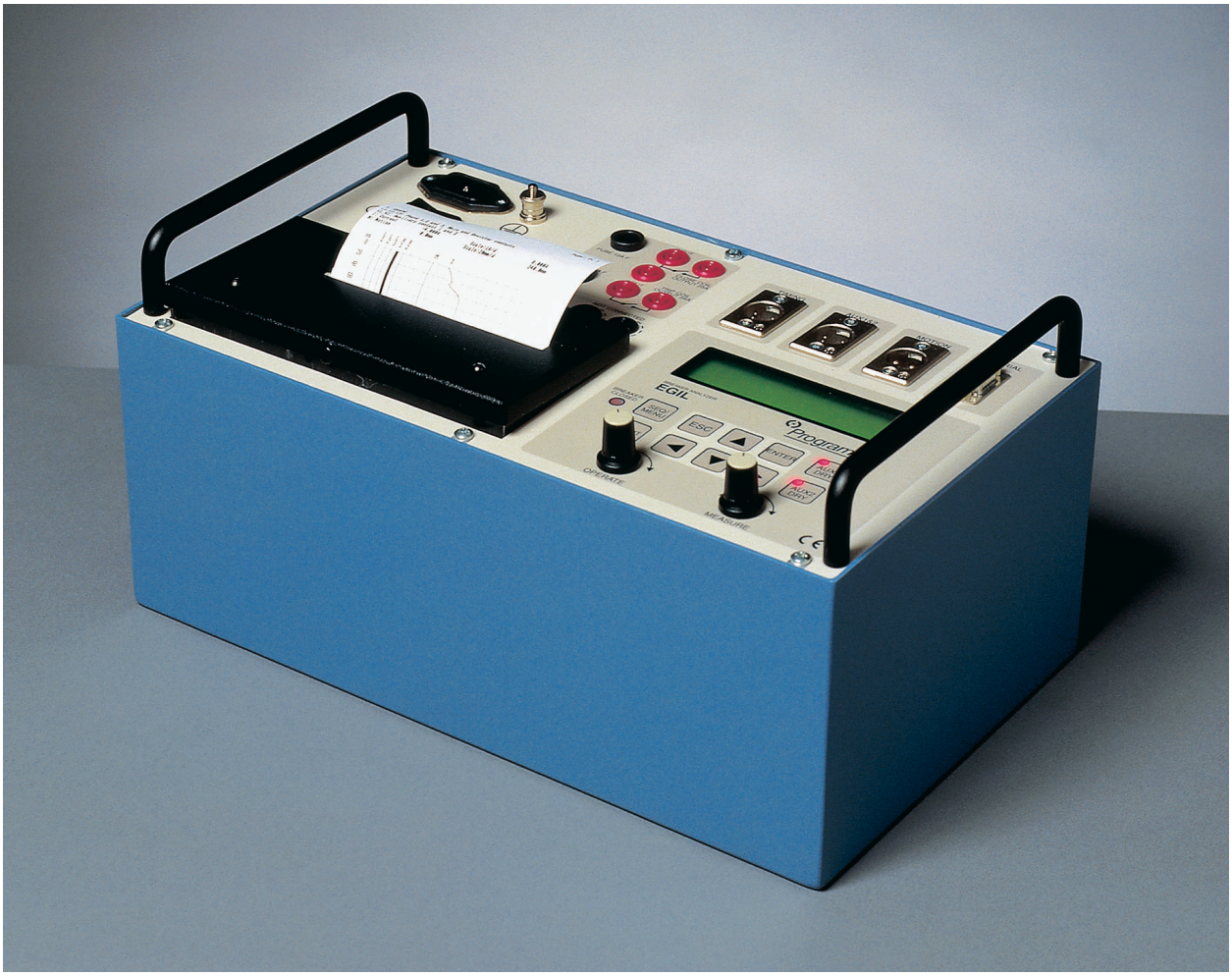
EGIL

Breaker Analyzer

Programma Products



User's Manual

GE Energy

USER'S MANUAL
for
Breaker Analyzer
EGIL

GE Energy

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About this manual

Chapters that you must read thoroughly

Chapter 1 (Safety), which presents information about the safety precautions that must be taken when using Egil in different types of situations.

Getting started

Chapter 2 (Quick instructions) is a quick guide to prepare Egil for time measurement or motion measurement (option) and to change measurement parameters or to run a measurement.

Egil's components

Chapter 3 (System components) contains a list of the components that are included in Egil and the accessories that can be ordered.

Chapter 4 (Description of Egil) presents an overview of the different control panel blocks.

Chapter 5 (Control panel) presents the control panel in detail.

Choosing menus and setting parameters

Chapter 6 (Menu options and parameter settings) presents the menu options and the parameter settings which you can make in the different menu headings.

Complete test procedures

Chapter 7 (How to make a time measurement) and chapter 8 (How to make a motion measurement) describes how you make different types of measurements with Egil.

Printing results

Chapter 12 (The printer) describes the different parts of the printout and how to change paper in the printer.

Troubleshooting

Chapter 10 (Troubleshooting) presents many of the most frequently encountered errors made by users and explains how to fix them. The error messages that are shown in the display window are also explained here.

Calibration

Chapter 11 (Calibration) explains how to calibrate Egil.

Options

Option - >

All options in this manual start with lines as above and stop with lines as below.

Option - End

1 Safety

1.1 General

IMPORTANT

• Read the manual and comply with the following instructions before using Egil.
• Always comply with local safety regulations.

Symbols on the instrument

Caution, refer to accompanying documents

Protective connector terminal

1.2 Warnings

WARNING

• Always make certain that the DC system in the substation is disconnected before connecting Egil.
• Always ground Egil.
• Before connecting Egil, turn off its master ON/OFF switch.
• Only connect Egil to an outlet protected with max 16 A overcurrent protection.
• Unplug Egil from the mains supply when it is left unattended or not in use.
• Do not attempt to service Egil yourself. Opening or removing covers may expose you to dangerous voltage. If you attempt to service Egil yourself the warranty is no longer valid.
• Do not use any accessories that are not intended for use together with Egil.
• Unplug Egil from the wall outlet before cleaning. Use a damp cloth for cleaning. Do not use liquid cleaners or aerosol cleaners.

CAUTION

• Use only approved mains detachable cable set with Egil. Main supply cables shall be rated for the maximum current for the equipment and the cable shall meet the requirements of IEC 60227 or IEC 60245. Mains supply cables certified or approved by a recognized testing authority are regarded as meeting this requirement.
• Polarity on AUX 1&2 must be red to + and black to -.
• Refer all servicing to qualified service personnel.
• If you need to return Egil, please use either the original crate or one of equivalent strength.

2 Quick instructions

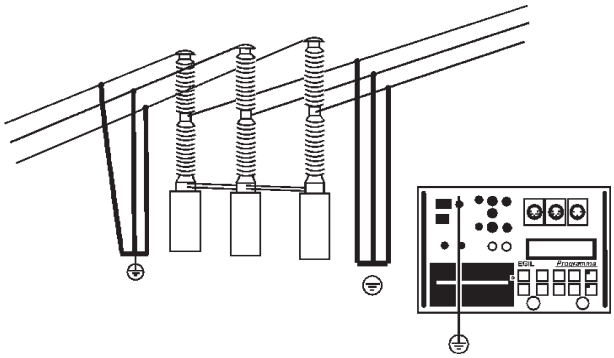
2.1 Preparing Egil for time measurement

IMPORTANT

• Read the chapter "Safety" before using Egil.

• Always comply with local safety regulations.

1. Check that Egil and the breaker are grounded as illustrated below:



2. Connect the power supply cable to Egil.

3. Connect Egil to the breaker: Connect the time measurement cable to the main contacts of the breaker and to Egil TIMING contact.

4. Connect the auxiliary contact measurement cable to the auxiliary contacts in the operating mechanism, and to Egil AUX1&2 contact.

4a. If the measurement is on **wet (AC voltage)** auxiliary contacts, set the timing auxiliary inputs to wet mode (LED is off).

4b. If the measurement is on **wet (DC voltage)** auxiliary contacts, set the timing auxiliary inputs to DRY mode (LED is on). **The red cable must be connected to the positive side of the auxiliary contact**

4c. If the measurement is on **dry** auxiliary contacts, set the timing auxiliary inputs to DRY mode (LED is on).

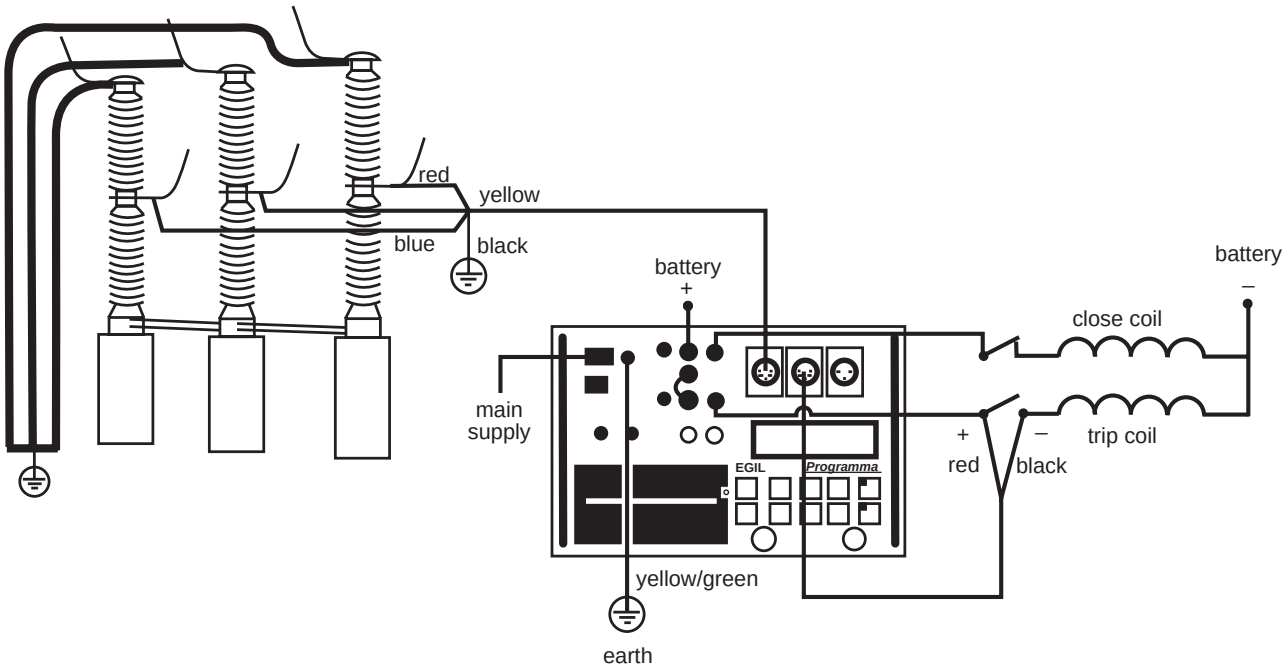
5. Connect the breaker close coil to Egil close coil output.

6. Connect the breaker trip coil to Egil trip coil output.

7. Make sure a jumper (if the trip and close coil have the same voltage source) is connected between the trip coil input and the close coil input.

8. Connect the battery + (plus) to Egil coil input.

9. Remove the ground connections from one side of the breaker as shown in the picture below.



IMPORTANT

When only one side of the breaker is grounded while making the test, special precautions must be observed to protect service personnel and the test equipment from harmful voltages.

10. Turn Egil power switch to on.

The stored settings in memory 0 (zero) are automatically recalled.
Egil and the breaker are now ready to operate.

Note! *If your time measurement fails, giving an error message in the display: "Not calibrated, press ESC", your Egil is equipped with an analog channel which is not presently in use.*
Select "Analog channel" in the main menu.
Select "Off". Now your time measurement will work.

2.2 Preparing Egil for motion measurement

(option)

Option - >

1. Check that Egil and the breaker are grounded. Connections are made according to the instructions in section 2.1 above.
2. Connect the power supply cable to Egil
3. Connect Egil to the breaker: Connect the time measurement and the breaker control circuits according to the instructions in section 2.1 above. Connect the motion measurement cable to the resistive motion transducer and to Egil MOTION contact. The transducer should be properly fitted to the breaker at the position recommended by the breaker manufacturer.
4. Turn Egil power switch on.

The stored settings in memory 0 (zero) are automatically recalled. Egil and the breaker are now ready to operate.

Option - End

2.3 Run a measurement

Operation and connection check

To run the sequence to check connection and operation without measurement, turn the OPERATE knob. The breaker should run according to selected sequence.

If the sequence runs as expected, proceed with a measurement, otherwise check the connections and the pulse length and delay settings in Egil.

Measurement

To run the sequence with measurement, turn the MEASURE knob. The breaker runs according to the selected sequence and Egil measures open/close time. In case the optional motion channel is used, velocity and other motion parameters are measured as well.

Note! *The sequence can be aborted at any time if you press ESC.*

Printing the results

After each complete measurement sequence, the test results are calculated. They are automatically printed if AUTO PRINTOUT is set to ON in the PRINT menu. If the AUTO PRINTOUT is set to OFF, press the PRINT button to print the results.

Note! *The printout can be interrupted at any time if you press PRINT or ESC.*

2.4 Change measurement parameters

Egil reads the status of the breaker (closed or open). Egil automatically sets the built-in sequence module to the next logical single operation.

If multiple operation is desired, perform the following steps:

1. Select the SEQUENCE menu by pressing the SEQ/MENU- button.
2. Select the operation from the menu.
3. Set the appropriate time delay values.
4. Turn the OPERATE and MEASURE knob to initiate operation or measurement.

For more information about menu options and parameters, see Chapter 6 (Menu options and parameter settings).

2.5 Printouts

The first part of the printout shows administrative data and test conditions.

The second part of the printout shows results in numeric and graphic form.

The results are also shown in the display window.

For more information about printouts and the printer, see Chapter 12 (The printer).

3 System components

3.1 Standard items

Egil standard unit includes the following

Item	Art. No.
Basic unit Egil,	BM-19070
Mains cable, 2.5 m (8.2 ft)	04-00XXX
Breaker control cables, black, 2x2 m (6.6 ft)	04-35030
Breaker control cables, red, 2x2 m (6.6 ft)	04-35032
Fuse, 12A F, 6.3 x 32 mm	33-07147
Cable, Extend, 10 m (32.8 ft)	GA-00150
Cable, TIMING, 5 m (16.4 ft)	GA-00160
Cable, AUX1&2, 2 m (6.6 ft)	GA-00170
Protective cable, 2.5 m (8.2 ft)	GA-00200
Thermal printer paper, 2 rolls	GC-00030
Transport case	GD-00190
Egil User's guide	ZP-BM01E
Egil Quick guide	ZO-BM01E

Egil extended unit includes the following

Basic unit Egil, with MOTION channel and SERIAL interface	BM-19073
Mains cable, 2.5 m (8.2 ft)	04-00XXX
Breaker control cables, red, 2x2 m (6.6 ft))	04-35030
Breaker control cables, red, 2x2 m (6.6 ft)	04-35032
Fuse, 12A F, 6.3 x 32 mm	33-07147
Cable, 1 m (3.3 ft), XLR - female	GA-00041
Cable, 7.5 m (24.6 ft), XLR	GA-00042
Cable, Extend, 10 m (32.8 ft)	GA-00150
Cable, TIMING, 5 m (16.4 ft)	GA-00160
Cable, AUX1&2, 2 m (6.6 ft)	GA-00170
Cable, DSUB 9PF/9PM	GA-00180
Protective cable, 2.5 m (8.2 ft)	GA-00200
Thermal printer paper, 2 rolls	GC-00030
Transport case	GD-00190
Egil User's guide	ZP-BM01E
Egil Quick guide	ZO-BM01E

3.2 Accessories

The following accessories can be ordered

Accessory	Art. No.
Extension cable Timing & AUX 1&2, 10 m (33 ft)	GA-00150
Transducer TLH 500, 500 mm (19.6") stroke	XB-30020
Transducer TS 150, 150 mm (5.9") stroke	XB-30030
IP6501, rotates through 357°	XB-31010
Assembly kit for TLH, TS or IP6501	XB-39010

For other lengths of TLH, TS: Contact GE Energy

4 Description of Egil

Breaker Analyzer Egil is intended for use in medium-voltage substations and industrial environments and is designed to test medium-voltage circuit breakers with no more than one main contact per phase. If the main contacts are equipped with parallel pre-insertion resistor contacts, Egil automatically records the difference between main and resistor contacts. Auxiliary contact timing as well as coil current traces are recorded.

As option, Egil can be equipped for travel motion recording and with a serial interface for PC-communication.

4.1 Fields of application

Egil is primarily intended for:

- Time measurement
- Automatic coil current measurement
- Travel motion measurement

Time measurement

There are two time measuring connections:

The TIMING connection with three time channels. Signals can be measured at both main contacts and pre-insertion resistor contacts on the same channel. Egil automatically senses if there is a pre-insertion resistor connected. No specific settings are necessary.

The AUX1&2 connection with two independent auxiliary inputs. These inputs can be used for contact-sensing or voltage-sensing.

The time for contact operations is measured in several different sequences (open/close).

The maximal measurement time for Egil is 100 seconds.

Automatic coil current measurement

The breaker coil current is measured by a built-in and fully insulated current sensor during the measured operating sequence.

Breaker operation sequence

A built-in sequencer automatically sets the instrument for the next sequential breaker operation. The operator can select other operation sequences using the arrowkeys of the keyboard, see section 8.2.

Other functions

The keyboard is used for entering control parameters via the menu system.

The display window shows the settings and can also be used for result read-out.

Test reports can be printed after each measurement sequence.

