Megger

TORKEL 900-series

Battery Load Unit

User guide

Art No. ZP-CS01E	Doc. CS033663IE	V09a	2023

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Battery Load Unit

User guide

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Contents

1 Introduction

1.1 Product description

This manual explains how to use TORKEL 900-series of battery load units, and it also covers the optional TXL (extra load units) and the BVM (Battery Voltage Monitor) system.

The instrument is designed mainly for capacity tests. The unit can be programmed to test a battery bank at constant current, constant power, constant resistance or using a user-defined load profile. TORKEL can also be used for testing battery chargers and other electrical equipment that require resistive load testing.

The BVM (Battery Voltage Monitor) is a battery voltage measurement device that is used for monitoring of cell voltages and battery blocks in battery banks commonly found in electrical power sub-stations, telecom facilities and computer data center UPS systems.

1.2 Features and benefits

Model overview

TORKEL	910	930	950
Current (max)	110 A	220 A	220 A
Voltage (max)	300 V	300 V	500 V
BVM functionality	No	Yes	Yes
Charging measurement	No	Yes	Yes
Full report functionality	No	Yes	Yes

1.3 Receiving instructions

- Check the equipment received against the packing list to ensure that all materials are present. Notify Megger of any shortage.
- Examine the instrument for damage received in transit. If damage is discovered, file a claim with the carrier at once and notify Megger, giving a detailed description of the damage.
- This instrument has been thoroughly tested and inspected to meet rigid specifications before being shipped. It is ready for use when set up as indicated in this user manual.

1.4 Warranty

Products supplied by Megger are warranted against defects in material and workmanship for a period of one year following shipment.

Our liability is specifically limited to replacing or repairing, at our option, defective equipment.

This warranty does not include batteries, lamps or other expendable items, where the original manufacturer's warranty shall apply.

We make no other warranty. The warranty is void in the event of negligence abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

Warranty repair

Equipment returned to the factory for repair must be shipped prepaid and insured.

Contact your Megger representative for instructions and a return authorization (RA) number.

Please indicate all pertinent information, including problem symptoms.

Also specify the serial number and the catalog number of the unit.

2 Safety

2.1 Symbols on the instrument

Caution, refer to accompanying documents.

Caution, risk of electric shock.

Hot, do not cover

Protective conductor terminal.

WEEE, Waste Electronic Equipment. Please utilize your local WEEE collection facilities in the disposition of this product and otherwise observe all applicable requirements.
The unit can also be returned to Megger at any time at no charge for the disposal.

Information duty regarding substances on REACH article 33, SVHC-list

This product contains a coin cell battery which contains 1,2- dimethoxyethane (CAS 110-71-4) above 0.1% by weight.

2.2 Safety instructions

- All safety and operating instructions must be read before using TORKEL.
- All safety and operating instructions for TORKEL must be followed.
- All safety and operating instructions must be retained for future reference.

WARNING

1. The electrical voltage and current used in battery testing is potentially lethal.
   Ensure that the AC supply is disconnected and any battery under test is disconnected before attempting any cleaning or maintenance of TORKEL.
2. Connection and disconnection procedures are extremely important. Be sure to follow the instructions carefully..
3. Do not touch conducting parts of the clamps on the current cables or the voltage sensing cables when they are connected to TORKEL.
4. Always connect protective earth (ground).
5. Misuse of TORKEL can be extremely dangerous.
6. Inspect cable connections to make sure there is no short circuit.
7. Use an easily accessible power outlet. This will ensure that you can disconnect the power quickly in case of a problem.
8. When a lead acid battery is charged or discharged i.e. when there is a current flow through the battery it is always a risk that the battery can explode.
   If there is a bad connection inside the battery and there is a current flow - the connection will burn off and there will be an arc, which will ignite the oxyhydrogen gas in the battery.
   For new open (vented) batteries the risk is medium to low but in old VRLA (sealed) batteries the risk is medium to high.
9. To minimize the risk for personnel injuries:
   Always place TORKEL/TXL as far away from the battery as possible. Never stand close to a battery during charge/discharge.

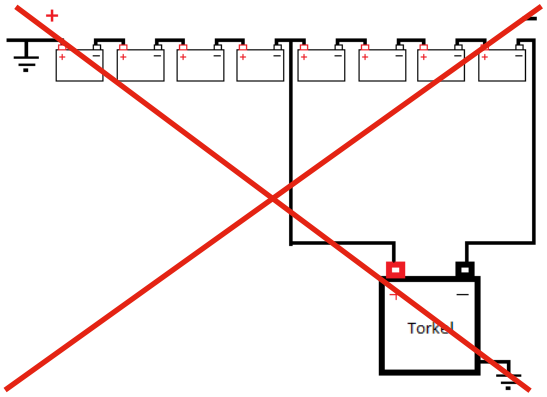
10. Too high discharge current applied on a battery can cause the battery to explode or get overheated. Be sure to not set too high current.
11. If the external current measurement is interrupted or giving false values during the test, the current will rise to a higher level than the set value before the test is shut down. If the battery is too small for this current or in a bad condition - it may explode.
12. Never use the TORKEL/TXL Extra Load in an explosive environment. Never put the TORKEL/TXL Extra Load where it can be reached by battery gas.
13. Improperly connected cables carrying high current can cause fire. Make sure that the cables are not twisted in such a way that could cause them to turn and come loose from the connector.
14. Make sure that there is no dust or dirt in or around the cooling fans before starting a discharge test. After starting a discharge test, check that the fans are running properly and that the airflow is good. Make sure no hair or clothing is sucked into the fans.
15. Position TORKEL/TXL Extra Load where air flow is unobstructed and where it does not come into contact with any flammable or heat-sensitive material. Keep a free distance of 1.5 m (5 ft) to the vertical sides of TORKEL/TXL and 2.0 m (6.5 ft) above TORKEL/TXL.
16. Do not place TORKEL a) near another TORKEL, a) TXL Extra Load or any other heat source or b) where the cooling airflow can be blocked. TORKEL will overheat if there is insufficient cooling.
17. External current shunt may not be used above 300 V DC
18. Do not use any other equipment other than what is provided or specified.

19. TORKEL connected to grounded battery systems

TORKEL connected to positive grounded battery system.

If connected as the picture below. TORKEL's max battery input voltage (voltage between battery input poles) is correct. But the voltage between TORKEL's negative battery input and ground is exceeding the allowed voltage between battery input and ground (500 V).

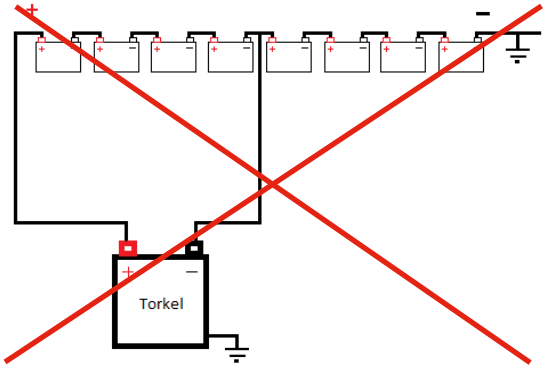
The below hook up must not be used.



TORKEL connected to negative grounded battery system.

If connected as the picture below. TORKEL's battery input voltage is correct (Voltage between battery input poles). But the voltage between TORKEL's positive battery input and ground is exceeding max voltage between battery input and ground (500 V).

The below hook up must not be used.



Important

1.	When using the external current measurement function: ■ Always replace the CT internal battery before a test or use the 9 V DC out from TORKEL. ■ Set the correct current ratio in the external current measurement menu.
2.	Do not use liquid detergents or aero-sols when cleaning TORKEL or TXL units. Use a damp cloth.
3.	If TORKEL has been stored below freezing for an extended period of time, you must allow 3 hours for it to adapt to room temperature.
4.	At high ambient temperatures and high loads, TORKEL will employ a heat reduction discharge scheme that under certain circumstances might induce a high frequency audible noise. This is normal, but can be taken as an indication that TORKEL is working close to its temperature limits.

Protection system

The unit has built-in protection system against over-heating and malfunctioning cooling fans. A built-in circuit breaker is an important component in the safety system. If the temperature will be too high and/or the cooling fans malfunction, the circuit breaker will trip. There is also a melting fuse connected in series with the circuit breaker.

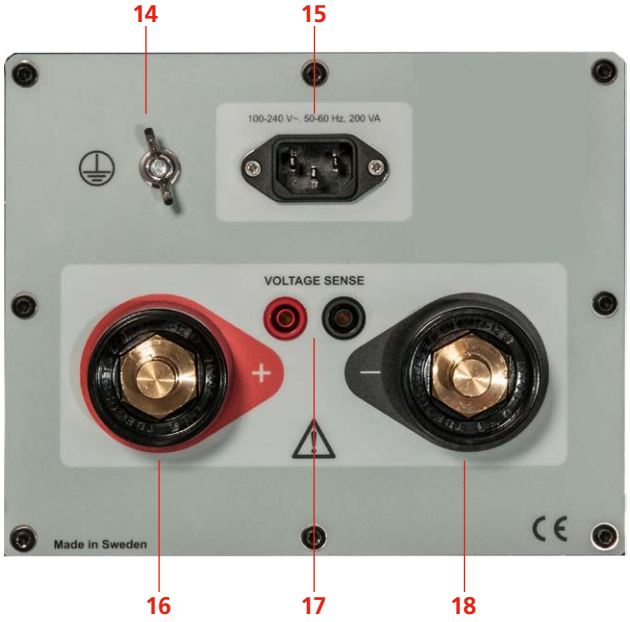
Always follow the safety instructions in section 2.2.

3 Instrument description and Accessories

3.1 Top panel

1. **TXL STOP**
   Output used for stop discharging from an external device (TXL). Galvanically isolated.
2. **SERVICE**
   Connector for service purposes only.
3. **ALARM**
   Output equipped with a relay contact for triggering an external alarm device.
4. **DC OUT**
   9 V output for external current clamp.
5. **I EXT ≤ 1 V**
   Input used to measure current in an external path by means of a DC clamp-on current probe or a current shunt.
6. **Display**
   Touch screen 7"
7. **BVM1, BVM2**
   USB connections for BVM units.
8. **USB connection**
   For USB memory stick.
   The USB memory stick must be FAT32 formatted.
9. **Ethernet connection**
   For reports connected to PC
10. **EMERGENCY STOP**
    Push to stop.
    The connection to the test object (battery bank) is interrupted in the same way as if mains would fail.
    In addition, a separate signal will stop the electronics and the discharge process stops.
    The emergency stop works even if the electronics fail.
    Reset the button by turning it clockwise
11. **Control knob**
    For entering settings etc. Press to confirm a setting.
12. **Buzzer**
    For alarms.
13. **ON/OFF switch**

3.2 Side panel



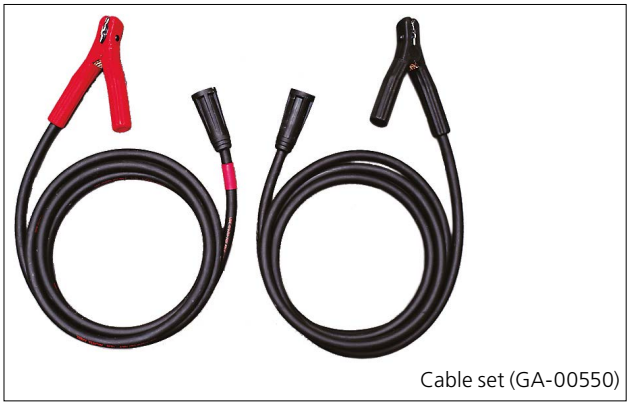
14. Protective conductor terminal
15. **MAINS**
    Connector for mains supply.
16. **+**
    Connection terminal (+) for the battery (or other DC source)
17. **VOLTAGE SENSE**
    Input for sensing voltage at the battery terminals. Impedance to the battery current terminals is >1 MΩ
18. **−**
    Connection terminal (-) for the battery (or other DC source).

3.3 Included accessories

TORKEL 910

Cable set

Cable set, 2 x 3 m, 25 mm² (10 ft), for connecting TORKEL to the battery.



Cable set (GA-00550)

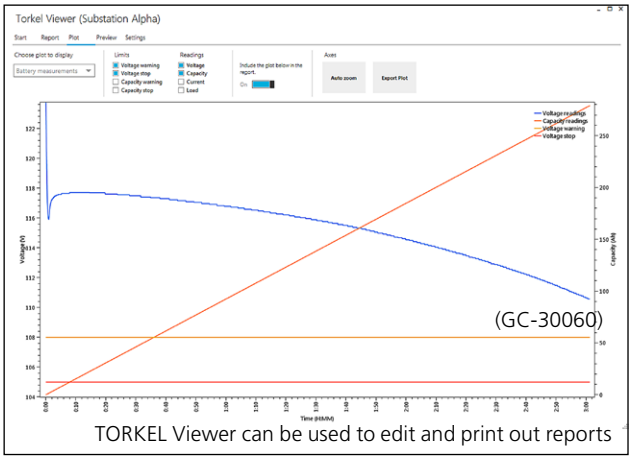
TORKEL 930/950

Cable set

Cable set, 2 x 3 m, 70 mm² (10 ft), for connecting TORKEL to the battery.

Cable set (GA-09550)

TORKEL Viewer



(GC-30060)

TORKEL Viewer can be used to edit and print out reports

Ground cable

5 m, (16 ft) (GC-30060)

3.4 Optional accessories

TXL extra loads

See chapter "2.2 Safety instructions" on page 8

BVM - Battery Voltage Monitoring

Enables automatic battery cell voltage logging during capacity tests. Up to 2x120 units can be used (Daisy-chain).
For complete information see the BVM data sheet.

Sensing leads

For measuring voltage at battery terminals. 2 x 5 m (16.4 ft).

Sensing lead set (GA-00210)

Clamp-on-probe

Clamp-on probe, 1000 A DC. To measure current in external circuit (in combination with the TXL instrument).

