DISTOMAT™ WILD DI1001 • DI1600 • DI2002

WILD HEERBRUGG

USER MANUAL

Leica

Contents

Fig. 1: DISTOMAT equipment in container

1. Introduction

The Wild DISTOMAT's DI1001, DI1600 and DI2002 can easily be fitted on the telescope of Wild optical and electronic theodolites. Adaptation on optical Kern theodolites is possible as well.

An optional GTS5 keyboard is available for distance reduction with an optical theodolite. The DISTOMAT is powered by a 12 V battery.

This manual explains how to obtain the maximum benefit from the DI1001, DI1600 and the DI2002. The two instruments, their functions and their handling are almost identical. Individual differences are especially noted.

On unpacking the instrument for first-time use, proceed as follows:

- Charge the battery
- Set up the equipment
- Check parallel adjustment
- Point to the reflector
- Try the various operations

Then read the remainder of this manual.

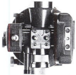


Fig. 2: Telescope adapter plate on an optical theodolite.

2. Setting up the equipment

For details of setting up and using the theodolite, see the theodolite manual.

On the underside of the DISTOMAT there is a base plate with an electric contact for use with a Wild electronic theodolite. This contact is used for power and data transmission.

Before fitting the DISTOMAT on an electronic theodolite, use a screwdriver or the blade of a pocket knife to remove the black plastic protective cap on the telescope adapter plate.

The DISTOMAT is secured to the telescope adapter plate by means oft the two spring-loaded clamping levers. The counterweight maintains the center of gravity in the tilting axis.

The DISTOMAT is now ready for use with this theodolite.

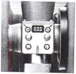


Fig. 3: Telescope adapter plate on an electronic theodolite.

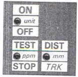


Fig. 8a: Keyboard DI1001

Fig. 8b: Keyboard

4. Use with an optical theodolite

4.1 Without optional keyboard GTS 5

[ON] Switches DISTOMAT on. Displays stored ppm and mm values.
Hold down key for 2 seconds to illuminate display.

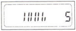
[OFF] Switches DISTOMAT off. The DISTOMAT is switched off automatically 10 minutes after the last key stroke.

[DIST] Measures and displays slope distance.

[TRK] Touch key twice within 2 seconds to start tracking program.

[STOP] Stops distance measurement. In [TEST] mode, switches acoustic signal off.

[STEP] Changes DI1600, DI2002 display in [INFO] and [in] mode.



Return-signal strength

Battery strength 0–9

[TEST] Hold down for 4 s to check display. Release to display return-signal strength and battery state.

Acoustic signal indicates return signal. Touch [STOP] to switch off acoustic signal.

Exit from test with [DIST], [TRK], [INFO] or [OFF].

[in] Assigns a particular measuring program to [DIST] key (DI1600, DI2002 only).

Hold down key for about 5 s to clear display. The measuring program currently assigned to [DIST] is displayed. Touch [STEP] to alter display in the following sequence one step at a time:

- dist — Normal distance measurement
- di — Rapid measurement (DI2002 only)
- dil — Repeat measurement (DI1600, DI2002 only)
- trc — Tracking
- rtrc — Rapid Tracking (DI1600 only)
- ldil — Long range distance measurement over 6 km (DI1600, DI2002 only)

[OFF] stores required measuring program.

mm

For input of prism constant (mm).

Hold down key for about 5s to clear display. Release to display stored prism constant.

To change prism constant in 10mm steps in DI1001/DI1600 and in 1mm steps in DI2002, hold down key. To change in 1mm steps in DI1001/DI1600 and in 0.1mm steps in DI2002, touch key briefly for each step.

Range ±99 mm in DI1001, DI1600 and ±9.9 mm in DI2002.

Constant = 0 for Wild circular prism

OFF stores new prism constant.

ppm

For input of scale-correction factor (ppm).

Hold down key for about 5s to clear display. Release to display stored ppm value.

To change scale-correction factor in 10ppm steps, hold down key. To change in 1ppm steps, touch key briefly for each step. With optional GTS5 keyboard, input to 0.1ppm is possible.

Range ±500 ppm

OFF stores new scale-correction factor.

Display in setting to metres

Display in setting to feet

unit

Sets units of measurement.

Hold down key for about 5s to clear display. Release to display units currently set.

Touch DIST to change units of measurement in the following sequence:

nn.001	metres, display to 1 mm	DI 2002 only
nn.0001	metres, display to 0.1 mm	
ft.01	feet, display to 0.01 ft	
ft.001	feet, display to 0.001 ft	
nn 400.	metres, 400gon	
nn 360.S	metres, 360° sexagesimal	
ft 400.	feet, 400gon	
ft 360.S	feet, 360° sexagesimal	
GSI 56	transfers signal strength (wi 56) with each distance measurement	

Input unit of measurement again to delete an existing wi 56 setting.

OFF stores new unit of measurement or word identifier (wi).

INFO

Displays the following DI1600/DI2002 parameters successively (stepped through by INFO):

- Last slope distance measured*
- Type of instrument and version of software
- Number (n) of measurements and standard deviation for single measurement. n = 1 in DIST mode*
- Return-signal strength*
- Measuring mode
- Unit of measurement
- Measuring frequency

* These values are lost after the DISTOMAT is switched off.