Option - >

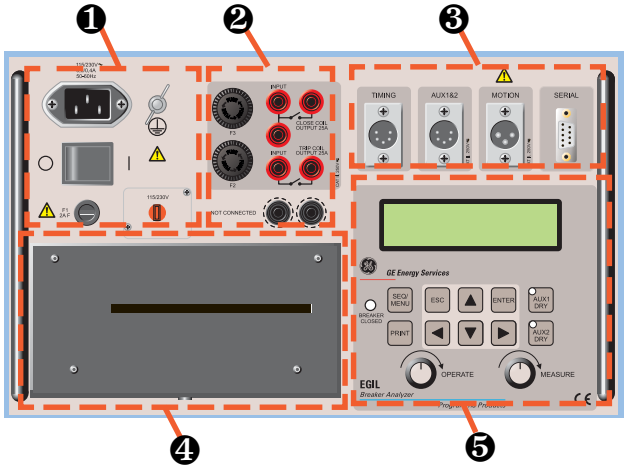
Options

As an option, Egil can be equipped with a motion measurement input. An analog channel gives you the ability to measure motion (using resistive motion transducers) or for voltage or current measurements.

Egil can also be equipped with an optional serial interface for communication with a personal computer. This will support communication with the CABA analysis program.

Option - End

4.2 Main blocks of front panel



The main blocks of the front panel are:

1. Main power supply
2. Sequencer.
3. Time/motion/serial inputs
4. Printer
5. Display window and keyboard

Chapter 5 (Control panel) describes the control panel function.

The main power supply

The power supply block is equipped with a fuse, a main switch, the connector for mains voltage, ground terminal and mains voltage switch 115 V/230 V.

Sequencer

The sequencer block is equipped with fuses for breaker control outputs and close and trip coil inputs/outputs.

There is also a built-in galvanically isolated analog current transducers to measure the current in the trip and the close circuit. AC and DC current up to 50 A is measured.

Time/motion/serial inputs

The time/motion/serial input block is equipped with inputs for measuring time and motion and a serial communication terminal.

Printer

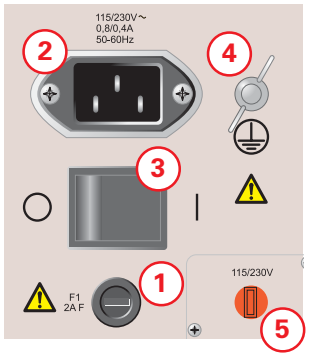
The printer block is equipped with a built-in printer for printing results and test conditions, numeral and graphical.

Display window and keyboard

The display window shows the settings and test results and the keyboard is used for entering control parameters via the menu system.

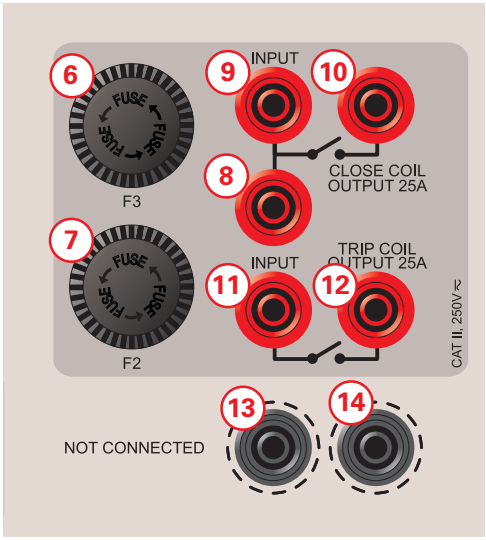
5 Control panel

5.1 Power supply



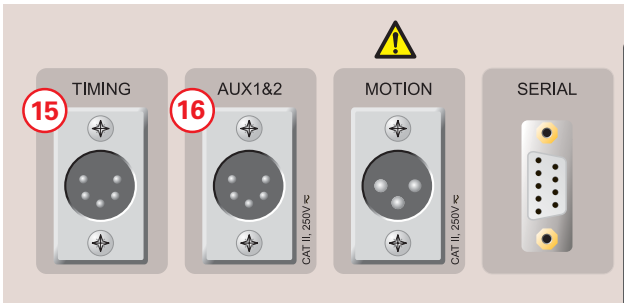
1. F1, Main fuse, 2 A F (quick acting)
2. Connector for mains voltage
3. Mains voltage ON/OFF
4. Ground (earth) terminal
5. Mains voltage switch 115 V 60 Hz or 230 V 50 Hz

5.2 Breaker control outputs



6. Fuse (F2) for breaker control outputs, 15 A F (quick acting)
7. Fuse (F3) for breaker control outputs, 15 A F (quick acting)
8. Close Coil input to internal contact (Close).
9. Close Coil input to internal contact (Close). Makes it possible to connect a jumper between 8 and 11.
10. Close Coil output from current measurement circuit back to the breaker.
11. Trip Coil input to internal contact (Trip).
12. Trip Coil output from current measurement circuit back to the breaker.
13. Not connected terminals for safe disconnection of breaker control wires. Not connected to internal circuits.
14. Same as 13.

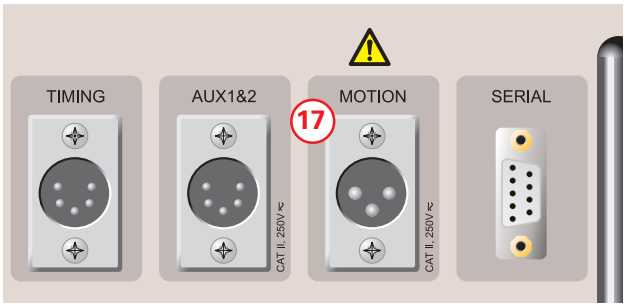
5.3 Timing inputs



15. XLR5 - Three time channels. Signals can be measured at both main contacts and pre-insertion resistor contacts on the same channel.
16. XLR5 - Two galvanically isolated time channels, intended for contact-sensing or voltage-sensing.

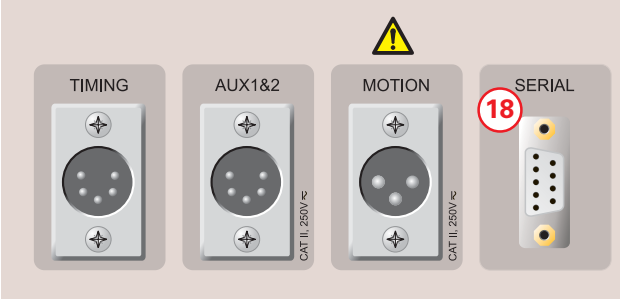
5.4 Motion input (option)

Option - >



17. XLR3 - Optional analog input channel, intended for measuring travel (motion) or some other analog entity.

5.5 Serial communication terminal (option)



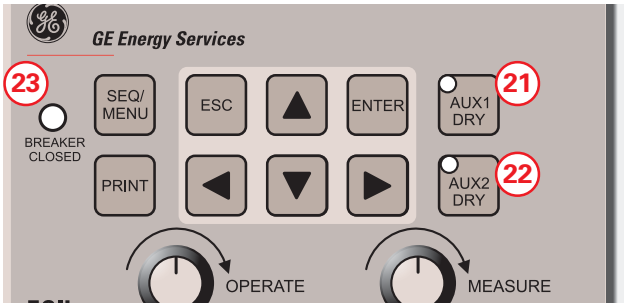
18. PC serial computer interface port used for data exchanges.

Option - End

5.6 Other

19. Printer.
20. Display window.

5.7 Indicators



21. Auxiliary input 1 mode button.
22. Auxiliary input 2 mode button.

The Light Emitting Diode (LED) on the AUX1 DRY or AUX2 DRY buttons show if the auxiliary contact senses contact or voltage (“dry” or “live”).

The LED is lit if Egil is in contact mode and delivers 24 V, 25 mA. The LED is off if Egil is in voltage mode and senses a voltage from 20 V to 250 V independent of the polarity.

Note! *This function is supplied only for the AUX1&2 TIMING inputs.*

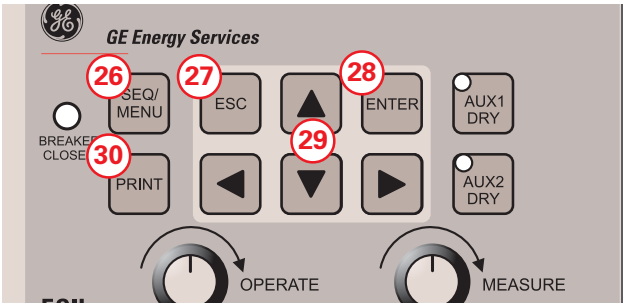
23. The BREAKER CLOSED indicator LED shows the breaker state. When the LED is lit, the breaker is closed and connected. When the LED is off, the breaker is open or not connected.

Note! *This function is only operational when you use the TIMING input.*

5.8 Operation knobs

24. OPERATE knob. Runs a breaker operation sequence without measurement.
25. MEASURE knob. Runs a breaker operation sequence, measuring and recording the results.

5.9 Function keys



26. SEQUENCE/MAIN menu key, to select the sequence and to set time parameters.
27. ESC button. Used to go back on a menu, or to cancel a measurement or printout.
28. ENTER button. Used to validate a choice or to go forward on a menu.
29. Arrow keys. Used to go to the next or previous choice on the same menu level.
30. PRINT key. Used to run a printout of measurement results.

For more information about function keys or menu options, see Chapter 6 (Menu options and parameter settings).

6 Menu options and parameter settings

6.1 Parameter values

There is a default set of parameter values, allowing you to start Egil and run a complete measurement without changing anything. This set of default values are permanently stored in memory DEFAULT and cannot be changed.

You can define your own parameter values by using either the SEQUENCE menu or the MAIN menu. Up to ten sets of values can be saved for future use, and you can decide which set that should be used as start-up values by storing it in memory number 0 (zero).

6.2 The SEQUENCE menu

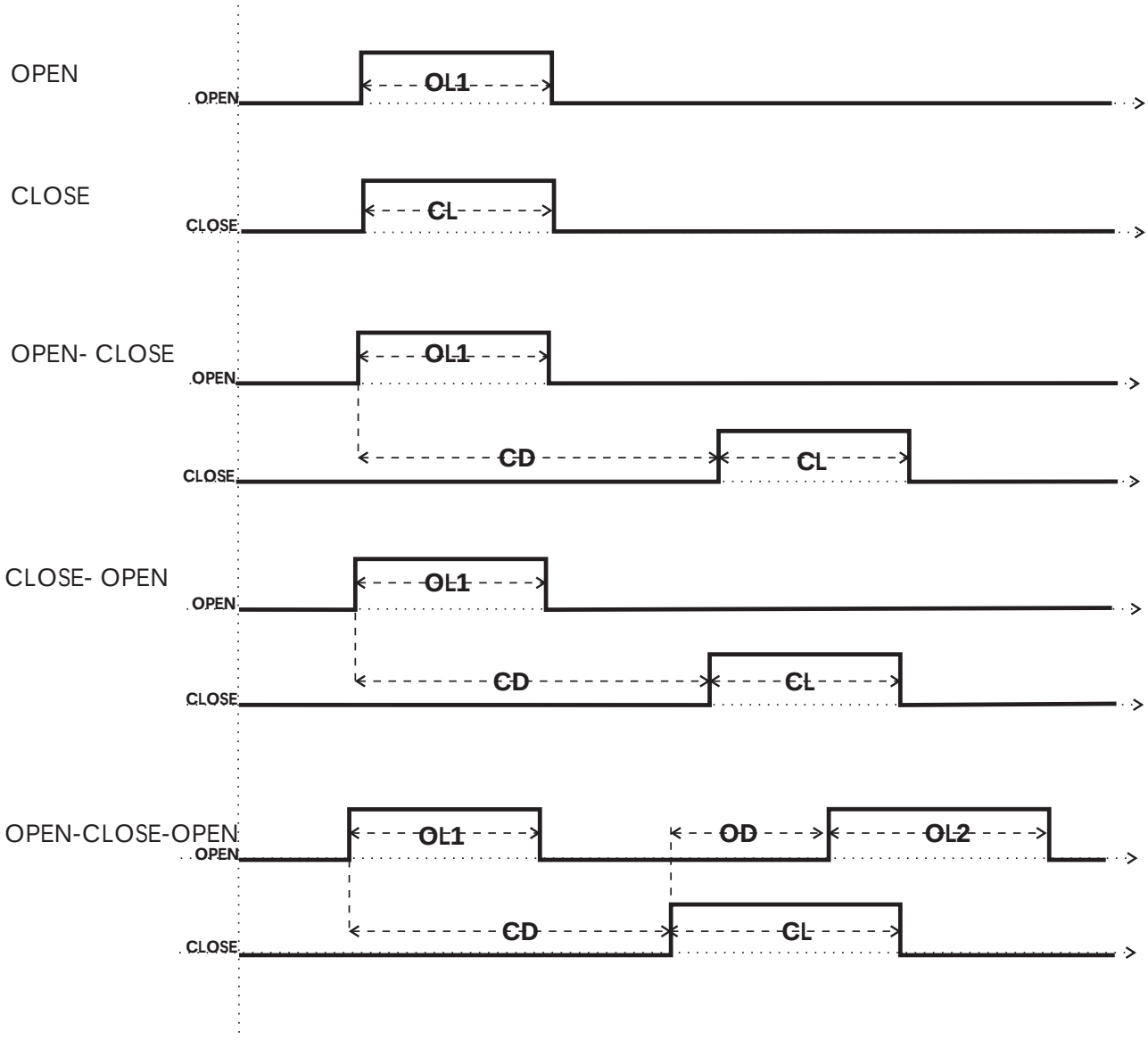
The SEQUENCE menu is displayed when you start Egil and is used to define functions of the trip/coils on the breaker.

You specify all the time parameters needed to generate a measurement sequence by choosing between the following time parameters. They correspond to the chronogram showed below.

C	Close-pulse
CO	Close-Open pulses
O	Open pulses
OC	Open-Close pulses
OCO	Open-Close-Open pulses

The chronogram below shows how pulses and pulse delays are defined:

SEQUENCES



OL1: Open pulse Length
OL2: Open pulse Length
CL: Close pulse Length
OD: Open pulse Delay
CD: Close pulse Delay

The sequence starts when you turn the MEASURE or OPERATE knob. The BREAKER CLOSED indicator, shows the state of the breaker.

During the measurement process the following messages appear in the display window:

```
Be Ready ...
```

(Egil prepares for operation)

```
Recording...
```

(Egil samples measurement data)

```
Analysing...
```

(Egil is analyzing measured data)

Set the AUTO PRINTOUTS in the PRINT menu to ON to receive an automatic printout of the results after the measurement sequence.

The results are shown on the printout according to the following:

- Room for administrative information regarding the breaker and the test
- Remarks
- Test prerequisites (e.g. the settings you have chosen from the menus)
- The results on a time-scale graph
- Calculated time and movement parameters
- A graphic presentation of the measured result

Note! *The sequence can be aborted if you press ESC. If a sequence is aborted than the recorded values are not retained. In this case, you will not be able to perform an analysis or print the values.*
The printouts can be aborted if you press ESC or the PRINT-button.

You can choose between the following parameters on the SEQUENCE menu:

Menu heading	Available settings	Explanation
Close pulse length	time in s or cy	Length for close pulse
Open pulse length	time in s or cy	Length for open pulse
Delay C-O1	time in s or cy	Open pulse delay at CO
Delay O1-C	time in s or cy	Close pulse delay at OC
Delay O1-C C-O2	time in s or cy	Delay of close and open pulse at OCO

Set pulses

To generate the different sequences, a maximum of five time parameters are needed.

The following table shows default settings, where applicable.

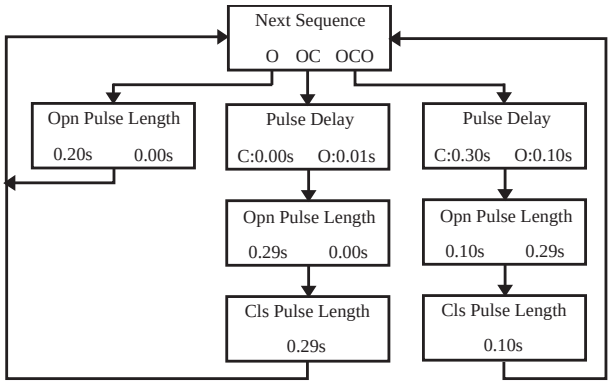
	C	O	CO	OC	OCO
Close pulse delay	-	-	-	0.01s	0.30s
Open pulse delay	-	-	0.01s	-	0.01s
Open pulse length1	-	0.20s	0.29s	0.1s	0.10s
Open pulse length2	-	-	-	-	0.29s
Close pulse length	0.20s	-	0.10s	0.29s	0.10s

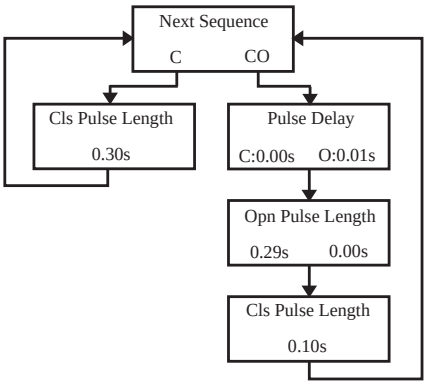
Remarks:

- Values that are impossible to define are marked with a “ - ”.
- Parameters for each sequence can be viewed and changed only when the sequence has been selected.
- In OCO sequence the open pulse delay plus the close pulse delay must not be greater than the open pulse length 1. If this sum is too small, the error message “Pulse errors” is displayed.
- If any pulse length is longer than the set measured time, the error message “Pulse error” is displayed.

6.3 Menu tree for the SEQUENCE menu

Below, is a diagram of the SEQUENCE menu. The pulse lengths and delay times in the example below are taken from the default settings.





6.4 The MAIN menu

From the main menu, you can set general parameters, print settings, save and retrieve settings and calibrate the instrument. If you have an Egil with the motion channel option, you can also choose analog channel, open speed and close speed settings. To access the main menu, press the SEQ/MENU button.