Clamp-on-probe (XA-12991)

(GA-00545)

Extension cables

Extension for GA-00550, 2 x 3 m, 25 mm², male/female.

Extension cable set (GA-00552)

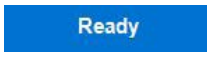
Extension for GA-09550, 2 x 3 m, 70 mm², male/female.

Extension cable set, high rating (GA-09552)

4 Menu system

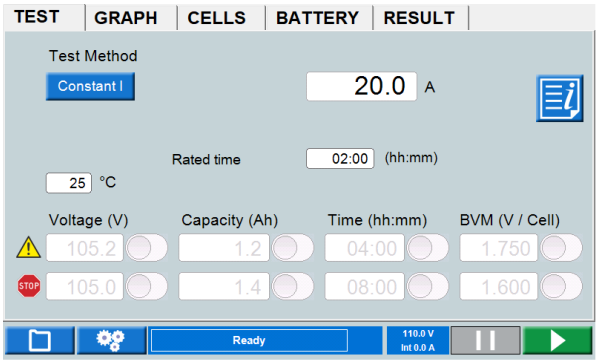
4.1 Main menu

Screen buttons

	Confirm
	Exit without changes
	Run
	Pause the test to make any corrections/changes in the settings*)
	Stop
	Temperature compensation Shown when compensation is enabled
	Quick guide
	Open test file library
	New test
	Test configuration
	Information bar Shows messages and is used for acknowledge alarms
	Information field Shows voltage and current

*) The pause time has limitations regulated by international standards. If the pause time is too long the battery may have to be recharged before a new test is done.

TEST menu



Test method

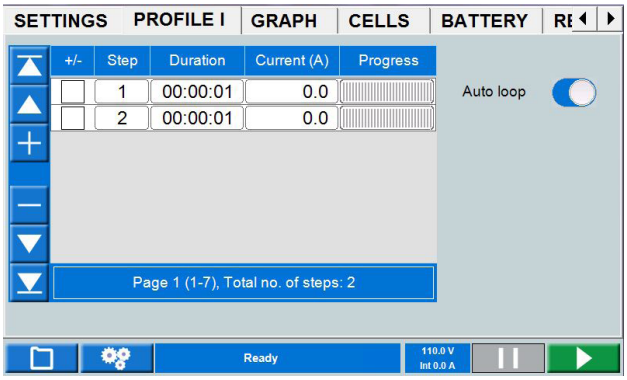
A test can be made in six test methods, "Constant I" is default.

1] Press the button and select test method.

- Constant I (current)
- Constant P (power)
- Constant R (resistance)
- Profile I (current profile)
- Profile P (power profile)
- V Logger (Current with monitoring during charge)

A] For **Constant I, P or R** you press the numeric field and make the settings for the parameter using the On-screen keyboard or the control knob.

For **Profile I** or **Profile P** a new tab will be shown on top of the screen together with a window for the settings.



Here you configure your profile and press  to start the test or press **SETTINGS** to return to the test menu.

For **V Logger** the voltage will be logged during charge. You can set time values for warning and stop.

Warning and stop limit parameters

You can set TORKEL to issue a warning and/or to stop:

- When the voltage has reached a certain level.
- When a certain amount of capacity is discharged.
- After a specified time.
- When a cell voltage has reached a certain level (if BVM is used, see section "9.2 BVM - Battery Voltage Monitor" on page 42).

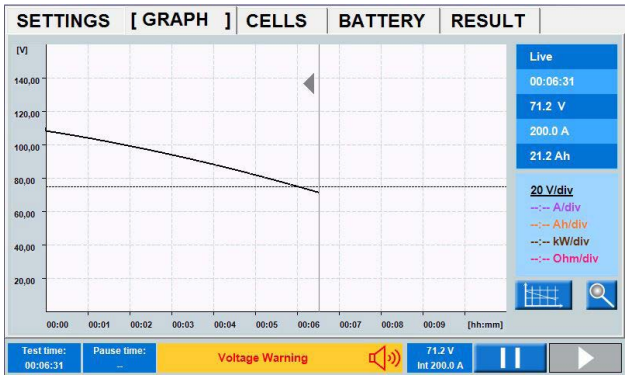
The warning and stop limits can be set and changed during a test.

The settings for the warning and stop levels are independent of each other.

See also chapter "7 Alarm function"

Warning limit

When a "Warning" limit is reached, the "information bar" turns yellow and the warning cause is displayed. The alarm buzzer sounds as well.

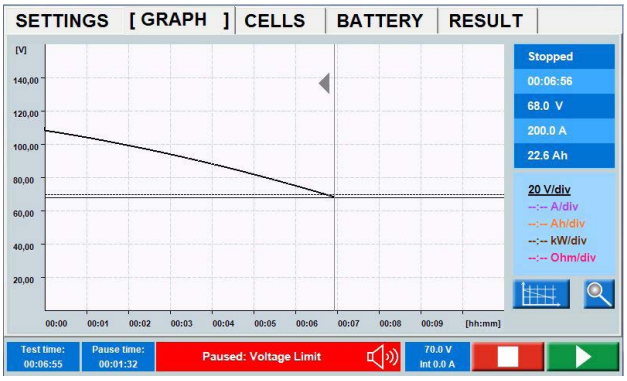


The warning is confirmed by pressing the "information bar" and the alarm buzzer stops to sound.

Note *The test will continue.*

Stop limit

When a "Stop" criteria is reached, the "information bar" turns red and the cause of stop is displayed.



Note *This means that the discharge is stopped and you can change parameters and continue the test or press*  *to close the test.*

When BVM stop limit is set and a BVM gets loose during test, the test stops.

Procedure for ignoring erroneous cells and, for example, connections that give misleading voltage drops is described under "CELLS (optional BVM)" on page 20

Setting the limit parameters

1] Press the numeric field and make the settings for the limit parameter using the On-screen keyboard or using the control knob (press to confirm).

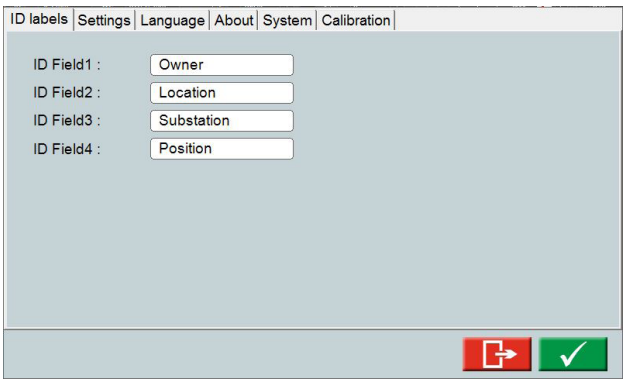
2] Enable the limit by touching the checkbox.

3] Go on with the desired parameters.

Test configuration

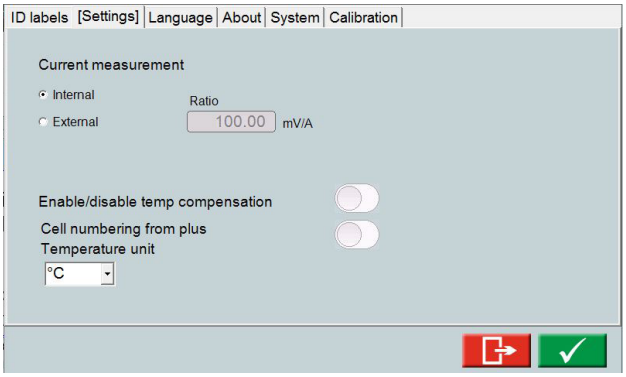
1] Press 

ID Labels



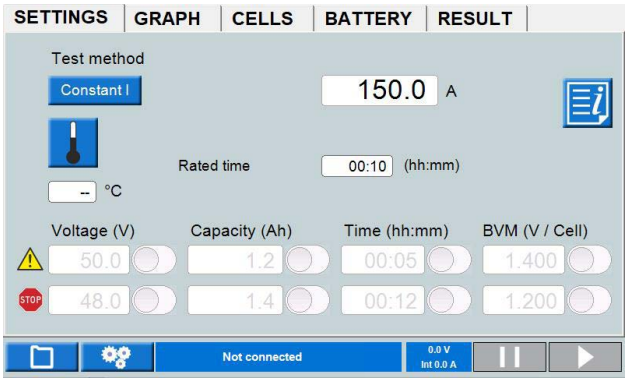
2] Click the label fields and enter the information as desired.

Settings



- Select **Internal** (prefault) or **External**.
  For external current clamp/current shunt set the **Ratio,** see section "6.2 Setting up external current measurement" on page 33.
- If desired enable temperature compensation.
- If desired enable cell numbering from plus (default numbering is from minus).

Temperature compensation



If temperature compensation is enabled, see above. The temp. compensation will be shown in SETTINGS menu.

Note *The activation of temperature compensation in settings remains active until deactivation occurs. The activation forces the user to always enter a temperature before starting a new test.*

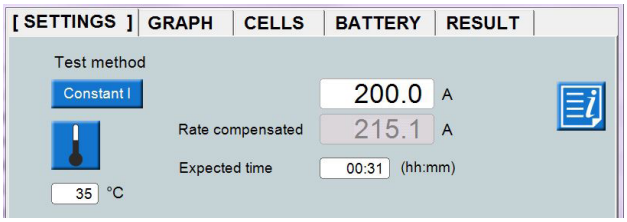
1] Press to make settings for the temperature compensated test.

2] Select **Rate** or **Time** correction.
You can select according to IEEE and IEC standards or **Manual** setting:

Rate Correction

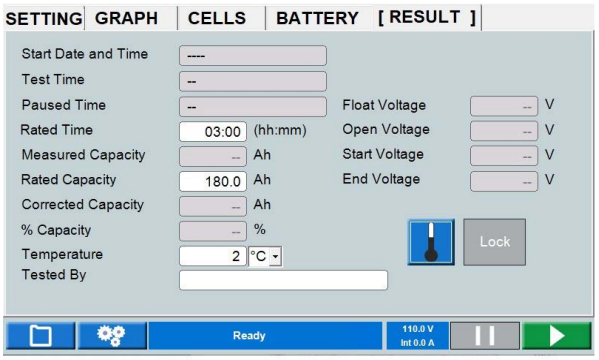
The rate compensation is for capacity tests up to 1 hour. Depending on the set temperature the nominal current will change.

It will be reflected in the "SETTINGS" menu.



In this example 200 A is set as nominal current. The temperature is set to 35 degrees.

It gives a compensated current discharge level on 215.1 A.



RESULT menu with temp compensation enabled.

Temperature compensation after performed discharge test

Before start of a discharge test, set temperature. Set also "Rated time" and "Rated capacity" on the "RESULT" menu

After test has been stopped press the button and save the test.

The "Rated time" and "Rated capacity" can also be set after test has been stopped

At the "RESULT" tab, press the button. and enable the temperature compensation.

The compensated capacity "% Capacity" is now calculated.

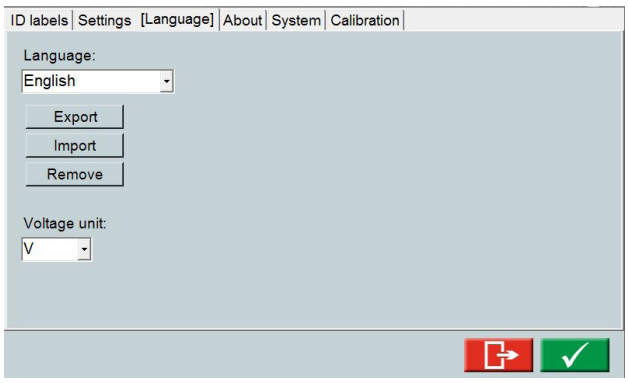
Setting of temperature discharge test

Click on the "temp" button, enable the "Time correction" and set temperature.

The compensated time is calculated for the specified temperature.

Set also the Rated capacity on the "RESULT" tab. The % Capacity" will be calculated after discharge test has been stopped and saved.

Language



- Manage language files for the internal software and select **U** or **V** as the symbol for voltage.

About

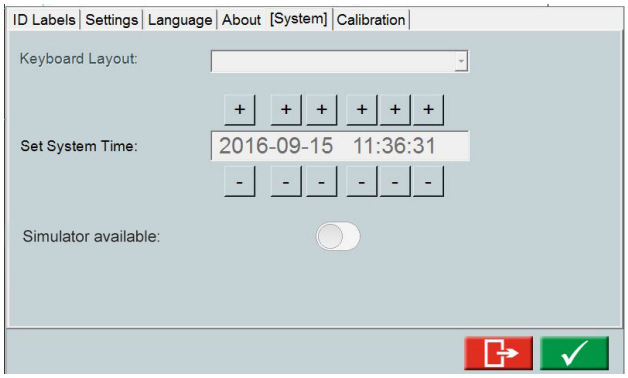
When an USB stick with a license file is inserted in one of the USB ports, the "License file" button will be highlighted in blue.

- Information about software version etc.
- Upgrade License.
  A license file is to be copied to TORKEL
  Upgrade can be performed to TORKEL 930/950.

How to upgrade

1] Press the "License file" button and select the license file from the menu that appears.
The upgrade will be performed directly.

System



- Select external keyboard.
- Set the time
- Simulator mode

Simulator mode

Using simulator mode you are can simulate a test without a battery and BVM connected.

1] Enable "Simulator available".

2] Shut down and restart TORKEL.

3] During start of TORKEL select the "BVM Simulator " button and "Simulator".

4] When the start menu appears, tap on the space bar and select "Connected"
After a short while, the button gets activated. From here a discharge test simulation with BVM can be performed.

5] When the TORKEL has been turned off, the simulator mode will be disabled when TORKEL is turned on again.