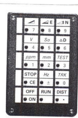


Fig. 9: Optional keyboard GTS 5

4.2 With optional keyboard GTS 5

The angular units set in the DISTOMAT must be the same as those of the theodolite being used.

ON — Switches DISTOMAT on. Displays stored ppm and mm value.

OFF — Switches DISTOMAT off. The DISTOMAT is switched off automatically 10 minutes after the last keystroke.

DIST — Measures and displays slope distance.

TRK — Starts tracking program.

STOP — Stops distance measurement. In TEST mode, switches acoustic signal off.

TEST — Displays return-signal strength and battery state.

Return-signal initiates acoustic signal. STOP stops the signal.

Exit from test with OFF, DIST or TRK.

[mm] mm [RUN]	Input of prism constant (mm): Range ±9.9 mm 0mm for Wild circular prism.
[ppm] ppm [RUN]	Input of scale-correction factor (ppm). Range ±999.9 mm
	Input in 0.1ppm steps. After [RUN], the display of ppm is rounded off to 1ppm, but the exact ppm value is taken into account for reductions.
[RUN] 44 [RUN]	Input of any additive constant see also 8. Range ± 9999.999 m or ±99999.999 ft Input of 10 m: [RUN] 44 [RUN] 10.000 [RUN]
[CE]	Clears entry of last digit before command is terminated by [RUN]. Clears error message.
[±]	Changes mathematical sign of input.

Horizontal distance and height difference

[DIST] or [TRK] . . . . [STOP] or DIL . . . . . [STOP]	Distance measurement and display of slope distance.
[V] V angle [RUN]	Enter vertical angle.

Input	360°	400 gon
272.3216	272°32′16″	272.3216 gon
272	272°00′00″	272.0000 gon

[CE]	Clears entry one digit at a time before data input is terminated by [RUN].
[⊿]	Display horizontal distance.
[⊿]	Display height difference.
[⊿]	Display slope distance.

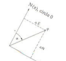


Fig. 10: Local rectangular coordinate system.

Coordinate differences

When horizontal distance and/or height difference have been determined and the azimuth/bearing is input, the rectangular coordinate differences ΔE and ΔN are computed with the correct mathematical sign.

They refer to a local coordinate system with the instrument station as origin and the 0 setting of the horizontal circle as north.

[DIST] or [TRK] . . . . [STOP] or DIL . . . . . [STOP]	Distance measurement and display of slope distance.
[V] V angle [RUN]	Enter vertical angle.
[⊿]	Display horizontal distance.
[⊿]	Display height difference.
[⊿]	Display slope distance.
[HZ] α [RUN]	Enter azimuth/bearing.
[⊿E]	Display ΔE.
[⊿N]	Display ΔN.

Key sequences for repeat display without remeasurement:
[V] [RUN] [⊿], [⊿] or
[HZ] [RUN] [⊿E], [⊿N]

Setting-out with [DIST]

[S_o] S_o [RUN]	Enter horizontal distance S_o to be set-out.
[DIST]	Measures and displays slope distance.
[V] V angle [RUN]	Enter vertical angle.
[ΔD]	Display setting-out difference $\Delta D = S_o - ⊿$.
[⊿]	Display horizontal distance.
[⊿]	Display height difference.
[⊿]	Display slope distance.

Setting-out with [TRK]

Touch [OFF] to delete previously stored V and S_0 values before starting the tracking program.

1. Tracking with horizontal distance

[V] V angle [RUN]	Enter vertical angle.
[TRK] . . . . [STOP]	Display horizontal distance.

2. Tracking with setting-out difference ΔD, without vertical angle

[S_0] S_0 [RUN]	Enter horizontal distance S_0 to be set-out.
[TRK] . . . . [STOP]	Display setting-out difference $\Delta D = S_0 -$ ⊿.

3. Tracking with setting-out difference ΔD, with vertical angle

[S_0] S_0 [RUN]	Enter horizontal distance S_0 to be set-out.
[V] V angle [RUN]	Enter vertical angle.
[TRK] . . . . [STOP]	Display setting-out difference $\Delta D = S_0 -$ ⊿.

During the tracking program, the display can be changed as follows:

[⊿]	Display slope distance.
[⊿]	Display horizontal distance if V angle is stored.
[ΔD]	Display setting-out difference ΔD if distance S_0 to be set-out is stored.

Touch [STOP] to stop tracking and display the height difference.

5. Use with a Wild electronic theodolite

5.1 T1000 (6 key version)

Settings on DISTOMAT
- Set scale correction (ppm) and prism constant (mm).
- Set units of measurement to metres.

Settings on theodolite
- Set GSI interface: [SET] [SET] [SET] [DIST] [RUN]
- Set units of measurement.

Operation
The DISTOMAT TEST program is started on the DISTOMAT. All other operations are controlled from the T1000 keyboard.

Refer to T1000 manual for further details.

5.2 T1000, T1600, T2002, T3000

Settings on DISTOMAT

- Set scale correction (ppm) and prism constant (mm) to 0.
- Set units of measurement to metres.

Settings on the theodolite

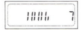
- Set scale correction (ppm) and prism constant (mm).
- SET MODE 26 RUN

Operation

On DISTOMAT, hold down TEST for 4s to check display.

