

Instruction Manual

Digiflex Com

Mess- und Ortungstechnik Measuring and Locating Techniques

Elektrizitätsnetze
Power Networks



Kommunikationsnetze
Communication Networks



Rohrleitungsnetze
Water Networks



Leitungsortung
Line Location





Digiflex Com

compact and light-weight

Time-Domain Reflectometer

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EC - Declaration of Conformity

CE Mark

We, the company

**Megger
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declare under sole responsibility that our product

Digiflex Com

is in conformity with the directive of the Council of European Communities for the Harmonization of the Laws of Member States on Electromagnetic Compatibility (EMC Directive 89/336/EEC) and Low Voltage (Directive 73/23/EEC).

This EC Declaration of Conformity is the result of a verification test performed by the department of Quality Assurance of Megger Kabelmesstechnik GmbH.

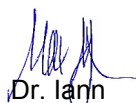
Conformance with the directive on Electromagnetic Compatibility was verified in accordance with the following standards:

EN 50081 Interference Emission, EN 50082 Interference Immunity
EN 55011 Product Standard, EN 61000-4-2 Electrostatic Discharge, and
EN 61000-4-4 Fast Interfering Electrical Transients

Conformance with the directive on Low Voltage was verified in accordance with the following standards:

EN 61010-1 Safety Regulations for Electrical Measuring, Control, Regulating, and Laboratory Instruments and EN 60529 Enclosure Protection

Radeburg, 13th of March 2003



Dr. Iann
Managing Director

1. GENERAL

1.1 Advice from Megger

The present system manual has been designed as an operating guide and for reference. It is meant to answer your questions and solve your problems in as fast and easy a way as possible. Please start with referring to this manual should any trouble occur.

In doing so, make use of the table of contents and read the relevant paragraph with great attention. Furthermore, check all terminals and connections of the instruments involved.

Should any question remain unanswered or should you need the help of an authorized service station, please contact:

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1.2 Terms and conditions of warranty

Megger accept responsibility for a claim under warranty brought forward by a customer for a product sold by Megger under the terms stated below.

Megger warrant that at the time of delivery Megger products are free from manufacturing or material defects which might considerably reduce their value or usability. This warranty does not apply to faults in the software supplied. During the period of warranty, Megger agree to repair faulty parts or replace them with new parts or parts as new (with the same usability and life as new parts) according to their choice.

This warranty does not cover wear parts, lamps, fuses, batteries and accumulators.

Megger reject all further claims under warranty, in particular those from consequential damage. Each component and product replaced in accordance with this warranty becomes the property of Megger.

All warranty claims versus Megger are hereby limited to a period of 12 months from the date of delivery. Each component supplied by Megger within the context of warranty will also be covered by this warranty for the remaining period of time but for 90 days at least.

Each measure to remedy a claim under warranty shall exclusively be carried out by Megger or an authorized service station.

This warranty does not apply to any fault or damage caused by exposing a product to conditions not in accordance with this specification, by storing, transporting, or using it improperly, or having it serviced or installed by a workshop not authorized by Megger. All responsibility is disclaimed for damage due to wear, will of God, or connection to foreign components.

For damage resulting from a violation of their duty to repair or re-supply items, Megger can be made liable only in case of severe negligence or intention. Any liability for slight negligence is disclaimed.

Since some states do not allow the exclusion or limitation of an implied warranty or of consequential damage, the limitations of liability described above perhaps may not apply to you.

1.3 Safety Instructions

All persons involved in the installation, operation, maintenance and repair of the **Digiflex Com** must have read this manual carefully.

The **Digiflex Com** and its supplementary equipment are in accordance with the current state of safety technology at the time of delivery. Owing to the work processes involved, however, there may be parts of the unit and its peripherals which cannot be given optimum protection without an unreasonable reduction in function and usability. Good personal safety practice is therefore indispensable in terms of the protection of staff and the unit.

Therefore, please comply with the following safety instructions!

GENERAL INSTRUCTIONS

Work on the **Digiflex Com** and its peripherals must only be carried out by trained and/or instructed staff. Other persons must be kept away.

This manual must be available for the supervisory, operating and maintenance staff to refer to.

Improper use may endanger life and limb, the **Digiflex Com** and connected equipment, as well as the efficient functioning of the unit (accident prevention regulations). The **Digiflex Com** may only be used for the purpose for which it is intended by the manufacturer.

Always use the correct tools in perfect condition for all work.

Regular checks must be made to ensure that the relevant safety regulations are being complied with during operation and maintenance.

Never operate the **Digiflex Com** and its peripherals if they are not in a technically perfect condition.

Only parts specified by Megger as accessories must be used for the **Digiflex Com** and its peripherals, as the necessary safety will not otherwise be guaranteed. No mode of working which detracts from the safety of the **Digiflex Com** must be used.

Replace a accumulator only when the device is switched off and disconnected.

The user is under an obligation to report any changes in the **Digiflex Com** to the supervisor responsible without delay.

The operator is under an obligation to shut the **Digiflex Com** down immediately in the event of a malfunction which detracts from the safety of staff. The **Digiflex Com** must only be put back into operation once the malfunction has been rectified.

ELECTROTECHNICAL INSTRUCTIONS

Connect the **Digiflex Com** and all its accessories according to instructions and regulations. Make sure the relevant regulations such as **EN, DIN, VDE** or national standards, respectively, are observed.

Repair and maintenance work must only be carried out when the unit is switched off (dead) and then only by a skilled electrician in accordance with current accident prevention regulations. A skilled electrician in the sense of the accident prevention regulations is a person who can assess the work assigned to him/her and recognise possible dangers on the basis of his/her technical training, knowledge and experience, and of his/her knowledge of the relevant regulations.

1.4 Indications used in the description

Important instructions concerning personal protection, work safety and technical safety are indicated as follows:

CAUTION



Caution indicates work and operating procedures which must be complied with in full to prevent the **Digiflex Com** and/or its peripherals from being damaged or ruined.

NB



NB indicates special technical requirements to which the user must pay particular attention when using the **Digiflex Com**.



Equipment protected by double insulation or reinforced insulation.

2. TECHNICAL DESCRIPTION

2.1 General Description

The **Digiflex Com** is a compact, light-weight and easy-to-handle digital time-domain reflectometer for locating faults in balanced telecommunication and control lines. It can be handled easily and so enables even an inexperienced user to locate faults precisely and fast. Experts in testing will find a variety of additional functions at their hands. By its design the **Digiflex Com** is a robust device suitable for field application.

The **Digiflex Com** is double-insulated and equipped with safety terminals to protect the user.

The **Digiflex Com** is similar to radar in that it employs the pulse reflection technique. Suitable test pulses are transmitted into the cable to be tested. The pulses travel along the cable at a propagation velocity that is dependent on the connected test object. In every place where the electric characteristics of the cable have changed, part of the transmission pulse is reflected and caused to travel back to the **Digiflex Com** where it will be displayed on the screen with a time delay corresponding to its propagation time.

A change in the electric characteristics of a cable may be caused either by a possible fault or by local circumstances such as junction boxes, connectors, or the end of the cable. The time delay between the incoming reflection and the moment of pulse transmission is the propagation time to the point of fault and back. The distance from a place of interest can be calculated by taking into account the specific pulse propagation velocity of the cable under test. Shape and size of the reflected signal allow conclusion to be drawn on the nature and size of the fault. Cable attenuation can be compensated for by applying a distance-dependent amplitude correction (amplitude correction) in order to display echoes from different points of reflection with comparable amplitudes irrespective of their distance. In this way the **Digiflex Com** shows a revealing picture of the connected cable. There is even a mode called IFL to locate any fault that is inconsistent in its time structure.

