Line Tester 1

Manual

English

Sienic GmbH

www.sienic.de Date: 04.04.2005 Ser.-Nr. ≥ 15

LT1Manual_2005-04-04

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Preface

At this point we would like to thank the buyer for his decision.

In manufacturing and, first of all, in the logistics the application of inductive wire guidance systems (WGS) are generally applied. A failure of WGS, e.g. a failure of all WG-vehicles by guide wire break, can cause to expensive delays.
The described test device LT1 serves the quick proof and if necessary to point the disturbance, whose cause lies in the guide wire. Also non-specialists can point the disturbances easily.

We also would like to thank the customers who have pointed out to us various influences. Without this, LT1 could never have appeared in this form. At the same time we would like to encourage all users to point out to us also in future possible improvements.

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1 General Information

1.1 Scope of Supply

• Test device LT1;
• Adapter cable for accessory equipment (3.5mm jack plug– 3x banana plug);
• Antenna for e-field-measurement (approx. 70 mm);
• Battery 9 V Type PP3 (9 V of block battery);
• Heights-distance blocks (Styropor);
• Manual.

1.2 Possibilities of Applications of LT1

• General functional test of the guide wire;
• Measurement of a standardized guide wire current directly above the guide wire;
• Proof of deep changes of the guide wire in the ground;
• Measurement of lateral deformation of magnetic field line;
• Localization of locations of break in the guide wire.

1.3 General Information for Applications of the LT1

Start-up:
• Open battery box on back (press cover latch downward);
• Connect 9 volt block battery. Do not exchange positive pole and negative pole;
• Close battery box.

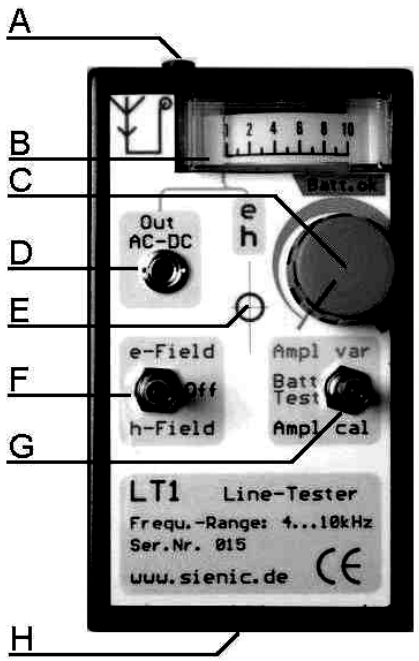
For all measurements with the LT1 the guide wire must be connected to a alternating source, generally a guide wire generator (line driver).
For some measurements the following measuring instruments can be helpful.
• Metal detecting device. A simple execution of the property market is sufficient.
• Multimeter (ohm range, DC voltage, AC current);
• Frequency Counter and Oscilloscope. Connection to AC-Output;
Frequency response AC-Outp ref. to 4. Technical Data.

The cause for abnormalities of h-field values can be also metal in the ground, e.g. structural steel . These can be proved with a metal detector.

A digital multimeter (DMM) is recommended for better readability in vertical position of LT1 (ref Fig. 3.1…3). A DMM provides also more exact results of measurement than the integrated analogue display.
DMM setting: V - DC, range 1... 2 V.

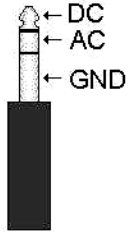
2 View of Device

2.1 LT1



A 2-mm connector with e field antenna.
B Integrated analogue display for e-, h field and battery test.
C Potentiometer for variable amplification.
D 3.5mm connector socket. Voltage output Pin assignment ref to 2.2 Adapter Cable.
E Horizontal position of h field sensor. Vertically 8 mm above LT1 bottom edge.
F Main Switch.
Off: Device is switched off
h-Field: Measurement of the magnetic alternating field (h field).
e-Field: Measurement of the electric alternating field (e field) via 2-mm connector.
G Amplification Selector Switch.
Ampl cal: Amplification calibrated.
Ampl var: Amplification variable (adjustable by potentiometer).
Batt Test: Analogue display = battery voltage [V].
H Millimeter scale for measurement of the vertical magnetic field abnormality.

2.2 Adapter Cable



GND Ground -> banana jack blue;
AC Wave of current of guide wire -> banana jack green;
DC DC-voltage ~ current of guide wire -> banana jack yellow; 4 mm socket for unused banana jack.