You can choose between the following menu headings.

Menu heading	Function
Setup	General parameters and options
Print	Print parameters
Save	Save configuration in memory blocks
Recall	Recall configuration from memory
Calibration	Calibration of current/voltage measurements and motion channel

Option - >

Analog Channel	Settings for motion channel
Open Speed	Speed calculation points
Close Speed	Speed calculation points

Option - End

Display	Show data/time on the display
Monitor	Show on-line measurement values

Setup

Here you set general parameters and options for:

Measure Time

Here you can choose between the measure times 1, 2, 5, 10, 20, 50 and 100 seconds. At 1 s, the time resolution is 0.1 ms and at 100 s, the resolution is 10 ms. You choose the unit for measure time in the TIME BASE section.

Note! *If you change the measure time, the measurements most recently taken are erased.*

Language

Here you choose between English, German, French, Spanish or Swedish. If you select another language than English and want Egil to "remember" this next time you start the instrument you must save the setting in memory "0".

Auto Sequence

Here you choose whether or not you want Egil to detect the breaker position. You may select any breaker operation independent of the breaker position.

Time Base

Here you choose the time unit for measuring. You can choose from milliseconds, 50 Hz cycles (equals periods) or 60 Hz cycles. 1 cy = 20 ms at 50 Hz and 16.67 ms at 60 Hz.

Option - >

Travel Unit

Here you choose the travel unit. You can choose from mm or inch (1 inch = 25.4 mm).

Option - End

Printouts

Here you set parameters for printouts. The maximum length for a printout is 20 squares.

Auto Printouts

Here you choose whether or not you want a report automatically printed out after every measurement. If you not activate this function, you must press the PRINT button after every measurement to get a printed report.

Contents

Here you can choose whether or not you want all pages printed out or just those pages containing graphs.

Compress Time

Here you choose if you want to activate time scale compression during the interval when something can happen on the channels.

Supress Bounces

Here you choose whether or not you want bounces (10 ms) to be filtered when printing numeric values. This setting does not apply to the graphic printout. Note: All raw data is stored in Egil's memory. Only the values that are printed are filtered. If the function is activated, the system gives you the time for the first contact connection at circuit closure and the time for last contact separation at circuit disconnection. If the function is not activated, all registered bounces are printed.

Note! *All raw data is stored in Egil's memory. Only the values that are printed are filtered. If the function is activated, the system gives you the time for the first contact touch at closure and the time for last contact separation at open. If the function is not activated, all registered bounces are printed.*

Resistor Contact

Here you choose whether or not you want Egil to measure resistor contacts. If no, you will only see open or closed main contacts on printouts.

Time Scale

Here you choose the time scale for the printout. The set measure time selections vary according to the table below:

Time	Time base selection							Unit
1s	Auto Region	1	2	5	10	20	50	ms/div
2s	Auto Region	2	5	10	20	50	100	ms/div
5s	Auto Region	5	10	20	50	100	250	ms/div
10s	Auto Region	10	20	50	100	250	500	ms/div
20s	Auto Region	0.02	0.05	0.1	0.25	0.5	1	s/div
50s	Auto Region	0.05	0.1	0.25	0.5	1	2.5	s/div
100s	Auto Region	0.1	0.25	0.5	1	2.5	5	s/div

The table will look different if you choose the time unit cycle instead.

Example: 1 ms/div corresponds to 0.05 cy/div at 50 Hz or 0.06 cy/div at 60 Hz.

If you choose AUTO, the interesting parts of the time scale measurement is automatically enlarged as much as possible.

If you choose REGION, you can enlarge a part of the measurement around a chosen midpoint. The system enlarges 10 squares before and 10 squares after the chosen midpoint. The time scale is automatically set to 1/1000 of the measure time you use. For example: 1 s corresponds to 1 ms/division.

Centre Point
The system displays this menu only when you have chosen the setting REGION from the TIME SCALE menu. Here you enter the midpoint of the area you want to print out. Refer to the section above.

(I) Current Scale(internal current measuring)
Here you set the scaling factor for the internal current axis. If you choose AUTO, the system automatically sets the scale so that axis becomes as large as possible. If you choose not to activate this function, the axis will not be displayed on the printout.

Option - >

Motion Scale

Here you enter the scaling factor for the motion axis. You can only use this setting if you have chosen to measure motion in the ANALOG CHANNEL menu. If you choose AUTO, the system automatically sets the scale so that axis becomes as large as possible. If you choose not to activate this function, the axis will not be displayed on the printout.

(X) Current Scale (external current measuring)
Here you enter the scale for the current axis if you measure current on the analog channel. You can only use this setting if you have chosen to measure current in the ANALOG CHANNEL menu. If you choose AUTO, the system automatically sets the scale so that axis becomes as large as possible. If you choose not to activate this function, the axis will not be displayed on the printout.

Voltage Scale

Here you enter the scale for the voltage axis if you measure current on the analog channel. You can only use this setting if you have chosen to measure voltage in the ANALOG CHANNEL menu. If you choose AUTO, the system automatically sets the scale so that axis becomes as large as possible. If you choose not to activate this function, the axis will not be displayed on the printout.

Option - End

Save in memory
Here you can save the settings in Egil's memory. You can store an array of settings in each of the 10 storage areas. All of the parameters that can be set in Egil's menus can be stored in memory with the exception of channel calibration for internal current axis and motion channel. However, the actual measurement results are not stored in memory but are written over by the next measurement or erased when Egil's power is switched off.

0
Save setting in memory area 0. The array of settings stored in memory area 0 are always activated when you turn on Egil.

1...9
Save settings in memory areas 1 - 9. You choose the memory area where you will store the settings and press ENTER to save..

Recall
Here you recall the settings that you have saved in Egil's memory.

0...9
Recall settings that have been saved in memory area 0 - 9. Memory 0 is recalled automatically at power on.

Default
Recall default settings.
The default settings are set at the factory. They are stored in memory 0 - 9. If you want to use the default settings every time Egil is switched on do as follows. Choose RECALL, DEFAULT and SAVE choosing memory 0.

Calibration
Calibration is used for calibrating the internal current axis channel and the motion channel. Refer to instructions on calibrating in chapter 11 "Calibration".

Option - >

Analog channel (option)
Here you can set parameters for measuring motion, among other things.

The analog channel in Egil is primarily intended for measuring motion but can also be used to measure current via a current shunt. It can also be used to measure voltage directly or via a voltage divider.

The table below shows the possible choices in the ANALOG CHANNEL menu.

Menu heading	Sub menu	Function
Motion	Stroke	Fill in the circuit breaker's estimated stroke. Subsequent measurements use the stroke length method.
	Calibrate	Calibrating transducer via the calibration routine. Subsequent measurements use the stroke length method.
	Transducer length	Fill in transducer's electrical length. Subsequent measurements use the stroke length method..
Current	Current shunt	State the shunt resistance to measure current trough an external shunt.
Voltage	Ext. Voltage divider	State the voltage divider's position to measure voltage using Egil's MOTION input directly, or via the voltage divider.
Off		Select "OFF" to turn off the analog channel. It is important that it is turned off if it is not in use.

First you choose which type of measurement you want to perform. Choose between MOTION, CURRENT and VOLTAGE.

Note! *If you are not using the analog channel, it is important that you deactivate the function by selecting the position "Off". Otherwise, there is a risk that you will get the error message "Not calibrated" since the motion channel expects events during a recording*

Choice MOTION

If you choose MOTION from the ANALOG CHANNEL menu, you have three alternatives: STOKE, CALIBRATING or TRANSD LENGTH. Options STROKE and TRANSD LENGTH represent two different measurement methods. These are described below.

CALIBRATING is used to determine the transducer's electrical length. This is used when you measure according the transducer length methodology.

Measurement Method STROKE

This method is suitable if you cannot directly connect the transducer to the moving contact. The principle behind this method is that you enter the **breaker's estimated stroke** in Egil. When the first measurement is taken after Egil is turned on, (it must be an single operation), Egil establishes a scaling factor from the difference between close and open position at the transducer and the given stroke. It does not matter if you use a linear or rotating transducer or how much the transducer moves in reality. This measurement method is mostly the same as the one used in MA31/61.

Example:

1. Choose MOTION and STROKE
2. Enter the breaker's estimated stroke when Egil prompts you to do so. Press ENTER. The value you enter will be valid until you enter a new estimated stroke, change measurement method, calibrate a transducer or turn off Egil.
3. Perform a measurement. The first measurement that is taken must be a single operation.

Measurement Method TRANSDUCER LENGTH

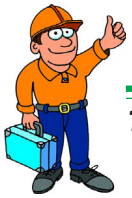
This method works best when you can directly connect the transducer to the moving contact. You enter the **transducer's length** instead of the breaker's estimated stroke. By using the transducer's length as a reference, Egil can then measure the breaker's stroke.

Example:

1. Choose MOTION and TRANSD LENGTH
2. Enter the transducer's length when Egil prompts you to do so. Press ENTER. The value you enter will be valid until you enter a new estimated stroke, change measurement method, calibrate a transducer or turn off Egil.
3. Perform a measurement. The first measurement that is taken must be an single operation.

CALIBRATING

We recommend that you calibrate the transducer, because the length that is printed on a transducer does not always correspond to the electrical length. To calibrate, choose the option CALIBRATE. After calibration, Egil automatically measures according to the TRANSD LENGTH method and the result from the calibration as transducer length.



Tip

Write the calibrated transducer length on the transducer. Then you only have to choose TRANSD LENGTH and enter the calibrated transducer length rather then calibrate the transducer length each time.

Example:

1. Choose MOTION and CALIBRATE
2. Choose TRANS POSITION 1. Move the transducer to a position near the end position. Voltage is shown in the display window that corresponds to the transducer's set position. If Egil displays the error message "Out of range", the transducer is too close to the end position. Correct and mark the position on the transducer. Then press ENTER to position 2 in Egil.
3. Choose TRANS POSITION 2. Move the transducer slide to a position near the other end position. Voltage is shown on the display that corresponds to the transducer's position. If Egil displays the error message "Out of range", the transducer is too close to the end position. Press ENTER to read the position 1 in Egil. If Egil displays the error message "Too small diff", then the difference in voltage between position 1 and 2 is too small. Start the calibration again from the beginning.
4. Decide DISTANCE POS 1-2. Measure the distance between the two marks on the transducer as accurately as possible. Enter the value in Egil. Press ENTER.
5. Egil displays the transducer length that resulted from calibrating. Make sure the value seems reasonable and press ENTER. The value you enter will be valid until you perform a new calibration, enter a new transducer length, change measurement method or turn off Egil.
6. Perform a measurement. The first measurement that is taken must be a single operation.

The choice CURRENT

The current in the breaker's close and open loops is automatically registered on the special current channel in Egil. If you want to measure other currents, you can use Egil's analog channel. One example of this could be if there are relays in the circuit that makes it impossible to measure the current through the close/trip coil via the control wires. In this case, you can measure current on the analog channel with help of a current shunt that is connected in series with the circuit you will measure current in.

Example:

1. Choose CURRENT from the ANALOG CHANNEL menu.
2. Enter the current shunt's resistance when Egil prompts you to do so. Press ENTER. This value is valid until you enter a new value for current shunt or turn off Egil.

If you do not know the current shunt's resistance, you can calculate it by dividing total ampere into total millivolt. These values are located on the shunt. For example, if the shunt has the value 20A/200 mV, that means the resistance is 200/20 = 10 mW.

The choice VOLTAGE

The analog channel can also be used to measure voltage. If the voltage is between -4 and 4V, it can be directly connected to the input. If the voltage is higher, an external voltage divider must be used. Because the voltage divider's ratio is entered in Egil, Egil can calculate and present the result with real values.

Example:

Choose VOLTAGE from the ANALOG CHANNEL menu.

Enter the voltage divider's ratio when Egil prompts you with EXT. VOLT. DIVIDER. The value to the left of the colon represents the input voltage that must be applied to the divider in order to get 1V out. For example, if the voltage divider used gives 1V, when 400V is connected, you enter the value 400:1. If you are not using a voltage divider, but instead connect the measuring device directly to the channel, the setting must be 001:1.

Open speed (option)

The functions in this menu allow you to input calculation points for open speed calculation.

Note! *You must choose MOTION in the ANALOG CHANNEL menu in order to activate the open speed*

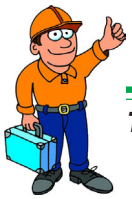
The open speed is calculated as an average speed between two points on the motion graph. In order to make this calculation, these two points must be entered in Egil. You

begin by entering the upper point. The upper point can be determined in two different ways:

- as a distance below the breaker's closed position
- as a position - the position of the moving contact at the instant of opening

The instant of opening is defined as the last separation of the main contact in the slowest phase.

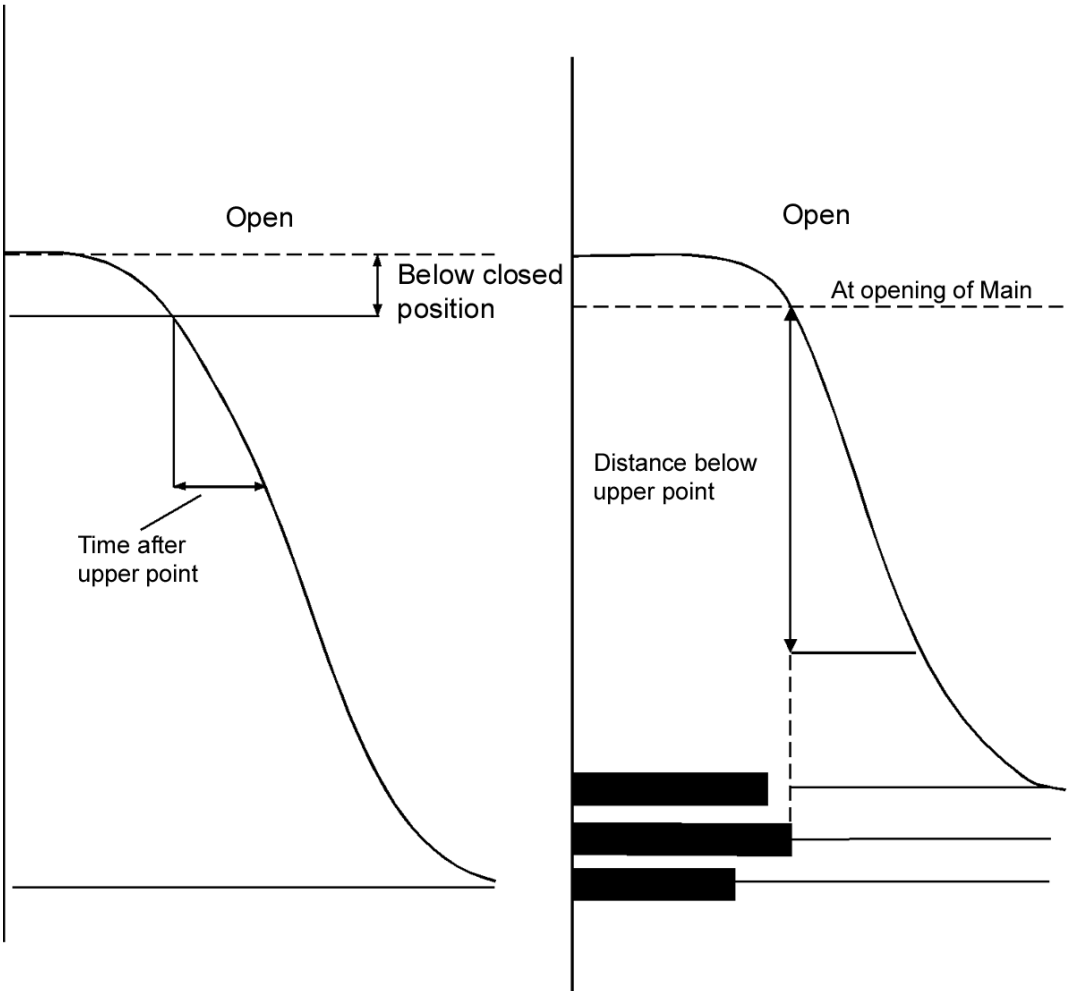
The lower point is based on the upper point. It can either be a distance below the upper point or a time after the upper point.



Tip

Calculating points, norms and point adjustments for speed and other parameters vary for different breaker types and must therefore be obtained from the breaker manufacturer. If you do not have access to the breaker manufacturer's speed calculating points specifications, as a general rule you can specify the upper point AT OPN OF MAIN (at main breaker's opening) and the lower point TIME AFTER UPPER: 10 ms (time after upper point). At 60 Hz, it is 8.33 ms or 0.5 cy. These values are based on an assumption that the breaker's speed is constant in the arcing zone. This occurs when the contact opens and continues to the next zero crossing which means at the most a half period ahead in time (10 ms at 50 Hz).

The picture below shows how the open speed calculation points are measured.



Example:
Choose OPEN SPEED from the main menu. Define the speed calculation:

```
MAIN MENU
<Open speed>
```

Choose the reference for the upper point speed calculation:

```
Opn: Upper point
<Below Cls Pos>
```

Define the distance between the upper point and steady state level.

```
Below Cls. Pos
0050.0 mm
```

You can also choose the option:

```
Opn: Upper point
<At Opn of Main>
```

Now you define whether the lower point will be related to the upper point by distance or by time.

Define the distance from the upper point:

```
Opn:Lower Point
<Distance< Time
```

```
Dist Below Upper
0010.0 mm
```

or define the time after the upper point:

```
Opn:Lower Point
Distance <Time>
```

```
Time After Upper
010 ms
```

Close speed (option)

The functions in this menu allows you to input calculating points for close speed calculation.

Note! *You must choose MOTION in the ANALOG CHANNEL menu in order to activate the close speed menu.*

Close speed is calculated as an average speed between two points on the motion graph. In order to make this calculation, these two points must be entered in Egil. You begin by entering the upper point. The upper point can be determined in two different ways:

- as a distance below the breaker's stable closed position or
- as a position - the position of the moving contact at the instant of closing.