The propagation time of the test pulse which is dependent mainly on the material of cable insulating material is taken into account by specifying a signal propagation velocity.

For measuring the distance to the fault, a movable cursor or a combination of marker and cursor are used. Distance is display in m, ft, or μs as selected by the user. In order for the distance to be indicated in m or ft, the pulse propagation velocity of the cable under test has to be entered before the test is carried out.

The greatest advantage of the pulse reflection method is its ability not only to find out that there is a fault but also to find its location and type.

The **Digiflex Com** allows two cables under test to be connected to L1 and L2 at the same time and to show two reflectograms simultaneously. This can be done using currently taken reflectograms or test results stored in memory.

The most important modes of testing are:

- Reflection measurement Pair (physical circuit) versus Built-in balancing network (dummy line)
- Difference measurement of two pairs
- Location of crosstalk (NEXT) Pair versus Pair (k1 measurement)
- Measurement of time-variable (intermittent) faults (IFL)

There are two display modes the user can choose between. When you wish to get a revealing overview of the cable under test and, at the same time, have a closer look at a cable section, you can choose the display mode which divides the screen of the **Digiflex Com** into two windows. The upper window shows the full distance range with a movable window marking a section the content of which is displayed zoomed in the lower window. There is yet another display mode with a full-screen display of the selected cable section.

Current device settings are display by the LCD. When a stored reflectogram is uploaded as trace 1, all relevant settings such as gain and NVP are also taken over from memory thus allowing the current test result to be easily compared with a reflectogram taken earlier.

The **Digiflex Com** is powered from a NiMH rechargeable accumulator fitting in a accumulator compartment in the bottom of the unit. The instrument has a Power-Down mode. Moreover, the unit can also be powered from an external source of power.

2.2 Specifications

Modes of testing:	
L1:	Reflection test of cable connected to socket L1 versus built-in balancing network
L2:	Reflection test of cable connected to socket L2 versus built-in balancing network
Alt:	A reflection test is carried out alternately on cables connected to sockets L1 / L2
Diff:	Measurement of difference between cables connected to sockets L1 and L2
NEXT:	Location of crosstalk between cables connected to sockets L1 and L2
Pairs to be connected:	2
Modes of operation:	
Single	Single test
Cont	Continuous testing
Average	Averaging of up to 256 test results
IFL	for intermittent faults (Intermittant <u>F</u> ault <u>L</u> ocation)
Measuring ranges at $v_{/2} = 100 \text{ m}/\mu\text{s}$	50, 100, 200, 400, 1000, 2000 m 4, 7.5, 15, 30 km (zoomed 5 m)
Zoom factors (X direction)	1, 2, 5, 10, 20 (depending on range of measurement)

Maximum resolution	1.25 cm for range 50 m at 50 m/μs 2.5 cm for range 50 m at 100 m/μs 2.5 cm for range 100 m 5 cm for range 200 m 10 cm for range 400 m 25 cm for range 1000 m 50 cm for range 2000 m 1 m for range 4000 m 2.5 m for range 7500 m 5 m for range 15 km 10 m for range 30 km
Accuracy	± 0.1% of range of measurement ± 1 cursor step
Gain	0 ... 80 dB in steps of 1 dB
Dynamic range	90 dB
Distance-dependent amplitude correction	settable in 99 steps
Distance reading	m, ft, or μs
Setting range of signal propagation velocity	
NVP	0.200 ... 0.999 in steps of 0.001
$v_{1/2}$	30.0 ... 149.9 m/μs or 98.4 ... 491.8 ft/μs
Pulse amplitude	5 ns 2 V±25 % at 120 Ω 10 ns 2 V±25 % at 120 Ω 20 ns 2 V±25 % at 120 Ω 50 ns 3,5 V–25 % at 120 Ω 200 ns 5,0 V–25 % at 120 Ω 750 ns 6,0 V–25 % at 120 Ω 3 μs 6,5 V–25 % at 120 Ω

Pulse width	<p>Pulse width is linked to range of measurement:</p> <p>5 ns for range 50 m (100 m/μs)</p> <p>5 ns for range 100 m</p> <p>10 ns for range 200 m</p> <p>20 ns for range 400 m</p> <p>50 ns for range 1 km</p> <p>200 ns for range 2 km</p> <p>200 ns for range 4 km</p> <p>750 ns for range 7,5 km</p> <p>750 ns for range 15 km</p> <p>3 μs for range 30 km</p>
Electrical strength of test inputs	250 V AC/DC 50/60 Hz CAT II (overvoltage category)
Memory locations	50
Measuring rate	up to 11 reflectograms per second (averaging mode, short range)
Display rate	up to 4 screen images per second
Display	256 x 128 pixels, back-lighted
Interface	RS 232 for PC / printer
Power supply	Replaceable NiMH rechargeable accumulator (7,2 V/2,2 Ah) or Plug-in mains unit (optional extra)
Mean operating time with one accumulator charge	ca. 6 hours
Languages	German, English, other languages as optional extras on request

Environmental conditions	
Operating temperature	-10 °C ... +50 °C
Storage temperature	-20 °C ... +60 °C (without accumulator)
Storage temperature (accumulator)	-20 °C ... +50 °C
Dimensions, mm	176 x 260 x 70 (L x W x H) 186 x 260 x 70 incl. measuring terminals
Weight	approx. 1.5 kg
Interelement protection class	II with accumulator compartment closed and protective cap on serial interface terminal
Enclosure protection	IP54

Subject to changes and alterations without further notice!

2.3 Items Supplied and Optional Extras

Items supplied:

Description
<p>Digiflex Com, consisting of</p> <p>Digiflex Com (G,E, two languages on request)</p> <ul style="list-style-type: none">- 2 pcs. set of test leads- Case for Digiflex Com- Accumulator 7,2 V / 2,2 Ah / NiMH- Charger- Plug-in mains unit for charger; 100 ... 240 V, 50/60 Hz- Instruction manual, according to country: German English More languages on request

Optional Extras:

Description	for use as
Rechargeable accumulator 7,2 V / 2,2 Ah / NiMH	replaceable accumulator
Winkis Com	PC software for evaluating and storing reflectograms
Printer set	means for the on-site preparation of test reports
Transportation case	for printer set
Plug-in mains unit	external source of power
Adapter cable	for charging the accumulator from a vehicle electric mains using the charging management of the charger case
Coax adapter	for testing coaxial cables
Fault Converter	for locating moisture-induced faults
Calibration with manufacturer's test certificate	

Subject to changes and alterations without notice!

3. OPERATION



Fig 1 *Digiflex Com*, Front View

3.1 Measuring Terminals

L1 In general, these measuring sockets are used for connecting the faulty line or line to be tested. When using this configuration please make sure that your *Digiflex Com* is set to mode L1. In mode NEXT this pair of sockets is used for receiving the crosstalk.

