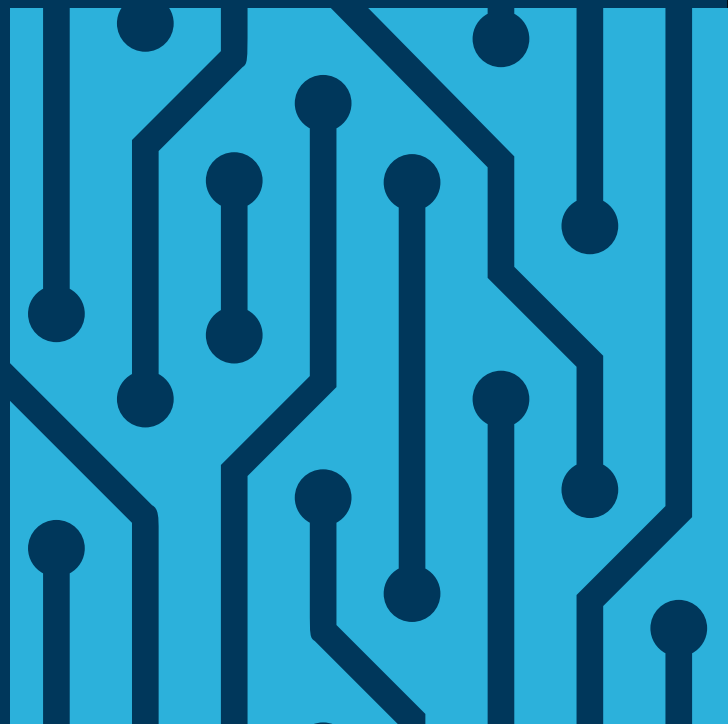


Application Note #18

Capacity simulation with Source-Sink Series QL



Using the combination of two functions of source-sink QL series, batteries and accumulators can be simulated, making them suitable for testing charging devices.

Capacitance Simulation

The capacitance simulation function allows the source-sink device to simulate the charging and discharging behavior of a capacitor.

In addition to specifying the capacitance value to be simulated, a start voltage must be set. The configured voltage corresponds to the charging voltage of the capacitor. Depending on the direction of current, into or out of the source-sink, the simulated capacitance is discharged or charged, and the voltage decreases or increases accordingly. The voltage change is determined by the following formula:

$$\Delta U = (I \cdot \Delta t) / C$$

ΔU : voltage Change/V
 I : current into or out of the capacitance/A
 C : set capacitance/F

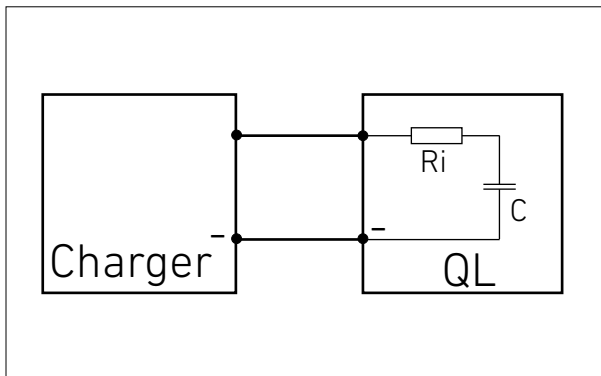
Requirements for Capacitance Simulation

The value of the capacitance C to be simulated must be chosen such that the time constant τ meets the following condition:

$$\tau \geq 2 \text{ ms} \quad (\tau = R \cdot C \text{ or } \tau = R_i \cdot C)$$



The simulation function cannot be activated while an internal resistance measurement, modulation function, list function, square wave function, or AC operating mode is running.



Circuit Diagram of Battery Simulation

Safety Instructions



Before starting operation, read the User Manual of the source-sink device carefully, especially the General Safety Instructions and the Safety Instructions for Connecting the Device Under Test (DUT)!

Internal Resistance Setting

In voltage mode, an internal resistance can be set and in current mode, an internal conductance can be configured.

The available range for the setting value of the internal resistance or conductance depends on the specific model (see technical specifications). The entered setting value becomes active immediately after confirmation. After powering on or resetting the device, the setting value defaults to 0.0 Ω or 0.0 S.