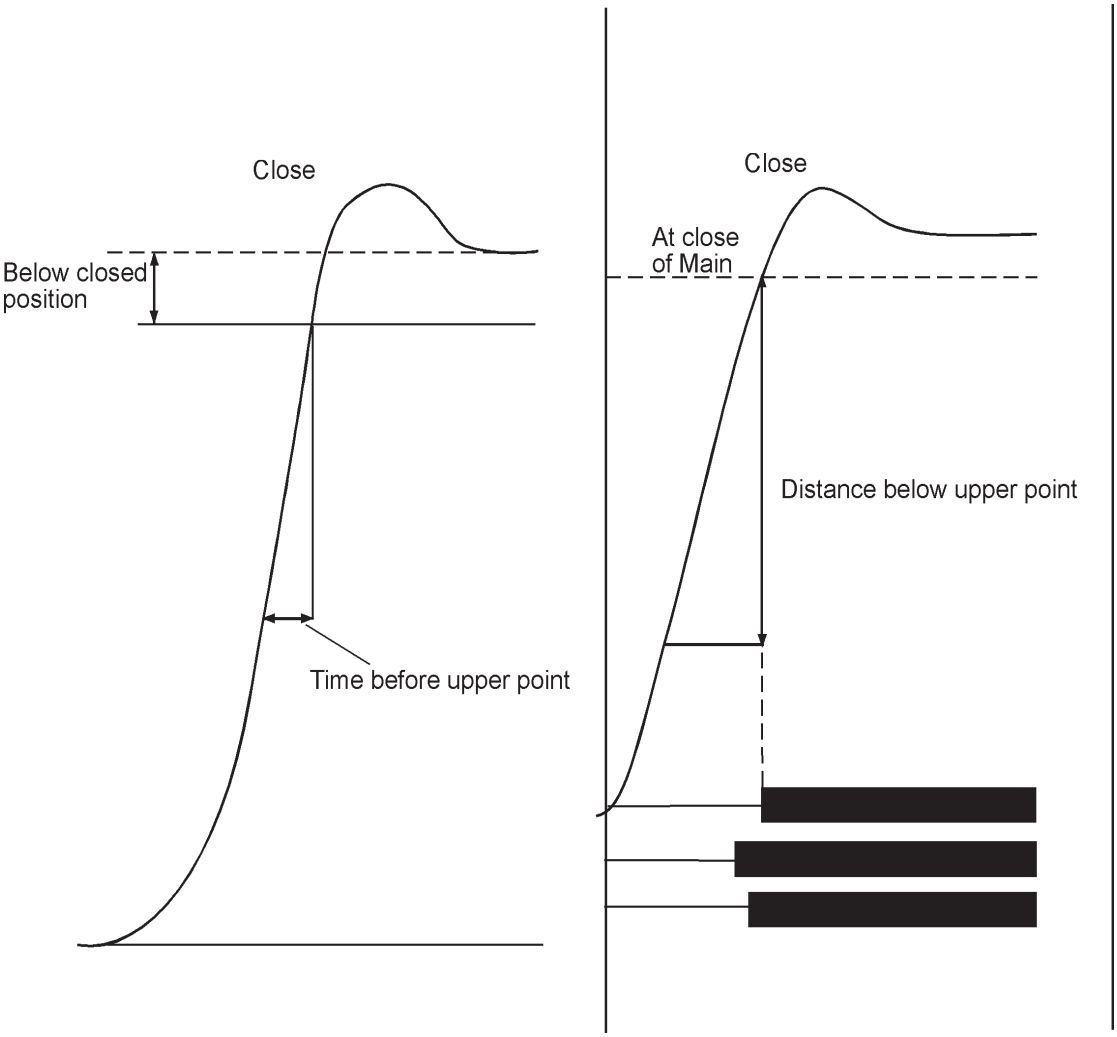
The moment in time is defined as the first contact touch at the main breaker position in the slowest phase.

The lower point is determined based on the upper point. It can either be a distance below the upper point or a time before the upper point.

Tip

Calculating points, norms and point adjustments for speed and other parameters vary for different breaker types and therefore must be obtained from the breaker manufacturer. If you do not have access to the breaker manufacturer's speed calculating points specifications, as a general rule you can give the upper point AT CLS OF MAIN (at main breaker's closing) and the lower point TIME BEFORE UPP. :10 ms (time before upper point). At 60 Hz, it is 8.33 ms or 0.5 cy. These values are based on an assumption that the breaker's speed is constant in the arcing zone. This occurs before the contact's closing.

The picture below shows how the close speed calculation points are derived.



Example:
Choose CLOSE SPEED from the main menu. Define the speed calculation:

```
MAIN MENU
<Close speed>
```

Choose the reference for the upper speed calculation point:

```
Cls:Upper speed
<Below Cls. Pos>
```

Define the distance between the upper point and stable closed position.

```
Below Cls. Pos
0050.0 mm
```

You can also choose the option:

```
Cls:Upper Point
<At Cls of Main>
```

Now you define whether the lower point will be related to the upper point by distance or by time.

Define the distance from the upper point:

```
Cls:Lower Point
<Distance> Time
```

```
Dist. Below Upp.
0010.0 mm
```

or define time before the upper point:

```
Cls:Lower Upp.
010 ms
```

```
Time Before Upp.
010 ms
```

Option - End

Display

In this menu, you can view data and calculated parameters from the latest measurement on the display. This can be useful if, for example, you do not want to print a report or you want to perform a thorough analysis of the breaker's state in relation to time. If you access this menu without having performed a measurement, you will get the error message:

```
Memory empty
```

There are four different values on the display:

- moment in time
- coil current
- measured value on the analog channel
- contact status on the time channel

The time relates to the beginning of the measurement. For each selected time, the corresponding value measured in that instant is shown. By changing the time, you can see the measured values for any time within the used measuring time.

If you press ENTER, the calculated parameters are shown. These are the same parameters that are shown in the printout.

Example:
The measured value below is displayed in the display window:

```
0041.7 ms 1.566 A
60.3 mm     CCC CO
```

At the selected time displayed in the upper left corner, the following value has been measured for coil current:

```
0041.7 ms 1.566 A
60.3        CCC CO
```

In the lower left corner, you can see the size value that you defined to measure with the analog channel. In this case, it is motion. During measurement of motion, the value represents the moving contact's distance from the breaker's stable open position.

Note! *If the analog channel is not activated (position Off), this field is empty.*

```
0041.7 ms 1.566 A
60.3 mm     ORC CO
```

Time channel's status:

```
0041.7 ms 1.566 A
60.3 mm     ORC CO
```

Status:
O = open
R = resistor
C = close

Note! *If you enter a time that exceeds the measure time used, the display window shows dashes instead of measured values.*

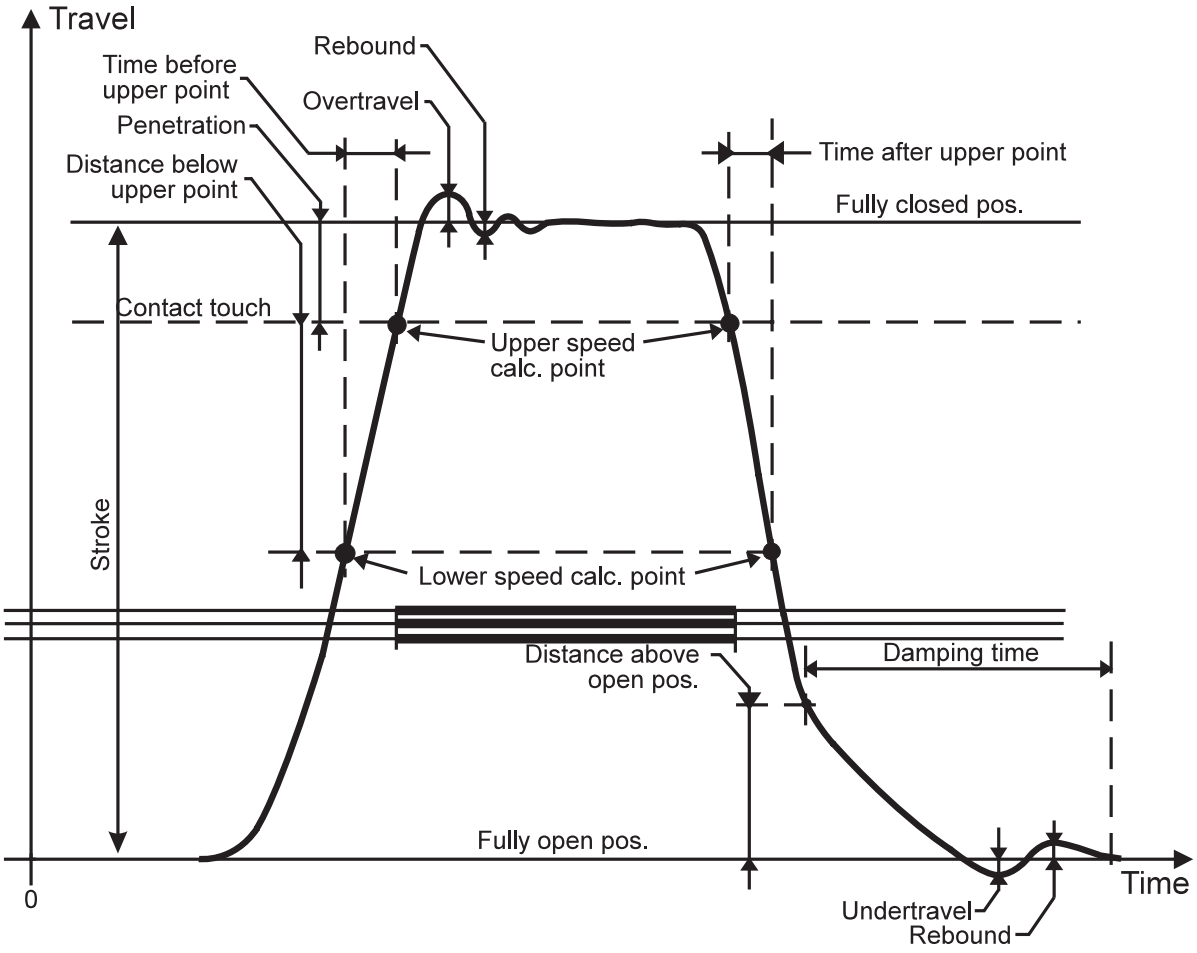
```
1000.1 ms       ——
——              ——
```

Calculated parameters

Press ENTER to see the calculated parameters. By continuing to press ENTER, you can step through all the calculated parameters. To view a previously shown parameter, press the ESC key.

Note! *You must choose MOTION from the ANALOG CHANNEL to display the parameters related to motion measurement.*

The calculated parameters are distinguishable between the different types of operations. The following curve diagram refers to the description of the calculated parameters.



The following ten parameters are calculated for the respective operation:

1. Function time for every phase

Close time is calculated as the first contact touch of the main contact. Open time is calculated as the last separation of the main contact.

Close

```
Closing Time L1
62.4 ms
```

Open

```
Opening Time L1
42.1 ms
```

During an OCO operation, the first and second opening times are shown according to the windows below:

```
1:Opn Time L1
43.0 ms
```

```
2:Opn Time L1
383.7 ms
```

2. Difference between the phases

This parameter is calculated as the largest difference between the three phases' main contacts.

Close

```
Cls Phase Diff
2.2 ms
```

Open

```
Open Phase Diff
1.4 ms
```

During an OCO operation, the difference between the phases at the first and the second opening operations are shown, see below:

```
1:Opn Phase Diff
1.9 ms
```

```
2:Opn Phase Diff
2.6 ms
```

3. Difference between main contact and resistor contact for each phase

During a close operation, the parameter is calculated as the time difference between the first contact touch of the main contact and the first contact touch of the resistor contact. During an open operation, the parameter is calculated as the time difference between the last separation of the main contact and the last separation of the resistor contact.

Close

```
Cls Main-Res L1
3.2 ms
```

Open

```
Opn Main-Res L1
0.0 ms
```

During an OCO operation, the difference between the main contact and the resistor contact during first and second open operations are shown according to the windows below:

```
1:Opn Main-Res L1
0.0 ms
```

```
2:Opn Main-Res L1
0.0 ms
```

4. Close - open (trip-free) time (only during CO and OCO operations)

This parameter is calculated as the time difference between the first contact touch of the main contact of the fastest phase and the last contact separation of the main contact of the slowest phase.

```
Time O-C
24.4 ms
```

5. Open - close (dead) time (only during OC and OCO operations)

This parameter is calculated as the time difference between the last contact separation of the main contact of the slowest phase and the first contact touch of the main contact of the fastest phase.

```
Time C-O
24.4 ms
```

6. Current peak (only during close operation and open operation)

This parameter shows the peak value for coil current measured with Egil's current channel. If the highest measured value is negative, it is depicted by a minus sign.

```
Current Peak
1.5 A
```

7. Contact penetration at the main contact for each phase (only during close operation and open operation)

During a close operation, the contact penetration is calculated as the difference in travel between the first contact touch of the main contact and the stable close position of the main contact.

During an open operation, the contact penetration is calculated as the difference in travel between the stable close position of the main contact and the position of the main contact at the instant of the last contact separation. See the curve diagram above.

```
Penetration L1
38.9 mm
```

8. Over travel (only during close operation and open operation)

This value shows how large a distance the breaker moves outside the stable close and open positions.

During a close operation, the over travel is calculated as the difference in travel between the breaker's stable close position and highest measured position. During an open operation, the over travel is calculated as the difference in travel between the breaker's stable open position and the lowest measured position. This parameter provides a specific measure that indicates the breaker's damping condition.

```
Over travel
10.3 mm
```

9. Rebound (only during close operation and open operation)

This value shows how large a distance the breaker bounces back after an operation.

During a close operation, the rebound is calculated as the difference in travel between the lowest measured position that occurs directly after the overtravel, and the breaker's stable closed position. During an open operation, the rebound is calculated as the difference in travel between the highest measured position that occurs directly after the overtravel and the breaker's stable open position.

If the rebound is to large, there is a risk of restriking during an open operation and contact bouncing during a close operation.

```
Rebound
1.7 mm
```

10. Speed

This value shows the breaker's average speed between the two defined calculation points.

During a close operation, the parameter is calculated as the average speed between two points on the motion graph, which are defined on the menu CLOSE SPEED.

During an open operation, the parameter is calculated as the average speed between two points on the motion graph, which are defined in the menu OPEN SPEED. To input the speed calculation points, see sections "Open speed" and "Close speed" in this chapter.

```
Closing speed
4.6 m/s
```

```
Opening speed
7.3 m/s
```

During an OCO operation, the first and second open speed are as shown below:

```
1:Opn speed
7.2 m/s
```

```
2:Opn speed
7.9 m/s
```

Monitor

This menu shows the actual status at Egil's outputs. This can be useful, for example to

- check that the measuring cables are correctly connected
- to adjust the position at a rotating transducer so that the zero point is not exceeded during an operation.

If you access this menu directly after you turn on Egil's power, the motion transducer's reading is shown as a percentage (providing that you chose to measure MOTION in the ANALOG CHANNEL menu). After the measurement is taken, the moving contact's distance, in relation to the breaker's stable open position, is shown.

The display window is divided into three parts which show:

- coil current
- the value on the analog channel
- the contact status at the time channel

Example:
The following measuring values can be read out from the display.

The instantaneous rate at the coil current that is measured with Egil's internal current channel.

```
Monitor     0.00 A
90.0 mm     ORC OC
```

In the lower left corner, the instantaneous value of the quantity you chose to measure with analog channel is shown. In this case, it is motion. During measurement of motion, this value represents the moving contact's distance from the breaker's stable open position. Before the first measurement, the motion transducer's output is shown as a percentage. This makes it easier to adjust a rotating transducer during mounting. See the example below.