L2 In general, these measuring sockets are used for connecting a faultless pair of conductors to be used as a reference for comparison with the test object connected to L1. In mode Diff this facilitates the detection of small fault reflections in the tested line connected to L1 because each reflection caused by a junction or terminal occurs in both lines at the same distance and approximately the same size and will thus almost be cancelled out in the reflectogram due to the applied method of subtraction. In mode L1, a line that is possibly connected to L2 will not have any influence whatsoever on the test.

Mode NEXT: This pair of sockets will carry the transmitted pulse.

Mode Alt: Testing is carried out alternately on L1 and L2.

Mode L2: Reflection measurement of L2

3.2 Display

The LC-Display has 256 x 128 pixels, controls for setting contrast, and switchable back lighting. This enables graphic information to be readable even in difficult lighting conditions.

The activated function is display in **inverted** representation.

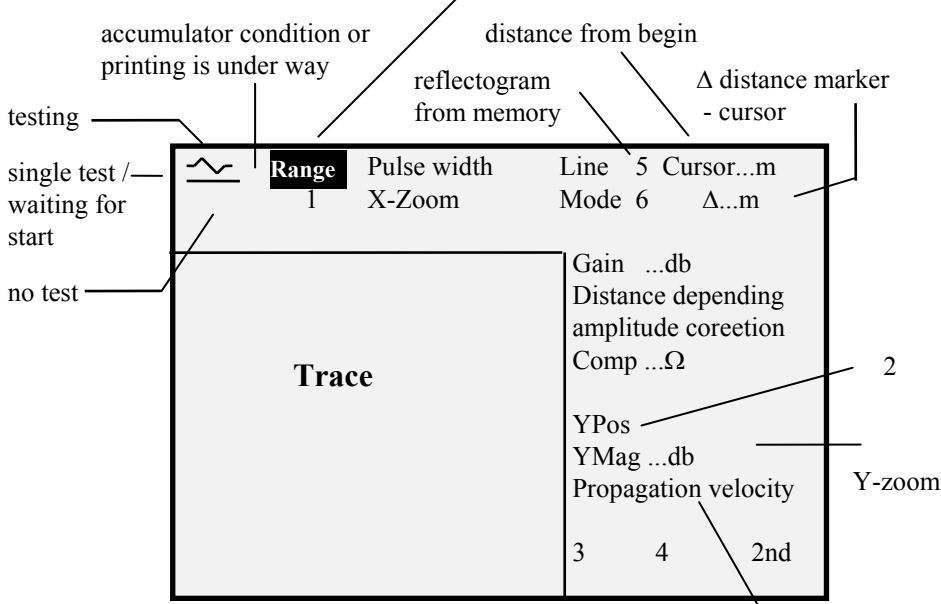


Fig 2 Display

- 1 Window on display (range/X zoom)
- 2 Vertical shift
- 3 Back light
- 4 Contrast
- 5 ,**M** for A loading; -**M** for D loading
- 6 Average counter in mode averaging

There are two modes of displaying the reflectograms: Press "Display" when you want to work with two images of the trace, see Fig 3. The upper is the reflectogram of the full range of measurement. There is a black bar below this overview indicating a section the position of which can be moved by means of the cursor.

The lower and larger part of the display shows this black section magnified in full detail. Use the cursor when you want to change the position of the section and change the X zoom factor when you want to change the width of the section.

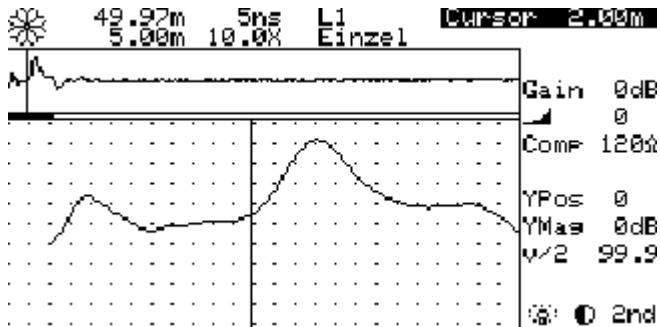


Fig 3: Reflection by the 2 m Interconnect Cable

The LC display will display a warning signal top left when the remaining charge of the accumulator is insufficient for further operation. Replace the accumulator or charge it in order to restore readiness for operation. Switch the instrument off before replacing the accumulator to retain all data.

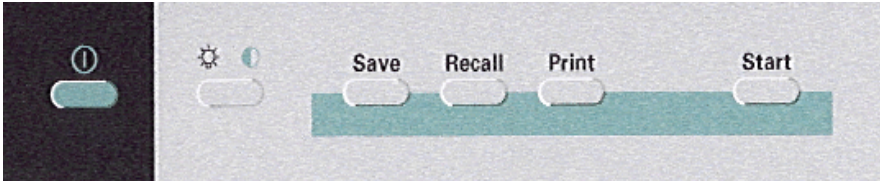
Press one of the following keys for ca. 1.5 s to return to the default value.

Function	Key(s)	Default value
Cursor	Cursor	0.0 m/ft/μs
Gain	Gain	0 dB
Amplitude correction	2nd Gain	0 (off)
Compensation	Comp	120 Ω
Vertical shift	Vert	0
Vertical zoom	2nd Vert	0 dB
Pulse propagation velocity	v/2 NVP	99.9 m/μs or 327.9 ft/μs or 0.667
Horizontal zoom	Zoom	1 (full range)
Mode of connection	Line	L1
Mode of operation	Mode	Single
Contrast	Light key (press for 3 sec)	standard contrast

3.3 Functions of Keys and Rotary Encoder

How to proceed:

- press key(s) to call function
- use rotary encoder for selection



On/Off

light

contrast

(hold down key, turn rotary encoder)

Save

Recall

Print

Start single test

Stop/Start cont.testing

Stop averaging

Quick-save operation to memory 1 by 2nd Save and 2nd Recall;
with Alt to memories 1 and 2.

When you press the help key (?) the **Digiflex Com** will display informations
on one of the following topics:

(key ?; select with rotary encoder; press key Mark, key ? for return):

- Information on help
- Fault location
- Operation
- Compensation
- Averaging
- Mode of display
- NVP or $\sqrt{1/2}$
- Types of cables
- Storage
- Device set-up
- Self test (via 2nd Menu)
- Accumulator charging
- DC external
- 2nd keys

Marker:

Activate cursor; move cursor to start point of measurement; set marker

Cancel

X-Zoom

Vertical shift

Y-Mag(nification)

Propagation velocity / NVP

Single or Dual Display

Menu

Menu/Units

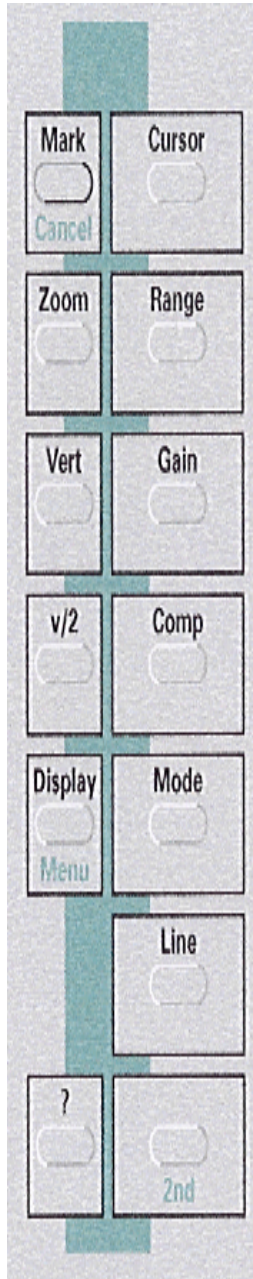
Menu/Interface

Menu/Printer

Menu/System

Menu/Power supply

Help



Cursor

Range (Measuring Range)

