Thickness measuring device

MIT-SCAN-T3

Description of the measuring method

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ZERSTÖRUNGSFREIE MESS- UND PRÜFTECHNIK

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1. Introduction

The non-destructive testing system is a cost-efficient method that delivers accurate thickness measurement on asphalt pavement and on concrete (highways) as well as on traffic circulation area pavements, on airfields and harbors. It provides important data necessary for the calculation of construction costs as well as to ensure the quality and life span of the road pavement and for self-monitoring.

For electromagnetic layer thickness measurements to be carried out reflectors ("antipoles") have to be inserted into the pavement. The electromagnetic layer thickness measurement method is thus used when new roads/circulation areas are to be constructed and when road pavements are renewed and/or always when reflectors have already been inserted.

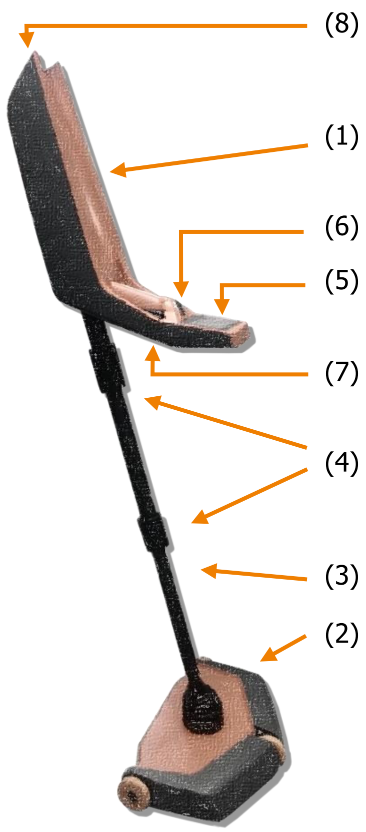
All types of surfacing material used in building and road construction works - bituminous composites, concrete or blast furnace slag - can be tested non-destructively with the MIT-SCAN-T3.

The innovative technical solution in a non-destructive measurement technology which offers a tool for combining quality assurance with profitability. The new technology provides the chance to optimize construction practices and to cut costs in the execution of construction works.

2. Principles of operation

The thickness testing device MIT-SCAN-T3 uses a pulsed induction method based on electromagnetic eddy current technology. This technology has a high noise immunity. The possibility to acquire data for several physical parameters in one measurement operation improves the quality and validity of the measuring results.

MIT-SCAN-T3



Measurement data are collected by a defined pass over the reflector. During one run, while the reflector is passed over, up to 150 position-dependent measurement points are collected by each of the four receiving sensors.

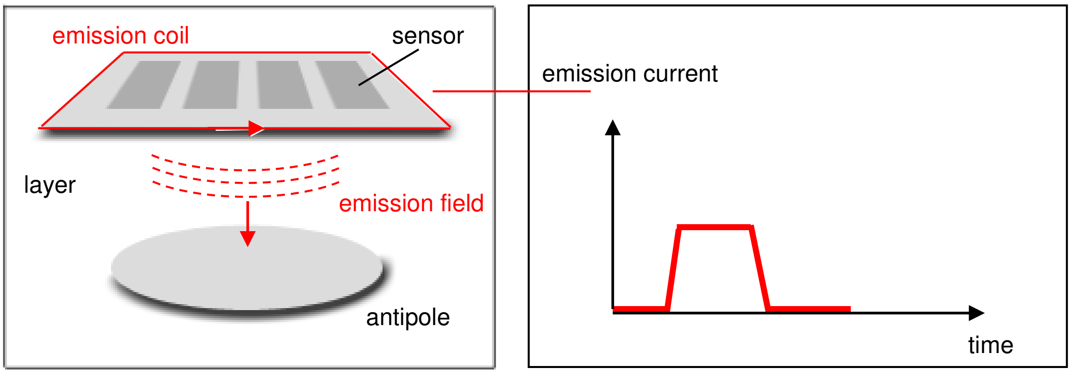
The signals received depend on the relative position of the instrument to the reflector as well as the shape, size and material composition of the latter. The relationship between each of these influences and the measurement signal are precisely determined during calibration and implemented in the firmware of the instruments.

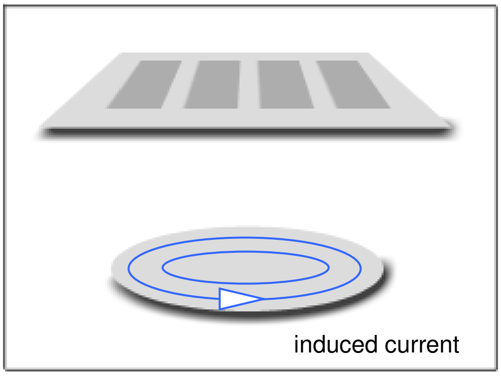
Due to the high number of individual measurement points assessed, the accuracy achieved is superior to that obtained by other methods.