3 Applications

3.1 General functional Test of the Guide Wire

This simple test checks the effectiveness of the guide wire. Use by disturbance of the guidance system at the whole guide wire or sectors. Ref 3.2.

Setting LT1: Main Switch -> 'h-Field'; Amplification Selector Switch -> 'Ampl cal'. Place LT1 lengthwise, vertically and concentric above the guide wire. Ref. Fig. 7. The guide wire current [mA_{eff}] results from:
a) Integrated analogue display [value] * 10; or
b) DC voltage output [V] * 100.

E.g.: Analogue display 7.5 * 10 or DC output 0.75 V * 100
Result: Guide wire current = 75 mA;.

It is recommended to take a sample at the beginning, the middle and the final area of the guide wire. These measured values should not differ more to than 20%.

Possible causes for abnormalities
• Depth of the guide wire. Ref 3.2 and 3.3.
• Guide wire defects. Ref 3.5 and 3.5.3.

3.2 Detection of a standardized Guide Wire Current above the Guide Wire

The measurement described in 3.1 is standardized for 18mm guidance wire depth. The measured value abnormality with 15 mm (20 mm) of guide wire depth amounts to 7% (-4%). Wire guided systems tolerate deviating guidance wire depths generally and measurement 3.1 is sufficient.
A correction of measured value with known different guide wire depth is described below.

A instruction with example ref '3.1 General functional test of the guide wire'.

A Correction of the current value with known differing guide wire depth is given by the following formula (divisor ref. Fig. 1.).

Corrected guide wire current = measured current value / divisor

E.g.: Known guide wire depth 10 mm, measured current value 90 mA_{eff}.
Divisor from Fig. 1 with 10 mm = 1.2.
Corrected current of guide wire = 90mA_{eff} / 1.2 = <u>75mA_{eff}</u>.

3.3 Detection of Deep Changes of the Guide Wire in the Ground

Abrupt changes of the depth of the guide wire can have an negative effect on the steering behavior of WGS, particularly at high driving speeds. Cause for this is the dependence of the side sensitivity of WG antennas of the distance antenna to the guide wire and therefore from the guide wire depth in the ground. Iron in the ground has similar effects

Previously LT1 must be calibrated as follows.

a) Setting LT1: Main Switch 'h-Field'; Amplification Selector Switch 'Ampl var'. Place LT1 lengthwise, vertically and centric above the guide wire. Ref Fig. 7.
b) From diagram in Fig. 2 the analog display value is determined by the given guide wire depth. If depth is unknown, default value of 18 mm is recommended.

c) This value is set by LT1 potentiometer in the analogue display or in an external measuring instrument on DC output ([V] = value / 10).

Example of a calibration:
The known guide wire depth is e.g. 20 mm. The analogue display value = 4.77 (≈ 4.8) is determined for 20-mm depth by Fig. 2. Set by LT1 potentiometer the LT1 analogue display value = 4.8 or DC output = 0.48 V.

With this setting examine the suspect spots (ref. Fig. 7). From Fig. 2 are taken, vice versa like with the calibration, the guide wire depths by the analogue display values.

Example of a detection of depth: (Ref Fig. 2)
Analogue display value = 6 or DC output = 0.6 V .-> guide wire depth = 10 mm.

3.4 Detection of lateral Deformations of the magnetic Field

3.4.1 General Information

It is pointed out that the chassis of the vehicle can affect, in addition, the lateral deformations of the magnetic field. Lateral deformations of the magnetic field are a main problem of inductive guided systems. The degree of the lateral magnetic field deformation is dependent on the vertical distance to the guide wire. It increase with increasing distance (ref. Fig. 4, Fig. 5). Therefore, the measurements should be taken by typical antenna height of about 50 mm +-10 mm (distance from ground to middle of coil of antenna). Between LT1 and ground set distance blocks (included) with the wished height. Ref. Fig. 6. A height of approx 40 mm is recommended (plus 8 mm of distance LT1 bottom to LT1 h-field sensor).

At detection of the lateral magnetic field deformation the position of LT1 is always horizontally and the LT1 longitudinal axis is parallel to the guide wire.

Ref 3.4.4. Continuing information.

3.4.2 Measuring Method 1

This is the standard-measuring method. The amount and direction of abnormality are determined. By lateral shifting of LT1, the vertex (position of zero line) of the magnetic field is determined if value of analog display is minimum.