Pulse width

Gain, dB

Distance depending amplitude correction

Compensation

Modes:

Single

Continuous

Average

IFL (for intermittent faults)

Mode of connection:

L1, L2, ALT (alternating)

Diff (Difference L1-L2)

NEXT (cross talk)

Second key functions

Possible settings in Menu:

Menu/Units	Units	meter feet seconds
	NVP units	NVP $\frac{V}{2}$
Menu/Interface	Baud rate	300 1200 9600 19200
	Parity (Parity bit)	None Even Odd
Menu/Printer	Printer	HP Deskjet Epson 24 needles Epson 9 needles Kodak Diconix
	Layout	Normal Special
Menu/System	Self test	Software version Serial number
	Date & time	mm.dd.yy / hh:mm:ss / AM/PM
	Language	German English 2 x other languages
Menu/Power supply	Device switched off	disabled off; 10 s ... 1200 s
	Back light switched off	disabled off; 5 s ... 600 s
	Measurement Rate Reduction	disabled off; 1 s ... 60 s

3.4 Getting Started (Insert / Replace Accumulator)

The accumulator compartment is located in the back of the **Digiflex Com**. Make sure that all test leads have been disconnected before opening the accumulator compartment. Switch the device off in order to retain all data. For inserting or replacing the accumulator open the lid and pull out the accumulator, if there is one. Insert the charged NiMH replacement accumulator with its contacts facing the receptacle of the compartment. Make sure that the accumulator is inserted properly, otherwise you would be unable to close the lid. Now the **Digiflex Com** is ready for operation.

3.5 Switching On and Off

Press key **①** to switch the **Digiflex Com** on. During run-up the manufacturer's logo will be shown for about 2 seconds.

After run-up has been completed, the **Digiflex Com** can be switched off any time by pressing key **①**. When being switched off the device saves all device settings, so the same operating status is restored when the instrument is switched on next time.

The **Digiflex Com** cuts back its function automatically some time after a key has been pressed last time in order to save accumulator power:

- The device is switched off after 360 sec,
- The back light of the display is switched off after 60 sec,
- The reduction of measuring rate is disabled

These default values as mentioned above can be changed in menu Power Supply.

Device on/off	off	10 sec ... 20 min	in steps of 10 sec
Light on/off	off	5 sec ... 10 min	in steps of 5 sec
Meas. rate reduction	off	1 sec ... 1 min	in steps of 1 sec

Key operations: 2nd; Menu; rotary encoder to Supply menu; Mark; rotary encoder for Vertical selection; Mark; use rotary encoder to set Time; Mark; Display.

In mode IFL the instrument will not be switched off. Nor will the **Digiflex Com** be switched off when power is supplied by the external mains unit.

3.6 Main Menu

Main Menu will appear automatically after the *Digiflex Com* has been switched on. In this menu measurements are taken employing the device settings that were in effect when the device was used last time. Most functions of *Digiflex Com* can be started directly from menu Measurement by means of the keys or rotary encoder as described in section 3.3.

3.7 Compensation of Initial Reflection

Use key Comp and the rotary encoder to adjust compensation such that the initial reflection is suppressed on the display. In principle this adjustment should be made in order to provide for optimum matching of the *Digiflex Com* to the impedance of the respective cable so as to be able to detect and locate a fault at close range, i.e. at a distance of up to 10 meters.

When a faultless pair of conductors of the same type of cable as the faulty one is available and when it is connect to sockets L2, the impedance of the faultless cable is used for reference in mode Diff. In this case compensation is not operational and matching is guaranteed. Use compensation when no faultless pair of conductors is available. Switch to mode L1 or L2 according to the socket pair used and select display mode "DUAL". Set cursor to distance zero and adjust compensation such that the upper image of the reflectogram is displayed as a horizontal line, if possible, and the initial reflection shown in the lower window of the display shows as small as possible. For facilitating the setting procedure, first set gain to 0 dB for coarse balancing and then increase it for doing the fine adjustment.

3.8 How to Locate a Fault

When you test a defective cable, always obey by the following basic rules:

- (1) Observe the safety precautions given in section 0 without fail.
- (2) **De-energise the cable to be tested, whenever possible. When you take measurements on a live line, its voltage must not exceed 250 V AC/DC. In this case do not open the accumulator compartment and do not remove the cap of the serial interface.**
- (3) The *Digiflex Com* is able to measure the length of the cable and the distance to a point of fault. It is not able, however, to find out the route of the cable between the point of measurement and the location of the fault.
- (4) The precision of the distance reading by the *Digiflex Com* can only be as good as the precision with which you know the pulse propagation velocity of the connected cable. In a wet cable the pulse travel time is increased, so the distance display is too long when the same settings are used as for a dry cable.

3.8.1 Fields of Application

The *Digiflex Com* allows various type of faults to be detected. These are a few examples:

3.8.1.1 Faults Causing a Negative Reflection

- (1) Short circuit: Direct contact of two conductors of a cable. This will cause a negative reflection, see Fig 4.

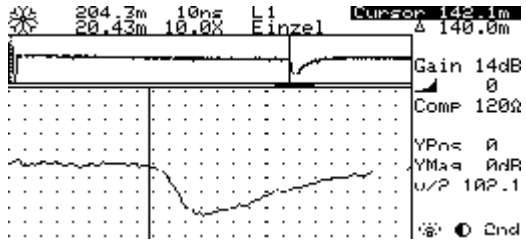


Fig 4 Type of Fault Causing a Negative Reflection

- (2) Short-circuit to shield: One conductor in a cable is in contact with the metal shield of the cable. For locating this type of short-circuit, first disconnect earth from the shield. Then connect the test leads to the shield and the conductor which is shorted with it.
- (3) Reversed (mixed-up) wires: Reversed wires generate a reflectogram similar to a short circuit but reflections are smaller in size.

3.8.1.2 Faults Causing a Positive Reflection

- (1) Open circuit: Open circuit means that one or both conductors of a pair of conductors are broken or have become detached. This will cause a positive reflection, see Fig 5.