Legend:
(1) Operating unit
(2) Sensor head
(3) Telescopic tube
(4) Two fixings at the tube
(5) Display
(6) Control button
(7) Search button
(8) Connection USB, head phones, charger

<u>In the following figures a schematic illustration shows the physical order of signal generation:</u>

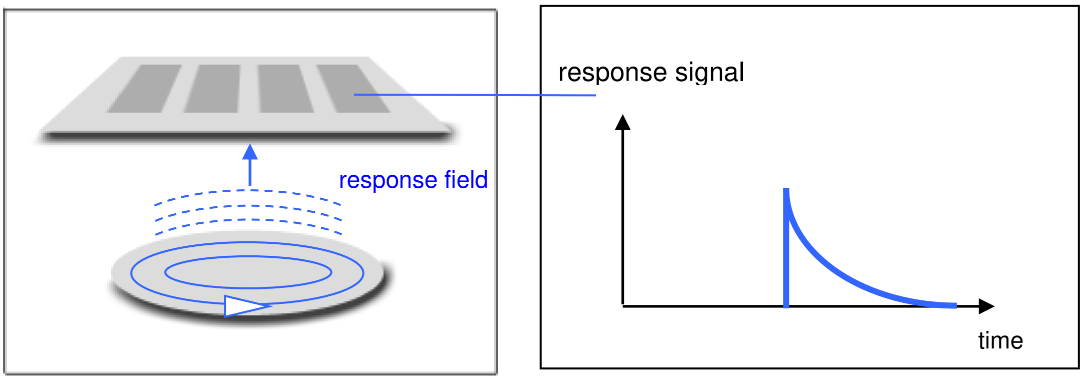
In the measurement sensor there is a current-traversed transmission coil. It generates a time-dependent magnetic field (emission field) that penetrates the pavement layer.





At the bottom of the layer is located a reflector (a foil or circular plate of metal). The pulsating magnetic field induces eddy currents in the reflector which subside exponentially and in turn generate a time-dependent magnetic field: the so-called response field.

In the measuring probe there are several sensors that assess the response field in its time course.



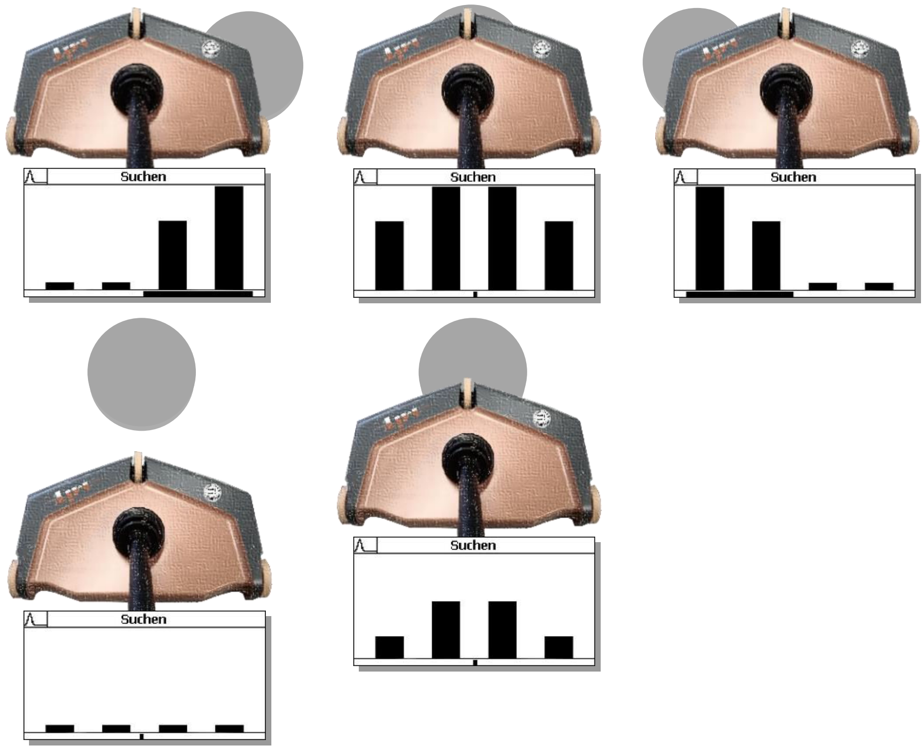
The emission field is generated by alternatingly switching the current on and off in very short intervals (in the range of a few microseconds). Once the emission field has completely subsided the response field is measured. In this way an overlap of the response signal and the comparatively strong emission signal is avoided. The emission signal does not cause disturbances. Even very weak response fields can be detected so that a high operating range is realized by this method.