Combination of Capacitance and Internal Resistance

By using the capacitance simulation together with the adjustable internal resistance R_i , the source-sink device can emulate the behavior of capacitors as well as batteries and accumulators, making it suitable for testing chargers. R_i can also be considered as the ESR (Equivalent Series Resistance) of electrolytic capacitors.

Notes on Interface Control

Commands and more detailed descriptions can be found in the user manual in chapter 5.

After activating the function, neither the capacitance nor the start voltage can be changed. To do so, the function must first be deactivated. SCPI Command:

```
FUNC:SIM:CAP 0
```

To restart the function with the same parameters, it must first be deactivated and then reactivated. SCPI Command:

```
FUNC:SIM:CAP 0;CAP 1
```

To pause the function, use the SCPI Command:

```
OUTP 0
```

To resume the paused function, use SCPI Command:

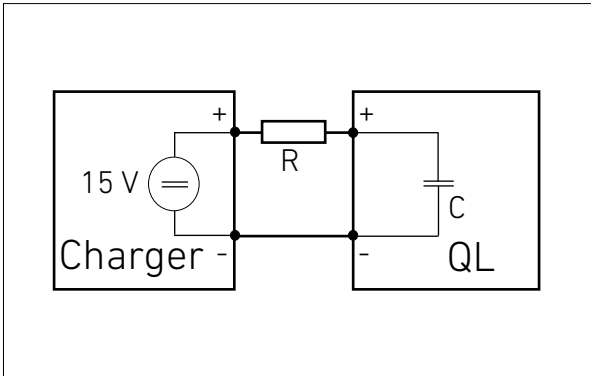
```
OUTP 1
```



Examples of Local and Remote Operation

1. Charging, $C = 1\text{ F}$

A capacitance of 1 F is to be simulated and charged from 0 to 15 V via an external charging resistor of $R = 0.56\ \Omega$.



User Interface:

Main Menu -> Settings -> Function -> Capacitor Sim.

Edit widget „Capacitance“: enter 1.0 .

Edit widget „Start Voltage“: enter 0 .

Confirm with „OK“.

Start the function with S+ -> Start.

Activate the charger (device under test).

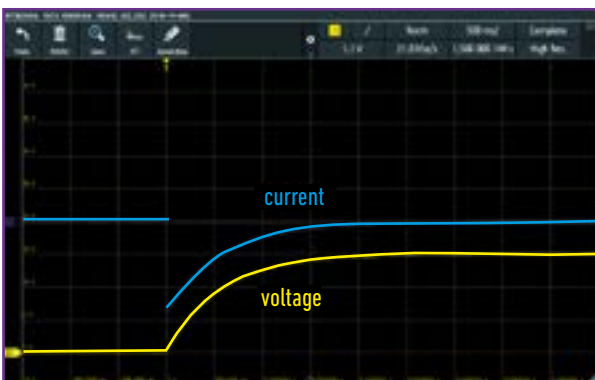
SCPI Commands:

FUNC:SIM:CAP:CAP 1 capacitance setting value 1 F

FUNC:SIM:CAP:VOLT 0 start voltage setting value 0 V .

FUNC:SIM:CAP 1 capacitor simulation function activation

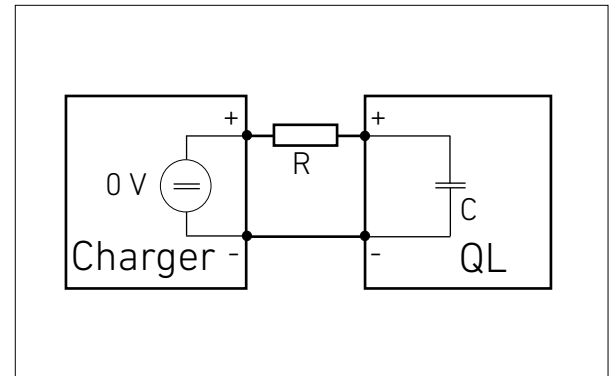
OUTP 1 output activation



Charging: $C = 1\text{ F}$ without R_i , using an external charging resistor $R = 0.56\ \Omega$

2. Discharging, $C = 1\text{ F}$

A capacitance of 1 F with an initial charge of 15 V is to be simulated and discharged to 0 V via an external charging resistor of $R = 0.56\ \Omega$.



User Interface:

Main Menu -> Settings -> Function -> Capacitor Sim.

Edit widget „Capacitance“: enter 1.0 .

Edit widget „Start Voltage“: enter 15 .