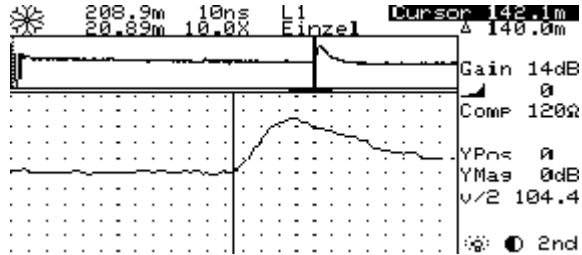


Fig 5 Type of Fault Causing a Positive Reflection

- (2) Resistance faults: If a cable is not properly connected in a junction box, increased contact resistance will occur. This type of fault generates a positive reflection in a size which is dependent on the quality of the connection resp. its resistance.
- (3) Shield interrupt means that the metal shield of a cable is broken or has become detached. To locate such faults and to suppress noise signals on the display, connect the test leads to the shield and to as many conductors of the cable as possible. This type of fault generates a fault reflection the size of which is dependent on the resistance of the interrupt.
- (4) Crossed lines ("split pairs") and restored reversed lines occur when a telecommunication cable is twisted or untwisted. Usually this may happen at a cable joint. This phenomenon is one of the main causes of crosstalk interference. Reversed wires in an untwisted cable will generate a positive error reflection. If an individual cable is twisted, a negative error reflection appears. As the distance between the points of crossing and crossing is usually very small, both reflections occur almost simultaneously and appear as a single weak reflection.
- (5) A humidity-induced fault is brought about by water penetrating into a defective line. At the beginning of a wet section a negative reflection similar to a short-circuit can be observed, followed at the end of the wet section by a small positive fault reflection typical of an open cable end. In some cases, e.g. if the moisture gradually increases or decreases with distance, these points of reflection spread into a constant up and down in the horizontal traceform. In an old cable which is wet along its entire length it may be difficult to detect a moisture-induced fault because the beginning and the end of the zone of moisture exposure are not clearly marked. It is only in rare cases that the fault reflection becomes apparent as clearly as for a short-circuit or broken line. Moisture in a cable filled with petrolatum may possibly result in very small fault reflections as the volume of moisture is only limited.

3.8.1.3 Further Fields of Application

- (1) T-joints (Tapped joints) occur when a conductor pair leading to an extension is tapped off a pair in the main line. Halving the characteristic impedance at the tap or bridge will result in a fault similar to a short circuit (negative reflection). The trace on display is difficult to assess if a pair of conductors is tapped at many points unless precise information about the structure of the cable network is available.
- (2) Some telephone lines are coil-loaded in order to increase the inductance of the line and thereby improve the transfer characteristic of a trunk line. The **Digiflex Com** will interpret the coils used for the inductive loading of the system as open ends. Connect the instrument to some point behind the coil if you want to locate a fault which is situated beyond the bounds of a coil-loaded section.

3.8.2 Testing a Cable with Known Nominal Velocity of Propagation NVP or with Known Pulse Propagation Velocity ($v/2$)

In many instances the route and characteristics of the cable are known in which case the nature and position of the fault can be located quickly. In such circumstances proceed as follows:

- (1) De-energise or disconnect the Faulty pair and, where appropriate, a good reference, if possible. When a test has to be performed under voltage, make sure that the voltage does not exceed ≤ 250 V AC/DC.
- (2) Use the test leads supplied with the **Digiflex Com** to connect the Faulty pair to Line 1 and, when appropriate, the good pair to Line 2.
- (3) Press key **①** to switch the **Digiflex Com** on. Menu Measurement will appear after a few seconds.
- (4) Press key (Line) to select the appropriate mode of measurement, e.g. Diff when a good pair is available or L1 when you test the Faulty pair alone.

Set to the desired unit of measurement (2nd; Menu; Menu Units), select a measuring range according to the length of the cable to be tested, set the pulse velocity to the desired option (NVP, $\frac{1}{2}$ in m/ μ s or ft/ μ s), set the display mode to "DUAL ". The sockets of the instrument are the zero mark of the cursor. Use the marker to subtract the supplied interconnect line.

- (5) Use keys ($\frac{1}{2}$) and the rotary encoder to set the cable-specific propagation time to the value specific value of the cable to be tested.
- (6) Match the **Digiflex Com** to the object under test as described in section 3.7.
- (7) First of all, try to find the (open) end of the cable.
- (8) Look for a fault reflection in the overview trace displayed on top. In doing so, increase gain or amplitude correction steadily until the point of fault is clearly visible.

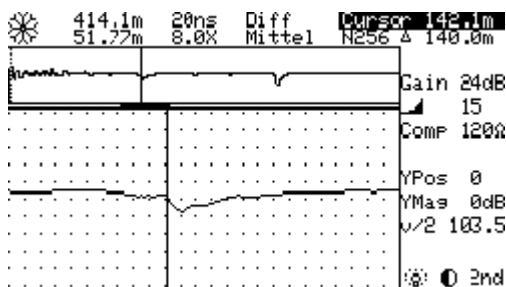


Fig 6. Display

- (9) Use the cursor to move the section marker (black bar between the two traces) such that the reflection is located above the bar. Then use the rotary encoder to move the cursor in the lower part of the screen to the place where the foot point of the fault is located (see Fig. 6).
- (10) The distance to the fault can now be read off directly. This value can be indicated in meters, feet, or nanoseconds depending on the setting in menu Units. The reflectogram can be saved in a the memory for documentation purposes .
- (11) Press **1** to switch the **Digiflex Com** off after the test has been completed.

3.8.3 How to Determine an Unknown Nominal Velocity of Propagation or Pulse Propagation Velocity

When the nominal velocity of propagation or pulse propagation velocity of the faulty cable is not known, a test sample of the same type of cable with known length is needed (or the distance to a specific point in the cable must be known).

Set the cursor to the foot point of the known reflection. Then adjust the NVP or pulse velocity setting such that the indicated distance to the fault correlates with the actual length of the sample. After that the distance to a fault reflection in the defective cable can be measured.

3.8.4 Simplification of Fault Location Using Comparative Tests

The reflectogram shown in Fig 6 shows cable and fault in virtually ideal conditions. In reality, however, there are cable junctions and other connections resulting in a trace which is normally similar to that shown in Fig 7 (good pair). In Fig. 8 (Faulty pair), in addition to the fault other cable reflections are visible which are caused commonly by connections with an impedance different from that of the line. These jumps in impedance also appear as reflections and thus render the detection of the reflection caused by the fault almost impossible. When a multi-pair cable is tested, a comparative test (see Fig 9) using a good pair (provided that not all conductors are defective) allows the point of fault to be detected. Connect the good pair to L2, the faulty pair to L1. Then select mode Alt by pressing key (Line). Move the cursor to the points where both trace diverge. In Fig 10 mode Diff was used which means that differences between both reflectograms (fault reflections in the defective cable) occur in places where the difference on display deviates from the horizontal. Use the cursor to measure the distance to the foot point of the deviation.

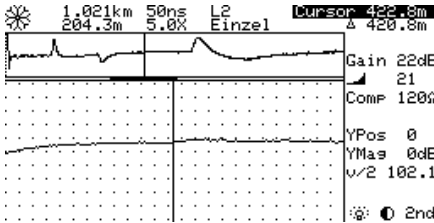


Fig. 7

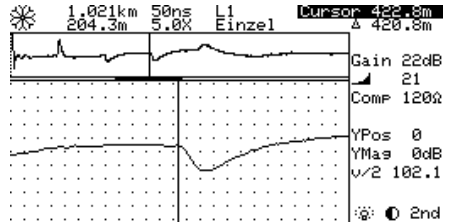


Fig. 8

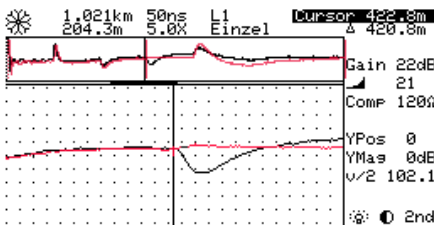


Fig. 9

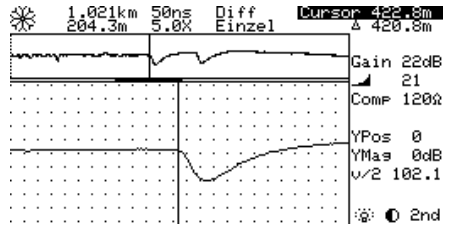


Fig. 10

3.8.5 Averaging

Interfering noisy signals may make the location of faults very difficult in particular when a fault has to be located in a long cable and when high gain is used. In order to solve this problem, the **Digiflex Com** is equipped with an averaging mode. Press function key Mode and use the rotary encoder to enable mode Averaging. The display will display the number of measurements taken for averaging (max. N256) top right. You can cancel averaging at any time if the number of measurements taken so far is sufficient for an efficient interference suppression. Pressing key Start one more time to start another averaging run.