Note! *If the analog channel function is not activated (in position Off), this field is empty.*

```
Monitor     0.00 A
90.0 mm     ORC CO
```

The time channel's instantaneous status:

```
Monitor     0.00 A
90.0 mm     ORC CO
```

Status: O = open
R = resistive
C = close

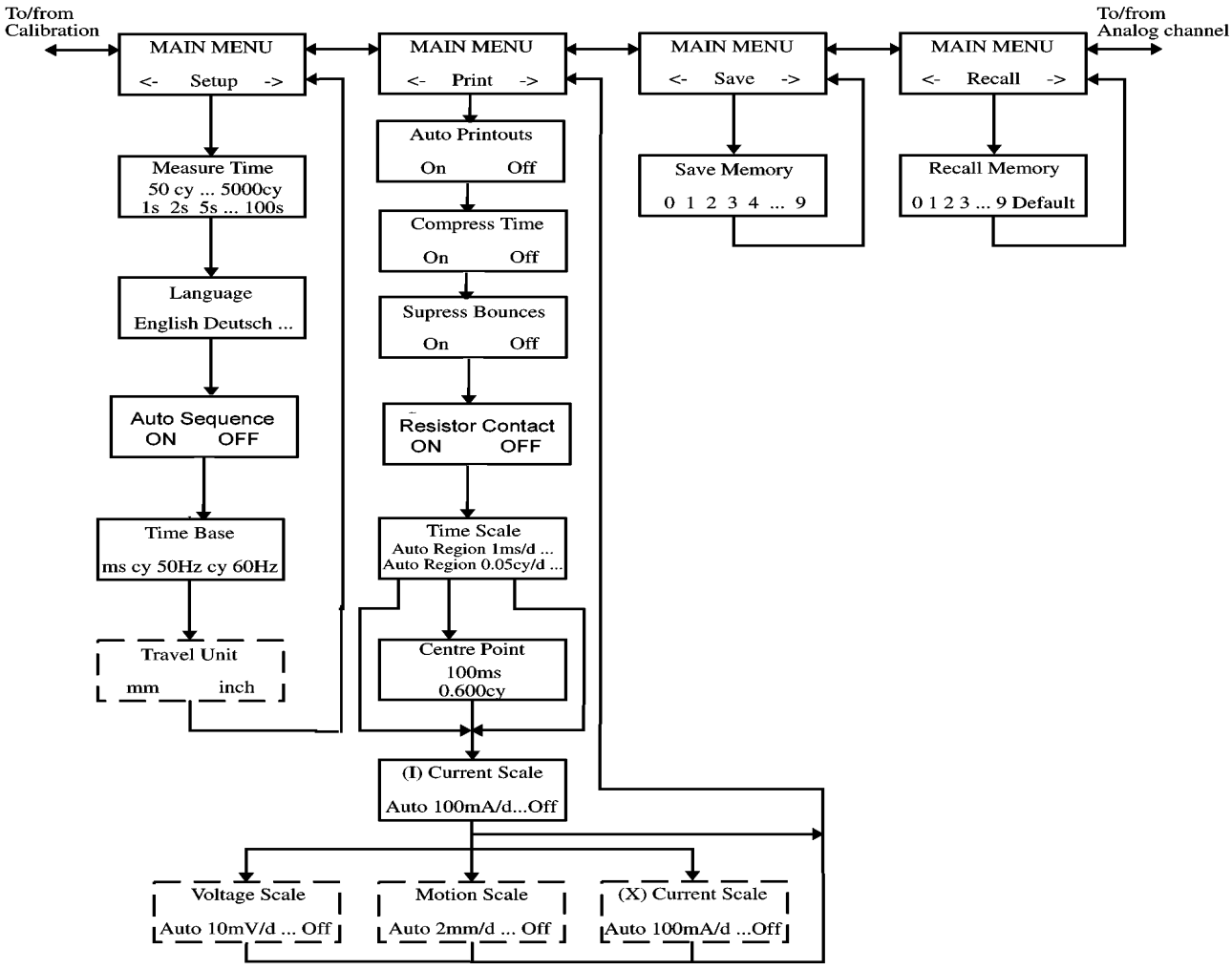
Example:
Adjusting a rotating transducer

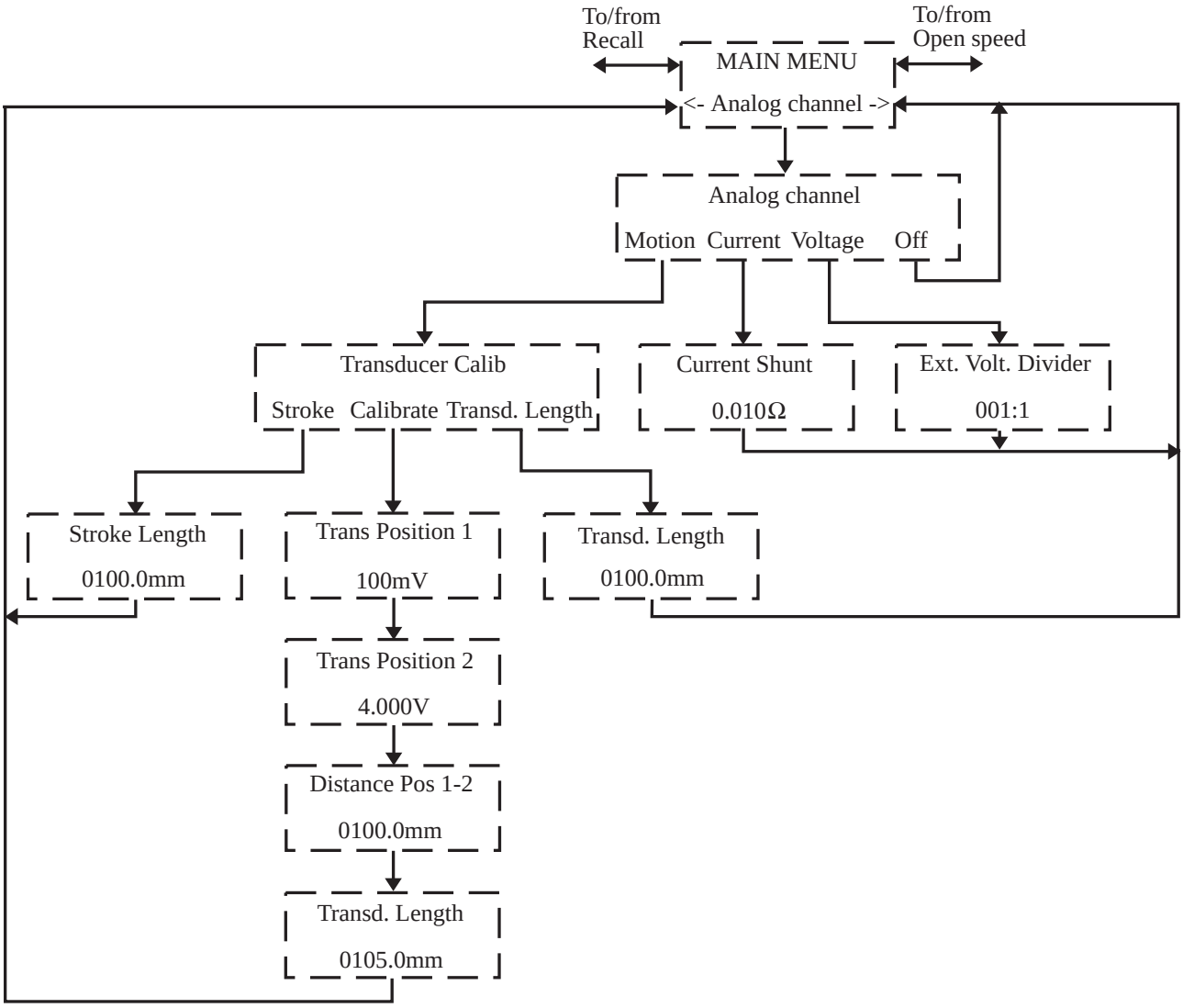
When you use a rotating transducer like a motion transducer, it is important that it is mounted so that the zero crossing is not exceeded during an operation. Complete the following steps:

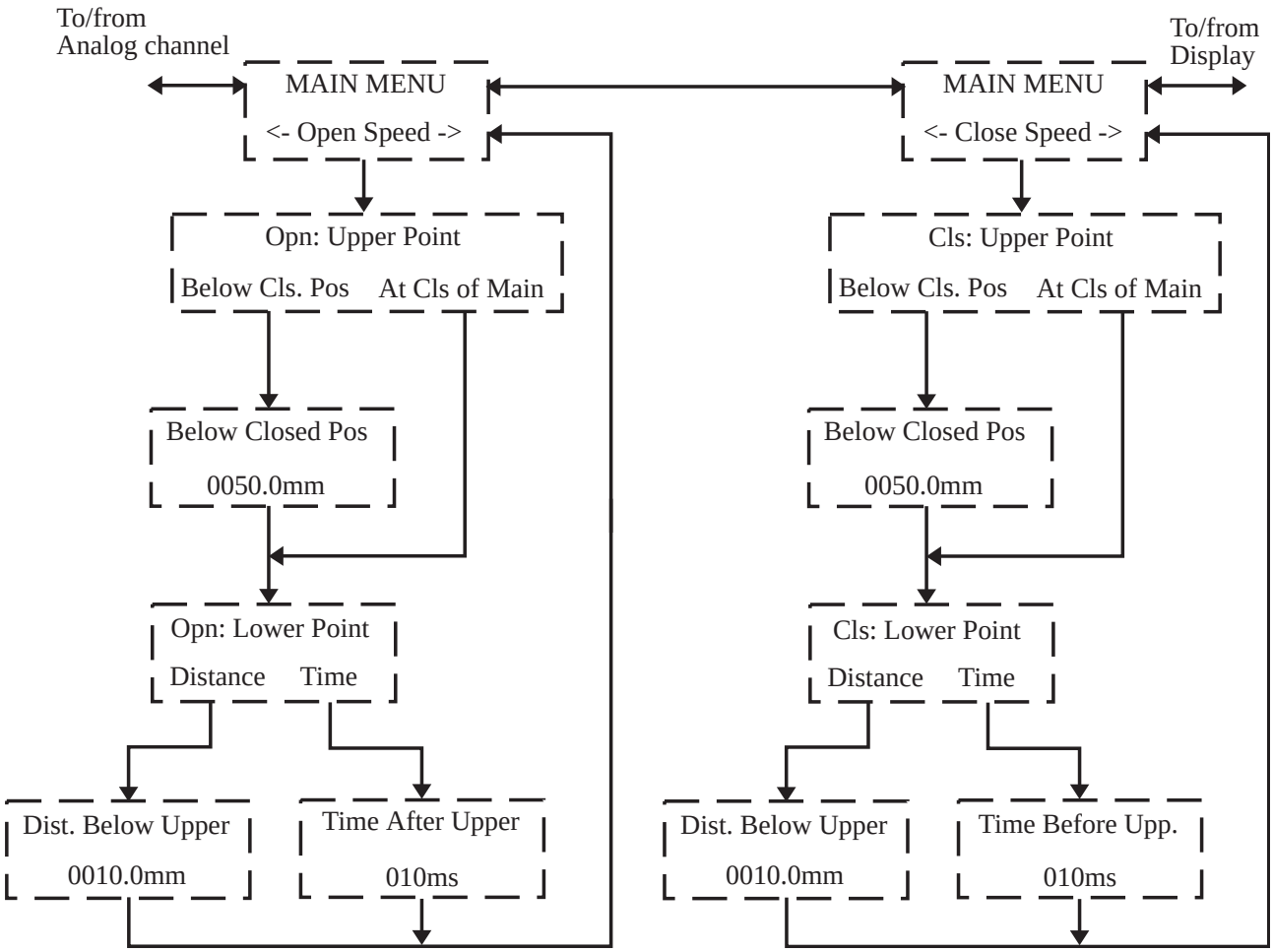
1. Mount the rotating transducer on the breaker.
2. Select the MONITOR menu. If a percentage is not shown in the lower left corner, restart Egil (turn off/turn on) and select the MONITOR menu again.
3. Gently loosen the transducer from its holder and turn it until about 50% is shown on the display. Now the transducer is in the middle of the measure region which means that it can rotate almost half way around in each direction without passing the zero crossing.
4. Make a measurement.

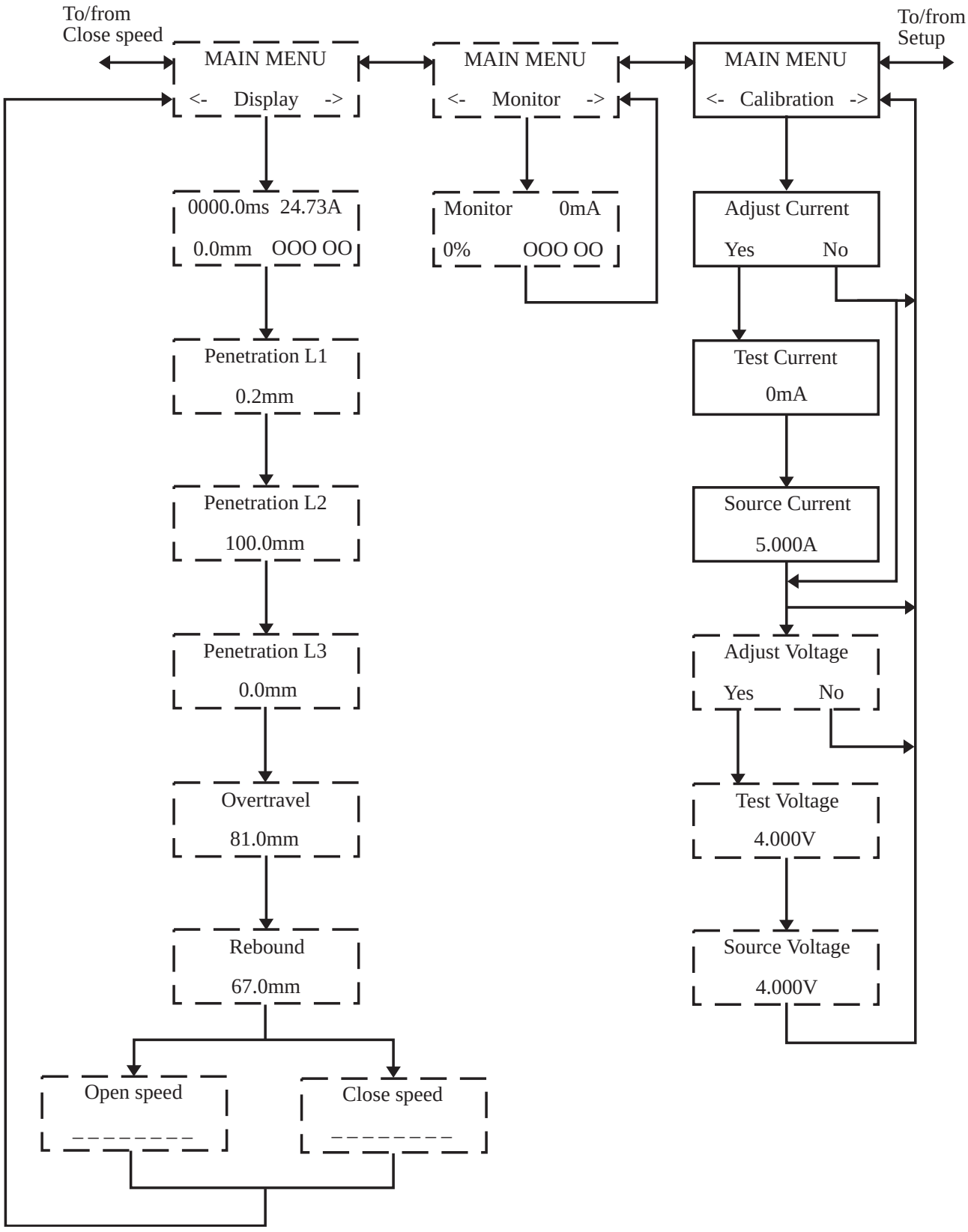
6.5 Menu tree for the MAIN menu

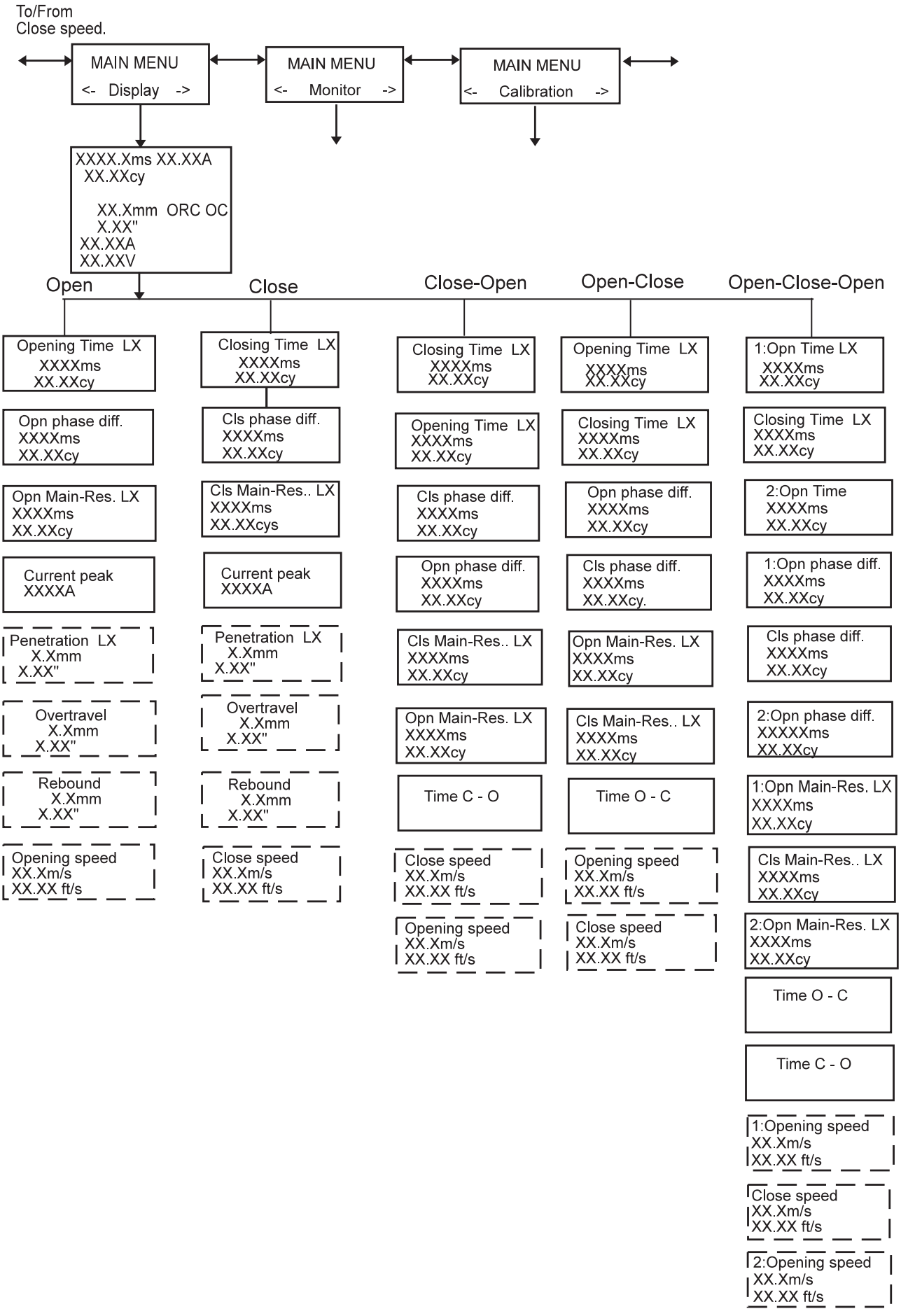
On the following pages, you can see a diagram of the menu headings and parameter settings in the MAIN menu.