To check return-signal strength and battery state, touch either TEST on the DISTOMAT or TEST 5 on the theodolite. To switch off acoustic signal of DISTOMAT touch STOP on the DISTOMAT Touch CE to stop test function and switch off DISTOMAT.

Refer to theodolite manual for further details.



Return-signal strength — Battery state

No return signal — Battery state

Display elements

6. Main functions

6.1 Test mode: TEST

Switches DISTOMAT into testmode. Display shows return-signal and battery voltage.

When the battery is fully charged, a 9 is displayed. Message 12 indicates that the battery is flat and measurement impossible.

The return-signal strength is shown by a series of vertical lines; the more lines there are, the stronger is the return signal.

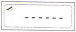
To correct the parallel adjustment of the DISTOMAT to the telescope, refer to section 7.

An acoustic signal indicates that the return-signal strength is adequate for distance measurement. Touch TEST again (or STOP on the keyboard) to switch off the acoustic signal.

A dash on the left of the display indicates that there is no return signal or a break in the beam.

Hold down TEST to check display. All display elements are shown for 4 seconds.

ppm mm



Progress of measurement

6.2 Distance measurement

When measurement begins, the scale-correction factor (ppm) and prism constant (mm) are displayed.

A flashing ◢ indicates that distance measurement is in progress.

If the measuring time is more than 2s the progress of measurement is shown by dashes. When the seventh dash is displayed, measurement is complete.

If there is a break in the measuring beam for more than 30s, measurement is automatically discontinued and message 55 is displayed. (In standard and repeat mode only.)

STOP stops distance measurement in progress.

The following measuring modes are available:

		Standard deviation	Measuring time
DI 1001:			
DIST	Standard mode	5 mm+5 ppm	1.5 s
TRK	Tracking	10 mm+5 ppm	1/0.3 s
DI 1600:			
DIST	Standard mode	3 mm+2 ppm	1.5 s
DIL	Repeat mode	3 mm+2 ppm	1.5 s
TRK	Tracking	10 mm+2 ppm	1/0.3 s
RTRK	Rapid-tracking	20 mm+2 ppm	1/0.15 s
LDIL	see 6.3		

		Standard deviation	Measuring time
DI 2002:			
DIST	Standard mode	1 mm+1 ppm	≤ 3 s
DI	Rapid measurement	3 mm+1 ppm	1.5 s
DIL	Repeat mode	1 mm+1 ppm	2 s
TRK	Tracking	5 mm+1 ppm	1/0.3 s
LDIL	see 6.3		

Display to 0.1 mm or 0.001 ft makes sense only for distance measurement in DIST or DIL mode and is limited to a maximum range of 2 km.

If in spite of a longer measuring time the prevailing atmospheric conditions cause a standard deviation greater than 0.5 mm, the instrument alternately displays slope distance and the standard deviation obtained.

Standard-measurement DIST
The standard deviation obtained is displayed (DI 1600/DI 2002 only) by INFO.

Rapid measurement DI (DI 2002 only)
Distance measurement with half of the «Standard» measuring time but lower accuracy (see table). This program is also suitable for increasing the range under poor atmospheric conditions.

Repeat measurement mode DIL (DI1600/DI2002 only)
The measured distance is displayed as arithmetical mean of all measurements taken. This alternates with a display of the number (n) of measurements and the standard deviation (s) in mm computed for a single measurement from n measurements. The number of measurements made and the standard deviation obtained can also be displayed by INFO.

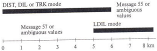
Tracking mode TRK
The measuring program in tracking mode begins with a fast measurement lasting 1s. The measurement is then updated at 0.3s intervals. Tracking is restarted automatically with a fast measurement after 30s and after a break in the measuring beam.
If the acoustic signal is sounded at 1s intervals, there is no return signal.

Rapid-Tracking RTRK (DI1600 only)
The measuring program in rapid tracking mode begins with a fast measurement lasting 1s. The measurement is then updated at 0.15s intervals. Tracking is restarted automatically with a fast measurement after 30s and after a break in the measuring beam.
If the acoustic signal is sounded at 1s intervals, there is no return signal.
Measured distances are available via output socket only (GSI interface). The corresponding ON-LINE manual to link the DISTOMAT to a computer is available on request.

6.3 Distance measurement over 6 km
(DI1600/DI2002 only)

Under excellent conditions, distance measurements which exceed the ambiguity limit of 6 km may be possible. In this case, the LDIL measurement program has to be assigned to the DIST key so that the correct distance corrections will be applied and the distance displayed correctly.

If the distance measured with DIST, DIL or TRC exceeds the ambiguity limit, message 55 will be indicated. A distance below the ambiguity limit using the LDIL mode will cause message 57.



7. Parallel adjustment of DISTOMAT to telescope

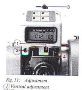


Fig. 11: Adjustment
1 Vertical adjustment
2 Horizontal adjustment
3 Optical sight
4 Spring-loaded clamping levers

For accurate measurements, the infra-red beam of the DISTOMAT must be parallel to the theodolite telescope's line-of-sight. Only a precisely adjusted DISTOMAT can measure with full accuracy and has the specified range.

Set up a GPH1A single-prism reflector at a distance of about 100m to 150m.