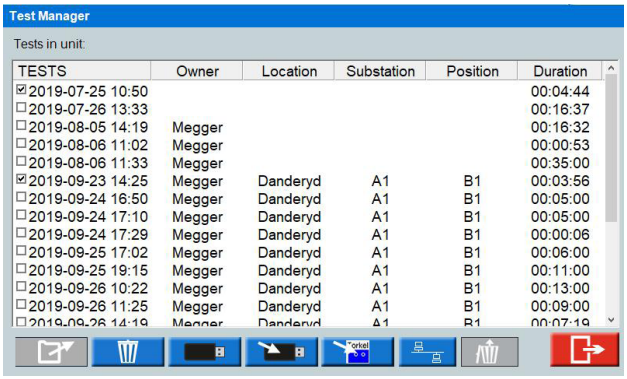
Calibration

See section "11.2 How to calibrate" on page 48.

Test Manager

The database can store up to 30 tests.

1] Press



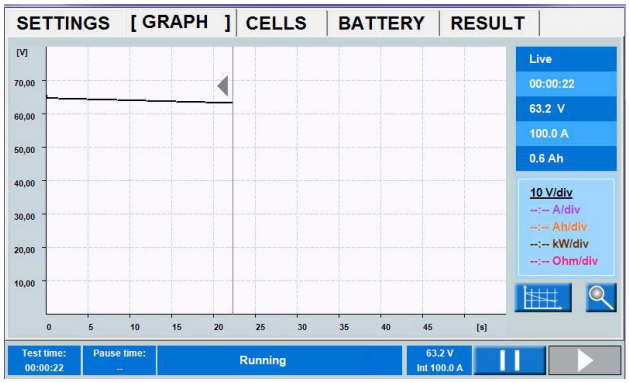
2] Select a test by marking the checkbox.

3] You can use the buttons at the bottom for actions described below:

	to open a test
	to put test in the trash can
	to undelete all tests
	to save test on USB stick for use in PC
	to import data from USB
	to save a test in TORKEL Win format wich makes it possible to open it in TORKEL Win
	To save tests via Ethernet cable to PC"

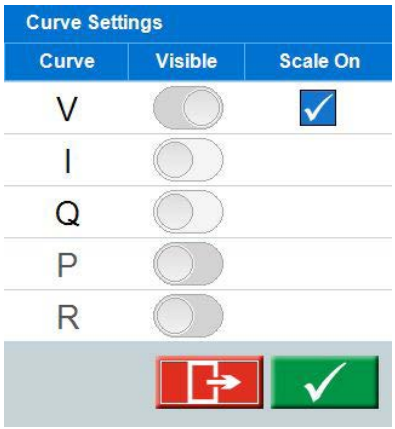
Note *Downloading and opening files in TORKEL may take some time depending on the size of the files.*

GRAPH



Graph settings

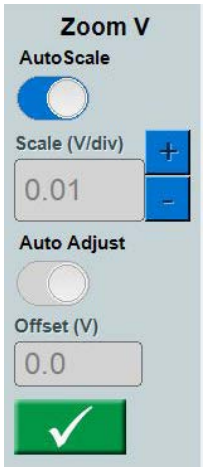
1] Press 



Make settings for the axis. Above is an example of a setting that will show the voltage curve.

Zoom

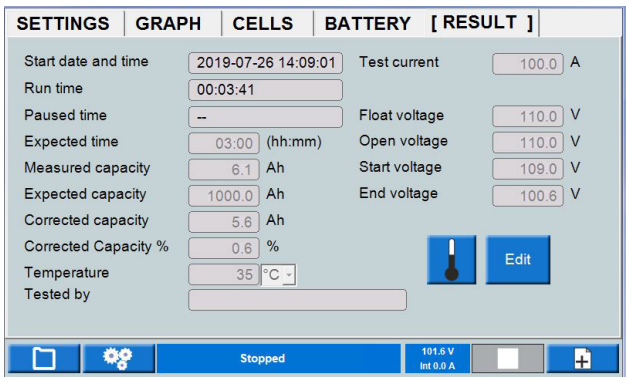
1] Press  to zoom the graph



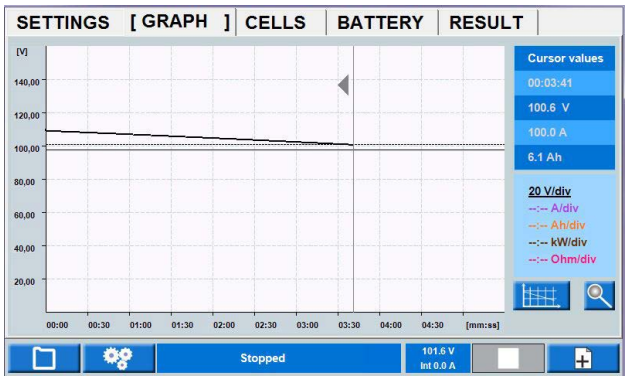
2] Set scale for y-axis and set the offset value or select Auto scale.

RESULT

After ending a test you can go into the different tabs to se the result.



1] In the RESULT and BATTERY tabs you can add information by pressing the "Edit" button.



By pressing in the diagram, test data for the selected time will be shown in the table.

The specific time interval can also be examined by zooming the time axle.

1] Press in the diagram were you want to examine details on the voltage curve.

2] Press the control knob shortly and turn it clockwise to zoom. Tap on the diagram and to scroll the cursor for this time interval.

3] To return to the full test, press the control knob shortly and turn it counterclockwise.

CELLS (optional BVM)

When using the optional BVM equipment you get information of the cell voltages, see also section "9.2 BVM - Battery Voltage Monitor" on page 42.

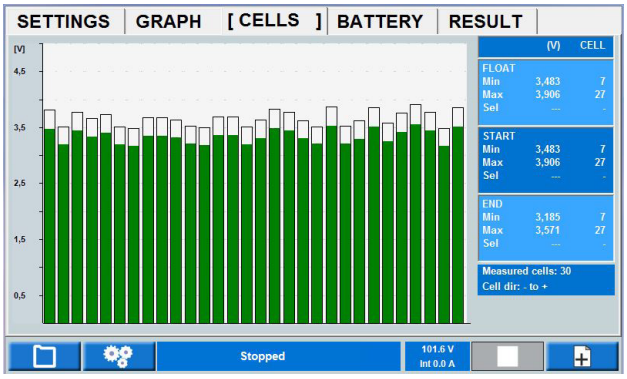


Diagram shows voltage per cell during the test. Numbering of cells depends on cell direction (cell 1 "+" or "-"). Information on cell numbering and direction are displayed on the screen.

- The LIVE voltage means the present voltage
- The FLOAT voltage means the voltage read prior to removing the battery charger.
- The START voltage is when the discharge tests start.

1] By pressing a cell bar, readings can be seen in the table as the "Sel" value.
The cell direction can be selected either from plus to minus or opposite (cell 1 "+" or "-")

Stop limit on cell voltage

If a cell reach the stop limit during a test it is possible to ignore the cell for future stop.

1] Press the status bar to silent the alarm

2] Shoot out or disconnect the failing cell/cells. The BVM should be kept in the loop.

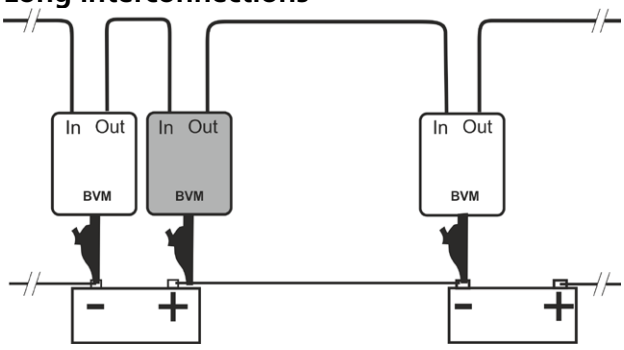
3] Press  to continue the test

Note *All BVMs that read 0V when restarted will be ignored for future cell voltage stop.*

How to ignore voltage drop in long interconnections in battery strings

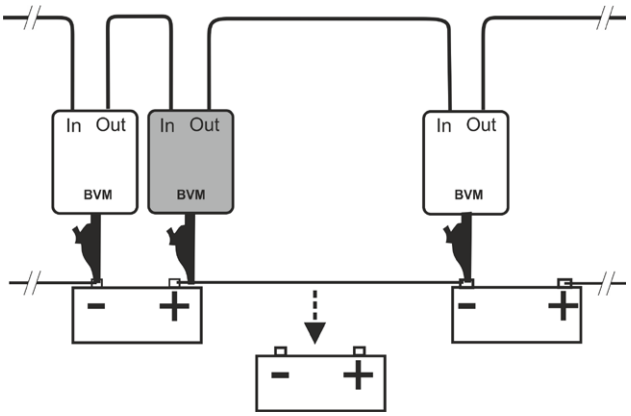
If there is a long interconnection in a battery string the voltage drop during a discharge test will affect the cell voltage value. This voltage drop can be cancelled by connecting a BVM on each side of the interconnection. It will be a 0 V bar, displayed as a gap in the bar graph. When the test starts all 0 V bars will be ignored and removed from the bar graph, in the data collection and in the report.

Long interconnections



Connection change if there is a voltage drop in the interconnection.

Disconnected cell



Connection change when a battery cell voltage drops below set limit. Faulty battery is disconnected but the BVM should remain in the loop.

4.2 TORKEL Viewer

TORKEL Viewer is delivered together with TORKEL (not with TORKEL 910) on a USB stick.

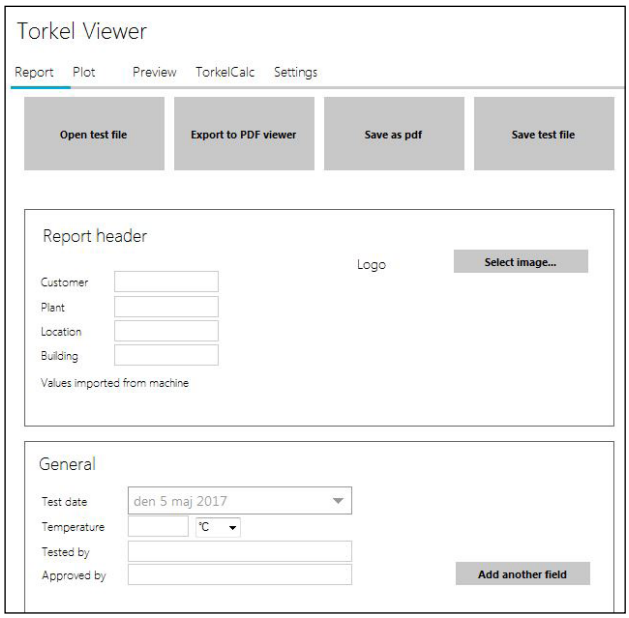
TORKEL Viewer runs under MS windows 7,8 and 10.

1] **Double click the: "TORKEL Viewer Setup.msi" file.**

2] **Follow instructions and the TORKEL Viewer will be installed on your computer.**

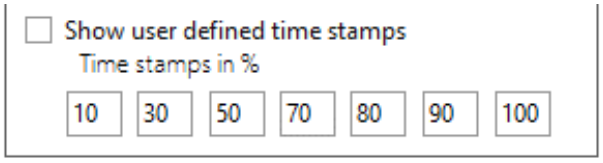
Note *After installation you can find a demo file at C:\Program Files (x86)\Megger\Torkel Viewer\Reporting.*

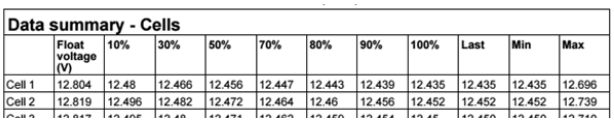
3] **Click**  **to open the program.**



- The "Report " tab includes several settings and options on how to set up the test report.
  With the "Save test file" button a test can be prepared in advance with information of the test object.
  Cell voltage reading with possibility of 7 percentage intervals applies to relevant standards and a possibility for user-defined choice.

Show user defined time stamps





Data summary - Cells

	Float voltage (V)	10%	30%	50%	70%	80%	90%	100%	Last	Min	Max
Cell 1	12.804	12.48	12.466	12.456	12.447	12.443	12.439	12.435	12.435	12.435	12.696
Cell 2	12.819	12.496	12.482	12.472	12.464	12.46	12.456	12.452	12.452	12.452	12.739

- The "Plot" tab gives you the possibility to check the battery measurements or the BVM voltages diagram.
  By right click and drag on the y-scale of resp. entity the diagram lines can be modified.
  The time scale can also be adjusted by right click and drag the scale.
  By placing the cursor in the diagram and scrolling with mouse, zooming of the time scale will be done.
  Clicking the "Auto zoom" will reset the diagram to the default appearance.
  Clicking the "Export Plot" button will export the diagram in a .png format.
  The BVM measurements can also be examined by selecting the BVM voltage diagram in the "Choose plot to display".
  The diagram can be moved by right click and drag.
  Each voltage cell can be checked by clicking on the cell bar. Float, start and end values are presented.
- The "Preview" tab is simply a way of checking the report after modification, prior saving or print out of the report.
- The "TorkelCalc" tab is used for calculating how many TORKELs and TXLs are needed.
- The "Settings" tab contains, among other things, language setting.
- The cell bar diagrams shows numbering of cells and whether it has + or - cell direction.

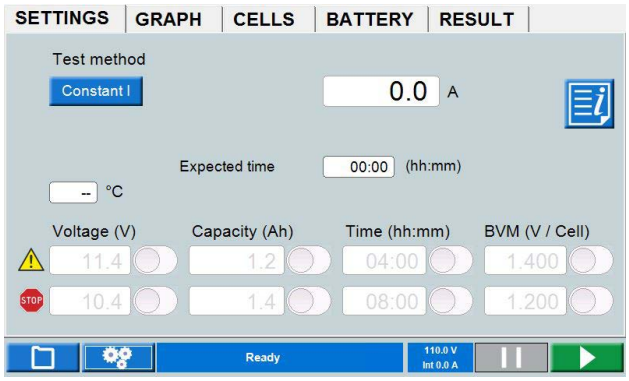
5 Making a test

5.1 Preparations for testing

WARNING
See the chapter "2.2 Safety instructions" on page 8.

1] Connect TORKEL to the mains voltage.

2] Switch on TORKEL.
The display will show the following after a short time:



Connecting the current cables to the battery

Important
Connection and disconnection procedures are extremely important. Be sure to follow the instructions.