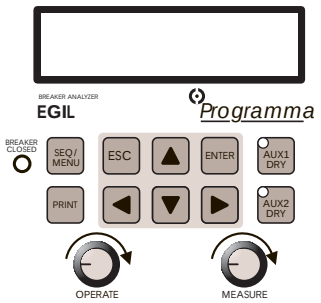

To/from
Recall
To/from
Open speed
MAIN MENU
<- Analog channel ->
Analog channel
Motion Current Voltage Off
Transducer Calib
Stroke Calibrate Transd. Length
Current Shunt
0.010Ω
Ext. Volt. Divider
001:1
Stroke Length
0100.0mm
Trans Position 1
100mV
Transd. Length
0100.0mm
Trans Position 2
4.000V
Distance Pos 1-2
0100.0mm
Transd. Length
0105.0mm


To/from
Analog channel
MAIN MENU
<- Open Speed ->
Opn: Upper Point
Below Cls. Pos
At Cls of Main
Below Closed Pos
0050.0mm
Opn: Lower Point
Distance
Time
Dist. Below Upper
0010.0mm
Time After Upper
010ms
MAIN MENU
<- Close Speed ->
To/from
Display
Cls: Upper Point
Below Cls. Pos
At Cls of Main
Below Closed Pos
0050.0mm
Cls: Lower Point
Distance
Time
Dist. Below Upper
0010.0mm
Time Before Upp.
010ms


To/from
Close speed
MAIN MENU
<- Display ->
0000.0ms 24.73A
0.0mm OOO OO
Penetration L1
0.2mm
Penetration L2
100.0mm
Penetration L3
0.0mm
Overtravel
81.0mm
Rebound
67.0mm
Open speed
Close speed
MAIN MENU
<- Monitor ->
Monitor 0mA
0% OOO OO
MAIN MENU
<- Calibration ->
To/from
Setup
Adjust Current
Yes No
Test Current
0mA
Source Current
5.000A
Adjust Voltage
Yes No
Test Voltage
4.000V
Source Voltage
4.000V


To/From
Close speed.
MAIN MENU
<- Display ->
MAIN MENU
<- Monitor ->
MAIN MENU
<- Calibration ->
XXXX.Xms XX.XXA
XX.XXcy
XX.Xmm ORC OC
X.XX"
XX.XXA
XX.XXV
Open
Close
Close-Open
Open-Close
Open-Close-Open
Opening Time LX
XXXXms
XX.XXcy
Opn phase diff.
XXXXms
XX.XXcy
Opn Main-Res. LX
XXXXms
XX.XXcy
Current peak
XXXXA
Penetration LX
X.Xmm
X.XX"
Overtravel
X.Xmm
X.XX"
Rebound
X.Xmm
X.XX"
Opening speed
XX.Xm/s
XX.XX ft/s
Closing Time LX
XXXXms
XX.XXcy
Cls phase diff.
XXXXms
XX.XXcy
Cls Main-Res.. LX
XXXXms
XX.XXcys
Current peak
XXXXA
Penetration LX
X.Xmm
X.XX"
Overtravel
X.Xmm
X.XX"
Rebound
X.Xmm
X.XX"
Close speed
XX.Xm/s
XX.XX ft/s
Closing Time LX
XXXXms
XX.XXcy
Opening Time LX
XXXXms
XX.XXcy
Cls phase diff.
XXXXms
XX.XXcy
Opn phase diff.
XXXXms
XX.XXcy
Cls Main-Res.. LX
XXXXms
XX.XXcy
Opn Main-Res. LX
XXXXms
XX.XXcy
Time C - O
Close speed
XX.Xm/s
XX.XX ft/s
Opening speed
XX.Xm/s
XX.XX ft/s
Opening Time LX
XXXXms
XX.XXcy
Closing Time LX
XXXXms
XX.XXcy
Opn phase diff.
XXXXms
XX.XXcy
Cls phase diff.
XXXXms
XX.XXcy.
Opn Main-Res. LX
XXXXms
XX.XXcy
Cls Main-Res.. LX
XXXXms
XX.XXcy
Time O - C
Opening speed
XX.Xm/s
XX.XX ft/s
Close speed
XX.Xm/s
XX.XX ft/s
1:Opn Time LX
XXXXms
XX.XXcy
Closing Time LX
XXXXms
XX.XXcy
2:Opn Time
XXXXms
XX.XXcy
1:Opn phase diff.
XXXXms
XX.XXcy
Cls phase diff.
XXXXms
XX.XXcy
2:Opn phase diff.
XXXXXms
XX.XXcy
1:Opn Main-Res. LX
XXXXms
XX.XXcy
Cls Main-Res.. LX
XXXXms
XX.XXcy
2:Opn Main-Res. LX
XXXXms
XX.XXcy
Time O - C
Time C - O
1:Opening speed
XX.Xm/s
XX.XX ft/s
Close speed
XX.Xm/s
XX.XX ft/s
2:Opening speed
XX.Xm/s
XX.XX ft/s

6.6 Select a menu item or parameter



The display shows the menu name on the first line and the alternatives on the second line. The selected item is indicated by "< >".

Example:

```
MAIN MENU
<  Setup  >
```

or

```
Next Sequence
<C>            CO
```

1. To select parameters, use the buttons for left-arrow and right-arrow.
2. Press ENTER to confirm your choice and to proceed to the next menu level.
3. Press ESC to return to the previous menu level.
4. Change a numeric value
5. In some menus a value can be set. Select the digit to be changed by the left and right arrow key.

```
Cls Pulse Length
0.20 s
```

6. Use the up and down arrows on the key-board to set the desired value.

```
Cls Pulse Length
0.50 s
```

7. Press ENTER to confirm and to continue to the next menu level.
8. Press ESC to return to the previous menu level.

6.7 Function keys

Key	Function
ESC	Go back to the previous menu level. If the currently displayed value has been changed, the change is cancelled.
ENTER	Confirm the selected alternative (indicated by "< >"), or confirm a displayed parameter value and proceed to the next function.
↑	Up-arrow key. Increase a value by one increment.
↓	Down-arrow key. Decrease a value by one increment.
→	Right-arrow key. A numeric field is then used to choose the number you will change. You change the value by using the up and down arrows on the keyboard. This key is also used to choose an option from a menu. The option you have chosen is shown within < >.
←	Left-arrow key. See right -arrow key above.

7 How to make a time measurement

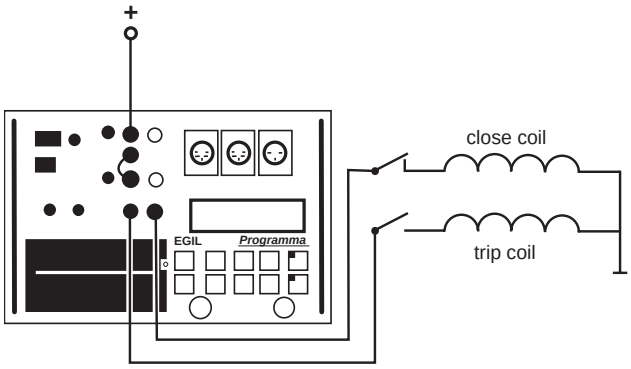
For control panel references, see Chapter 5 (Control panel).

IMPORTANT

- *Read the chapter "Safety" before using Egil.*
- *Always comply with local safety regulations.*

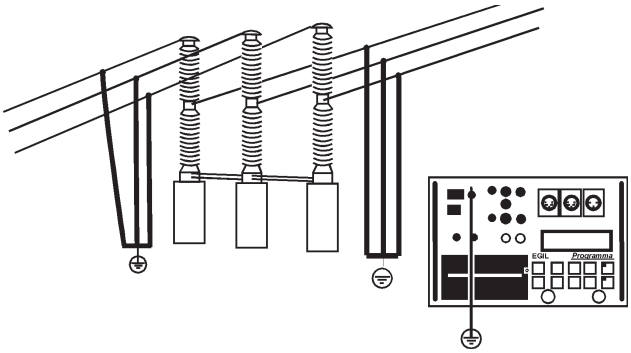
WARNING

- *Do not short-circuit or touch the auxiliary voltage. Use of "touch-proof" connectors is recommended.*
- *Both breaker sides must be grounded when making connections to the breaker.*
- *Always disconnect the breaker control circuit from Egil control output, before doing any work on the breaker.*
- *To avoid unintentional breaker operations while working on the breaker, connect the breaker control circuit to Egil blind terminals (13 and 14) as illustrated below.*



7.1 Connecting the device

1. Make sure that Egil and the breaker are grounded as illustrated below:



2. Connect the power supply cable to Egil (2).

3. Connect Egil to the breaker.
Connect the time measurement cable to the breaker main contacts and to Egil TIMING contact (15).

4. Connect the auxiliary contact measurement cable to the auxiliary contacts in the operating mechanism and to Egil AUX1&2 contact (16).

4a. If the measurement is on **wet (AC voltage)** auxiliary contacts, set the timing auxiliary inputs to wet mode (LED is off).

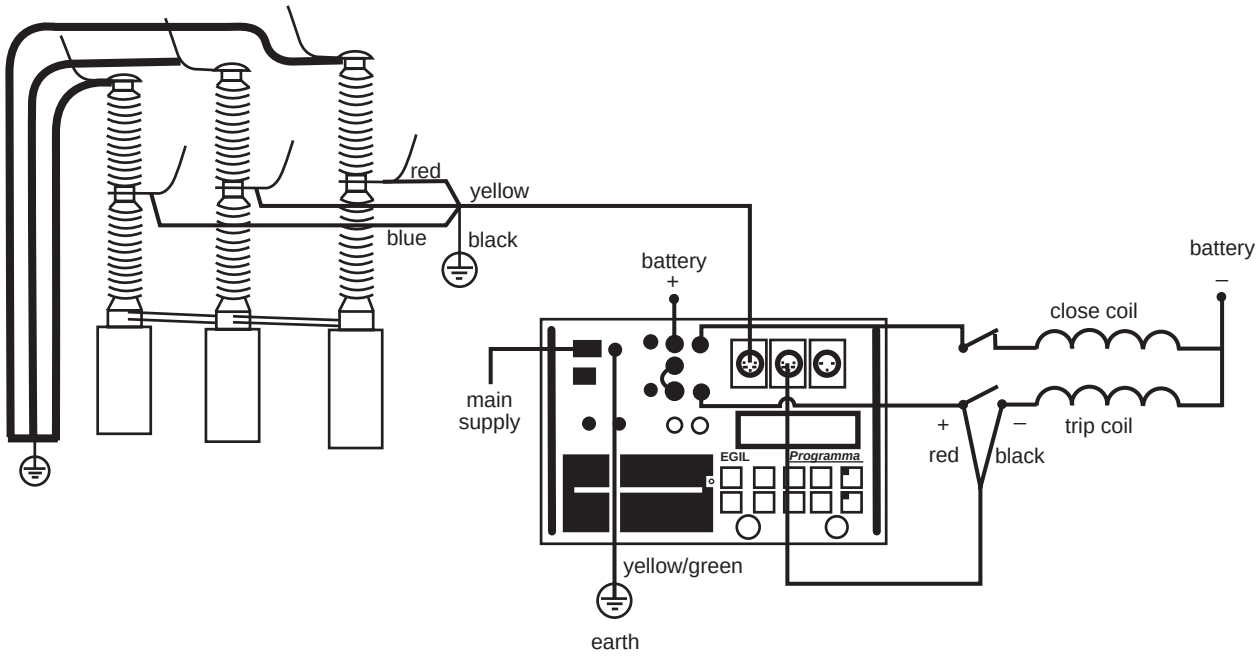
4b. If the measurement is on **wet (DC voltage)** auxiliary contacts, set the timing auxiliary inputs to DRY mode (LED is on). **The red cable must be connected to the positive side of the auxiliary contact**

4c. If the measurement is on **dry** auxiliary contacts, set the timing auxiliary inputs to DRY mode (LED is on).

5. Connect the breaker close coil to Egil close coil output (10).

6. Connect the breaker trip coil to Egil trip coil output (12).

7. Make sure a jumper is connected between the trip coil input (11) and the close coil input (8), (if the trip and close coil have the same voltage source).
8. Connect the battery plus (+) to Egil coil input (9).
9. Remove the ground connections from one side of the breaker as shown in the picture below.



IMPORTANT

When only one side of the breaker is grounded while making the test, special precautions must be observed to protect service personnel and the test equipment from harmful voltages.

10. Turn Egil power switch on (3).
Egil is now ready to operate.

7.2 Setting parameters

Egil reads the status of the breaker (closed or open). The built-in sequence module is automatically set to the next logical single operation.

If multiple operation is requested, perform the following steps:

1. Select a sequence operation from the SEQUENCE menu by pressing the arrow-keys. 2.
2. Press ENTER to set pulse delay times and pulse length values if needed and press ENTER to confirm your settings.

For more information about parameters, see Chapter 6 (Menu options and parameter settings).

7.3 Running a measurement

Running a single close (C) or open (O) operation.

1. Connect the breaker as shown in section 7.1 above.
2. Run a breaker operation without measurement by turning the OPERATE knob. This tests the connection. Run the operation with measurement by turning the MEASURE knob.

Running an Open-Close-Open (O-C-O) operation.

1. Connect the breaker as shown in section 7.1 above.
2. Select O-C-O (open-close-open) operation in the SEQUENCE menu by using the arrow keys.
3. Press ENTER to set the close and open delay values. The default value is 300 ms (0.30 s) for close pulse delay and 10ms (0.01 s) for opening pulse delay. Press ENTER to continue.
4. Set the pulse length values if needed. Press ENTER to confirm your settings.
5. Run a breaker operation without measurement by turning the OPERATE knob. This tests the connection. Run the operation with measurement by turning the MEASURE knob.

Note: *The first measurement must be a single close or open operation.*

7.4 Reading the printouts

For more information about the printer, see Chapter 12 (The printer).

The first part of the printout shows administrative data and test conditions.

The second part of the printout shows the result in numeric and graphic form.

You can also view the results on the display if you activate the DISPLAY option on the MAIN menu.

8 How to make a motion measurement (option)

Option - >

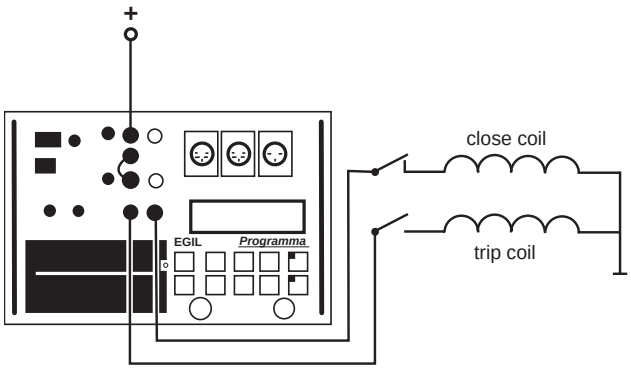
For control panel references, see Chapter 5 (Control panel).

IMPORTANT

- *Read the chapter "Safety" before using Egil.*
- *Always comply with local safety regulations.*

WARNING

- *Do not short-circuit or touch the auxiliary voltage. Use of "touch-proof" connectors is recommended.*
- *Both breaker sides must be grounded when making connections to the breaker.*
- *Always disconnect the breaker control circuit from Egil control output, before doing any work on the breaker.*
- *To avoid unintentional breaker operations while working on the breaker, connect the breaker control circuit to Egil blind terminals (13 and 14) as illustrated below.*

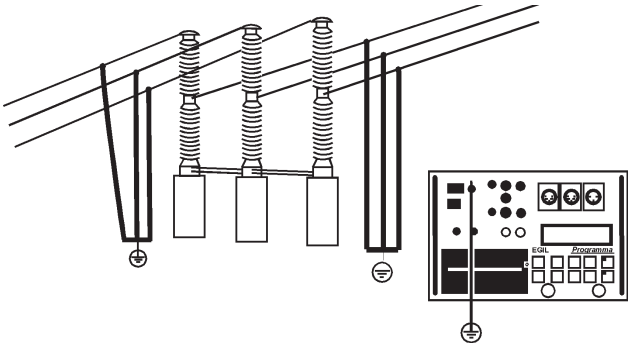


IMPORTANT

If only one side of the breaker is grounded while making the test, special precautions must be observed to protect service personnel and the test equipment from harmful voltages.

8.1 Connecting the device

1. Make sure that Egil and the breaker are grounded as illustrated below:



2. Connect the power supply cable to Egil.

3. Attach the transducer to the breaker rod or to the operating mechanism.

4. Connect the motion transducer cable to the MOTION connector.

5. Connect Egil to the breaker.
Connect the time measurement cable to the breaker main contacts and to Egil TIMING contact (15).

6. Connect the auxiliary contact measurement cable to the auxiliary contacts in the operating mechanism and to Egil AUX1&2 contact (16).

6a. If the measurement is on **wet (AC voltage)** auxiliary contacts, set the timing auxiliary inputs to wet mode (LED is off).

6b. If the measurement is on **wet (DC voltage)** auxiliary contacts, set the timing auxiliary inputs to DRY mode (LED is on). **The red cable must be connected to the positive side of the auxiliary contact**

6c. If the measurement is on **dry** auxiliary contacts, set the timing auxiliary inputs to DRY mode (LED is on).

7. Connect the breaker close coil to Egil close coil output (10).

8. Connect the breaker trip coil to Egil trip coil output (12).

9. Make sure a jumper is connected between the trip coil input (11) and the close coil input (8).

10. Connect the auxiliary voltage plus (+) to the coil input (9) on Egil.

11. Turn Egil power switch on (3).

Select measurement method

1. Select MOTION from the ANALOG CHANNEL menu.

2. Choose the measurement method.

If you use a rotating transducer or a linear transducer that is not directly mounted on the moving contact, select measure method STROKE LENGTH. Enter the moving contact's nominal stroke length and press ENTER. For more information, see section 6.4 "Analog Channel".