Check that the DISTOMAT is correctly seated in the adapter.

Point to yellow target.

No return signal

Touch TEST to display return signal.

If the DISTOMAT is severely out of parallel adjustment, there may be no return signal when the telescope is pointed to the target.

View the optical sight. Turn the vertical and horizontal adjustment screws to bring the white cross of the optical sight of the DISTOMAT onto the target.

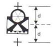
An acoustic signal will be heard as soon as a return signal is received.

7.1 Checking parallel adjustment

Vertical plane

a) Point to yellow target. Touch TEST.
Turn vertical drive counterclockwise until display of return-signal strength is reduced to four lines. Note position of horizontal hair relative to target.

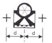
b) Turn vertical drive clockwise until display of return-signal strength is again reduced to four lines. Note position of horizontal hair relative to target.



If in these two positions the horizontal hair is about equidistant above and below the centre of the target, the infra-red measuring beam is vertically parallel to the telescope's line-of-sight.

If this is not the case, the parallel adjustment of the DISTOMAT needs correction.

Horizontal plane

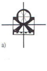


Repeat the procedure as above but with the horizontal drive and vertical hair.

If the vertical hair is about equidistant to left and right of the centre of the target, the infra-red measuring beam is horizontally parallel to the telescope's line-of-sight.

If this is not the case, the parallel adjustment of the DISTOMAT needs correction.

7.2 Corrections to parallel adjustment of DISTOMAT to telescope



a)

a) Point to yellow target. Touch TEST.

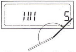
b) With Allen key turn vertical adjustment screw counterclockwise until display of return-signal strength is reduced to four lines. Note position of Allen key.

c) With Allen key turn vertical adjustment screw clockwise until display of return-signal strength is again reduced to four lines. Note position of Allen key.

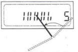
d) Turn Allen key counterclockwise to the mid-position between the two extremes.

b)

c)



d)



e) Repeat procedures (b) to (d) above but with horizontal adjustment screw.

The DISTOMAT should now be correctly adjusted for maximum return-signal strength, i.e. parallel to the theodolite telescope's line-of-sight. Check adjustment by repeating the procedures described in section 7.1 and readjust if necessary.

8. Prism constant (mm)

To ensure that the correct distance is displayed, set the appropriate prism constant for the type of prism used. The constant for Wild circular prisms is 0.

For other makes or types of reflector, measure an accurately known base line to determine the prism constant.

For industrial applications, any additive constant can be stored via optional keyboard GTS5. Input see 4.2.

The input of an additive constant will set the prism constant automatically to zero. Vice-versa the input of a prism constant will set the additive constant automatically to zero.

Word identification wi = 58 transferes the additive constant to a computer or GRE.

9. Scale-correction factor (ppm)

The scale-correction factor in ppm (parts per million) applies corrections for errors proportional to the measured distance, i. e. for atmospheric conditions, reduction for height above sea level and the projection scale factor.

9.1 Atmospheric correction ΔD_1

The displayed distance is correct only if the scale-correction factor stored in the DISTOMAT is correct to compensate the atmospheric conditions prevailing at the time of measurement.

The atmospheric correction takes into account atmospheric pressure, ambient temperature and relative humidity.

For very precise distance measurement within 1ppm, the ambient temperature must be determined accurately to within 1°C, atmospheric pressure to 3mb and relative humidity to within 20%.

The atmospheric correction may be taken directly from graph.

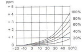


Fig. 12: Influence of relative humidity

Relative humidity does not greatly affect the accuracy of measurements. It is mainly of importance in very hot and humid conditions. For very precise distance measurement, relative humidity must be taken into account together with atmospheric pressure and ambient temperature.

The nominal refractive index n = 1.0002818 is computed in accordance with Barrel and Sears's formula as applied to the DISTOMAT carrier wave of 0.85μm for an atmospheric pressure p = 1013.25mb, an ambient temperature t = 12°C and a relative humidity h = 60%.

$$\Delta D_1 = 281.8 - \left[\frac{0.29065 \cdot p}{(1 + \alpha \cdot t)} - \frac{4.126 \cdot 10^{-4} \cdot h}{(1 + \alpha \cdot t)} \cdot 10^{x} \right]$$

where:
ΔD_1 = atmospheric correction in ppm
p = atmospheric pressure (mb)
t = ambient temperature (°C)
h = relative humidity (%)
α = 1/273.16

$$x = \frac{7.5\,t}{237.3 + t} + 0.7857$$

If the default value of 60% relative humidity is retained, the greatest possible error in the correction is 2ppm.

9.2 Reduction to mean sea level ΔD_2

For places above sea level the correction is always negative, and based on the formula:

$$\Delta D_2 = -\frac{H}{R} \cdot 10^3$$

where:
ΔD_2 = reduction to mean sea level in ppm
H = instrument height (m) above sea level
R = earth radius 6378 (km)

9.3 Correction for projection-scale factor ΔD_3

The projection-scale factor depends on the locally used projection system. Usually, local tables are published. For cylindrical projections such as Gauss-Krüger the correction factor in ppm, is based on the following formula:

$$\Delta D_3 = \frac{X^2}{2R^2} \cdot 10^6$$

where:
ΔD_3 = projection-scale factor in ppm
X = northing in km, offset from projection-line 0 at scale factor 1
R = earth radius 6378 (km)

In countries where the scale factor is not 1, above formula cannot be used as it stands.