Use the cables supplied with TORKEL or other cables of suitable size. Follow the numbered steps that are set forth below. Inspect each connection to make sure it is securely fitted.

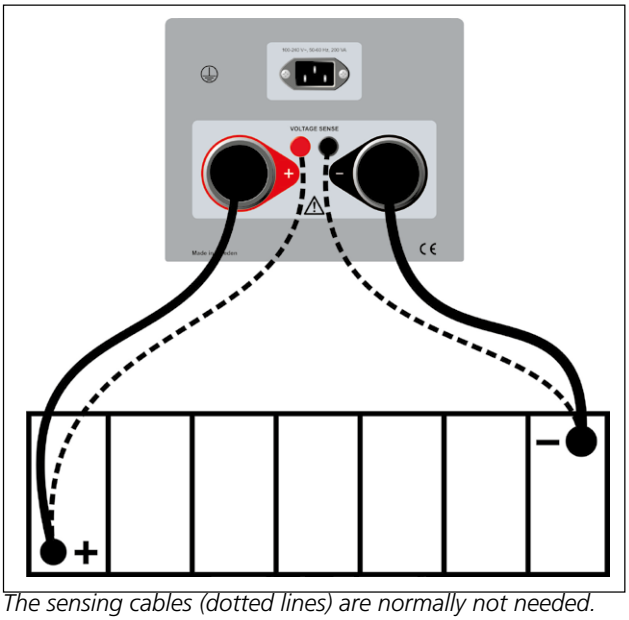
1] Connect one end of the first cable to the negative (-) terminal on TORKEL.

2] Connect the other end of the first cable to the negative (-) pole of the battery.

3] Connect one end of the second cable to the positive (+) pole of the battery.

4] Connect the other end of the second cable to the positive (+) terminal on TORKEL.

Tip
To get a more accurate voltage reading when current cables are long and the discharge current is high.
Connect the voltage sensing cables between the "VOLTAGE SENSE" input on TORKEL and the battery terminals.



The sensing cables (dotted lines) are normally not needed.

Note
TORKEL automatically selects the voltage range when voltage is applied to the high-current terminals.

If load polarity is incorrect the load will not be connected internally. On the display the "space bar" will be red and an alarm will sound. This is true for both the battery and voltage sense terminals.

You can start a test in any of the menus. While test is running you can go into any tab and pause the test and make changes and continue the test.

Emergency stop button

The button is intended to be used if a fault occur in the test object and/or the external testing cables.

1] Press the button  to immediately interrupt discharging.
TORKEL will still have power and the cooling fans will run at maximum speed.

2] Reset the stop button by turning it right.
If you consider it safe to continue the test you can start the test again.

5.2 Test at constant current

Preparations

Follow the safety precautions set forth in section "2.2 Safety instructions" on page 8 and the preparations for testing in section "5.1 Preparations for testing" on page 24.

Select "Test Method"

1] Press "Constant I"

2] Set the desired current by pressing the numeric field and make the settings for current using the On-screen keyboard.

3] Make settings for warning and stop limits, see section "Warning and stop limit parameters" on page 17.

Tip
You can change the settings for current and limits at any time in "TEST".

Starting the test

1] Wait for "Connected ready" to be displayed on the information bar and the control knob is lit.

2] Press 
The current value (A) will be displayed and the control knob lamp will start blinking.

Pausing the test

1] Press 

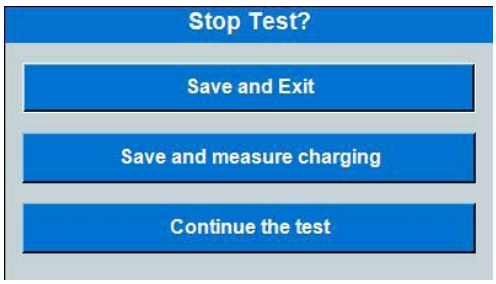
2] Restart by pressing 

Note *Any TXL Loads connected to TORKEL must be restarted manually.*

Ending the test

WARNING
Do not disconnect any cables until the test is completed and stopped

1] Press 



2] Press "Yes"

3] Disconnect the cables in reverse order that they were connected.

WARNING
Do not connect a discharged battery to a battery that has not been discharged. The batteries must be charged to the same potential (voltage) before they are connected together.

For viewing results and report see section "5.7 Viewing results and reporting" on page 30.

5.3 Test at constant power

TORKEL can be used to conduct a discharge test at constant power instead of constant current. All procedures are the same except that you must set TORKEL differently before starting – you set the power instead of the current.

Preparations

Follow the safety precautions set forth in section "2.2 Safety instructions" on page 8 and the preparations for testing in section "5.1 Preparations for testing" on page 24.

Configuring TORKEL for constant power

1] Calculate the current at the end of the test (divide the power by the voltage).

2] Then make sure that the total current does not exceed 2999 A and that the TORKEL and TXL units can load with the required current throughout the test.

Select "Test Method"

1] Press "Constant P"

2] Set the desired Power by pressing the numeric field and make the settings for power using the On-screen keyboard.

3] Make settings for warning and stop limits, see section "Warning and stop limit parameters" on page 17.

Tip
You can change the settings for power and limits at any time in "TEST".

Starting the test

4] Press ▶
The power value (kW) will be displayed and the control knob lamp will blink.

Pausing the test

1] Press ❙❙

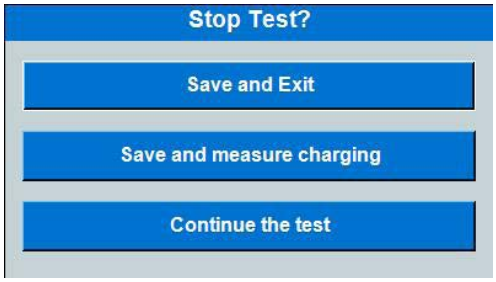
2] Restart by pressing ▶

Note *Any TXL Loads connected to TORKEL must be restarted manually.*

Ending the test

WARNING
Do not disconnect any cables until the test is completed and stopped

1] Press 



2] Press "Yes"

3] Disconnect the cables in reverse order as described in section "Connecting the current cables to the battery" on page 24

WARNING
Do not connect a discharged battery to a battery that has not been discharged. The batteries must be charged to the same potential (voltage) before they are connected together.

For viewing results and report see section "5.7 Viewing results and reporting" on page 30.

5.4 Test at constant resistance

TORKEL can be used to conduct a discharge test at constant resistance instead of constant current. All procedures are the same except that you must set TORKEL differently before starting – you set the resistance instead of the current.

Preparations

Follow the safety precautions set forth in section "2.2 Safety instructions" on page 8 and the preparations for testing in section "5.1 Preparations for testing" on page 24.

Select "Test Method"

1] Press "Constant R"

2] Set the desired Resistance by pressing the numeric field and make the settings for resistance using the On-screen keyboard.

3] Make settings for warning and stop limits, see section "Warning and stop limit parameters" on page 17.

Tip
You can change the settings for resistance and limits at any time in "TEST".

Starting the test

4] Press 
The resistance value (Ohm) will be displayed and the control knob lamp will blink.

Pausing the test

1] Press 

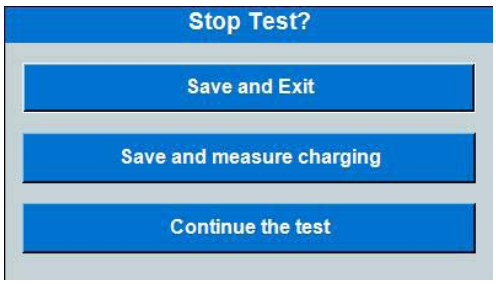
2] Restart by pressing 

Note *Any TXL Loads connected to TORKEL must be restarted manually.*

Ending the test

WARNING
Do not disconnect any cables until the test is completed and stopped

1] Press 



2] Press "Yes"

3] Disconnect the cables in reverse order as described in section "Connecting the current cables to the battery" on page 24

WARNING
Do not connect a discharged battery to a battery that has not been discharged. The batteries must be charged to the same potential (voltage) before they are connected together.

For viewing results and report see section "5.7 Viewing results and reporting" on page 30.

5.5 Testing with a load profile

TORKEL can be used to conduct a test that incorporates a current profile or power profile. A profile can consist of up to 20 time intervals. The duration and the magnitude of the load can be specified for each interval.

If you want step or steps to be repeated you enable the "Auto Loop".

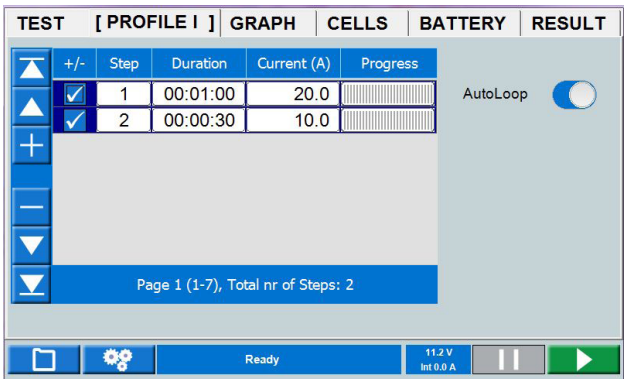
Note *Using more than 20 steps will slow the system.*

Preparations

Follow the safety precautions set forth in section "2.2 Safety instructions" on page 8 and the preparations for testing in section "5.1 Preparations for testing" on page 24.

Select "Test Method"

1] Press "Profile I" or "Profile P"



2] Set the desired "Duration" by pressing the numeric field and make the settings for duration using the On-screen keyboard.

3] Set the desired current or power by pressing the numeric field and make the settings for current using the On-screen keyboard.

4] Make settings for warning and stop limits, see section "Warning and stop limit parameters" on page 17.

Tip
You can change the settings for current/ power and limits at any time in "TEST".

Starting the test

5] Press ▶
The current value (A) or power (kW) will be displayed and the control knob lamp will blink.

Pausing the test

1] Press ❙❙

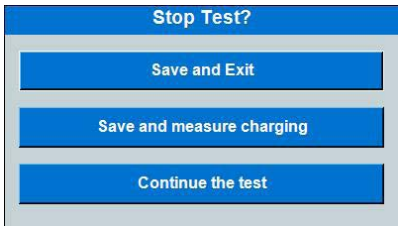
2] Restart by pressing ▶

Note *Any TXL Loads connected to TORKEL must be restarted manually.*

Ending the test

WARNING
Do not disconnect any cables until the test is completed and stopped.

1] Press ■



2] Press "Yes".

3] Disconnect the cables in reverse order as described in section "Connecting the current cables to the battery" on page 24

WARNING
Do not connect a discharged battery to a battery that has not been discharged. The batteries must be charged to the same potential (voltage) before they are connected together.

Tip
You can select to make the charging test immediately after a discharging test and keep all connection as they are.

For viewing results and report see section "5.7 Viewing results and reporting" on page 30.

5.6 V Logger

TORKEL can log the voltage during charging of the batteries.

Starting "V Logger" directly after a discharge test

Tip
You can select to make the charging test immediately after a discharging test and keep all connection as they are.

1] Press"Save and start V logger".
This will be a separate new test.

2] Press ▶

3] Start charging the batteries.

4] You can change the Warning and Stop limits during the test.

Starting "V Logger" as a separate test

Preparations

Follow the safety precautions set forth in section "2.2 Safety instructions" on page 8 and the preparations for testing in section "5.1 Preparations for testing" on page 24.

Select "Test Method"

1] Press "V Logger" button.

2] Make settings for warning and stop time, see section "Warning and stop limit parameters" on page 17.

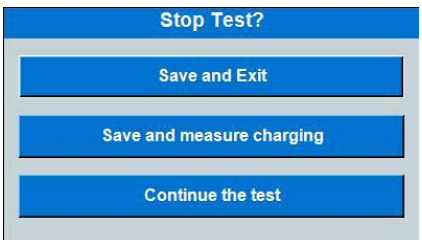
3] Press ▶

4] Start charging the batteries.

Ending the test

WARNING
Do not disconnect any cables until the test is completed and stopped.

1] Press ■



2] Press "Yes".

3] Disconnect the cables in reverse order as described in section "Connecting the current cables to the battery" on page 24

WARNING
Do not connect a discharged battery to a battery that has not been discharged. The batteries must be charged to the same potential (voltage) before they are connected together.

5.7 Viewing results and reporting

Viewing the results

1] Select the "RESULT" tab to view the test results

2] In the RESULT and BATTERY tabs you can add information by pressing the "Edit" button.

Float voltage	The voltage value prior the charger is removed.
Open voltage	The value prior start of discharge test.
Start voltage	The value given after the first initial decrease of the battery bank at a start of a discharge test.
End voltage	The value at the end of discharge test

REPORT

The saved tests can be stored on an USB memory stick and transferred to a PC or transferred using FTP communication. The included PC software TORKEL Viewer can be used to edit and print out reports. See paragraph "4.2 TORKEL Viewer" on page 30.

Edited reports can be transferred back to TORKEL i.e. you can design the test and settings in TORKEL Viewer.

Note *The USB memory stick must be FAT32 formatted.*

Download tests to PC with Ethernet cable

Method 1

Using a data switch between TORKEL and the PC.

1] Connect the Ethernet cable to TORKEL connector

2] Open up the file manager on TORKEL.

3] Press the button.
The Transfer menu opens up with IP address.

4] Start the TORKEL Viewer.

5] Select “Open FTP connection”.

6] See section “TORKEL FTP browser” below.

Method 2

Connecting Torkel to PC with an Ethernet cable(without data switch).

1] Connect the Ethernet cable to Torkel(right "service" connector)

2] Open up the file manager on TORKEL.

3] Press the  button. Transfer menu opens up with IP address.

4] Setup of IP address on PC, Win 10:

5] From the Control Panel
Network and Internet
Network and sharing centre

6] Click on network "Ethernet"
Properties

7] Double click on "Internet Protocol Version 4(TCP/IPv4)"

8] Mark the "Use following IP address:"

9] Type in the IP address seen on TORKEL and change the last digit to another number.

