measuring site plan with USB flash drive 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. 42, p. 48) and are saved as a file on USB flash drive and the storage place will be changed from "PC" to "USB" in the table. After connecting the flash drive to the thickness measuring device, the prepared data sets will synchronized. 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.

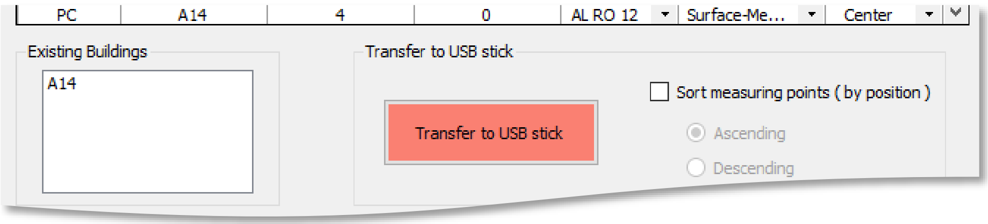


Fig. 43 Transfer the generated measuring point plan to a USB flash drive

5.5 Selection of measured values

Data transferred from device can be selected in tab "Data".

It is possible to filter the measurement data using the filter function (s. Fig. 44). Several criteria can be queried at the same time.

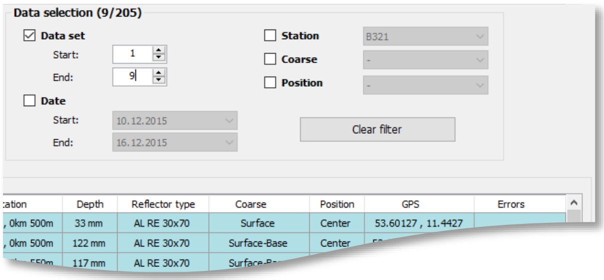


Fig. 44 Selection of measured data set by filter

Data sets can also be selected in the table:

- To select all data sets:
  Left-click with the mouse in the table, then use 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. 36, p. 43) in "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 location, layer type and position can be corrected afterwards. Right-click on the relevant cell and input correct data (s. Fig. 45).

To delete single data sets first mark the relevant row and press the "Del" key.

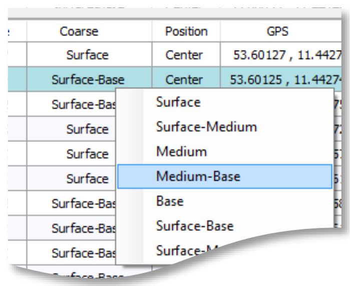


Fig. 45 Correction of data

5.7 Synchronize and save data

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

"Synchronization" button:
Press this button to synchronize data with the active file on USB flash drive. In Fig. 46 a synchronization of data sets e.g. with device "Prototype 003" is shown.

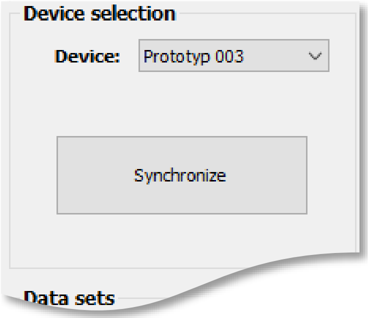


Fig. 46 Synchronize data

Menu Tools - "Synchronize USB flash drive":
Select device whose data has to be synchronized with USB flash drive.

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

MIT format:
In this format the data is encrypted before saving and can be loaded into the software at any time via "Import".

Please note:

The form sheet cannot be reloaded later with the program. It is therefore recommended to save the used data sets in MIT format (*.mit).

Excel format:
By pressing button "Export selected data sets" (s. Fig. 47), the data sets are saved as XLSX file.

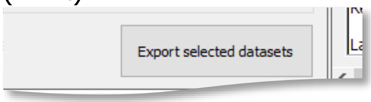


Fig. 47 Data storage

5.8 Form sheet

MIT Project Software transfers measurement data from a construction site to a measurement sheet report analogous TP D-StB 12. Therefore, the relevant measurement data has to be selected (s. sec. 5.5, from p. 50).

5.8.1 Form sheet settings

The menu item "Form sheet" contains several settings of the form sheet (s. Fig. 48):

- "Update": Calculations in form sheet are updated (only possible, if result preview is deactivated).
- "Zoom": The width of the form sheet can be changed from 50 % to 200 %.
- "Show/hide company logo": A company logo can be inserted at 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. The saved file will be opened automatically.

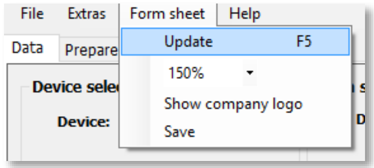


Fig. 48 Form sheet settings

Please note:

To be able to generate a form sheet, the following data must be entered for each measuring site:

- Location
- Layer type
- Position of reflector to axis

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. 37, p. 45). If the results preview is deactivated, the update is performed under the menu item "Form sheet" - "Update" (s. Fig. 48, p. 53).