9.4 Examples

a: **Atmospheric correction only**

t = +32.0°C
p = 953 mb
h = 85%

ΔD_1 = +35.4 ppm

b: **Atmospheric correction and reduction to sea level**

t = +15.0°C
p = 847 mb
h = 68%
H = 1500 m

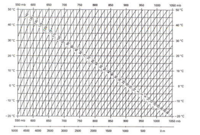
ΔD_1 = + 48.9 ppm
ΔD_2 = −235.2 ppm
Total = −186.3 ppm

c: **Atmospheric correction, reduction to sea level, and projection-scale factor**

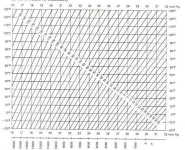
t = +27.0°C
p = 960 mb
h = 45%
H = 500 m
X = 125 km

ΔD_1 = + 28.5 ppm
ΔD_2 = − 78.4 ppm
ΔD_3 = +192.1 ppm (may be taken from local tables)
Total = +142.2 ppm

Atmospheric correction in ppm with °C, mb, H (Metre)
at 60% relative humidity



Atmospheric correction in ppm with °F, inch Hg, H (Feet)
at 60% relative humidity



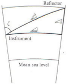


Fig. 13: Height measurement

10. Reduction formulae

The DISTOMAT computes slope distance, horizontal distance, and height difference in accordance with the following formula, which takes into account earth curvature and mean refractive index ($k = 0.13$) for height difference ⊿ and horizontal distance ⊿. The horizontal distance is computed for the instrument station, not for the reflector station.

⊿ = displayed slope distance = $D_0 \cdot (1 + ppm \cdot 10^{-6}) + mm$

D_0 = measured (uncorrected) distance in metres
ppm = scale correction in ppm
mm = prism constant in mm

Horizontal distance ⊿ $= Y - A \cdot X \cdot Y$
Height difference ⊿ $= X + B \cdot Y^2$

Y = ⊿ $\cdot |\sin \zeta|$
X = ⊿ $\cdot \cos \zeta$
ζ = measured vertical angle

$$A = \frac{1 - k/2}{R} = 1.47 \cdot 10^{-7}\ [m^{-1}]$$

$$B = \frac{1 - k}{2R} = 6.83 \cdot 10^{-8}\ [m^{-1}]$$

$k = 0.13$
$R = 6.37 \cdot 10^6\ m$

In the DIL program, the following values are displayed:

$\bar{D}$ = slope distance as arithmetical mean of all measurements ade
s = standard deviation of a single measurement
n = number of measurements made

These values are computed as follows:

$$\bar{D} = \frac{1}{n} \cdot \Sigma_{i=1}^{n} D_i$$

Σ = sum
D_i = single measurement

$$s = \sqrt{\frac{\Sigma_{i=1}^{n} (D_i - \bar{D})^2}{n - 1}} = \sqrt{\frac{\Sigma_{i=1}^{n} D_i^2 - \frac{(\Sigma D_i)^2}{n}}{n - 1}}$$

Standard deviation $S_{\bar{D}}$ of the arithmetical mean of the distance may be computed as follows:

$$s_{\bar{D}} = \frac{s}{\sqrt{n}}$$

11. Electrical equipment

Fig. 14: Mini-battery GEB76, 0.5Ah.

11.1 12 V Nickel-cadmium batteries

The DISTOMAT requires a 12 V DC power source. Three Wild batteries are available. Note that the mini-battery GEB76 cannot be used together with the optional GTS 5 keyboard. A cable for connecting a 12 V car battery is also available.

11.2 Operating time

The values given below are valid only for new batteries at normal temperatures. Age of batteries and temperatures below +20°C (68°F) may reduce the operating time.

Number of distance measurement with fully charged battery

Mini battery GEB 76 (0.5 Ah)	about 350
Small battery GEB 70 (2 Ah)	about 1400
Large battery GEB 71 (7 Ah)	about 4900

Fig. 15: GKL 12 battery charger for two mini-batteries GEB 76 or two small batteries GEB 70.

Fig. 16: GKL 14 battery charger for large battery GEB 71 (7 Ah).

11.3 Battery charging

Set voltage selector of battery charger to 115 V or 220 V/230 V. Connect charger to AC mains (line). Connect battery. The red charging indicator should light up.

If the red charging indicator does not light up, there is no mains supply, the battery fuse has blown and must be replaced, or one of the cable connections is faulty. The green power indicator of the GKL 14 should also light up; if it does not, the connection to the mains is faulty or there is no mains supply.

Make sure the battery is fully charged before use of the DISTOMAT. A completely flat battery takes about 14 hours to recharge.

The battery charger GKL 12 has a built-in overload protection timer. With a battery connected, simply press the red button to start a 14-hour charge. If there is a break in the AC mains supply, the timer restarts automatically. At the ent of the charging period, it automatically switches off the power supply.

Do not leave the battery on charge for too long. A time switch for the GKL 14 (available from electrical shops) is recommended for setting the charging time.