Setting LT1: Main Switch -> ‘h-Field’, Amplification Selector Switch -> ‘Ampl var’, potentiometer approx 3 o'clock position is recommended.
Shift LT1 laterally to the guide wire, until analogue display shows a minimum. The horizontal lateral distance from LT1 to the guide wire corresponds to the lateral

deformation of the magnetic field. The scales at two sides of LT1 indicate the amount in mm and direction (+/). Ref Fig. 6.

3.4.3 Measuring Method 2

This method makes possible a continuous measurement. LT1 must be led with the help of a apparatus (not included) concentric along the guide wire. About the BNC output, measured values can be stored with a logger and be evaluated. Only the amount of the lateral deformation is determined, not the direction (+ or-).

Because of the nonlinearity of the LT1 characteristic curve for the lateral deformation, the following measuring error results at approx 50-mm vertical distance about ground.
Side area 0 mm to 15 mm maximally + 4%;
Side area 15 mm to 20 mm maximally-4%;
Side area 20 mm to 25 mm maximally - 8%;

With measuring method 1 the direction and if necessary the more exact value can be determined in important sections.

LT1 must be calibrated before use of the measuring method 2. During the calibration and the following measurements the vertical distance LT1 to ground must be identical.

Calibration for measuring method 2:

a) Setting LT1: Main Switch ‘h-Field’, Amplification Selector Switch ‘Ampl var’, potentiometer approx 3 o'clock position.
b) Shift LT1 laterally to the guide wire, until analogue display shows a minimum.
c) From this position, shift LT1 laterally to the guide wire 15 mm (direction arbitrarily) and adjust analogue display to value 7.5 (DC output signal 0.75 V) by potentiometer.

For the measurement of the lateral magnetic field abnormality, move LT1 in the middle along to the guide wire.

Relation from lateral deformation of the magnetic field lines to the analogue display value resp. DC output signal.

Side deformation [mm] = Analogue display value * 2 mm or
Side deformation [mm] = DC output signal [V] * 20 mm / V.

Example:
Analogue display value = 7; -> 7 * 2 mm = 14 mm of side deformation or
DC output = 0.7 V; -> 0.7 V * 20 mm / V = 14 mm of lateral deformation.

3.4.4 Additional Information

The shape of a not disturbed magnetic field is circularly around the guide wire and the apices of the magnetic field lines are perpendicular to the guide wire. Apex deviate from the perpendicular to the guide wire by a laterally parasitic influence. With increasing distance above ground this lateral abnormality will increase. Measurements of the side abnormality should take place preferably at height of the vehicle antenna (approx. 50 mm). The connecting line of the apex is called zero-line. Ref. Fig. 4. and Fig. 5.
The cause for lateral magnetic field deformations is asymmetrical iron to the guide wire in the ground. Also magnetic couplings between the guide wires have a substantial influence. The magnetic coupling is frequently caused by the structural steel of building. Disturbances are often in the zone of the vertical abutments of the building. The chassis of the vehicle can contribute additionally to the coupling. Note: Pay attention when laying of guide wires. The distance to abutments or walls should be as large as possible .

3.5 Localization of Breaks in the Guide Wire

3.5.1 In General

The following tests are recommended, if there are suspect results by "3.1 General functional Test of the Guide Wire".

Note: The groove of the guide wire should not be poured or covered with electroconductive material. Thereby the e-field of the guide wire is shielded. Measurements of e-field in these spots are more difficult.

3.5.2 Principle of Measurement

The measuring principle is based on the fact that one terminal of guide wire is connected to AC signal and the other to earth line. Up to the location of break LT1 receives the AC signal of the e-field along the guide wire connected to AC voltage (ref. Fig. 3). The position of break can be located in range of cm / inch.

3.5.3 Instruction for Localization of Break of Wire

NOTE! Opening the linedriver may be done only by the qualified personnel because of **high voltage** (supply voltage).

a) Unplug power from generator.
b) Disconnect guide wire from generator.
c) Test the guide wire with ohm meter for break and test connection to the earth line. To effects with connection with earth line ref. 3.5.4. Special Cases.