10] Click on the "Subnet mask:" Values automatically filled.

11] Press "OK" and "OK" to verify change of settings.

12] Start TORKEL Viewer and select "Open FTP connection".

13] See section "TORKEL FTP browser" below.

TORKEL FTP browser

14] TORKEL FTP browser now opens up.

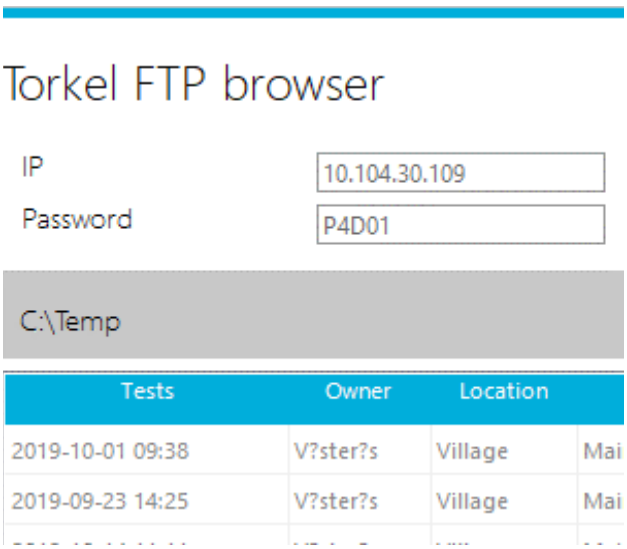
15] To establish a connection with TORKEL, write in the IP address that are given on Torkel.

16] The password is the serial number on TORKEL.

17] Press "Connect".

18] A list of the test files in TORKEL shall now appear.

19] By clicking in the grey field, a library can be selected where test files shall be stored. In the picture below, It's C:\Temp.



20] To save a test file to PC, mark the test file and press the "Download" button.

21] A test can also be transferred to TORKEL by selecting the "Upload" button.

22] Tests can be deleted in TORKEL by selecting a test in the list and click "Delete".

6 External current measurement

6.1 General

External current measurement must be used when:

- TORKEL is working together with TXL Loads.
- Testing without disconnecting the regular load.
  Since total current is measured, TORKEL can compensate for changes attributable to the regular load. The total current from the battery is then kept at a constant value. This ensures accurate test results.

The external current measurement function enables TORKEL to measure the total current in an external path and base regulation on this measurement.

A DC clamp-on current probe (optional accessory) has to be used for this measurement. It can be applied at one of the battery terminals or at an inter-cell connector. The DC clamp-on current probe must measure the total current, including that which passes through TORKEL.

A current shunt can also be used, but this requires opening the current path and connecting the shunt in series. The current shunt must be connected to the negative side of the battery.

WARNING
External current shunt may not be used above 300 V DC

Important
Always activate the warning and stop limit functions when using external current measurement. This will protect your batteries if the DC clamp-on current probe will malfunction.

Important
If a current shunt is used it must be connected on the negative side of the battery.

Tip
For tests where it is important to obtain the desired current within a few seconds or less it is better to use internal current measurement since it provides faster regulation.

6.2 Setting up external current measurement

WARNING
See the chapter "2.2 Safety instructions" on page 8.

DC clamp-on current probe

Preparation and requirements of the DC clamp-on current probe to be used.

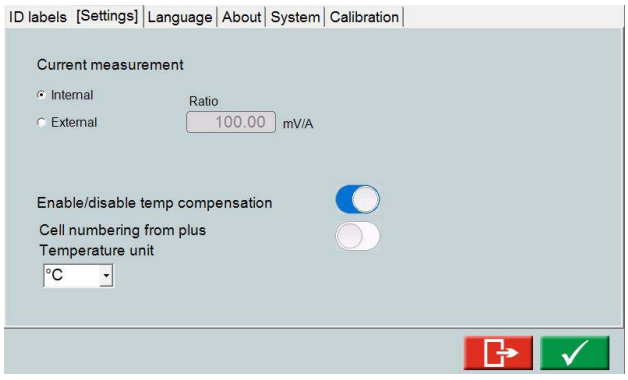
- The DC clamp-on current probe output voltage must not exceed 1 V.
- Make sure that the DC clamp-on current probe has fresh batteries. The batteries must last throughout the entire test.
- The DC clamp-on current probe must be accurate and calibrated and it must be able to carry a load of 600 kΩ. Please note that a DC clamp-on current probe is usually less accurate in the lowest part of its measurement range.

Resetting the output voltage

1] Place the DC clamp-on current probe as far as possible from any magnetic field

2] Connect a DC voltmeter (set to 2 V full scale) to the DC clamp-on current probe.

3] Switch on the DC clamp-on current probe and adjust its zero knob to set the output to 0.0 V



The mV/A ratio for the input can be set to a value between 0.1 mV/A and 100 mV/A.

1] In "TEST" press 

2] Press "Settings".

3] Select "External" for "Current measurement".

4] Press the numeric field to set the "Ratio" for the current clamp to be used 

5] Press 

6] Activate the warning and stop limit functions.

7] Connect the DC clamp-on current probe to input **I EXT ≤ 1 V**. Best results are obtained if the cables running from the DC clamp-on current probe are twisted.

Note *If the DC clamp-on current probe has an adapter for using external power supply. Use the power supply from TORKEL (DC Out) connector, that gives 9 V.*

Important
The DC clamp-on current probe must always be applied in such a way that current through TORKEL is included in the measurement.

8] Apply the DC clamp-on current probe to the conductor.

9] Turn on the power switch on the DC clamp-on current probe.

10] Make the setup for preferred test mode.

Troubleshooting

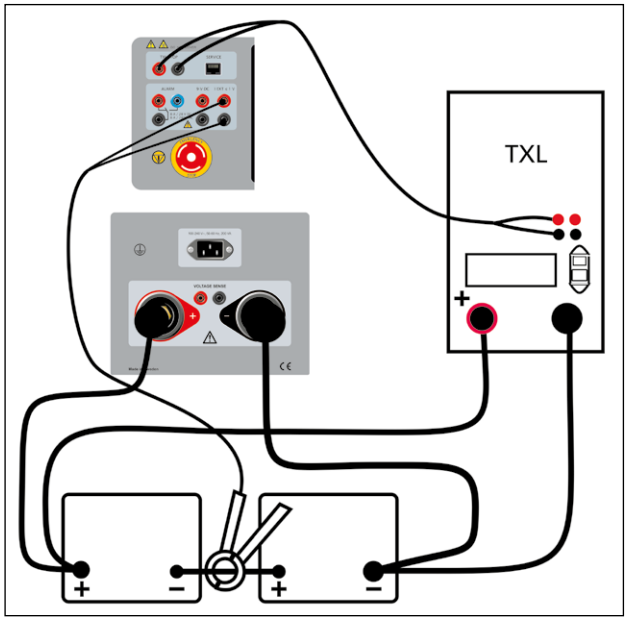
1] Check that the DC clamp-on current probe is properly connected to TORKEL.

2] Check that the DC clamp-on current probe is switched on.

3] Check that the DC clamp-on current probe has fresh batteries.

4] Check the following settings in “TEST SETTINGS”, "Settings":
- “I measurement” must be set to “External”.
- The mV/A ratio must match the ratio that appears on the DC clamp-on current probe itself.

6.3 TORKEL used together with TXL Extra Load



A current shunt can also be used, but this requires opening the current path and connecting the shunt in series

1] Set the parameters on Torkel.

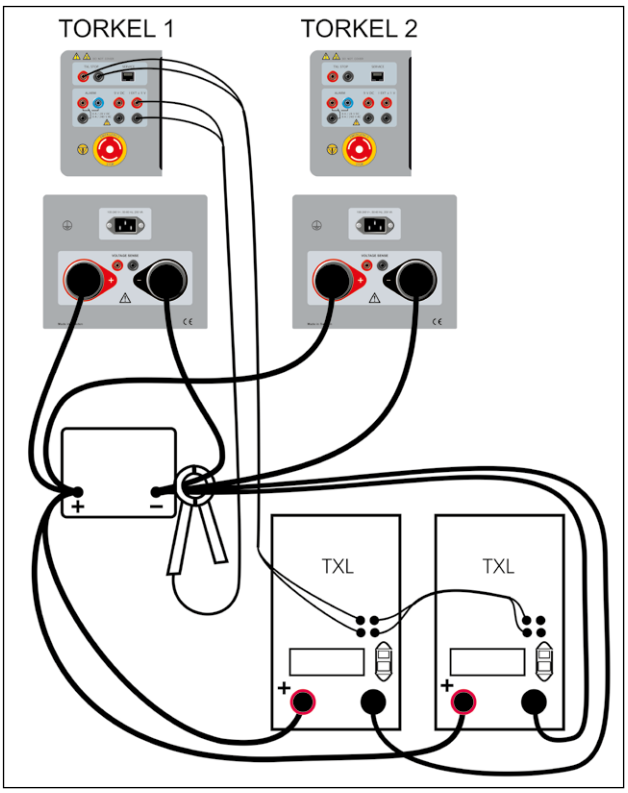
2] Decide voltage and resistor value on TXL.

3] Lift the breaker on TXL to start the discharge with TXL.

4] Start the discharge from Torkel.

Multiple units used together

One TORKEL control



Torkel 1 regulates the total current and also stops the TXL units at end of test.

1] Apply the clamp-on-probes as illustrated above.

2] Set the desired total current on TORKEL 1.

3] Set max current on TORKEL 2.

4] Set warning limits only on TORKEL 1.

5] Set the stop limits. The voltage and test period (time) can be set on each individual TORKEL. Stopping after a certain capacity (Ah) is reached can only be activated on TORKEL 1.

Note *Only TORKEL No. 1 is to control the TXLs.*

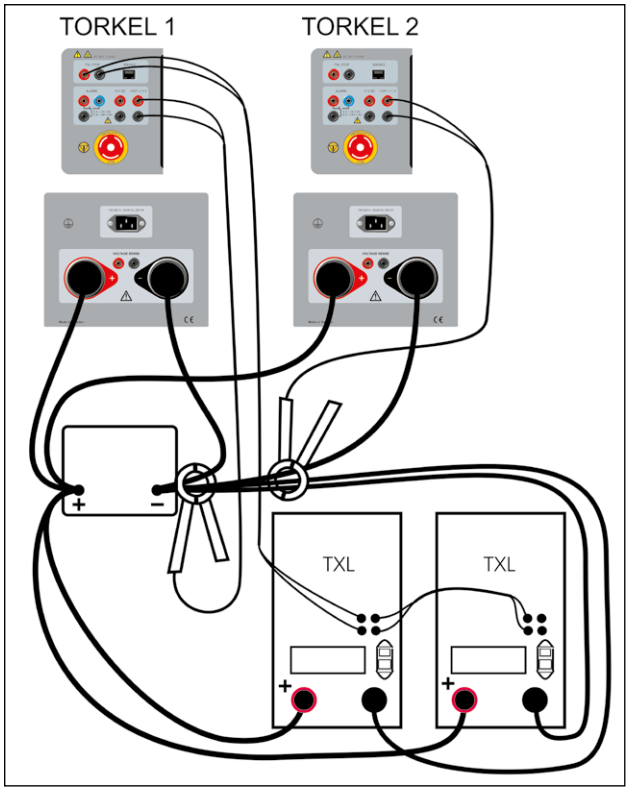
6] Set switch <F1> to the upper (ON) position on the TXLs.

7] Then start the TORKEL that has the highest number (when numbered as set forth above). Now start the TORKEL with the second highest number, then the third highest, etc. Finally, start TORKEL 1.
Starting the TORKELs in this order prevents the current from being higher than desired at the beginning of the test.

Two or more TORKEL and TXL units

TORKEL 1	Measures the entire battery current.

TORKEL 2	Measures all current except the current through TORKEL 1.
TORKEL 3	Measures all current except the currents through TORKEL 2 and TORKEL 1 (and so forth).
The last TORKEL	Measures only the current through itself and the TXLs.



Example with two TORKELs. The first TORKEL regulate the TXLs and the second TORKEL contributes in the total regulation.

1] Apply the clamp-on-probes as illustrated above.

2] Set the desired total current (same value) on both (all) TORKEL units.
As a result, the maximum regulation capability of all TORKEL units will be used. You do not need to pay any attention to the message reading "Cannot regulate" as long as it does not appear on TORKEL No. 1.

3] Set warning limits only on TORKEL No. 1.

4] Set the stop limits. The voltage and test period (time) can be set on each individual TORKEL. Stopping after a certain capacity (Ah) is reached can only be activated on TORKEL No. 1.

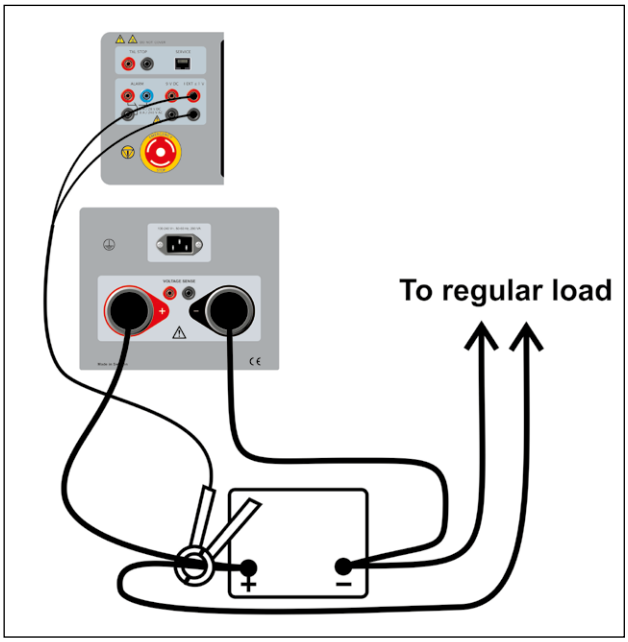
Note *Only TORKEL No. 1 is to control the TXLs.*

5] Set switch <F1> to the upper (ON) position on the TXLs.