Figure 17 shows the typical discharge rate of a NiCd battery. The voltage of a fully charged battery drops rapidly from index 9 to 7. The voltage drop from index 7 to 3 takes longer. The drop from index 3 to 1 is again fairly rapid. When the battery voltage drops below 11.0 V (index 1), message 12 appears on the display.

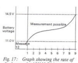
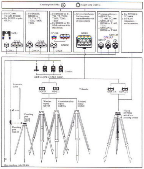
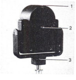


Fig. 17: Graph showing the rate of discharge of a 12V NiCd battery.

12. Reflector equipment

(see brochure G1 440)





Reflector carrier

The reflector carrier determines the height of the reflector target above the tribrach. For work with forced-centred equipment, the height of the target above the tribrach is usually the same as the height of the theodolite's tilting axis above its tribrach dish.

The height of the GRT10 reflector carrier is adjustable to the tilting-axis height of any Wild theodolite.

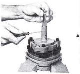
The height of the GZR1, GZR2 and GZR3 reflector carriers is fixed. These carriers are designed for use with specific theodolite models, as follows:

Height of reflector/target above tribrach dish:

GRT10	adjustable
GZR1	180mm tilting-axis height: T1, T16
GZR2, GZR3	196mm tilting-axis height: T2, T1000, T1600, T2002, T3000

Precision reflectors for DI 2002

In order to take full advantage of the high measuring accuracy of the DI2002 we recommend using the Wild GPH1AP and GPH1ZP precision reflectors. For more details please refer to Product Information (Geodesy 3/89) and the corresponding instructions.



▲ *Fig. 18: Back view of single prism holder GPH1A with prism GPR1.*

1 Aiming notch
2 Rotary knob to lock prism in holder
3 Press-button to release holder from plumbing pole or prism carrier

◄ *Fig. 19: Adjustment of height of GRT10 reflector carrier.*

Use screwdriver to slacken screw. Set carrier to line marking required height. Retighten screw.

13. Wild GRE 3/GRE 4 data terminal

Fig. 20: DISTOMAT and GRE data terminal connected to battery by Y-shaped cable 409 684.

For linking the DISTOMAT to a or GRE data terminal, the cable 409 684 connects the DISTOMAT and GRE to the battery GEB 70 or GEB 71. Alternatively, the GRE can be connected to the DISTOMAT via the optional keyboard.

Set the GRE as follows:

[SET] [MODE] 70 [RUN] 2400 [RUN] [RUN]	2400 baud
[SET] [MODE] 71 [RUN] 2 [RUN] [RUN]	Even parity

Clears existing format and sets standard recording format as follows:

[SET] [FORM] [±] [●] [RUN] 11 [RUN] 21 [RUN] 22 [RUN] [REC]

Point No.	Hz	V	◢	ppm mm	wi 56
Manual data input			Automatic data transfer		

Instead of the above, any other recording format may be input (see GRE manual).

The measured slope distance is displayed in the DISTOMAT and is automatically transferred to the GRE together with the stored ppm and mm values. In addition, the return signal value (wi 56) can be recorded automatically with the measured data.

Horizontal distance, height difference and setting out difference cannot be recorded. Only in tracking mode with horizontal distance or with setting out difference, there values can be recorded.

14. Messages

Message	Cause	Remedial action
03	Invalid input	[CE], enter correct command
12	Battery voltage too low (<11.0 V)	[OFF]; change battery.
21	Parity error	[CE]; check connections. Check parameters set on DISTOMAT and other device.
52, 53	Temperature inside instrument too high or too low	[OFF]; leave instrument to cool down or warm up.
55	Interference during measurement (e. g. no return signal, break in beam, excessive air turbulence)	[CE]; repeat measurement. Increase number of prisms.
	Close-range signal too weak (e. g. obstacle interferes with beam)	[CE]; check adjustment, remove obstacle etc.
	Measurement exceeds ambiguity	[CE]; set LDIL mode
56	[DIL] mode; difference to last measurement too great	[CE]; repeat measurement.
57	Measurement below ambiguity	[CE]; set DIST, DIL or TRK mode
62	Invalid wi	[CE]
70 – 99	System error	Call nearest service centre.

15. Useful hints

1 If there is a big temperature difference between the instrument and the environment, leave the instrument to adapt to the ambient temperature before measurement. The time needed for adaptation is about 2 minutes for each 1°C.

2 If the display of the DISTOMAT remains blank when the instrument is switched on, check the following:
- Cable links
- Battery fuse
- State of battery

3 If the DISTOMAT cannot measure, check the following:
- State of battery
- Return-signal strength
- Parallel adjustment of DISTOMAT to telescope
- Correct orientation of reflector to DISTOMAT
- Prisms clean and free from condensation?
- DISTOMAT lenses clean?
- Number of prisms adequate?
- Range excessive or poor atmospheric conditions?
- Break in beam due to an obstacle?
- Correct seating of DISTOMAT on adapter (black protective cap removed?)

4 Severe heating can reduce the efficiency of the diodes and affect the instrument's range. In very hot weather or strong sunlight, shade the DISTOMAT.

5 Direct sunlight can damage the diodes. Never point the DISTOMAT directly at the sun.

6 For maximum efficiency at long range, shade the reflector prisms from intense sunlight or rain.

7 Only a single reflector should be visible in the telescope field of view. If the infra-red beam strikes more than one reflector, interference occurs and results in incorrect measurement. Other reflecting surfaces within the beam's range, such as traffic signs and cat's-eye reflectors, can also cause errors.