d) Test both clamps of guide wire at the generator on electrical isolation against earth line. There is electrical isolatation, if there is high impedance on both guide wire clamps against earth contact at the generator supply plug.
e) Connect guide wire to generator.
f) Connect generator to power.
g) If both guide wire clamps are electrically isolated (ref. d)), one guide wire clamp must be connected to ground wire (ref. Fig. 3).
Note: Remove the connection after the tests again!
h) Locate location of break.
Setting LT1: Main Switch ‘e-Field’, Amplification Selector Switch ‘Ampl var’.
To get maximum coupling to the guide wire, the e-field-antenna should be placed in centre and as near as possible above the guide wire groove (ref. Fig. 8). Adjust amplification that clearly a signal is recognized (LT1-display about 5). Due to different signal shielding of the guide wire a readjustment of amplification can be necessary. At the location of break the signal strength abrupt change to zero (ref. 3.5.2 Measurement principle). At this spot an electrostatic shield above the guide wire is possible in less cases and should be considered at least.
Locate location of break by choosing the position of measurement approx half of the remaining section. The first measuring position is half of guide wire (middle of wire length), the second measuring position is middle of half section etc.

Hint: With the use of Adapter Cable and high LT1 amplification during the e-field measurement feedback can occur from AC-output to e-field-antenna (overmodulation).
LT1 reference signal (earth line) is given by the capacity of the LT1 housing to ground and / or operator. With touching LT1 3.5mm connector socket and ground by the operator, a better connection is given to the earth line.
Influences of disturb signals, e.g., from fluorescent lamps, can be considered by comparison measurements approx 10 cm away from the guide wire.

3.5.4 Special Cases

Because of variety of errors and their effects, e.g., ohm value at connection of guide wire to ground (structural steel) or the position of the defect (at the beginning or middle of the guide wire), an exact manual is not possible.

Possible errors and their effects are described for (a) electrically isolated and (b) nonisolated generator outputs to earth line.

a) Generator output is electrically isolated.

a1) Guide wire has <u>one</u> connection to ground wire, e.g., via structural steel.
- No effect on WG system.

a2) Guide wire has several connections to ground wire.
- Guide wire section is short-circuited. The current flows via the defect, e.g. via structural steel, partly or entirely.

a3) Guide wire has break. One guide wire part has connection to ground wire.
- On account of a capacitive resistance (capacity guide wire to earth approx 100pF/m) flows current from guide wire to earth. The amperage takes from the location of fracture to the generator towards. The values can amount to approx 20 mA.

b) Generator output is electrically nonisolated.

b1) Guide wire has no connection to ground wire (identic to a1).
b2) Guide wire has connection to ground wire, e.g. structural steel (identic to a2).
b3) Guide wire is interrupted. (identic to a3).

4 Technical Data

Results are not indicated to [A/m] or [V/m] like usually for h- or e-field measuring instruments. h-field measurements are standardised to a guide wire current. e-field measurements are used for yes/no decisions (ref 3.5.3 h). LT1 was developed specially for inductive guided systems.

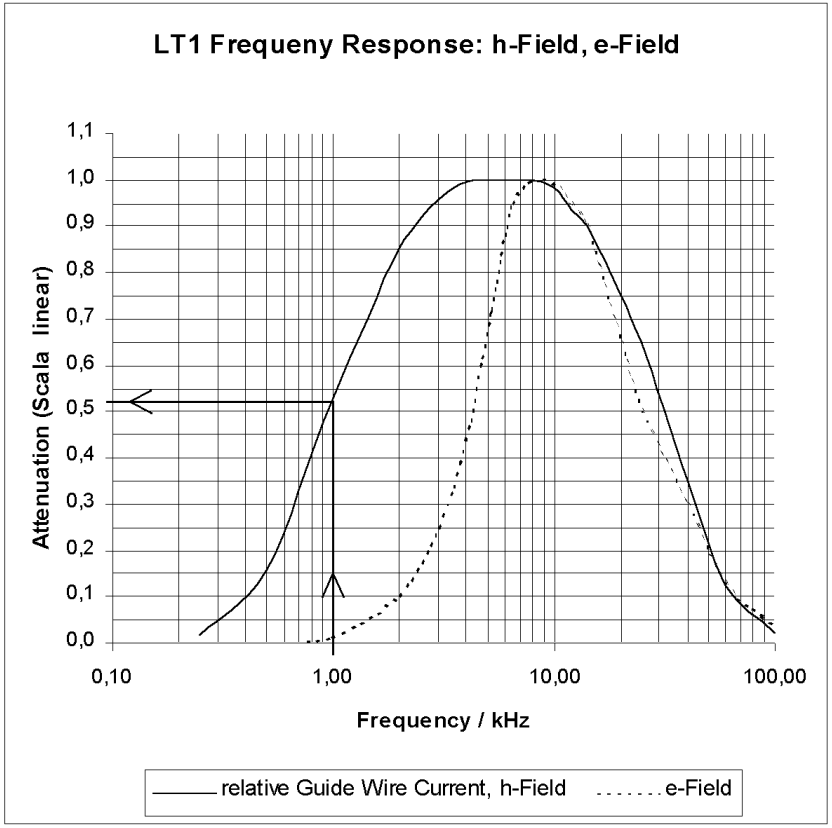
Measuring principle:	Magnetic field (h field) vertical component to front-plate. Sensor position 8 mm above LT1 bottom edge and long-symmetric to the housing (circular mark on front plate). Electric field (e field) via 70 mm antnna on 2 mm connector.
Analogue display:	Analogue display for h field, e field and battery-test. Accuracy: + - 10% full-scale. Display value = DC output [V] * 10.
Signal-output:	3.5mm connector socket. AC/DC output for h- and e-field. Offset on AC is battery voltage / 2. Output serial resistance 1kohm. DC output level [V] = Analogue display / 10. DC output level [V] ≈ AC output level [V_{eff}]
Power consumption:	typically 2.5 mA at 6-10 V=.
Battery:	9 volts block battery Type PP3. Operating time approx 150 hours per battery.
Manufactur method:	SMT, thereby compact construction.
Dimensions:	DxWxH / mm 108 x 61 x 45 incl. operating elements without e-field antenna.
Weight:	150 grammes.
Temperature	+10 ^{O}C to +45 ^{O}C (not condensing).