3. Performing a measurement

Search mode

By pressing the search button a continual readout mode for all sensors is activated. The result is displayed as four vertical bars. The length of the bars correlates to the distance of the respective sensor from the reflector. By moving the measuring probe a few centimeters above and along a 2 m wide corridor the reflector can be located. In the figures below the bar diagram on the display and the position of the reflector and the measuring probe are shown schematically.

Schematic illustration of the display image and the position of the reflector and the measurement probe to one another:



Reflector search mode (example: circular plate of 12 cm diameter ALRO12)

Measurement

Before starting a measurement, information on the type of reflector used must be correctly entered, because the algorithms applied for calculation of layer thickness are dependent on the reflector type. A measurement is performed by passing the device over the reflector. Rectangular reflectors are passed over perpendicular to their long sides. Since the analysis result also contains the lateral position of the reflector, it is not necessary to exactly determine the reflector center. It needs merely to be detected within a corridor of about 10 cm width. The testing device is positioned about 10 cm with the front wheel to the reflector´s long side. By pressing the measurement button the measurement is started. Measurements are started to be taken by moving the probe in the direction of the reflector. The device is path-controlled and acquires measurement points at intervals of about one centimeter for each sensor while it is moved along the surface of the layer that is under investigation. During measurement, starting from the left, a diagram is created on the display. It shows the calculated average of all four sensor values. In this way, information regarding the measurement situation is provided during the test run. The measurement run is automatically stopped when a distance of approx. 1.5 m has been covered. The measurement result is calculated in one second and shown on the display.

Handling of measurement results

The measurement results/data set is saved and available as a readout on the display. Sometimes the operator prefers data to be written manually into a protocol signed by two persons on the construction site. Later data can be transferred to a desktop PC.

Assessment of the measuring site

If an unexpected measurement is determined, according to our experience the cause usually is a defect of a foil reflector (deviation of dimension, destruction of the foil). Therefore, provision has been made for determining the length and width of the reflector as well as the material quality. This should be accomplished immediately after the depth measurement has been carried out by passing over the foil reflector twice - once in perpendicular and once in parallel to its long axis. The quality of reflector is a value calculated from the thickness of the material and electrical conductance.

4. Assortment of reflector

The choice of the reflector material is dictated by where the reflector is to be placed (concrete or asphalt), while the reflector type (sheet metal, foil and dimension) determines the position of the reflector in the layer and the maximum layer thickness that can be measured. It is important to meet requirements on the minimum surfacing layer when using sheet metal formats.

Only those reflectors that have been implemented in the firmware by MIT and which are mentioned in the operating manual can be used. Reflector material has to be standardized and certificated by the manufacturer.

MIT recommends the use of circular plates for the following reasons:

Circular plates can easily be inserted; in general they are placed directly in front of the paver without adhesives.

Circular plates are very robust against incidental damage during installation and thus ensure high precision measurements.

The direction of the measurement path over the reflector can be chosen randomly. This enables the taking of measurements also under unfavorable conditions.

Circular plates can be produced at a low-cost.

Table of MIT-circular plates:

Designation	Application area	Layer type	Minimum surfacing layer	Measurement range
AL RO 07	Asphalt	Surface course	15 mm*	15 - 120 mm
AL RO 12	Asphalt	Binder	40 mm	15 - 180 mm
AL RO 30	Asphalt	Base	120 mm	40 - 350 mm
ST RO 30	Concrete	Subconcrete	120 mm	40 - 350 mm

*): When plastic aggregates are used, otherwise 20 mm.

Minimum surfacing layer: The minimum surfacing layer is the thickness of the material from reflector to the road surface on a completed road construction.