Confirm with „OK“.

Start the function with S+ -> Start.

Activate the charger (device under test)

SCPI Commands:

FUNC:SIM:CAP:CAP 1 capacitance setting value 1 F

FUNC:SIM:CAP:VOLT 15 start voltage setting value 15 V

FUNC:SIM:CAP 1 capacitor simulation function activation

OUTP 1 output activation

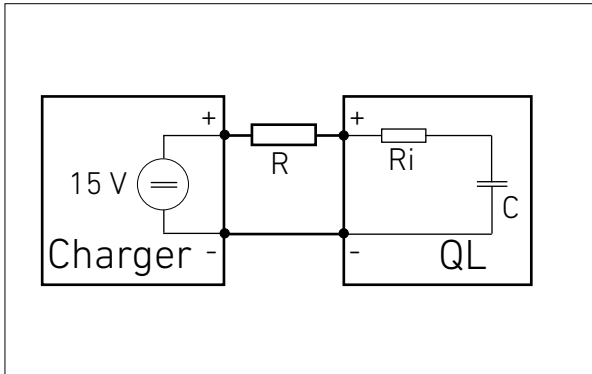


Discharging: $C = 1\text{ F}$ without R_i , using an external charging resistor $R = 0.56\ \Omega$.



3. Charging, $C = 0,8 \text{ F}$, $R_i = 0,4 \Omega$

A capacitance of 0.8 F without initial charge and an internal resistance of 0.4Ω is to be simulated and charged to 15 V via an external charging resistor of $R = 0.56 \Omega$.



User Interface:

Main Menu -> Settings -> Basic Settings -> Internal Resistance: enter 0.4.

Main Menu -> Settings -> Function -> Capacitor Sim.

Edit widget „Capacitance“: enter 0.8.

Edit widget „Start Voltage“: enter 0.

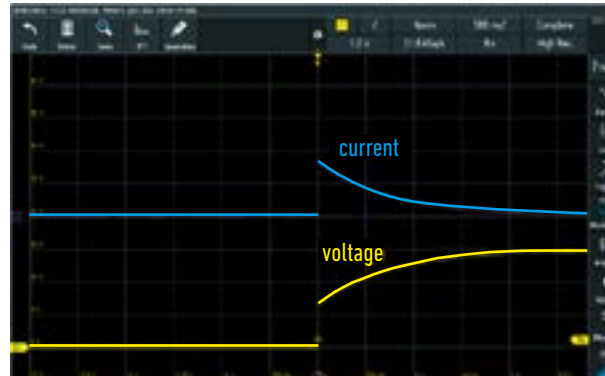
Confirm with „OK“.

Start the function with S+ -> Start.

Activate the charger (device under test)

SCPI Commands:

IRES 0.4	simulated internal resistance setting value 0.4Ω .
FUNC:SIM:CAP:CAP 0.8	capacitance setting value 0.8 F
FUNC:SIM:CAP:VOLT 0	start voltage setting value 0 V .
FUNC:SIM:CAP 1	capacitor simulation function activation
OUTP 1	output activation



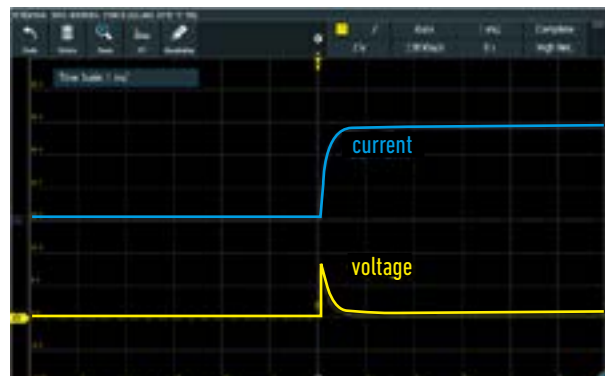
Charging: $C = 0.8 \text{ F}$ with $R_i = 0.4 \Omega$ and external charging resistor.



Note:

The simulation of capacitance and resistance is subject to the control speed of the source-sink and may therefore deviate from the theoretical values.

During charging or discharging, a voltage spike may occur at the start. This is due to the fact that the regulation of the source-sink requires a few $100 \mu\text{s}$ to respond. The voltage spike increases when the control speed is set to SLOW.



Zoom in den Startpunkt des Ladevorgangs