Frequency range * 4 kHz – 10 kHz.

* Measurements of the guide wire current (ref 3.1 and 3.2) are from 4 - 10 kHz frequency-independently. Outside 4 kHz to 10 kHz a correction is necessary. Measurements from about 1kHz to 30kHz in h-mode are possible.

Example of correction at 1 kHz for applications 3.1 and 3.2:
From diagram below attenuation = 0.53 at 1 kHz
Corrected measured value = measured value / attenuation.

For applications 3.3, 3.4 and 3.5 the Amplification Selector Switch is in 'Ampl var'-position. The correction is set by potentiometer anyway.



5 Diagrams Fig. 1 - 8.

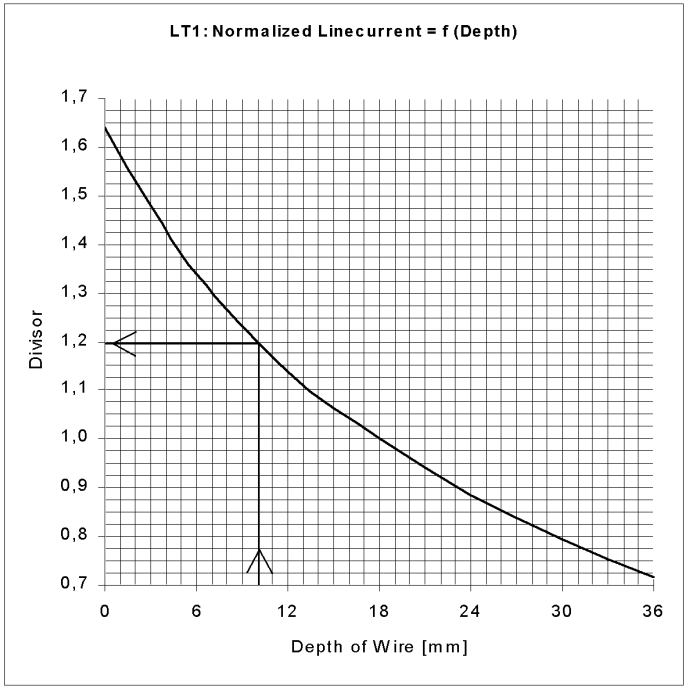


Fig. 1 Relation Divisor and depth of guide wire.

Ref 3.2

Example: Determination of the divisor (1.2) from guide wire depth (10 mm).
By x-axis = 10 mm vertically upwards up to the intersection, then horizontal to the left to y-axis = 1.2).