5. Layout drawing

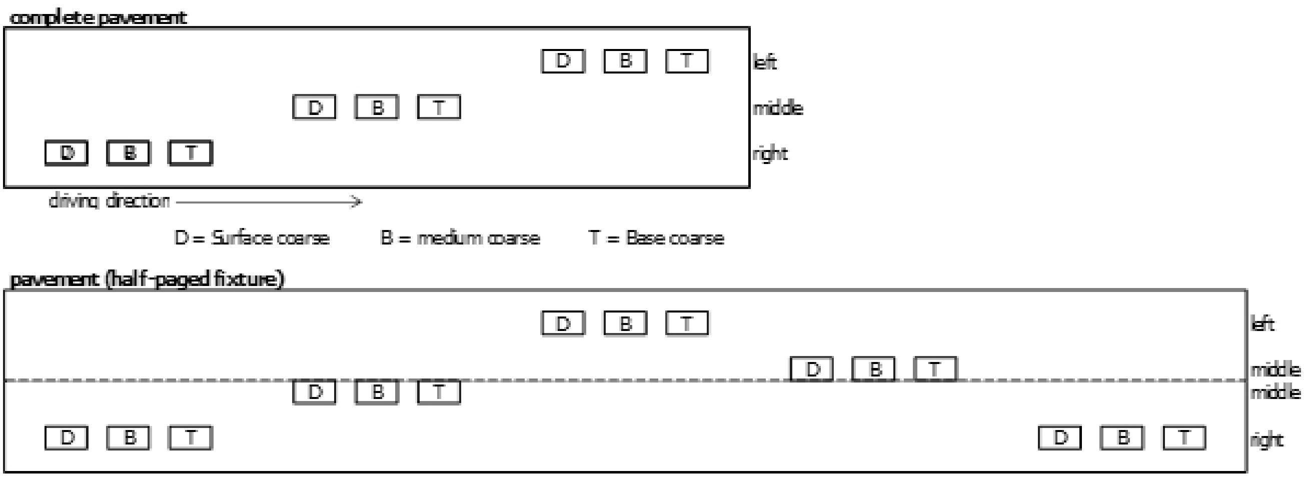
The layout drawing determines the type of reflector to be used and its position in the road. The following rules should be observed:

A. Testing site
The testing site should include all reflectors necessary to measure all constructed layers in one road location (maximally three reflectors).
The reflectors are placed under the layer that is to be tested. Rectangular reflectors are placed with the long side parallel and minimum 1 m from the road border. The reflectors for the different layers are placed in direction of construction with a minimum distance of 1 m between them. For implementation of these layout rules it will be necessary to make exact side markings. There should be no other metals within 1 m of the testing site and the individual sensors.

B. Arrangement of testing sites
The number and arrangement of the testing site depends on the length of the construction section and road width. For roads up to 5 m width, the test points are arranged alternatingly to the left and to the right (in zig/zag). The distance between test points for short construction sections (length about 500 m) is 20 m and for long sections, it is up to 50 m. In multi-lane roads the three test points are arranged right, middle and left in one line perpendicular to the road border.

The arrangements given for the test points provide a sufficiently high statistical assurance regarding evaluation of construction performance. The client and the construction firm may agree on other arrangements if the individual situation requires deviations.

Scheme of layout drawing:



6. Technical specifications

Application conditions:

Distance between reflectors:	1 m (edge to edge)
Distance to crash barriers or similar:	1 m
Distance to parking vehicles:	2 m
Operation temperature:	-10°C to 50°C (14 °F to 122 °F)
Asphalt temperature:	up to 110°C (230 °F)

Any foreign metallic objects must be removed from the road lane. Safety boots with metal caps can cause disturbances, if not used appropriately. Wet roads, weakly conducting and magnetic aggregates do not cause erroneous measurements.

Standard antipoles/reflector material and measuring depths:

Aluminum circular plates (for the use in asphalt pavements):

Diameter 7 cm	for depths up to 12 cm
Diameter 12 cm	for depths up to 18 cm
Diameter 30 cm	for depths up to 35 cm

Steel circular plates (for the use in concrete):

Diameter 30 cm	for depths up to 35 cm

Aluminum foils and aluminum sheets (for asphalt):

30 x 70 cm	for depths up to 50 cm
30 x 100 cm	for depths up to 50 cm
33 x 33 cm	for depths up to 40 cm
16.5 x 16.5 cm	for depths up to 30 cm

Tolerances of MIT-SCAN-T3:

Resolution:	1 mm
Accuracy:	± (0.5 % of the measurement value + 1 mm)
Reflector determination:	for rectangular reflectors: Determination of width ± 2.5 % Determination of length ± 1.5 % Detection of too thin or too strongly damaged materials Data logger for further evaluation of signals on a desktop PC
Memory:	Capacity: 5,000 data sets; each data set contains: site, date, time, reflector type and the measured layer thickness; sequential arrangement of data sets
PC interface:	for data transport to desktop PC for data integration into Microsoft Excel, and accounting software) data integration into other user application software on request
Power supply:	NiMH storage battery 12V/ 2Ah
Operation time per battery charge:	≥ 8 hours or about 1,000 measurements
Charging time:	about 1.5 hours
Test device:	40 cm x 145 cm x 26 cm (16 in x 57 in x 10 in) Due to its telescopic tube the device is individually adjustable. Weight incl. battery 4 kg (8.8 lbs)
Carrying case:	85 cm x 50 cm x 34 cm (33 in x 19 in x 13 in)