8 Some types of walkie-talkie transmitter may affect measurement if used near the DISTOMAT. Avoid transmitting a message from the instrument station during measurement.

16. Checking the frequency

Fig. 21: Transmitter lens with frequency-measuring head

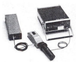


Fig. 22: Frequency meter used for scale check of DISTOMAT

The quartz oscillator in the DISTOMAT has been calibrated at the factory through the full temperature range of the instrument. The calibrated frequency at every temperature is stored in the DISTOMAT microprocessor.

The internal temperature of the DISTOMAT is measured constantly. The frequency used for the computation of distance is the frequency corresponding to the internal temperature.

For routine survey work, there is no need to check the instrument's frequency. For high-precision deformation and control surveys, a check of the measuring frequency may be desirable. For this check, fit a frequency-measuring head in front of the transmitter lens and connect to a frequency meter to display the effective measuring frequency. For further details see «Product Information» 1/89.

The annual frequency drift in the DI 2002 is about 50 Hz (1 ppm). As a rule, the frequency should be checked only at a Wild service centre.

If the user wishes to check the frequency, a recently calibrated frequency meter with an accuracy of 10^{-7} (5 Hz) should be used. An uncalibrated frequency meter can lead to errors and is useless.

Touch [INFO] to display the frequency (e.g. 49 999 995 Hz) used for the computation of the distance. The measuring frequency displayed varies and depends on the temperature within the instrument.

The effective frequency should be within about ±50 Hz (1ppm) of the displayed frequency. If the difference exceeds 50 Hz, the DISTOMAT should be taken to the nearest Wild service centre for recalibration.

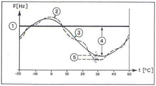
A difference between the displayed and effective frequencies can also be taken into account later in processing the raw data at the office, or by keyboard input as a scale-correction factor (ppm).

Example:

Displayed frequency displayed in response to [INFO]	= 49 999 995 Hz
Effective (measured) frequency	= 49 999 967 Hz
Difference between displayed and effective frequencies	= +28 Hz
Scale correction to apply = 28 : 50	= +0.56 ppm
Slope distance displayed	= 1463.2415 m
Correction = 1 463 (+0.56 x 10^{-6})	= +0.0008 m
Corrected slope distance	= 1463.2423 m

If the displayed frequency is higher than the effective frequency, the wave length used for computation of the distance is too short. Thus the displayed distance is too short. Thus the correction is positive. Or vice-versa.

Fig. 23:
1 Nominal frequency (50 MHz)
2 Measuring frequency
3 Frequency curve (polynomial) stored in the instrument's memory, available for display
4 Frequency curve dependent on temperature computed by the instrument and stored in its memory
5 Component of standard deviation proportional to distance, i.e. for:
DI 2002 $\sigma < \pm 1$ ppm
DI 1600 $\sigma < \pm 2$ ppm



17. Care of equipment

Transport: For transport by road, rail, ship, or air, use shockproof packing for the instrument in its case. If possible, use original Wild packaging.

Cleaning and drying: Blow dust off lenses and prisms. Lenses, eyepieces, and prisms must be handled with special care. Always use a soft, clean cloth or clean cotton wool. Breathe on glass components, then wipe gently. If necessary, slightly moisten cloth or cotton wool with pure alcohol. Do not use any other liquid. Never touch optical glass with your fingers.

Cables and plugs: Clean periodically. Plugs must not get dirty. Protect from moisture. Rinse dirty cable connectors with pure alcohol and leave to dry thoroughly.

Condensation on prisms: If a prism is cooler than the ambient air, condensation may form on the glass. If this happens, warm the prism(s) for some time by placing it/them in a warm environment (room, vehicle, inside your coat etc). Wiping the prism is useless.

Storage: If an instrument has become wet, unpack on return to base. Carefully clean instrument, accessories, case, and foam inserts. Wipe dry. Repack only after all the equipment is again thoroughly dry.

18. Technical data

Distance measurement
Measuring modes:

		Standard deviation	Measuring time
DI 1001:			
DIST	Standard mode	5 mm+5 ppm	1.5 s
TRK	Tracking	10 mm+5 ppm	1/0.3 s
DI 1600:			
DIST	Standard mode	3 mm+2 ppm	1.5 s
DIL	Repeat mode	3 mm+2 ppm	1.5 s
TRK	Tracking	10 mm+2 ppm	1/0.3 s
RTRK	Rapid-tracking	20 mm+2 ppm	1/0.15 s
LDIL	see 6.3		
DI 2002:			
DIST	Standard mode	1 mm+1 ppm	≤ 3 s
DI	Rapid measurement	3 mm+1 ppm	1.5 s
DIL	Repeat mode	1 mm+1 ppm	2 s
TRK	Tracking	5 mm+1 ppm	1/0.3 s
LDIL	see 6.3		