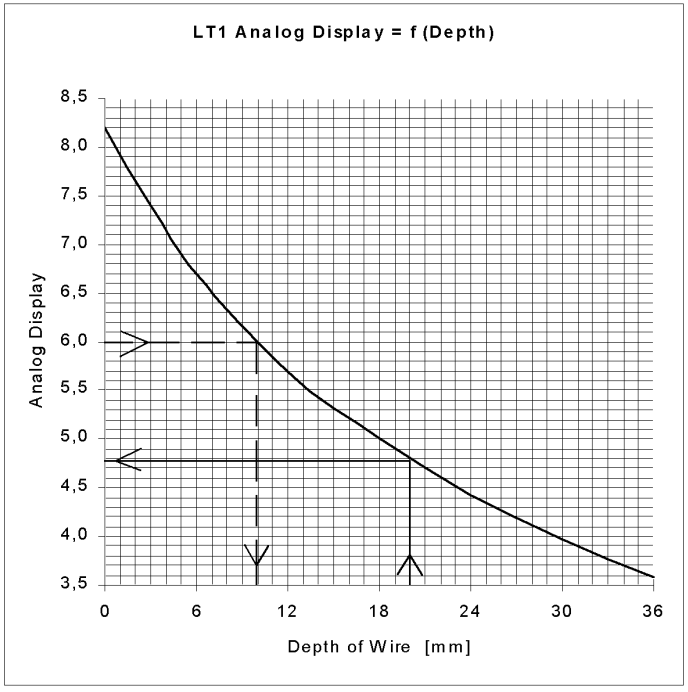


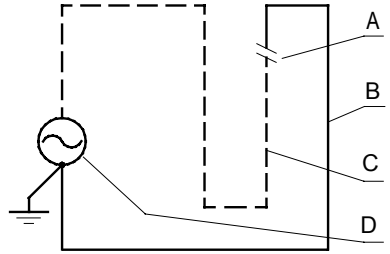
Fig. 2 Relation guide wire depths and analogue display value.

Ref 3.3

Example calibration: Determination of the analogue display value (4.8) from guide wire depth (20 mm).
By x-axis = 20 mm vertically upwards up to the intersection, then horizontal to the left to y-axis = 4.8).

Example: Determination of the guide wire depth (10 mm) from analogue display value (6).
By y-axis = 6 horizontal right up to intersection, then vertically downwards to x-axis = 10 mm).

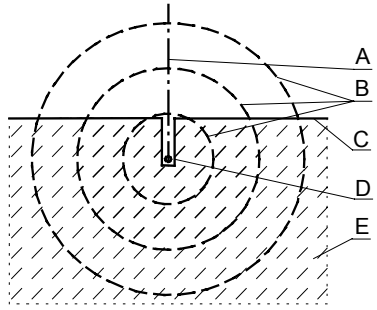
Fig. 3 Break of Guide Wire



A Location of guide wire break;
B Guide wire section connected to ground wire;
C Guide wire section connected to AC signal;
D AC source (guide wire generator);

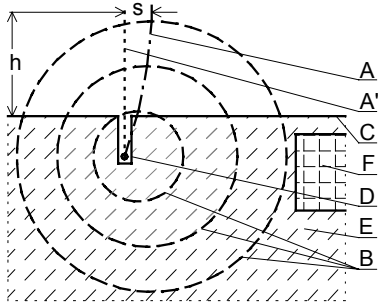
The connection of the guide wire to ground wire must be carried out separately if guide wire generator is electrical isolated.

Fig. 4 Ideal magnetic Field



A Zero-line of the undisturbed field;
B Magnetic field lines;
C Surface of lane;
D Guide wire;
E Concrete;

Fig. 5 Laterally deformed magnetic field



A Zero-line of the deformed magnetic field;
A' Ideal zero-line;
B Magnetic field lines;
C Surface of lane;
D Guide wire;
E Concrete;
F Iron;
's' = side abnormality at height 'h';

Fig. 6
LT1-position on measurement of the lateral deformation and measuring method 1. Lateral deviation 10 mm. With measuring method 2 LT1 is centric above guide wire.
Ref 3.4.1-3

Fig. 7
LT1-position on measurement of the guide wire current and guide wire depth. LT1 long-sided, vertically and centric above guide wire.
Ref 3.1-3

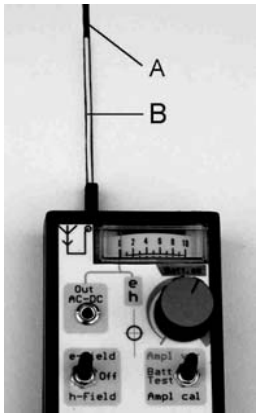


Fig. 8
LT1 view on determination of the break position of guide wire (e field measurement)
A Groove of guide wire
B e-field antenna.
Ref. 3.5.2