If you use a linear transducer that is directly mounted on moving contact, select measure method TRANSD LENGTH. Enter the transducer's length and press ENTER. If the exact length of the transducer is unknown, you can find out what it is by calibrating the transducer. For more information, see section 6.4 "Analog Channel".

Egil is now ready for motion measurement. Remember that the first operation must be a single close or open operation.

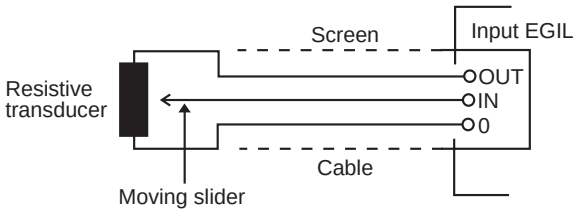
Connect the transducer

1. Connect the OUT terminal to one end of the position transducer (potentiometer).

2. Connect the IN terminal to the slide of the transducer.

3. Connect the 0 terminal to the other end of the transducer.

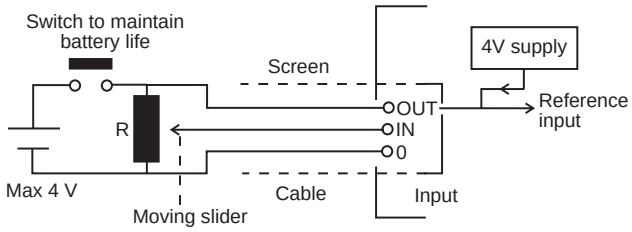
4. The cable shield should not be grounded on the transducer side.



Resistive position transducer with very low resistance:

When the resistance is below 100 ohm, an external power supply has to be used, e.g. two torch (flashlight) batteries in series. Connect them across the transducer as shown below.

Except for extra power supply there is no difference in the way a low resistance position transducer is used.

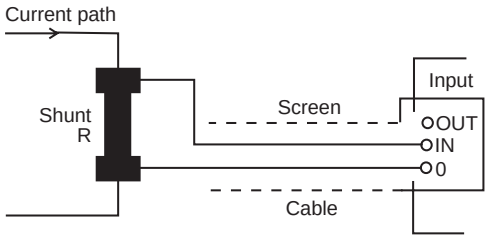


Measuring current with a external current shunt

Current shunt:

1.. Choose a current shunt (resistor) with appropriate current capacity. Low resistance gives low voltage drop. High resistance gives higher resolution because of higher measuring voltage.

2.. Connect voltage sensor wires to the IN terminal and to the 0 terminal.



For currents between 0 - 10 A, a 100 mW shunt is appropriate. For currents between 10 - 25 A, a 10 mW shunt is appropriate. Remember, that the current over the shunt should never exceed 4 V.

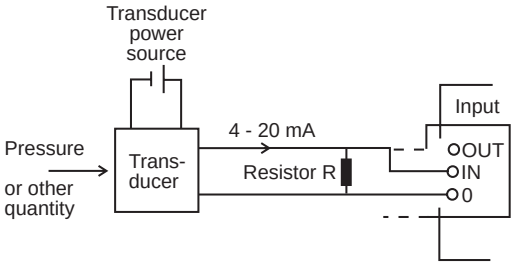
Make your setting in the ANALOG CHANNEL.

Choose CURRENT and set the shunt value.

For information about specific settings, see Chapter 6 (Menu options and parameter settings).

Measuring other quantities

4-20 mA transducer (for pressure or other quantity):



1. Connect the resistor across the input terminals IN and 0.
2. Connect the transducer across the resistor.

8.2 Setting parameters

Egil reads the status of the breaker (closed or open). The built-in sequence module is automatically set to the next logical single operation.

If multiple operation is requested, perform the following steps:

1. Select a sequence operation from the SEQUENCE menu by pressing the arrow-keys.
2. Press ENTER to set pulse delay times and pulse length values if needed and press ENTER to confirm your settings.

For more information about parameters, see Chapter 6 (Menu options and parameter settings).

8.3 Running a measurement

Running a single close (C) or open (O) operation.

1. Connect the breaker as shown in section 8.1 above.
2. Run a breaker operation without measurement by turning the OPERATE knob. This tests the connection. Run the operation with measurement by turning the MEASURE knob.

Running an Open-Close-Open (O-C-O) operation.

1. Connect the breaker as shown in section 8.1 above.
2. Select O-C-O (open-close-open) operation in the SEQUENCE menu by using the arrow keys.
3. Press ENTER to set the close and open delay values. The default value is 300 ms (0.30 s) for close pulse delay and 10 ms (0.01 s) for opening pulse delay. Press ENTER to continue.
4. Set the pulse length values if needed. Press ENTER to confirm your settings.
5. Run a breaker operation without measurement by turning the OPERATE knob. This tests the connection. Run the operation with measurement by turning the MEASURE knob.

Note: *The first measurement must be a single close or open operation.*

8.4 Reading the printouts

For more information about the printer, see Chapter 12 (The printer).

The first part of the printout shows administrative data and test conditions.

The second part of the printout shows the result in numeric and graphic form.

You can also view the results on the display if you activate the DISPLAY option on the MAIN menu.

Option - End

9 Connecting Egil to a computer (option)

Option - >

Numbers within parentheses in this section refer to the description of Egil's control panel in Chapter 5 (Control panel).

If Egil is equipped with a connector marked SERIAL (18), Egil can be connected to a computer in which the CABA Breaker Analysis program has been installed. This enables you to:

- store settings and test parameters for individual breakers in the computer
- make quick evaluations and comparisons
- print out reports
- store test results in the computer

The communication proceeds via the computer's serial port and the serial cable which is included when you purchase CABA for Egil.

Note! *If you do not use the included serial cable, make sure that the cable you use instead is a standard serial cable with a 9-pin D-sub male connector at one end and a 9-pin-socket D-sub female connector at the other. It must be of the straight-through type, i.e. the wires connected to terminals 2 and 3 must not be crossed.*

The version R03B or a later version of the CABA Breaker Analysis program must be installed in the computer.

9.1 Connecting the computer

To connect Egil to the computer you must take the following steps in the sequence shown below:

1. Connect the cable included with CABA for Egil between Egil's serial port (18) and the computer's serial port.
2. Start the computer.
3. Turn on power to Egil.
4. Start CABA.

9.2 Operating Egil while running CABA

For detailed information and guidance, see the CABA User's Manual.

Note! *On the CABA menu headed "6.2 Computer Configurations", check to see that the correct serial port is selected and that the baud rate is set to 19200. Note, however, that 38400 will also work in some situations.*

1. You create the breaker in the computer using the regular procedure, with one restriction: The test plan you select must be intended for Egil.

When the computer establishes a connection with the breaker analyzer, the program checks whether an Egil or another type of breaker analyzer is present, then adapts the on-screen information accordingly. When the communication between the computer and Egil has started, a message reading "Connected to PC" appears in Egil's display window.

```
Connected to PC
```

Note! *You cannot perform any operations or make any settings via the control panel on Egil while this message appears in the display window.*

2. After you have selected "Measure" in CABA (found at the bottom of the connection list), the message in Egil display window changes to "Next sequence".

```
Next sequence
< C >           CO
```

3. If the breaker is in the wrong state (open or closed) it can now be operated with the OPERATE knob. In Egil's SEQUENCE menu, you can select the desired sequence, set pulse duration and set delay times for the close and trip pulses using the same procedures as those set forth in Chapter 6 (Menu options and parameter settings), see sections 6.2 and 6.3.

4. Turn the MEASURE knob in the usual way to execute the measurement, whereupon Egil takes measurements and sends the results to the computer.

9.3 How to use Egil's internal printer from CABA

All forms and graphs created in CABA can be printed out on Egil's internal printer. However, you cannot make printouts using Egil's internal printout format while Egil is connected to CABA.

Before you can print from CABA on Egil's internal printer, you must make the following settings (start with the CABA menu headed "6 Basic Settings"):

1. In the menu headed "6.2 Computer Configurations": **Printer port must be set to TM1600/EGIL.**
2. In the menu headed "6.3 Printer list": **One of the TM1600/EGIL printers must be selected.**

After you make the above settings you can print from CABA using the regular procedure.

Option - End

10 Troubleshooting

10.1 General

The display does not show anything

Possible cause: Fuse F1 may be broken.

Remedies: Check that the mains voltage selector switch is set in an accurate position. Also check the mains voltage with a volt meter. Reset the fuse.

Breaker control circuits malfunctions

Possible cause: The 12 A F fuses are broken.

Remedy: Check the fuses and replace them.

The printer does not print and no message on the display

Possible causes: Problems with the paper (incorrectly turned paper roll, the thermo sensitive side - outside of roll - must face towards the operator, bad quality, wrong size, etc.). Internal fault in Egil.

Remedies: Use the paper recommended by Programma Electric AB, and turn it correctly. Contact Programma Electric AB or your Egil service representative.

When CABA is started with Egil connected, CABA displays a message reading "Communication error".

Possible cause: Wrong cable used for connection. Wrong communication port set in CABA.

Remedy: Use the cable delivered with CABA for Egil as described in Chapter 9 (Connecting Egil to a computer). Check the CABA menu headed "6.2 Computer Configurations", to see if the correct communication port has been set (normally COM1) and that the baud rate setting is correct (normally 19200).

You are unable to print from CABA on Egil's internal printer

Possible cause: Wrong printer port set in CABA. Wrong printer selected in CABA.

Remedy: Set the printer port to TM1600/EGIL in the CABA menu headed "6.2 Computer Configurations". Select one of the TM1600/EGIL printers in the CABA menu headed "6.3 Printer List".

10.2 Displayed values

Reading: Strange result

Possible cause: Something is wrong with your settings. The settings are correct, but you have started the preparations for the next measurement too soon.

Remedies: Check the parameter settings. Restore the old settings. For more information about parameters, see Chapter 6 (Menu options and parameter settings).

Reading: Dashed lines instead of values

Possible cause: In DISPLAY mode: The time set exceeds the established measuring time. On the motion part of the test report: Egil was not able to compute the speed because the points were not located. (The difference between the time values is too short, for example).

Remedies: Set a new value located inside the measurement interval. Check your settings and change them if necessary.

Reading: Motion: Speed calculation failed

Possible cause: Egil was not able to find the points specified by your settings.

Remedy: Change your settings. For more information about parameters, see Chapter 6 (Menu options and parameter settings).

10.3 Error messages

Message:	**Incorrect Status, Check hook-up, Set analog off**
Possible cause:	The motion transducer is not moving or moving less than 5%, but the time input detects a change of state.
Remedy:	Check the connection & mounting of the Motion transducer.

Message:	**Not calibrated, Adjust current, Adjust voltage**
Possible cause:	The unit has a new EPROM , and the calibrations data are not found.
Remedy:	Calibrate the current & voltage input.

Message:	**EPROM conflict**
Possible cause:	Mixing of EPROM versions between the Master & the 1st or 2nd slave EPROMs.
Remedy:	Contact your GE representative for Programma Products.

Message:	**ROM ERROR**
Possible cause:	Internal fault in Egil, checksums of ROM do not match.
Remedy:	Turn off the power. Contact your Programma Electric AB representative.

Message:	**Not calibrated (showed at start-up)**
Possible cause:	Calibration data are missing.
Remedy:	Calibrate the unit by choosing CALIBRATION from the MAIN menu. For more information, see Chapter 11 (Calibration).

Message:	**Memory corrupted**
Possible cause:	The settings which you try to recall are corrupt.
Remedy:	Press ESC. If you just turned on the power, the default settings will be loaded, otherwise try to recall the default or another setting. If you cannot correct this, contact your Programma Electric AB representative.

Message:	**Memory is empty**
Possible cause:	The memory is empty because you have not recorded any data or you have interrupted the last recording process.
Remedy:	Press ESC. Run a measurement.

Message:	**Printer Error**
Possible cause:	The printer is out of paper or the head lever is up.
Remedy:	Press ESC. Load new paper or close the head lever.

Message:	**Setting changed**
Possible cause:	For CENTRE POINT - Egil is not able to take your value as the centre point of the plot. Egil has made its own proposal. For TIME AFTER UPPER & TIME BEFORE UPPER - due to round-off errors, the location of the lower point is slightly shifted.
Remedy:	Press ESC to see the value proposed by Egil. You can keep the value or change it. Press ESC to see the recalculated value. You can keep it or set another one.

Message:	**Pulse errors**
Possible cause:	In OCO sequence open delay pulse + close pulse delay are shorter than open pulse length No. 1 (i.e. opening pulses are overlapping).
Remedy:	Press ESC, change the parameters and start a new measurement.

Motion option

Option - >

Message:	**Overflow**
Possible cause:	Motion calculation failed because the value is greater than 1000 mm (39.4”).
Remedy:	Press ESC and check the calibration.

Message:	**Not calibrated, press ESC (showed at measurement)**
Possible cause:	Motion calculations failed because of wrong conditions.

Remedy:	Press ESC. Make a new measurement with a single sequence. Switch off the analog channel if only time measurement is needed.

Message:	**Motion analysis failed**
Possible cause:	The motion analysis is not possible because the breaker did not operate or it did not reach its final position determined by the sequence setting.
Remedies:	Repeat the measurement. Check the settings. Check that the breaker is in right position and that springs are charged before the measurement.

Message:	**Out of range**
Possible cause:	For analog channel parameters: The parameter value is out of the allowed range for this parameter. See corresponding specification. For TRANS POS1 & 2: The transducer piston is to close to the end of course (inside the 50 mV zone from the end).
Remedies:	Press ESC. The setting which was valid before the incorrect input appears once more. You can set a new value. Move the transducer piston out of the 50 mV zone.

Message:	**Too small diff.**
Possible cause:	For TRANS POS 2: The transducer piston has not moved enough, between the position 1 and 2 (less than 400 mV).
Remedy:	Press ESC and move the piston to another position.

Option - End

11 Calibration

You can calibrate Egil by adjusting the current and the voltage measurement. The zero adjustment is made automatically at the start-up of Egil. The scale adjustment is defined as described below.

Note! *Only qualified personnel should perform the calibration function.*

Select CALIBRATION in the MAIN menu:

```
MAIN MENU
< Calibration >
```

11.1 Coil current measurement

Confirm that you want to continue calibrating the current scale.

```
Adjust Current
<Yes>          No
```

Note! *Only qualified personnel should perform the calibration function.*

Egil as an Ampere meter

1. Connect a stabilized DC current source with a calibrated ampere meter in series to the close coil input and output.
2. Turn the OPERATE or MEASURE knob to close the contacts.
3. Adjust the current to around 5A. Note: If the test current is too low, the display will indicate “out of range!”

```
Test Current
xx A
```

4. Press ENTER to continue.

Loading the precise current value

1. Enter the correct current value that was generated during the calibration procedure, red out from the ampere meter.

```
Source Current
xx A
```

2. Press ENTER to finish the current calibration.

Note! *During the calibration most of the keys and knobs are disabled.*

11.2 Voltage measurement

(Motion channel)

Confirm that you want to continue with the calibration of the voltage scale.

```
Adjust Voltage
<Yes>          No
```

Note! *This action changes the scale factor and must be done by qualified personnel only.*

Egil as a Volt meter

1. Connect a stabilized voltage source with a calibrated volt meter in parallel to the motion input, pin 1 and 3.
2. Adjust the voltage in the motion circuit to about 4 V. Note: If too low or too high voltage is applied, the display will indicate “out of range!”.

```
Test Voltage
xx V
```

3. Press ENTER to continue.

Loading the precise voltage value

1. Enter the correct value of the voltage used during the calibration procedure red out from the volt meter.

```
Source Voltage
xx V
```

2. Press ENTER to finish the calibration process.

Note! *During the calibration most of the keys and knobs are disabled.*

Egil as a timer

1. Connect the start input of a calibrated frequency counter to the close coil input/output of Egil.
2. Connect the stop input of the frequency counter to the open coil input/output of Egil.
3. Set the delay time of open to 500 ms.
4. Select a C-O operation.
5. Connect timing channels L1/L2/L3 to the open input/output.
6. Turn the MEASURE knob.
7. Compare the timing result of Egil with the result of the frequency counter.

Note! *This is a verification of the timing accuracy. There are no possibilities of adjustments.*

12 The printer

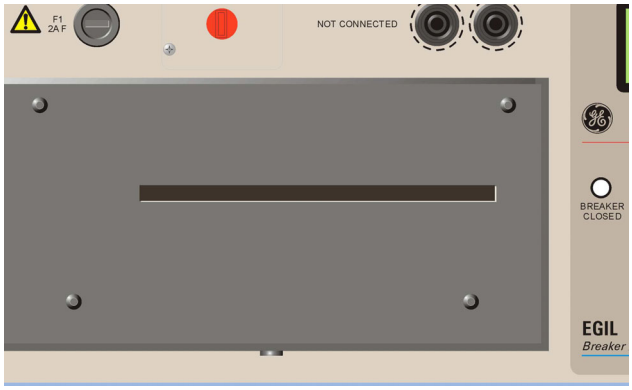
12.1 General information

The printer is a highspeed text/graphic thermal printer. This technology gives a silent operation, long life, and a good contrasted printing.

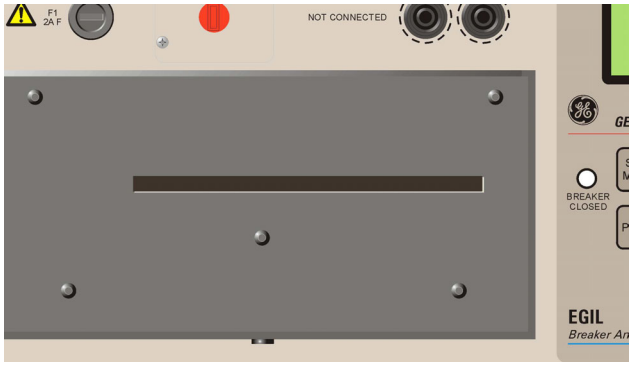
It uses heat sensitive paper with a width of 114 mm (4.488 in.) maximum.