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. 36, p. 43). If layer thickness determination of several layers is performed at the same measurement point, the program automatically calculates individual layer thicknesses for the following layer systems (s. Fig. 49):

- Two-layer construction
- Three-layer construction

MIT Project Software averages the measured values if several results are available with same course setting and location. This presetting can be made in menu item "Extras" (s. sec. 5.2, p. 45).

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

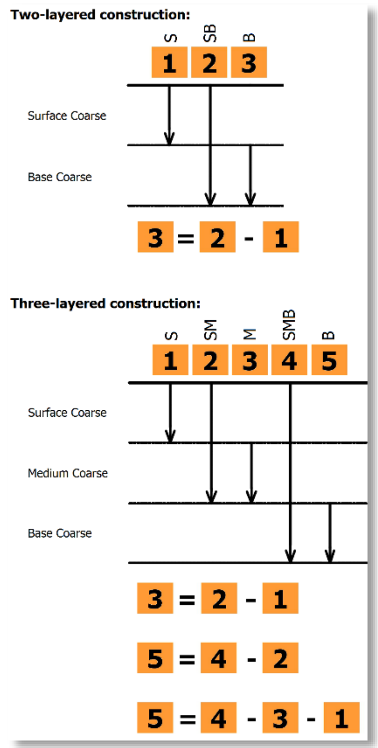


Fig. 49 Calculation of layer construction

5.8.4 Setting up a form sheet

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

In the footer (s. Fig. 50) the operator has to enter the result of the functionality test according to TP D-StB 12 (s. sec. 3.4, from p. 38). If not confirmed or even negated, the functionality test is considered to be failed. To complete the form sheet, additional information can be added in the footer regarding the used device and measured antipoles.

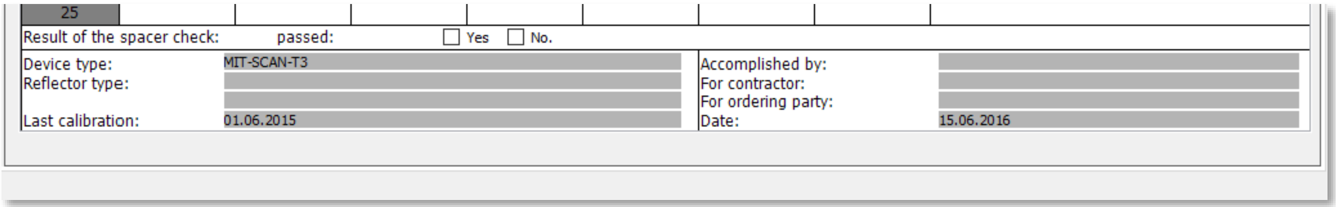


Fig. 50 Footer of form sheet

5.9 GPS data and Google Maps

In the third tab of MIT Project Software, the highlighted measurement data is displayed as markers in Google Maps (s. Fig. 51).

Fig. 51 Measurement data displayed in the tab of 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 is 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 MIT-SCAN-T3 App

With the help of the MIT-SCAN-T3 app measurement progress, results and measurement plans can be exchanged between the device and mobile phone. The app can be downloaded from Google Play or the Apple Store. When the program is started for the first time, permission to access the location recognition must be granted in order to be able to save and receive the GPS data from the measuring points as well as the authorization to access files to create the log.

The status line at the top of the screen shows the connection to a device by means of a green Bluetooth symbol (see Fig. 53). If this symbol is red and crossed out, there is no connection to a MIT-SCAN-T3. A white icon indicates that the phone is searching for nearby devices.

The symbol  shows if there is a connection to as BIM[7] project. (Green = connection / red = no connection)

[7] BIM = Building Information Modelling (Method of networked planning, execution and management of buildings and other structures using software)

Note:

The following authorizations are required to use the app:

- Access to the GPS
- Access to the memory

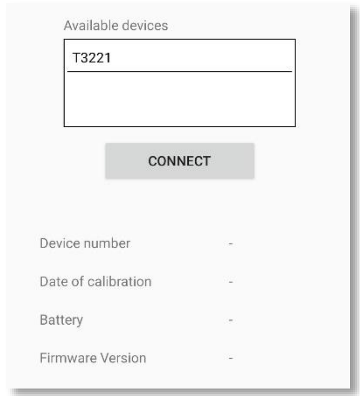


Fig. 52 Start Screen

Fig. 53 Connection symbols

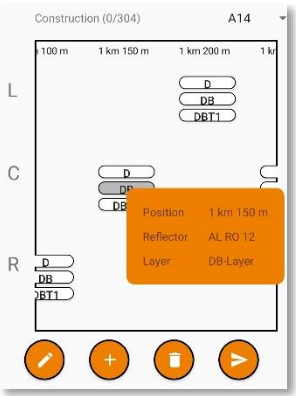


Fig. 54 Prepared measuring points

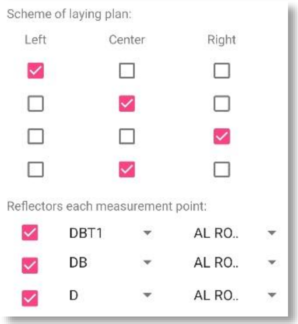


Fig. 55 Create new measuring points

6.1 Start Screen

After starting, the app automatically searches for a layer thickness measuring device nearby. To do this, Bluetooth must be activated on the phone. The corresponding device is selected and connected. The connection request is then confirmed on the MIT-SCAN-T3. The device data is downloaded to the phone. The user receives information on the serial number, the date of the last calibration, the battery level and the firmware version of the device (see Fig. 52).

6.2 Prepared measuring points

In this tab, prepared measuring points are called up and displayed. Data can be edited, added or deleted. Changes can be transferred to the MIT-SCAN-T3.

To edit an individual measuring point, the point is select and an editing dialog opens by using the pencil symbol (see Fig. 54).

A new measurement project can be created with the "+" sign. The name of the structure, the step size and the start and end of the measuring points are specified in the corresponding dialog (see Fig. 55). In addition, a layout diagram can be created and a reflector type can be specified for each layer to be measured.

This data can then be sent to the MIT-SCAN-T3. The transferred data can be found in the measuring device in the menu item Measure - Prepared measuring points.

6.3 Measurement

The app automatically recognizes the start of the measurement with the MIT-SCAN-T3, all data is transferred to the phone. The user receives an overview of the measurement information and all relevant data that is displayed at the end of the measurement (the reflector type recognized or set before the measurement, the measured layer, the measured layer thickness and the value of the material quality). The material quality can be used to assess the quality of the measuring point and is ideally between -1 and 1. A checkbox at the top right indicates whether GPS data is available for the measuring point.

Fig. 56 Measuring result

With a click on  the measurement curve data can be displayed and  shows any error messages that may be present for the measurement.

A table with the last ten measurements is displayed in the lower part of the screen.

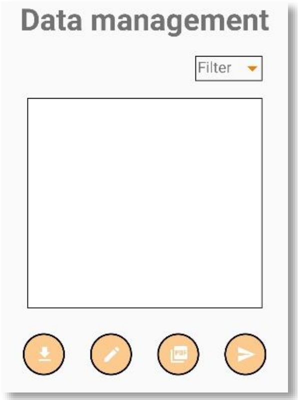


Fig. 57 Data management

6.4 Data management

Measurement data can be retrieved from the device, which can be filtered according to various information (structure, date, layer).

The following options are available to the user via the symbols below the table:

 Download records from the device to the phone

 Create a signature for the PDF export (this will be inserted into the document under the result table)

 Create a PDF document or a ".mit" file with selected data

 Upload selected data to a BIM project

7 Firmware/Software update

The firmware is the interface between hardware and operator. In order to incorporate new requirements and findings, the manufacturer reserves the right to make changes to the firmware at any time. Only with an up-to-date firmware[8] and software the manufacturer can guarantee the faultless functioning of the device.

It is the customer's responsibility to obtain information about software and firmware updates and should periodically check for the current version. They are available for download at:

https://www.mit-dresden.de/en/service/downloads.html

8 Plausibility check

Although MIT programs the software/firmware with the greatest possible care, errors and mistakes are possible. We recommend a plausibility check after every software/firmware update by at least one measurement series being recalculated manually.

[8] The current firmware version is the last status published by MIT

9 Technical data

Measurement data	800 measurement points
High measurement accuracy	±(0.5 % of measured value + 0.04 in)
Measurement range	0.5 - 19.5 in depth[9]
Asphalt temperature	up to 230 °F
Operating temperature	+14 °F to +122 °F
Battery life	8 hours respectively 1000 measurements
Charging time	1.5 hours
Memory capacity	up to 5000 data sets
Interface	USB flash drive
Weight	Net weight 8.8 lb Gross weight 40 lb

Table 4 Technical data

[9] The measuring range depends on the respective reflector.

10 Scope of delivery

- Basic device
- NiMH (12 V/2 Ah) battery
- Calibration for aluminum circular plates (diameter: 7, 12, 30 cm)
- Test certificate
- GPS module inside
- Battery charger
- Car charger
- Carrying strap
- Instruction manual
- USB flash drive for data transfer
- MIT Project Software including license key
- Transport box

Accessories:

- MIT wheeled spacer
- Headphones
- External charger
- Further customer-requested calibrations
- Consumables (reflectors)
- Evaluation software MIT-ProAsphalt

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