6] Then start the TORKEL that has the highest number (when numbered as set forth above).

Now start the TORKEL with the second highest number, then the third highest, etc. Finally, start TORKEL No. 1.
Starting the TORKELs in this order prevents the current from being higher than desired at the beginning of the test.

Constant current, regular load connected



A current shunt can be used instead of the DC clamp-on current probe but this requires opening the current path and connecting the shunt in series.

7 Alarm function

7.1 Description

The TORKEL alarm function is provided by a buzzer and a relay connected to the <ALARM> - connector. An external alarm device can be connected to this connector if desired.

Devices higher than Cat II must not be attached to the alarm connector.

Relay contact

8 A / 28 V DC
0.28 A / 250 V DC (resistive load only)
8 A / 240 V AC

Connector insulation

Voltage to ground must not exceed 250 V.

The following events can cause an alarm to be issued

- Warning level is passed.
- Discharging is stopped because a stop level is reached.
- TORKEL can not regulate the current to the desired level.
- Thermal protection device trips or a fan does not rotate as expected.
- The connection to the battery is broken.
- Other fault situations such as battery voltage too high or too low or excessive current through TORKEL.

Note *TORKEL will safely interrupt the discharge and issue an alarm if any of the internal temperatures should exceed the safe operating limits.*

Resetting the alarm

You can reset the alarm by pressing the information bar.

8 How to obtain the desired current

8.1 When a single TORKEL isn't enough

TORKEL regulates current by lowering its internal resistance as the voltage drops. However, the resistance elements built into TORKEL impose a limit beneath which further lowering is impossible.

- You must make some simple calculations before starting a test to find out whether or not TORKEL will be able to provide the desired load current.
- You must also make certain that TORKEL will be able to sustain this current until the test ends.

When a single TORKEL cannot provide the current you need, you can:

- Connect one or more TXL Extra Loads to TORKEL.
- Connect two or more TORKELs in parallel.
- Connect two or more TORKELs and two or more TXL Extra Loads into a single system.

When two or more TORKELs are connected into a single system, you will normally use the "External current measurement" function.

TXL connected to TORKEL

TXLs are resistive loads which are unable to provide any sort of regulation. Regulation is provided by TORKEL which measures the total current and keeps it constant. See the chapter headed "2.2 Safety instructions" on page 8 which shows how to connect the TXL(s) and TORKEL(s).

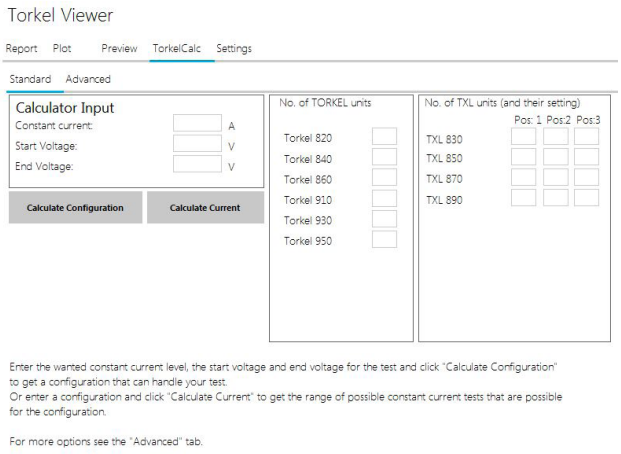
When TXL Extra Loads are connected to TORKEL, you must check:

- That the current flowing through the TXLs when the test is started is not higher than intended.
- That TORKEL has enough regulation capability a) to compensate for the drop in current through the TXLs at the end of the test and b) to set the current to the correct value at the beginning of the test.

How many units are needed?

Automatic calculation - TorkelCalc

In TORKEL Viewer (not included with TORKEL 910) you can use TorkelCalc to figure out how many TORKEL and TXL are needed.
See "4.2 TORKEL Viewer" on page 22.



Manual calculation

1. Number of TXLs – Current flowing through TXL(s) at beginning of a test

At the beginning of the test, as high a percentage as possible of the current must flow through the TXLs, thereby providing the TORKEL(s) with as much reserve regulation capability as possible. However, the current through the TXLs must not, of course, exceed, the desired current value (A).

Tip

Remember that the internal resistances of the TXLs can be set manually. For accurate calculation, add the cable resistance to the internal resistance.

- The current in an individual TXL can be obtained by dividing the voltage at the beginning of the test by the internal resistance of the TXL in question (see tables below).
- Calculate the number of TXLs that you can connect without exceeding the desired total current.

2. Current flowing through TXL(s) at final voltage

- Multiply the total current through the TXL(s) which you obtained in step 1 above by the final voltage, and then divide by the voltage at the beginning of the test.

3. Number of TORKELs – for the current regulation

The TORKEL or TORKELs in the system must regulate the current to the desired value and compensate for the drop in current through the TXL(s) that occurs at the final voltage.

- The amount of regulation needed can be obtained by subtracting the current value (A) obtained in step 2 above from the desired current.
- Calculate the number of TORKELs required for the current regulation.

4. Are all of the TXLs needed?

If the total load-providing capability of the TORKEL(s) exceeds the amount of regulation needed by a wide margin (as set fort in step 3 above), you can perhaps conduct the test with fewer TXLs. If this margin is wider than the current through one of the TXLs at the final voltage, this TXL is not needed.

Note *Discharge is from 2.15 V to 1.8 V per cell*

TORKEL 910

Systems TORKEL 910 and TXL 830 (Pos 2)		
12 V battery (6 cells)		
Max constant current	**No. of TORKEL 910**	**No. of TXL 830**
144 A	1	1
221 A	1	2
298 A	1	3
376 A	1	4
443 A	2	4
24 V battery (12 cells)		
Max constant current(A)	**No. of TORKEL 910**	**No. of TXL 830**
264 A	1	1
419 A	1	2
574 A	1	3

Systems TORKEL 910 and TXL 850 (Pos 3)		
48 V battery (24 cells)		
Max constant current	**No. of TORKEL 910**	**No. of TXL 850**
342 A	1	1
575 A	1	2

Systems TORKEL 910 and TXL 870 (Pos 3)		
110 V battery (54 cells)		
Max constant current	**No. of TORKEL 910**	**No. of TXL 870**
188 A	1	1
266 A	1	2
344 A	1	3
422 A	1	4
532 A	2	4

Systems TORKEL 910 and TXL 870 (Pos 1)		
220 V battery (108 cells)		
Max constant current	**No. of TORKEL 910**	**No. of TXL 870**
112 A	1	1
156 A	1	2
195 A	1	3
235 A	1	4
313 A	2	4

TORKEL 930

Systems TORKEL 930 and TXL 830 (Pos 3)		
12V battery (6 cells)		
Max constant current	**No. of TORKEL 930**	**No. of TXL 830**
183 A	1	1
299 A	1	2
414 A	1	3
24V battery (12 cells)		
Max constant current	**No. of TORKEL 930**	**No. of TXL 830**
384 A	1	1
615 A	1	2
846 A	1	3

Systems TORKEL 930 and TXL 850 (Pos 3)		
48 V battery (24 cells)		
Max constant current	**No. of TORKEL 930**	**No. of TXL 850**
452 A	1	1
685 A	1	2
918 A	1	3
1151 A	1	4

Systems TORKEL 930 and TXL 870 (Pos 3)		
110 V battery (54 cells)		
Max constant current	**No. of TORKEL 930**	**No. of TXL 870**
225 A	1	1
314 A	1	2
392 A	1	3
470 A	1	4
628 A	2	4

Systems TORKEL 930 and TXL 870 (Pos 1)		
220 V battery (108 cells)		
Max constant current	**No. of TORKEL 930**	**No. of TXL 870**
112 A	1	1
156 A	1	2
195 A	1	3
235 A	1	4
313 A	2	4

TORKEL 950

Systems TORKEL 950 and TXL 890 (Pos 1)		
480 V battery (240 cells)		
Max constant current	**No. of TORKEL 950**	**No. of TXL 890**
65 A	1	1
70 A	1	2
90 A	1	2
100 A	1	3
120 A	2	2

9 Optional equipment

9.1 TXL830/850/865/870/890 (Extra Loads)

The TXL830, TXL850, TXL865, TXL870, and TXL890 Extra Loads comprise resistive loads. They can be used together with TORKEL Load Units to increase loading capability. The TXL Extra Loads can not provide regulation by themselves but TORKEL measures total current from the battery and regulates the load characteristic. When TORKEL is stopped it sends a stop signal to the TXL Extra Load.

- TXL830 28 V
- TXL850 56 V
- TXL865 260 V
- TXL870 280 V
- TXL890 480 V

Panel

The panels for the TXL models differ somewhat but the functionality is the same.

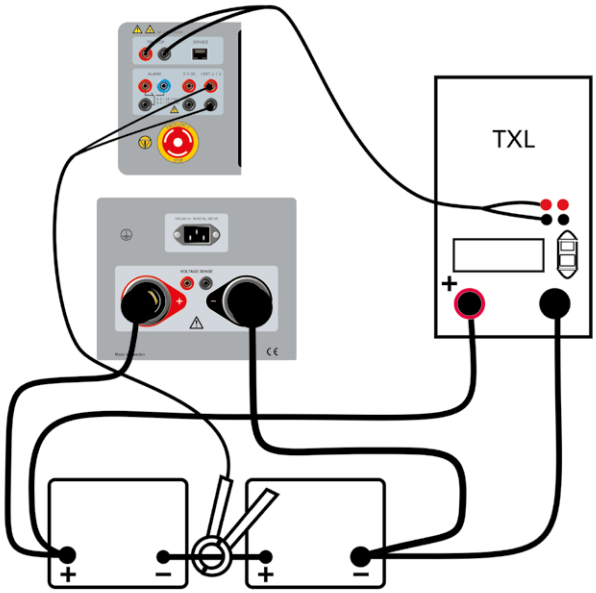
1.	Selector switch Switch used to set the desired voltage range and/or resistance value. **WARNING** **Do not exceed maximum voltage.**
2.	Control **CONTROL IN** Input for control signal from TORKEL-unit. Galvanically isolated. **CONTROL OUT** Output used for the control signal sent from TORKEL to the adjacent TXL-unit. Galvanically isolated.
3.	Circuit breaker **F1** Voltage-controlled circuit breaker that connects the resistors in the TXL Extra Load to the battery. **Note** F1 will not latch or remain at upper (ON) position unless the mains switch is turned on and a control signal from TORKEL is present at the "CONTROL IN" input.. **WARNING** **The circuit breaker F1 is an important component in the safety system. If the temperature will be too high and/or the cooling fans malfunction, the F1 will trip. It is important to never operate the unit if there is any damage or malfunction to the circuit breaker or if any damage or malfunction is suspected.**
4.	Mains inlet **MAINS** Connector used for mains supply, equipped with ON/OFF switch.
5.	Connection terminals for the battery **+ (Terminal)** Positive (+) current connection for battery or other DC source, being tested. **– (Terminal)** Negative (-) current connection for battery or other DC source, being tested. Insulation voltage to ground: 2200 V

Using the TXL

When an extra load is to be used, you must use the external current measurement function (see the chapter headed "6.2 Setting up external current measurement" on page 33).

1] Set the range selector switch to the desired position.

2] Connect as shown below.



3] Connect the control leads between the **TXL CTRL** output on TORKEL and the **CONTROL IN** input on the TXL.
If two or more TXLs are to be used, provide a connection between the **CONTROL OUT** output on the first TXL and the **CONTROL IN** input on the second TXL, etc.

4] Connect the TXL to the mains voltage

5] Switch on the TXL.

Testing

WARNING
See the chapter "2.2 Safety instructions" on page 8. for safety precautions.

1] Proceed in the same way as set forth in the chapter headed "5.1 Preparations for testing" on page 24 but before you start TORKEL you must set switch F1 to upper (ON) position on the TXL. (You must do this manually.)

2] Start TORKEL by pressing 

3] When TORKEL is stopped, manually or by any stop condition, the TXL will also shut off the discharge current.

9.2 BVM - Battery Voltage Monitor

The BVM (Battery Voltage Monitor) is a battery voltage measurement device that is used for monitoring of cell voltages and battery blocks in battery banks commonly found in electrical power sub-stations, telecom facilities and computer data center UPS systems. In conjunction the TORKEL unit, and test data management software, such as PowerDB or TORKEL Win, the BVM enables a completely automated battery bank capacity test to be performed.

BVM is available in three kits:

- BVM150 with 16 BVM units
- BVM300 with 31 BVM units
- BVM600 with 61 BVM units

1. **Control cable – Output socket**
2. **Control cable – Input socket**
3. **Battery sense – Dolphin clip**

The BVM is designed in modular form where one BVM device is used for each battery or "jar" in the string to be tested. It measures the voltage for each battery cell and each unit can handle up to 20 V. The BVMs connects to the batteries in a "daisy-chain" fashion, thereby providing easy and economical expandability to meet the testing requirements for small-to-large battery bank systems. Up to 240 BVMs can be daisy-chained in a single battery bank under test.

The included dolphin-style battery clamp can be easily removed and exchanged with different styles of standard banana plug clamps and/or extension cables to accommodate any battery connection requirement.

There is an Activity LED on the BVM that flashes whenever an individual BVM transmits data back to the data acquisition host computer. This LED activity is useful for indicating that the device is functioning properly.

Note *The BVM readings are continuously ongoing. A typical reading from a battery bank is around 30 seconds. Depending on the number of cells/BVM's connected.*

The other parts of the BVM system: AC Adapter, Power and Signal Connector and cables.

Power & signal connector unit

The BVM units require external 24 DC power and RS-485 data communications for operation. These functions are provided by a combination of an external DC power supply and a Power & signal connector unit". The Power & signal connector conversion is performed within a single moulded plug that connects directly to the laptop computer or other data acquisition device. The Power & signal connector has an RJ-45 connector that provides a connection to the first BVM unit in the chain, and this connection provides RS-485 data and power to all BVM units in the BVM string.