IMPORTANT

- *Only use the specified type of paper.*
- *The new version of the printer is not exchangeable for a printer in an older EGIL because they have unlike cable connectors. You can also see the difference on the top cover, see images below.*



Old printer, four screws on top



The new version of printer has five screws on top

12.2 Printouts

The page of the printout is divided in 4 main parts:

- The general text part (part 1, 2, 3)
- The test conditions part (part 4, 5)
- The test results part (part 6, 7)
- The graphical printout (part 8)

Note! *Parts 5 and 7 are used in the motion option which is not part of the basic package.*

Parts 1 - 7 are illustrated below:

Space for your report data.

EGIL TEST REPORT Page: 1( )
SA-01200 R03A01 V000
SA-01210 R03A01 V000
Date:_____ Session: 1

1. BREAKER DATA

Station:	Line/Compartment:
Breaker ID:	Serial number:
Manufacturer:	Breaker type:

2. TEST DATA

Type of test:	Operator:
Company name:	Reference:

Space for your comments.

3. COMMENTS

Parameters you have selected for breaker operation.

4. GENERAL TEST CONDITIONS

Sequence: C		
Measuring time: 1s		Time base: seconds
Pulse	Length	Delay
Open		
Close	0.20s	
Open		

Parameters you have selected for travel (motion) measurement.

5. MOTION TEST CONDITIONS

Nominal stroke length: 100.0mm

Closing speed calculation points

Upper point: at close of main contact
Lower point: 10.0ms before upper point

Filtering you have selected for time results.

6. TIMING RESULTS
L1,L2,L3: Phase 1,2 and 3, Main and resistor contacts
X1,X2: Auxiliary contact 1 and 2
Presented events:
Initial contact touch at closure and final contact separation at opening
Opening bounces < 10ms are suppressed

Tabular printout of time measurements at main contacts.

L1	L2	L3
42.9ms Close	42.1ms Close res. 42.9ms Close	41.9ms Close res. 42.3ms Close

Tabular printout of time measurements at auxiliary contacts.

X1	X2
33.0ms Open	41.7ms Close

Timing calculations

Parameter/Phase	L1	L2	L3
Closing Time	42.9ms	42.9ms	42.3ms

.....

Page: 2( )

Difference between phases

Closing Time	0.6ms

Difference between main & resistor contacts

Parameter/Phase	L1	L2	L3
Closing Time	0.0ms	0.8ms	0.4ms

Current calculations

Current peak	1.650A

Tabular printout of travel (motion) calculations.

7. MOTION RESULTS

Parameter/Phase	L1	L2	L3
Penetration	8.5mm	8.5mm	11.9mm
Closing speed	4.9m/s		
Overtravel	14.4mm		
Rebound	6.5mm		
Stroke	100.0mm		

The graphical printout

The graphical printout shows the current, the motion and the contact events in relation to the measured time.

The timing printout matrix is 3 x 20, and the current/ motion matrix is 12 x 20 divisions.

The printout scale for the current and voltage is 5 x 5 mm. This gives a possibility to copy the graph on a copying machine by a factor 2, to enlarge the result on a A4 format page. The scale of the graph will then be 10 x 10 mm (1 x 1 cm).

The contact events (3 timing inputs and 2 auxiliary inputs) in relation to time are shown on the first five lines. The 3 timing inputs sense the type of contact and is printed as follows:

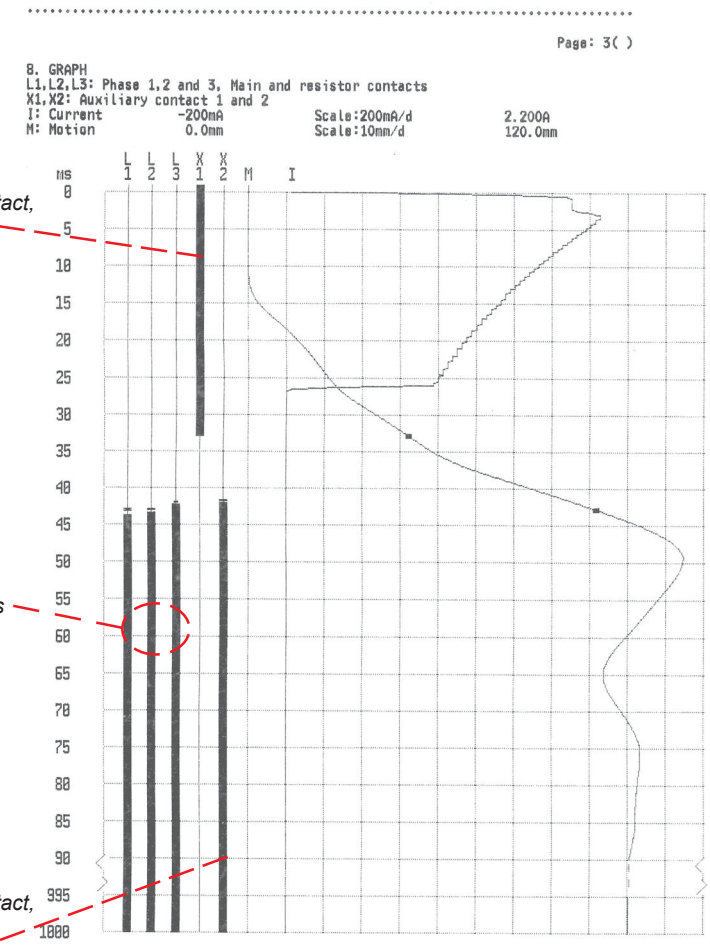
Type of contact	Input values	Printed line
No contact - Open	∞ Ω	Fine line
Resistor contact closed	10 Ω to 3 000 Ω	1 mm line
Main contact closed	< 10 Ω	2 mm line

The scale for the current is written on the second part of the graph: for example 10 A/div.

The scale for the motion (option) is written on the same graph as the current: for example 50 mm/div.

Part 8 is illustrated below:

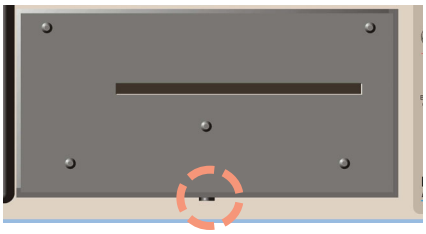
Graphical printout



12.3 Paper reload

Proceed as follows to reload paper:

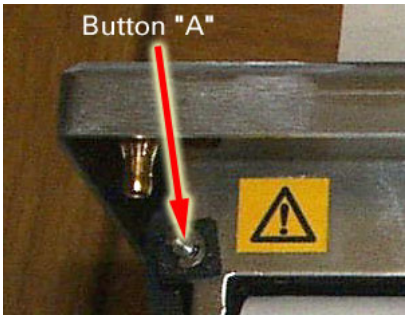
1. Release the printer locking mechanism with the button on the front of the printer cover.

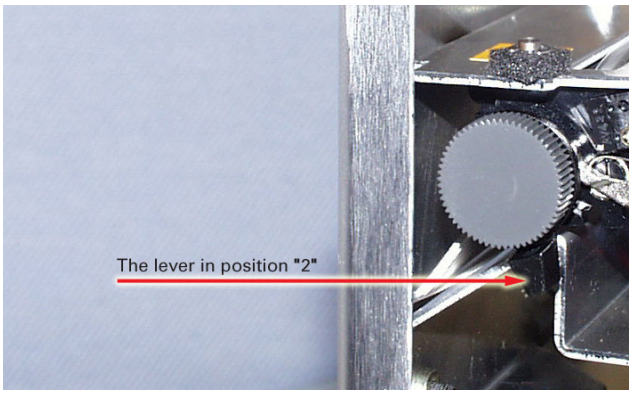


2. Pull the printer straight out and place it on the top panel.

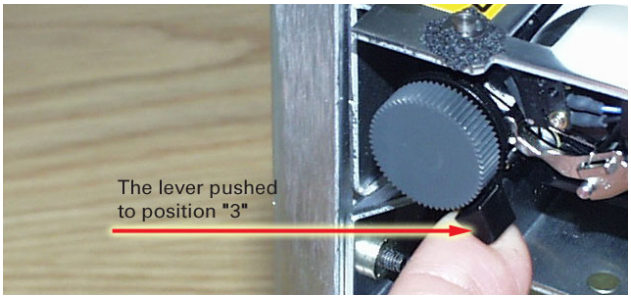
Note! *Do not disconnect any cables.*

3. Push the button ”A”, the lever below will snap to position ”2”.

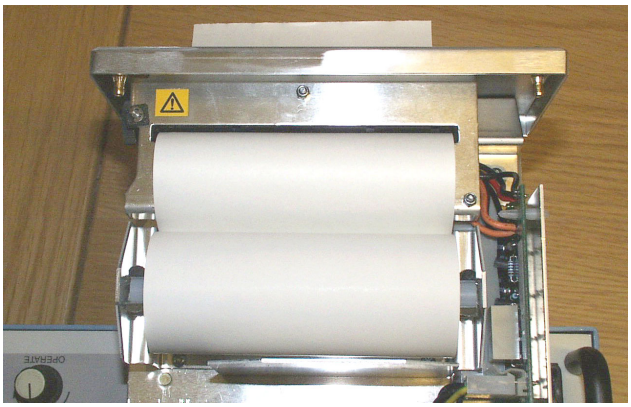




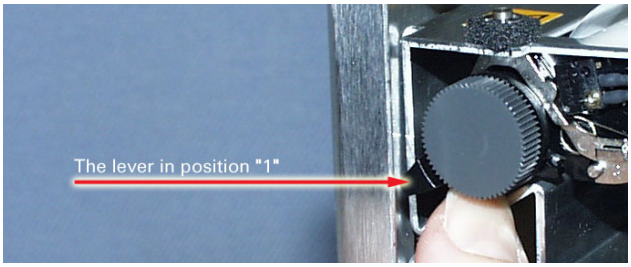
4. Push the lever from ”2” to position ”3”.



5. Insert the new paper roll into the slot with the printing surface facing down, see image below.
6. Pull the paper out about 20 cm (8 inches) and tear of excess.



7. Push back the lever to position ”1”.



IMPORTANT

Make sure that the cables are properly connected

8. Put the printer back into its holder and make sure that it is securely locked.

13 Specifications

13.1 EGIL

General

Specifications are subject to change without notice.

Application field:	The instrument is intended for use in medium voltage substations and industrial environments up to 130 kV
Mains voltage:	115/230 V AC (switchable), 50-60 Hz
Languages:	English, German, French, Spanish or Swedish
Operating temperature:	0 to +50°C (+32 to +122°F)
Storage temperature:	-40 to +70°C (-40 to +158°F)
Humidity:	5% to 95% RH, Non-condensing
Dimensions:	360 x 210 x 190 mm (14.2" x 8.3" x 7.5")
Dimensions transport case:	420 x 300 x 230 mm (16.5" x 11.8" x 9.0")
Weight:	6.3 kg (14 lbs). 10 kg (22 lbs) with accessories and carrying case

CE-marking

EMC:	EMC Directive 89/336/EEC am. by 91/263/EEC, 92/31/EEC and 93/68/EEC
LVD:	Low Voltage Directive 73/23/ EEC am. by 93/68/EEC
Measurement time:	1 to 100 s
Resolution:	0.1 to 10 ms
Time base accuracy:	0.05% of the reading ± resolution

Current measurement

Range:	±25 A per channel, sum of currents is measured
Resolution:	25 mA
Accuracy:	1% of the reading ±100 mA
Working voltage:	250 V AC/DC

Breaker operation

Sequences:	C, O, C-O, O-C, O-C-O.
Continuous current:	5 A
Max current:	25 A during 300 ms, rest time 1 min
Contact function:	Two independent control functions.
Contact characteristics:	Non bouncing, Closing time maximum 0.1 ms.
Make/Break capacity:	25 A, 250 V (AC or DC) per contact function.
Start breaker operation:	By rotary switch.
Pulse length:	Adjustable in steps of 10 ms
Pulse delay:	Adjustable in steps of 10 ms
Working voltage:	250 V AC/DC

TIMING

Number of channels:	3 with common ground

Status thresholds

Closed:	< 10 Ω ±20%
Resistor:	10 Ω ±20% to 3 kΩ ±20%.
Open:	> 3 kΩ ±20%
Open Circuit voltage:	24 V ±20%
Short circuit current:	100 mA ±20%

AUX 1&2

Number of channels:	2, galvanically isolated

Contact-sensing (Dry)

Status Threshold:	
Closed:	< 600 Ω ±30%
Open:	> 600 Ω ±30%
Open Circuit voltage:	20 V ±20% DC
Short circuit current:	25 mA ±20%

Voltage sensing (Wet)

Status Threshold:	8 – 13 V < 8 V – Open Indication > 13 V – Close Indication Polarity insensitive
Working voltage:	250 V AC/DC

MOTION (Optional)

Number of channels:	1 independent
Max Cable length:	10 m

Input

Range:	-4 to +4 V
Resolution:	2 mV
Accuracy:	1% of the measurement range
Transducer resistance:	1 kΩ to 5 kΩ
Input impedance:	150 kΩ

Output

Open circuit voltage:	4,092 V ±4 mV
Short circuit current:	115 mA

SERIAL (Optional)

Type:	V24, RS232C
Format:	8 bits, 1 stop bit, no parity
Speed:	1200 - 19200 baud
Protocol:	Xon/Xoff

Printout

Type of printout:	Graphic and numeric
Printer:	Thermal printer with fixed print head
Graphic resolution:	8 dots/mm - 203 dpi
Paper width:	114 mm (4.5")

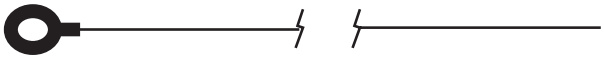
13.2 Cables

Mains power supply

Suited for respectively region/ country
Standard cable length

Earth (ground)

Art. No. GA-00200
Cable length 3 m (9.8 ft) green/ yellow cable with round or U-end terminal



Breaker control cables

Art. No. 04-35030
Cable length 2x2 m (6.6 ft)
Banana contacts (black) in each end

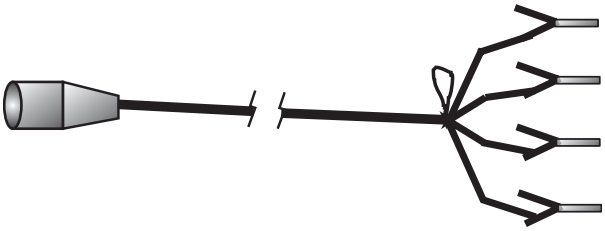
Breaker control cables

Art. No. 04-35032
Cable length 2x2 m (6.6 ft)
Banana contacts (red) in each end

Cable for measuring main contacts (TIMING)

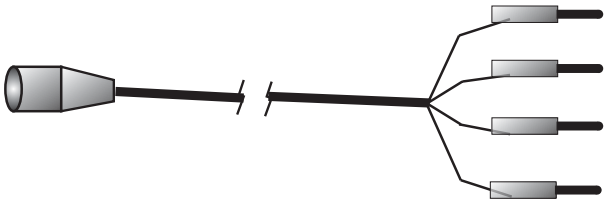
Art. No. GA-00160
Cable length 5 m (16.4 ft)
5-pin XLR contact (female) to 4 crocodile clamps.

1x black	Ground GND
1x red	L1
1x yellow	L2
1x blue	L3



Cable for time measuring of auxiliary contacts (AUX1&2)

Art. No. GA-00170
Cable length 2 m (6.6 ft)
5-pin XLR contact (female) to 4 banana contacts (male)
1x black AUX1 GND
1x red AUX1
1x black AUX2 GND
1x red AUX2



Extension cable for above cables (TIMING and AUX1&2), (extra accessories)

Art. No. GA-00150
Cable length 10 m (32.8ft)
5-pin XLR contact (female) to 5-pin XLR contact (male).

Connection cable for motion transducer (MOTION) (extra accessories)

Art. No. GA-00041
Cable length 1 m (3.2 ft)
Shielded, 3-pin XLR contact (female) in one end, unconnected in the other end.

Extension cable for motion transducer (extra accessories)

Art. No. GA-00042
Cable length 7.5 m (24 ft)
Shielded, 3-pin XLR contact (female) to 3-pin XLR contact (male)

13.3 Connections

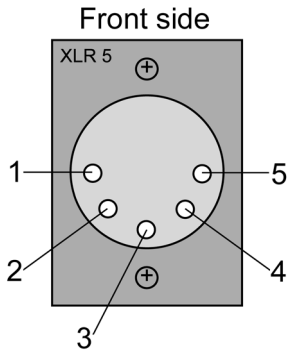
TIMING input

1: Channel L1 signal L1
2: Channel L2 signal L22
3: Common ground ..... GND
4: Channel L3 signal L3
5: Not connected

AUX1&2 inputs

1: Channel AUX1 ground GND1
2: Channel AUX1 signal AUX1
3: Channel AUX2 ground GND2
4: Channel AUX2 signal AUX2
5: Not connected

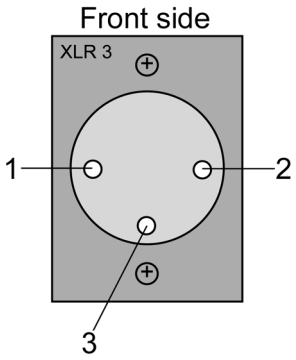
The XLR5 plug, used for both TIMING and AUX1&2 inputs is illustrated below:



Motion input (option)

1: Ground ..... GND
2: Out ..... OUT
3: In ..... IN

The XLR3 plug, used for the MOTION input is illustrated below:



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