3.8.6 Mode NEXT

Mode NEXT (Near End cross (X) Talk) is for measuring the cross-talk coupling k_1 between two pairs of conductors. Unwanted crosstalk coupling occurs in particular when wires have been crossed.

The *Digiflex Com* is able to pinpoint the fault precisely, so the fault can subsequently be eliminated to the point. For instance, the device can determine the beginning and the end of a "split pairs" section in a longer trunk line which is composed of a number of sections.

The point of crosstalk coupling is located as in any normal reflection test. This mode is different, however, in that the pair which shall carry the transmitter pulse is connected to L2 and the pair tested for crosstalk to L1. Press key Line and use the rotary encoder to enable mode NEXT.

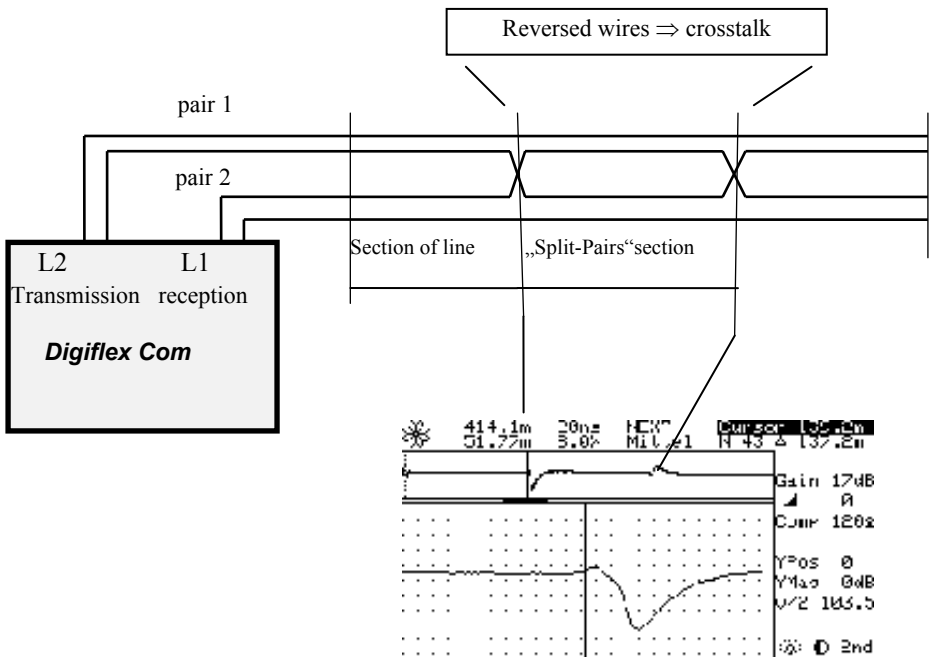




Fig. 11

The direction of the pulse at the beginning of the "Split Pairs" section may be positive or negative depending on the direction in which the wires have been connected to the device. At the end of the "Split-Pairs" section the reflection is always inverted as compared with its beginning.

3.8.7 Mode IFL

This mode (Intermittent Fault Location) is for detecting faults which occur only intermittently. After this mode has been activated, reflection measurements are permanently carried out and displayed on top of each other on the screen. The range of differences (envelope) between the maxima of the individual reflection tests is filled up. We recommend to use an external power supply when performing a long-term test.

Press key Mode and set the rotary encoder to IFL to activate this mode. Press key Start to conclude testing, the display reads  top left. Pressing key Start one more time starts another test run; the display  reads top left.

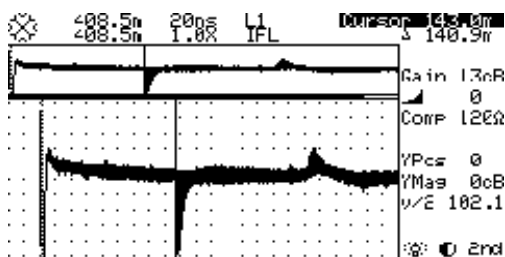


Fig. 12

3.8.8 Distance depending Amplitude correction

Due to the attenuating characteristics of each cable, any signal is more and more attenuated the longer the distance to the point where the reflection takes place. If in a cable there are two points of fault of identical size which are at a certain distance from one another, the echo by the more distant fault will be noticeably smaller than that by the nearer fault. It may even happen that due to the attenuation of the cable a strong fault at a long distance is displayed with a smaller echo amplitude than a small fault from near-by fault the echo of which is scarcely attenuated. This may lead to misinterpretations.

The **Digiflex Com** has a distance-dependent amplitude correction mode (amplitude correction) which allows echos of identical size to be displayed with identical echo amplitude irrespective of their distance to the **Digiflex Com**. This makes the assessment of reflectograms much easier. Press 2nd Gain to activate amplitude correction; use the rotary encoder to set the amplitude correction factor.

3.8.9 How to Use the Marker

If you use only the cursor you can just determine the distance from the **Digiflex Com** to the point of reflection in the cable. The marker offers you additional means to set a point of reference in the cable and to take measurements in relation to this point by means of the cursor. We recommend to use the marker

- when subtracting the length of the test leads,
- when the length of a cable section has to be measured (in particular when a cable is composed of sections with differing NVP / $\sqrt{2}$ values),
- for measurements in relation to a known point of reference (this will increase measuring accuracy), and
- for determining the NVP / $\sqrt{2}$ value of a cable section of known length.

Press key Mark to set or erase the marker. To this end press key Cursor and move the vertical line by means of the rotary encoder to the desired point of reference. Then press key Mark; the marker will now be displayed as a vertical dotted line. When you subsequently use the rotary encoder to move the cursor away from the marked position, the numerical values on display top right will change. The numerical value behind Cursor indicates the distance between the output of the **Digiflex Com** and the position of the cursor whereas the numerical value behind Δ indicates the distance between the marked point of reference and the cursor position. Pressing key Mark one more time will erase the marker. The marker cannot be set to position 0 m.

3.8.10 Change of Pulse Width

Press keys 2nd Range to change pulse width. Doing so will not change the display range.

Display range (Range/Zoom at $v_{1/2}=100 \text{ m}/\mu\text{s}$)	Default pulse width	Setting range
5 m	5 ns	5 ns
10 m	5 ns	5, 10 ns
20 m	5 ns	5, 10, 20 ns
50 m	5 ns	5, 10, 20, 50 ns
100 m	5 ns	5, 10, 20, 50 ns
200 m	10 ns	10, 20, 50, 200 ns
400 m	20 ns	20, 50, 200 ns
1 km	50 ns	50, 200, 750 ns
2 km	200 ns	200, 750, 3000 ns
4 km	200 ns	200, 750, 3000 ns
7.5 km	750 ns	750, 3000 ns
15 km	750 ns	750, 3000 ns
30 km	3000 ns	3000 ns

The offered combinations of pulse width and display range take into account that not every pulse width is suitable for every display range. Thus short pulses are only suitable for testing at close range. On the one hand, they allow tests to be made with high resolution but they are too heavily attenuated and spread at longer distance, on the other. Long pulses are much less attenuated with distance, so clear echos can be received from distant points. At close range, however, they are inferior to shorter pulses due to their poor resolution.