Distance measurement	fully automatic	
Signal attenuation	fully automatic	
Breaks in beam	result not affected	
Display LCD, with illumination		
Least count DI 1001/DI 1600	0.001 m	0.01 ft
Least count DI 2002	0.0001 m	0.001 ft
Unit of measurement	metre	foot
Conversion factor m to ft	3937 ÷ 1200	
Carrier-wave length	0.850 μm IR	
Measuring system	frequency base 50 MHz ≙ 3.0 m	
Quarz ageing rate (DI 2002 only)	≤ 1 ppm/year	

Linearity close-range accuracy (DI 2002 only)

Distance deviation compared with laser interferometer as reference ±0.6 mm within the range from 1m to 120 m

Range with Wild circular prisms

DI 1001:

Number of prisms	Atmospheric conditions		
	poor[1]	average[2]	excellent[3]
1	500 m	800 m	900 m
3	700 m	1100 m	1300 m

DI 1600 / DI 2002:

Number of prisms	Atmospheric conditions		
	poor[1]	average[2]	excellent[3]
1	1200 m	2500 m	3500 m
3	1500 m	3500 m	5000 m
7	1700 m	4500 m	6000 m
11	1800 m	5000 m	7000 m

[1]) Strong haze, visibility about 3 km; or very bright sunlight, severe heat shimmer.
[2]) Light haze, visibility about 15 km; or moderate sunlight, slight heat shimmer.
[3]) Overcast, no haze, visibility about 30 km, no heat shimmer.

Scale-correction factor (ppm)		
Input on DISTOMAT	+500 ppm to −500 ppm / 1 ppm	
Input on keyboard GTS 5	+999.9 ppm to −999.9 ppm / 0.1 ppm	
Storage	permanent memory, until new input	
Prism constant (mm)	**DI 1001 / DI 1600**	**DI 2002**
Range	±99 mm	±9.9 mm
Smallest step	1mm	0.1 mm
Input	on DISTOMAT or keyboard GTS 5	
Storage	permanent memory, until new input	
For Wild circular prism	0 mm	
GTS 5 optional keyboard		
Input of vertical angle	400 gon	360°
Least count	0.1 gon	1″
Distance for setting-out	metres	feet
Least count	1 mm	0.01 ft
Displayed values		
DISTOMAT only	⊿	
DISTOMAT with optional GTS 5 keyboard	⊿, ⊿, ⊿, ΔE, ΔN, ΔD	
Optics		
Clear objective aperture	22 mm	
Focal length	50 mm	

Beam width at half power	
DI 1001:	1.4' (40 cm at 1000 m)
DI 1600/DI 2002:	2.5' (70 cm at 1000 m)
Temperature range	
Operation	−20°C to +50°C (−4°F to 122°F)
Storage	−40°C to +70°C (−40°F to 158°F)
Power supply	12V DC
Operating time	see 11.2
Mini-battery GEB76, 0.5Ah	NiCd, 12V (10 gas-tight cells)
Fuse	0.8A microfuse, 2 contact pins
Charging unit	GKL12 or GKL12-1 (with US plug)
Small battery GEB70, 2Ah	NiCd, 12V (10 gas-tight cells)
Fuse	2.5A slow-acting FST5020 5x20
Charging unit	GKL12 or GKL12-1 (with US plug)
Large battery GEB71, 7Ah	NiCd, 12V (10 gas-tight cells)
Fuse	2.5A slow-acting FST5020 5x20
Charger	GKL14

Battery charger GKL12 and GKL12-1 with US plug	for mini-battery GEB76 and small battery GEB70, charges 2 batteries at a time
Mains supply	115V/230V +10% −15%, 50/60 Hz
Consumption	about 5W
Charging current	2 x 0.2A ±10% (0.05A GEB76)
Time required to charge flat battery	about 14 hours
Ambient temperature for charging	+10°C to +30°C (+50°F to +86°F)
Battery charger GKL14	for large battery GEB71, 7Ah
Mains supply for charger	115V/230V ±20%, 50−60 Hz
Consumption	about 25W
Charging current	0.7A ±10%
Time required to charge flat battery	about 14 hours
Ambient temperature for charging	+10°C to +30°C (+50°F to +86°F)
Tilting range	about −65° (−70gon) to zenith
Distance between DISTOMAT/telescope axis	
T1, T16, T2	
T1000, T1600, T2000, T2002	40mm (0.131ft)
T3000	60mm (0.197ft)

8/5/97

#1 11, Signal 164.577
#2 1111 Sig 164.603
#3 111, Sig 164.702
#4 1111, Sig 150.229
#5 1111, Sig 164.578
#6 11, Signal 164.541

Weights	
DI1001	0.5 kg (1.1 lb)
DI1600/2000	0.6 kg (1.3 lb)
Counterweight GGD13	0.5 kg (1.1 lb)
Keyboard GTS5	0.1 kg (0.2 lb)
Mini-battery GEB76, 0.5Ah	0.4 kg (0.9 lb)
Small battery GEB70, 2Ah	0.9 kg (2.0 lb)
Large battery GEB71, 7Ah	3.0 kg (6.6 lb)
Case	2.0 kg (4.4 lb)
Dimensions of case	0.32m x 0.26m x 0.18m (1.04ft x 0.85ft x 0.59ft)

Quality assurance documents. Routinely supplied with each DI2002:

- Diagram with distance deviations compared with laser interferometer results as reference (for distance range 1m ÷ 120m)
- Results of compensation from a base measurement in all combinations (21 runs)