Test with BVM and TORKEL

WARNING
See the chapter "Safety" for safety precautions.

1] Connect the BVM units as shown in the connection diagram, see below.
Each BVM is identical and can be connected in any battery test position. Up to 120 BVMs can be daisy-chained in a single battery bank under test.
If you need more than 120 BVMs they must be connected in two loops, see connection diagram on next page.

Note *The BVM units must be connected following the battery cell sequence order. The BVM connected to the "To 1:st BVM unit" port of the Power and Signal connector must be connected to the most Negative pole of the battery. The red dolphin clip shall be connected to the most Positive pole of the battery. The connection is the same regardless of the cell numbering selected in TORKEL.*
Power up the BVM system after completion of all the BVM connections.

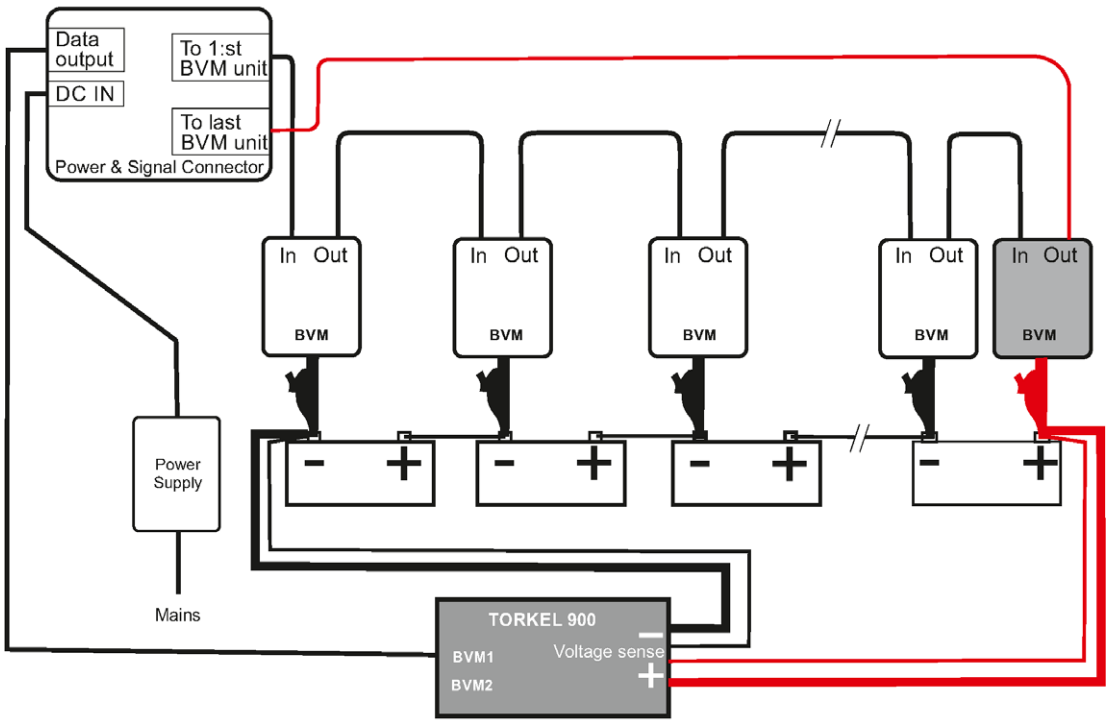


Fig.9.1 The BVM units must be connected following the battery cell sequence order. The red dolphin clip shall be connected to the most Positive pole of the battery.

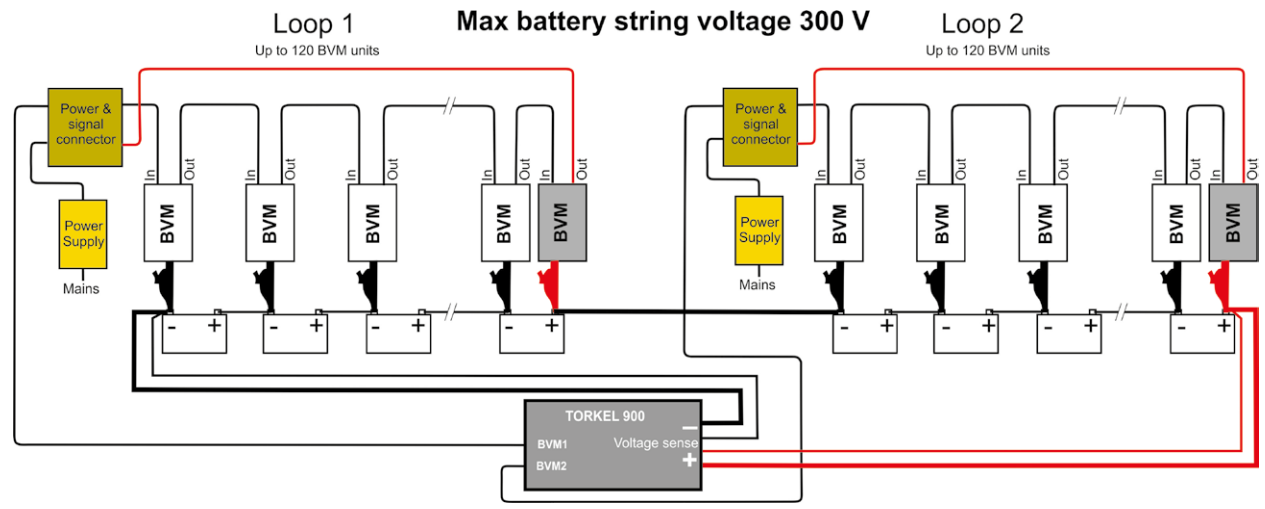


Fig.9.2 When the battery bank exceeds 120 cells, this connection with 2 BVM loops shall be used.
Connect the first loop to the BVM1 connector on TORKEL and the second loop to the BVM2 connector on TORKEL.

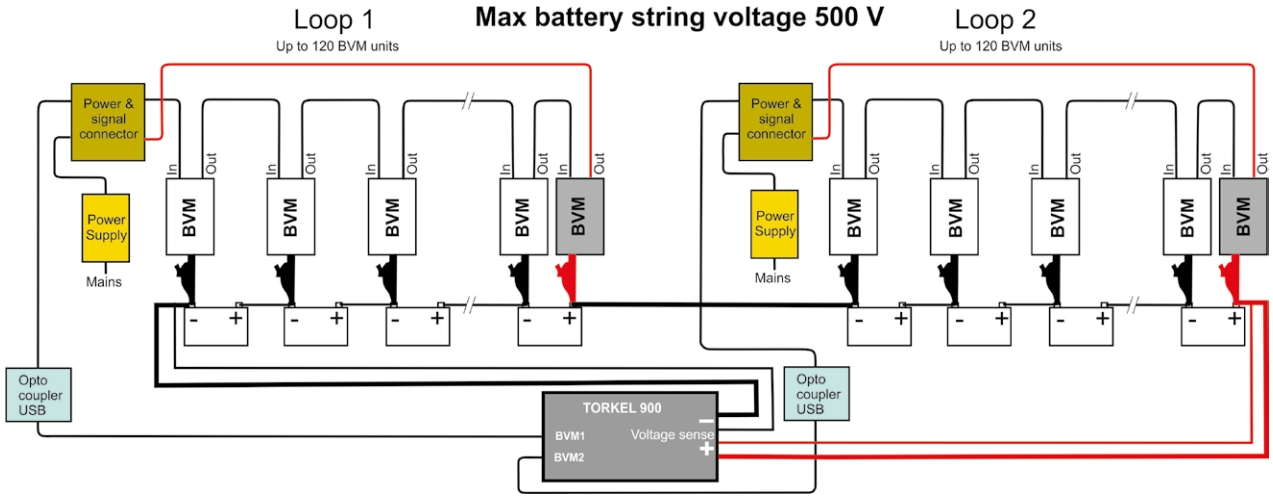


Fig.9.3 The connection shown above must be used when the battery bank voltage is between 300 V and 500 V.
It includes two opto couplers and two ungrounded power supplies.

Warning
A BVM control cable must never be connected directly to a computer network inlet.
When battery string voltage is over 300 V an opto coupler must be used, see Fig. 9.3.

2] **A. Battery string voltage max 300 V**
Connect the cable from "Power & signal connector" to BVM1 / BVM2 terminals on TORKEL 900.
B. Battery string voltage max 500 V
Connect the cable from "Power & signal connector" to Opto Coupler (UH401-2kV).

3] **A. Battery string voltage max 300 V**
Connect to a **grounded** Power Supply
B. Battery string voltage max 500 V
Connect to a **ungrounded** Power Supply

Warning
Do not use any other Power Supply than the original delivered together with BVM.

4] Start TORKEL 900

The BVM "Auto Discovery" feature enables the host device to automatically determine the number of batteries under test and provide sequential identification of each BVM in the test string.

Note *The cell numbering can be done from minus to plus or reversed and shall correspond to the setting in TORKEL. The red BVM conected to plus is not included in the numbering.*
When "Cell number from plus" is selected in TORKEL settings, the most positive cell is Cell 1, when this setting is not selected, then the most negative cell is Cell 1.

The initialization time for the BVMs depends on how many BVMs are connected. E.g. with 2 loops and 240 BVMs, it is about 3 to 4 minutes. With 1 loop and 12 BVMs, some seconds. The connected cells are shown under tab "CELLS".

Loose BVM unit detection

If BVM unit 1 comes loose during test, the first bar in the bar graph indicates and a beep sounds.

If the BVM unit between 2 and 3 cell becomes loose, the staple bars for cell 2 and 3 indicates.

If the last BVM unit is loose, the last staple in the staple bar diagram indicates.

Test with BVM – without TORKEL

BVM can handle battery voltage upp to 600 V, but then without TORKEL 900. With this connection, only the voltage can be monitored.

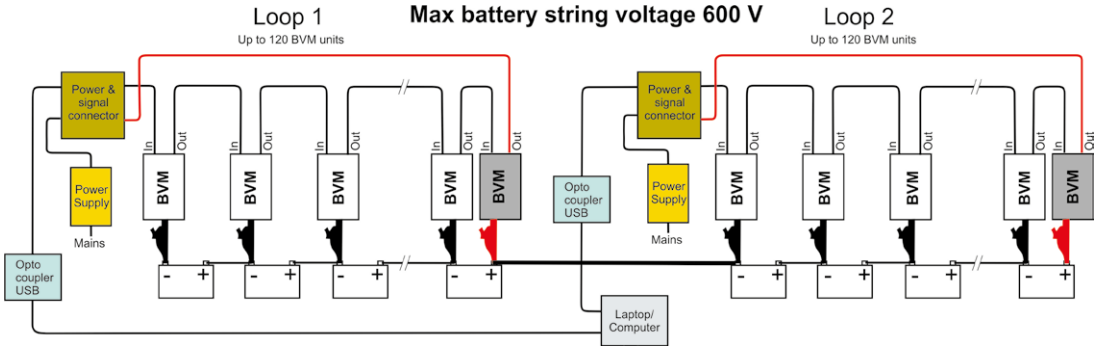


Fig.9.4 The connection is made the same as in example above (Fig9.3) but without TORKEL 900.

Optional BVM equipment

See appendix A. Accessories for connection of BVM modules to.battery poles.

BVM Cal Kit

Calibration system for BVM units. (Part no. CJ-90090)

Instructions for calibration included with the BVM Cal Kit.

Extension cables

The BVM cables (USB) may be extended 2 x 5 m with an **Opto Coupler** (e.g. B&B UH401 2 kV) in between.

Note *"Active" USB cables does not work.*

10 Troubleshooting

Problem	Cause	Remedy
BVM connected to TORKEL		
BVM does not get initialized	Problem with the connection to BVM port	Check/verify BVM connector on TORKEL
Communication lost with BVM units	Cable/power fault	Check cables, BVM units and Power supply to the BVM units.
		Check/replace the Power & Signal converter.
External measurement with current probe		
No readings	Current probe ratio not set	Set ratio in “Configuration” “Settings
	Current probe not activated	Turn on current probe
	Battery/power failure	Check battery/power supply
Faulty readings	Zero adjustment not done	Zero adjust
Other		
Impossible to switch on the circuit breaker F1 on the TXL unit	Control cable from TORKEL to TXL not connected properly	Check the connection
No voltage measurement in TORKEL	Bad connections	Check battery connectors
TORKEL fans revs up	Emergency Stop button pressed	Release emergency stop button
	Fans blocked	Remove blocking objects from fan

11 Calibration

11.1 General

By using the internal calibration program TORKEL will be calibrated on internal/external current and internal/external voltage. However, external instruments must be used.

- Stable voltage power supply (vary less than 1% per second) with capability up to 200 V DC.
- Current source (vary less than 1% per second) supplying upp to 100 A DC at a voltage of at least 24V DC, e.g. a 2pcs. 12V car battery in series can be used.
- Accurate reference instrument, e.g. HP 34401A, must be used.
- A current shunt with accuracy class 0.1% for connection in series with the current source.

11.2 How to calibrate

1] Switch on TORKEL.

2] Press  button to enter the configuration menu.

3] Press "Calibration" tab.

4] Press "Start" and follow on-screen instructions.

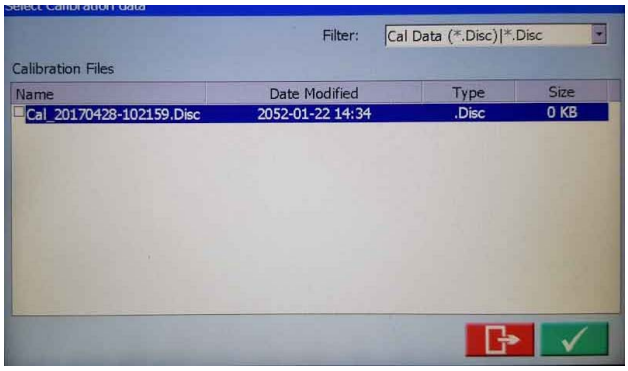
WARNING
Follow the instructions carefully. Battery connectors may have dangerous voltage

Note *You can press "Skip" to continue to the next calibration step. No value will be added. Press "Previous" to redo a calibration point.*

5] Next menu "Restore".