3.8.11 Self Test

After turn on, the **Digiflex Com** performs an automatic selftest. If error code 1 is display the Lithium accumulator is (almost) discharged (the device will still operate for a short while, but you should submit it to the Customer Service to have the Lithium accumulator replaced).

Error code 2 asks for setting the clock (2nd Menu, Menu/System Mark, go with rotary encoder to Date&Time Mark, select unit of time with rotary encoder Mark, select unit of time with rotary encoder Mark for return). If both errors occur at the same time, error code 3 is display.

Key combination (2nd Menu, Menu/System Mark, Self test Mark) starts a comprehensive self test. Please contact our Customer Service should any error code be display.

3.9 Memory Function

The *Digiflex Com* has 50 memory locations. This is how to save a trace:

- Press key Save
- Use the rotary encoder to select a free memory location or a location that will be overwritten. The selected memory location is displayed in inverted mode
- Press key Mark

The memory window will display location number, date and time of measurement, and parameter Range of the stored reflectogram. Parameter Range is display according to the value of $V_{1/2}$ or NVP which is currently set. This has the consequence that any change of the $V_{1/2}$ setting will also change this value in the reflectogram. When a trace is loaded, $V_{1/2}$ is re-set to its stored value. In mode ALT two adjacent memory locations are made available for storage. Memory location 1 is for quick saving triggered by key combination 2nd Save. If mode ALT is set, quick saving will use memories 1 and 2. For this reason we suggest not to use memory locations 1 and 2 for any reflectograms which shall be retained in memory for a longer period of time.

This is how a reflectogram is loaded from memory:

- Press key Recall
- Use rotary encoder to select memory location. The selected location is display in inverted mode.
- Press key Mark
- Use rotary encoder to toggle between loading, A loading, and D loading
- Press key Mark

Mode of loading	Mode of display	Indication
Loading	Reflectogram stored in selected memory location	
A loading	<p>The reflectogram from memory is shown as a dotted line, the reflectogram currently taken is shown as a continuous line.</p> <p>If you wish to erase the display of the trace stored in memory, do so by using the key combination <i>Recall</i> ⇒ <i>set rotary encoder to Erase 2nd trace</i> ⇒ <i>Mark</i>.</p>	,M top right in front of Cursor
D loading	<p>Difference between current reflectogram and reflectogram from memory</p> <p>If you wish to return to the display of the current reflectogram, do so by using the key combination <i>Recall</i> ⇒ <i>set rotary encoder to Erase 2nd trace</i> ⇒ <i>Mark</i>.</p>	-M top right in front of Cursor

Use key combination 2nd Recall for a quick download of a trace from memory location 1.

The traces stored in memory can later be used for processing or for printing out a hardcopy. It is also possible, however, to upload them to a PC using the PC software program **Winkis Com** which is available as an optional extra. For printing out a reflectogram it is important first to use Recall to load the trace from memory before pressing key Print. Another benefit of the memory mode is that it simplifies fault locating and diagnosis. When a number of test objects with identical cable characteristics are tested, the entire test set-up can be taken over from a reflectogram already stored in a memory location, so fault locating can be started without any delay. The memory mode also allows a current reflectogram to be compared with up to 50 reflectograms stored in memory.

3.10 Serial Interface

The serial interface of the **Digiflex Com** allows reflectograms to be loaded to an external PC or to connect a printer for printing out a hardcopy. Go to Menu/Printer to choose from HP Deskjet, Epson 24 Needles, Epson 9 Needles, and Kodak Diconix. The Print function enables the current content of the display to be printed by the connected printer. Moreover, the trace just loaded can be transferred to a PC for storing and documentation purposes provided the communication software **Winkis Com** which is available as an optional extra is installed on the PC. **Winkis Com** can also be used for re-loading a reflectogram including its set-up. Furthermore **Winkis Com** gives you access to all reflectograms stored. Please refer to the software manual if you wish to learn some more details.


The default configuration of the **Digiflex Com** serial interface is as follows:

Baud rate 9600, 8 data bits, no parity, 1 stop bit

Part of the set-up can be set in Menu/Interface.

Pin assignment of the interface cable:

Digiflex Com			Printer/PC	
9 pol.			25 pol.	
RX	Pin 2	←→	Pin 2	TX
TX	Pin 3	←→	Pin 3	RX
GND	Pin 5	←→	Pin 7	GND

ATTENTION  **Always** cover the 9-pin connector of the **Digiflex Com** with its protective cap when it is not in use. **Make absolutely sure that all test cables have been removed when the serial interface is being used!**

4. NIMH ACCUMULATOR CHARGER

4.1 Charging the Accumulator

First connect the cable from the plug-in mains unit to the DC-IN socket of the charger, and only then plug the mains unit into a mains outlet.

Now insert the appropriate NiMH rechargeable accumulator into the charger case until it engages gently.

The indicator lamp shall light up red after the accumulator has been inserted.

After charging has been completed (approx. 4 hours), the indicator lamp will light up green. You may now remove the accumulator or leave it in the charger.

4.2 General Instructions on How to Handle a NiMH Accumulator

ATTENTION



Do not short-circuit a accumulator.

Do not dismanttle or modify a accumulator.

Do not dispose of in fire.

Protect batteries from moisture.

Do not expose batteries to strong impacts.

Make sure that a damaged accumulator is disposed of **immediately and properly**.

NOTE



A NiMH accumulator may heat up when being charged or discharged. This is normal and does not indicate a defect.

Dispose of batteries which cannot be used any longer properly or submit it for RECYCLING.

4.2.1 Safety Precautions

Protect the device from **moisture**.

Do not cover the **ventilation slots** of the plug-in mains unit.

Do not insert any **items** into the **ventilation slots**.

Never expose to **direct heat** or **direct sunlight**.

Do not open the device as there are no user-maintained components inside and any warranty might be invalidated.

Do not store or use charger and mains unit in the close vicinity of **storage media**.

Only use the plug-in mains unit supplied.

4.2.3 Practical Hints

In order not to reduce the service life of a NiMH accumulator unnecessarily, make sure that the accumulator is at room temperature when charging is started.

"Overnight charging" will not cause any trouble since an intact accumulator cannot be overcharged. Once charging has been completed, the device will change over to trickle charging to compensate for natural self-discharge.

The optimum way of operation is to have two accumulators, with one remaining in the charger while the other one is used for powering the *Digiflex Com*.

The charger and the inserted accumulator will heat up during charging (hand hot). This is normal and does not indicate any defect.

When the operating life of a accumulator becomes perceptibly shorter even at full charge, you will need to replace it with a new one.

5. CARE AND MAINTENANCE

Neither the ***Digiflex Com*** nor any of its accessories contain components which require regular care and maintenance to keep them operational. Submit the ***Digiflex Com*** or its accessories to your service shop or to Megger for repair should any defect occur.