Using the Restore option could be useful when a calibration (for some reason) is out of order.

When pressing the "Restore" button, the below menu opens up.



A list with previous calibration files comes up. To select any of the calibration files, click on the check box and press the  button. Confirm with "OK".

The selected file will then be used as the Torkel default calibration file.

Now the calibration file has to be stored.
Press the "Previous" button 4 times to reach the "Store" menu and press "Store".

Press "Skip" button once to enter the stop menu.
Press "Stop".Leave the calibration by pressing the  button. Restart Torkel.

Note *If the "Skip" button is pressed the calibration values will not be saved.*

6] To calibrate, press the "Skip" button instead of selecting the "Restore" option. Follow the instructions on screen to calibrate the Torkel.

7] After the calibration steps performed. Select "Store" to save the calibration.

8] Connect a USB stick to save the calibration report. Reports can be opened with Excel.

9] Press "Stop" to stop the calibration and leave the calibration routine. The fans will start and run for about 10 seconds.

10] Press the " v " button to close the calibration routine.

12 Specifications

SPECIFICATIONS TORKEL 900-SERIES

Specifications are valid at nominal input voltage and an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Environment

Application field	The instrument is intended for use in high-voltage substations and industrial environments.
Temperature	
Operating	0°C to +50°C (32°F to +122°F) Power derating at temperatures over +35°C (+95°F)
Storage & transport	-40°C to +70°C (-40°F to +158°F)
Humidity	5% – 95% RH, non-condensing
Shock/Vibration/Fall	
Instrument only	ETSI EN 300 019-2-7 class 7M2
Instrument in transport case	ISTA 2A
Altitude	
Operating	3000 m (10000 ft)
Storage	10000 m (33000 ft)
Encapsulation class	IP20

CE-marking

LVD	2014/35/EU
EMC	2014/30/EU
RoHS	2011/65/EU

General

Mains voltage	100 – 240 V AC, 50/60 Hz
Power consumption	200 W (max)
Power interruption	40 ms (max)
Protection	Thermal cut-outs, Automatic overload protection, Emergency stop button
Dimensions	519 x 315 x 375 mm, (20.5" x 12.4" x 14.7")
Weight	19.5 kg (43.0 lbs) instrument 31.9 kg (70.3 lbs) incl. standard transport case 39.2 kg (86.4 lbs) incl. large transport case
Display	7" LCD, Capacitive touch screen
Available languages	Czech, English, French, German, Romanian, Russian, Spanish, Swedish
Number of test files	30 (max)
Test time	240 h (max)

Measurement section

Current measurement

Display range	0.0 to 2999.0 A
Basic inaccuracy	±(0.5% of reading +0.1 A)
Resolution	0.1 A

Internal current measurement

Range

TORKEL 910	0 to 110 A
TORKEL 930/950	0 to 220 A

Input for clamp-on probe

Range	0 to 1000 mV DC
mV/A-ratio	0.30 mV/A to 100.00 mV/A
Input impedance	>1 MΩ

Voltage measurement

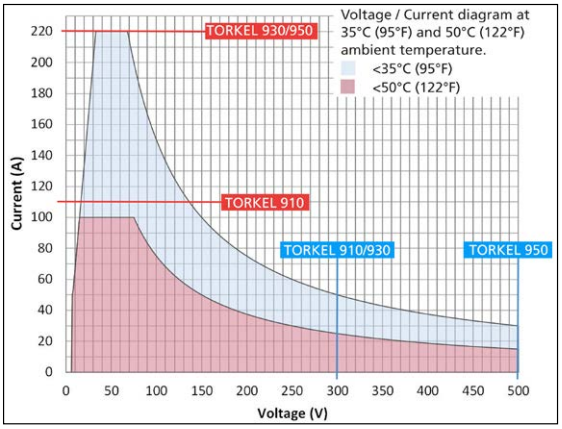
Voltage	0 to 500 V DC
Inaccuracy	±(0.5% of reading +0.1 V DC)
Resolution	0.1 V
Sample rate	10 Hz, Values are saved when change is >10 mV

Time measurement

Inaccuracy	±0.1% of reading ±1 digit

Load section

Battery voltage	7.5 V3) to 300 V1) / 500 V2)
Power	15 kW (max)
Load patterns	Constant current, constant power, constant resistance, current or power profile



Constant I

Range

TORKEL 910	0 to 110.0 A
TORKEL 930/950	0 to 220.0 A
Inaccuracy	±(0.5% +0.2 A)
Resolution	0.1 A
Ripple	max 0.5 A peak

Constant R

Range	300 mΩ to 3 kΩ
Inaccuracy	±1% typical
Resolution	100 mΩ

Constant P

Range	0 to 15 kW
Inaccuracy	±1% typical
Resolution	10 W

Inputs

+	7.5 [3] to 300 V[1] 7.5 to 500 V[2]
–	0 V
I EXT ≤ 1 V	1 V DC, 300 V DC to ground

1) TORKEL 910 and 930 2) TORKEL 950
3) On sw from R02G. Min voltage is 2V

VOLTAGE SENSE	Impedance to the current terminals is >1 MΩ

Outputs

ALARM	
Relay contact	28 V DC, 8 A, 240 V AC, 8 A Devices higher than Cat II must not be attached
TXL STOP	
Relay contact	250 V DC, 0.28 A, 28 V DC, 8 A, 250 V AC, 8 A
9 V DC	9 V DC, ±7% max 100 mA

Communication ports

BVM1 BVM2	USB connection for BVM units
	USB connection for USB memory
SERVICE	For service of the instrument

1) TORKEL 910 and 930 2) TORKEL 950
3) On sw from R02G. Min voltage is 2V

SPECIFICATIONS TXL830/850/865/870/890

Specifications are valid at nominal input voltage and an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Environment

Application field	The instrument is intended for use in high-voltage substations and industrial environments.
Temperature	
Operating	0°C to +40°C (32°F to +104°F)
Storage & transport	-40°C to +70°C (-40°F to +158°F)
Humidity	5% – 95% RH, non-condensing

CE-marking

LVD	2014/35/EU
EMC	2014/30/EU
RoHS	2011/65/EU

General

Mains voltage	100 – 240 V AC, 50/60 Hz
Power consumption	75 W (max)
Protection	Thermal cut-outs, automatic overload protection
Dimensions	
Instrument	210 x 353 x 600 mm (8.3" x 13.9" x 23.6")
Transport case	265 x 460 x 750 mm (10.4" x 18.1" x 29.5")
Weight	13 kg (29 lbs) 21.4 kg (47 lbs) with transport case
Cable sets	
for TXL830/850	2 x 3 m (9.8 ft), 70 mm², 270 A, with female plug/clamp. Max. 100 V. 5 kg (11 lbs)
for TXL865/870/890	2 x 3 m (9.8 ft), 25 mm², 110 A, with female plug/lug. Max. 480 V. 3 kg (6.6 lbs)

Load section

	Voltage (DC) max.	Current max.	Power max.
TXL830	28 V	300 A	8.3 kW
TXL850	56 V	300 A	16.4 kW
TXL865	260 V (98 A max)	117 A	25.5 kW
TXL870	280 V (56 A max)	112 A	15.8 kW
TXL890	480 V (32 A max)	62 A	15.4 kW

Internal resistance, 3-position selector

	Position 1	Position 2	Position 3
TXL830	0.275 Ω	0.138 Ω	0.092 Ω
TXL850	0.55 Ω	0.275 Ω	0.184 Ω
TXL865	2.65 Ω	5.05 Ω	0.12 Ω
TXL870	4.95 Ω	2.48 Ω	1.24 Ω
TXL890	14.10 Ω	7.05 Ω	3.52 Ω

Maximal currents, 3-position selector [1)]

Position 1

	Current	*Voltage*	*Cells*	*Cell voltage*
TXL830 28 V max	100 A	27.6 V	12	2.3 V
	78.5 A	21.6 V	12	1.8 V
TXL850 56 V max	100 A	55.2 V	24	2.3 V
	78.5 A	43.2 V	24	1.8 V
TXL865 260 V max	93.7 A	248.4 V	108	2.3 V
	73.4 A	194.4 V	108	1.8 V
TXL870 280 V max	50.1 A	248.4 V	108	2.3 V
	39.2 A	194.4 V	108	1.8 V
TXL890 480 V max	32.3 A	469.2 V	204	2.3 V
	26.0 A	367.2 V	204	1.8 V

Position 2

	Current	*Voltage*	*Cells*	*Cell voltage*
TXL830 28 V max	200 A	27.6 V	12	2.3 V
	156 A	21.6 V	12	1.8 V
TXL850 56 V max	200 A	55.2 V	24	2.3 V
	156 A	43.2 V	24	1.8 V
TXL865 260 V max	49.2 A	248.4 V	108	2.3 V
	38.5 A	194.4 V	108	1.8 V
TXL870 140 V max	50.1 A	124.2 V	54	2.3 V
	39.2 A	97.2 V	54	1.8 V
TXL890 230 V max	35.2 A	248.4 V	108	2.3 V
	27.8 A	194.4 V	108	1.8 V

Position 3

	Current	*Voltage*	*Cells*	*Cell voltage*
TXL830 28 V max	300 A	27.6 V	12	2.3 V
	235 A	21.6 V	12	1.8 V
TXL850 56 V max	300 A	55.2 V	24	2.3 V
	235 A	43.2 V	24	1.8 V
TXL865 14 V max	115 A	13.8 V	6	2.3 V
	90 A	10.8 V	6	1.8 V
TXL870 140 V max	100 A	124.2 V	54	2.3 V
	74.8 A	97.2 V	54	1.8 V
TXL890 230 V max	70.5 A	248.4 V	108	2.3 V
	55.2 A	194.4 V	108	1.8 V

1) The data examples apply to lead batteries.

SPECIFICATIONS BVM

Specifications are valid at an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Environment

Application field	The instrument is intended for use in medium-voltage substations and industrial environments. Altitude <2000 m (6500 ft) above sea level.
Temperature	
Operating	0°C to +50°C (32°F to +122°F)
Storage & transport	-20°C to +70°C (-4°F to +158°F)
Humidity	5% – 95% RH, non-condensing

CE-marking

LVD	2014/35/EU
EMC	2014/30/EU
RoHS	2011/65/EU

General

Power supply	
Mains voltage	100–240 V AC, 50/60 Hz
Power consumption	50 VA (max)
Protection	Over voltage, reverse voltage, voltage transients, ESD
Dimensions	
BVM unit	75 x 64 x 25 mm (3" x 2.5" x 1")
Carrying case	575 x 470 x 205 mm (22.6" x 18.5" x 8.1")
Weight	
BVM unit	0.07 kg (0.15 lbs)
With accessories and carrying case	BVM system of 16 units 7 kg (15 lbs) BVM system of 31 units 8.8 kg (19 lbs) BVM system of 61 units 12.5 kg (27 lbs)

Measurement section

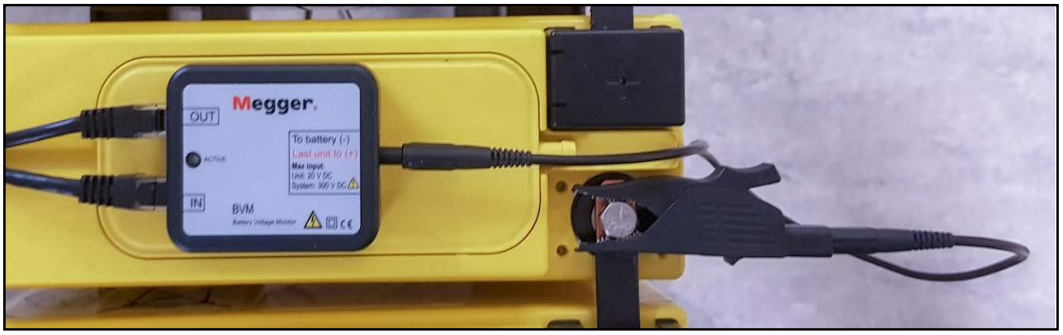
Maximum number of BVM	240 (2x120)
Voltage ranges	0-20 V DC
Resolution	1 mV both ranges
Inaccuracy	< 0.1% of full scale ±0.01 V DC
Battery string voltage	300 V DC (max)
Measurement input impedance	1 MΩ

13 Appendix A

Accessories for connection of BVM modules to battery poles.

13.1 Extension lead

The extension lead should be used as an extension from the BVM module to the battery bolt with the dolphin clip.
Part number 04-30050



Cable with ring connector for battery poles

Cable with M8 ring connector, 0.3m. For permanent installation on the battery.

Part number KG-00690

Cable with flat connector for battery poles

Cable with 6.3 mm insulated female flat connector, 0.3 m.

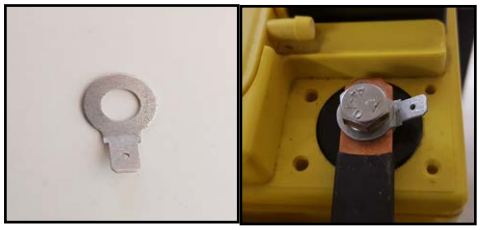
Used together with a M8 cable lug (45-10046)

For permanent installation on the battery pole.

Part number KG-00692

Cable lug to mount on the battery pole.

Part number: 45-10046



Battery bolt for BVM module connection

This battery pole bolt with dimension M8 x 18 replaces the ordinary bolt.
Part number: 40-06300

Cable Extension lead with Velcro band

With use of the Velcro band to hold the BVM module in place together with the extension lead(04-30050), will release stress from the dolphin clip and improve the connection to the battery bolt.

Velcro band, length 0.3 m.

Part number: 19-62200

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Megger

This instrument is manufactured in SWEDEN.

The company reserves the right to change the specification or design without prior notice.

Megger is a registered trademark

Subject to change without notice. Art. No. ZP-CS01E	Doc. CS033663IE	V09a	2023