Never use any aggressive solvent or detergent for cleaning your ***Digiflex Com*** and its accessories. Use a soft, dry cloth for cleaning your ***Digiflex Com*** and its accessories. When the device is very dirty, moisten the cloth with some mild soap (do not use any abrasive agents) and clean it. Make sure that all traces of moisture have evaporated before the ***Digiflex Com*** and its accessories are used again.

6. APPENDIX

6.1 List of Abbreviations Used

ALT	Alternating test
DC	Direct current
EMV	Electromagnetic compatibility
IEC	International Electrotechnical Committee
IFL	Intermittent fault location
LCD	Liquid crystal display
LED	Light emitting diode
NEXT	Near end cross (X)-talk
NiMH	Nickel metal hydrid
NVP	Nominal velocity of propagation
TDR	Time domain reflectometer
VDE	Verein Deutscher Elektrotechniker (Association of German Electrotechnical Engineers)

6.2 Conversion: NVP $\Leftrightarrow v/2$

Conversion NVP $\Rightarrow v/2$ ($m/\mu s$)

$$\frac{v}{2} = \frac{NVP \cdot 299.79 \frac{m}{\mu s}}{2}$$

Conversion $v/2$ ($m/\mu s$) \Rightarrow NVP

$$NVP = \frac{2 \cdot \frac{v}{2}}{299.79 \frac{m}{\mu s}}$$

6.3 Table: NVP and $v/2$ for Common Types of Cables

Insulation	Typical propagation time		
	$v/2$, m/ μs	$v/2$, ft/ μs	NVP
Oil-impregnated paper	75-84	246-276	0.50-0.56
Poly, cross-linked	78-87	256-285	0.52-0.58
Poly, filled with Petrolat	96.0	314.8	0.64
Polyethylene	100.5	329.6	0.67
PTFE	106.5	349.3	0.71
Paper	108-132	354-433	0.72-0.88
Poly, foamed	122.9	403.4	0.82
Air	141-147	462-482	0.94-0.98

From your own measurements:

Insulation or type of cable	Propagation time		
	$v_{/2}$, m/ μ s	$v_{/2}$, ft/ μ s	NVP

6.4 Glossary

Resolution In a → TDR device, resolution describes the minimum distance between two successive faults in a cable at which the events are depicted on the screen as individual echoes which can be discriminated and, consequently, can be measured. When the echoes superpose each other, the starting time of the second echo – its so-called foot point – cannot be measured. In this event the resolution is too small. Resolution depends on the duration of the used → pulse. Obviously short pulses mean much better resolution than long pulses. The distance range which can be covered, on the other hand, is much shorter for short pulses as compared with long ones.

IFL Intermittent Fault Location

This mode is for measuring cable faults which are inconsistent over time.

Pulse In a → TDR device, pulses are used as transmitter signals. A pulse is an electrical signal with high amplitude and short duration. When travelling along the cable, each pulse is more and more deformed (attenuation of amplitude, increase in signal duration). The width (duration) of a pulse is measured between those points at which the pulse has half its maximum amplitude. In locating a fault, its distance is determined by moving the cursor to the foot point of the echo – i.e. to its starting point. As each pulse grows wider and wider when travelling along the cable, the achievable → resolution is more and more reduced with growing distance.

**(Factor of)
Propagation
Time** NVP

**Balancing
Network** The balancing network is for simulating the input resistance of the cable to be tested. It is used for suppressing the display of the transmitter pulse so that reflections can be depicted and measured directly from the output of the *Digiflex Com* – there is no dead zone as otherwise usual.

NEXT

Near End Cross (X) Talk

NEXT (Crosstalk) describes the coupling of signal components into a neighbouring → Pair running in parallel. Crosstalk is undesirable as each component coupled into a neighbouring pair will impair the signal-to-noise ratio in this line. This is why in standards on data communication equipment, certain minimum values are required for crosstalk. Crosstalk attenuation is usually worst at the near end, i.e. when one pair is used for transmission and another pair for reception. Crosstalk may also be introduced by other faults in the cable (e.g. a faulty junction box with improper shielding of individual → pairs from one another). The **Digiflex Com** is able to locate these types of faults.

NVP

(= Nominal Velocity of Propagation)

The value of NVP, also called propagation time factor or "reduction factor" (Verkuerzungsfaktor in German), is a way to describe the propagation velocity of a signal along a line. It specifies the ratio of signal propagation velocity to the velocity of light. If, for instance, the NVP of a cable is specified to be 0.65, the propagation velocity along the cable is:

$$v = \text{NVP} \cdot c = 0.65 \cdot 299.79 \frac{\text{m}}{\mu\text{s}} = 194.86 \frac{\text{m}}{\mu\text{s}}$$

where $c = 299.79 \text{ m}/\mu\text{s}$ velocity of light. There may be differences between the information given in data leaflets or the table in the manual and actual propagation times in real objects due to the dependence of NVP on the material used. As a rule, the difference is greater in balanced cables than in coaxial cables. Moreover you have to reckon with the individual pairs having slightly different values of NVP. This has to be attributed to the fact that the shields of different conductors contain different types of dye in order to be able to distinguish individual conductors. As each dye has a different value of ϵ_r , signal propagation velocity is different from pair to pair.

In the **Digiflex Com**, signal propagation velocity can be set as either NVP or $v/2$.

Impulse	→ Pulse
Split Pairs	Improperly connected, twisted two-wire connection. The conductors of the individual pairs are not properly twisted with each other in pairs. New pairs are generated by the fact that at either end of the line one conductor is reversed. Begin (split) and end (resplit) of the reversed section show strong crosstalk interference. Split Pairs are the result of erroneous installation.
Pair	Pair of conductors of a balanced (symmetrical) line
STP	(= Shielded Twisted Pair) Line which consists of a number of twisted two-wire pairs. Each pair is wrapped in a foil shield of its own. By S/STP (Screened Shielded Twisted Pair) a cable is understood the entire body of which is enclosed in a common shield.
Balanced Line	Two-wire line with the voltages of either conductor versus earth being equal in size but opposite in polarity. Usually two-wire line are twisted (twisted pairs) to avoid any interference effects.
TDR	(= Time Domain Reflectometer) The Digiflex Com is a reflectometer operating in what is known as the <i>time domain</i> . Apart from the amplitude, the Digiflex Com measures exclusively <i>propagation times</i> with the aim of calculating the distance to cable inhomogeneities. In doing so it employs a different operating principle than a frequency-domain instrument (network channel analyser, spectrum analyser).
UTP	(= Unshielded Twisted Pair) Line consisting of a number of twisted two-wire line pairs. Unlike an → STP cable, the individual pairs are not shielded. By S/UTP (Screened Unshielded Twisted Pair) a cable is understood the entire body of which is enclosed in a common shield.

$v/2$

In cable testing it is common practice to specify the signal propagation velocity in term of half the actual velocity. When employing the reflection technique, this is a usual way of taking twice the signal travel path into account. To depict a reflection on the screen, the signal has to travel from the meter to the fault and back. If the $v/2$ values of various cables are listed in a table, these values can directly be used to convert the measured signal propagation time t_x into fault distance E.

$$EQ E = \sqrt{v/2} \cdot t_x$$

Reduction Factor
(german "Verkürzungsfaktor")

→ NVP (Nominal Velocity (of) Propagation)

