Problem PE-N Relay – Deye HV Hybrid Inverter

I took the trouble to make a few measurements on the Deye high voltage hybrid inverter with the oscilloscope, as I mainly experience problems when the inverter switches back to On-Grid mode. The wiring is done as the Manual SG01HP3 says on page 27 (Wiring diagram with neutral line ungrounded). Please see also the attached video links for further input. If there are open questions to the setup, please feel free to ask.

It turns out that the control of the PE-N relay (signal island mode) is problematic. The relay dropping out too early is the main cause of problems with overvoltages against the earth potential. These overvoltages are present for up to two seconds and can therefore potentially damage electrical equipment and trigger residual current monitors. Deye also does not comply with the principles of all-pole disconnection. When disconnecting from the mains (L1,L2,L3), the neutral conductor must be lagging; when connecting to the mains, the neutral conductor must be leading. This prevents a star point shift. I have recorded two scenarios which will be described later.

In the following diagram the expected sequence is shown with comments for the transitions.

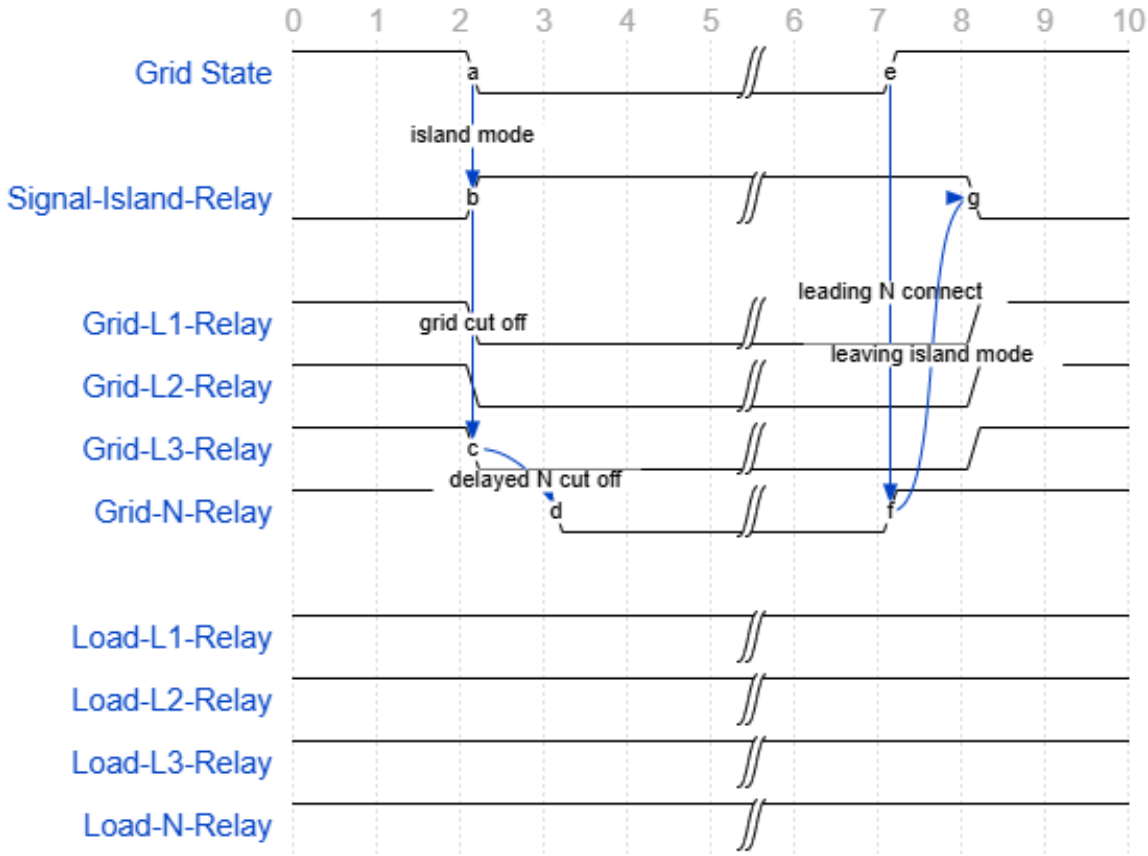

Figure 1 - expected sequence grid loss and recovery

Table 1 - description of sequences

a → b	The grid loss is detected. The PE-N relay should immediately be closed.
b → c	All phase relay (L1,L2,L3) need to be opened first.

c → d	For a short time, a second PE-N connection needs to be accepted (at house connection box from grid side and inside Deye inverter). After it is ensured that the phase relays are opened, the neutral point relay at grid side can be opened with a small delay.
d → e	Off-grid mode active. The grid is now fully disconnected.
e → f	The grid state is okay again. The reconnection process can need to start with leading neutral point relay on grid side.
f → g	The reconnection of the phase relay is starting now. All phase relays can be closed again and the PE-N relay can also be opened.

Measurement Setup

- Deye SUN-30K-SG01HP3-EU-BM3 (signal island mode activated, VDE4105 setup, latest firmware: MAIN 1086 / HMI C03B)
- Measurement setup: see attached picture; (neutral conductor, L1, L2 and L3 of LOAD are all measured with passive probe against earth, divider factor 10); a hairdryer hangs between L1 and N as load (not shown in figure below)
- Please also see the video on my YouTube channel for the full setup: Video Setup

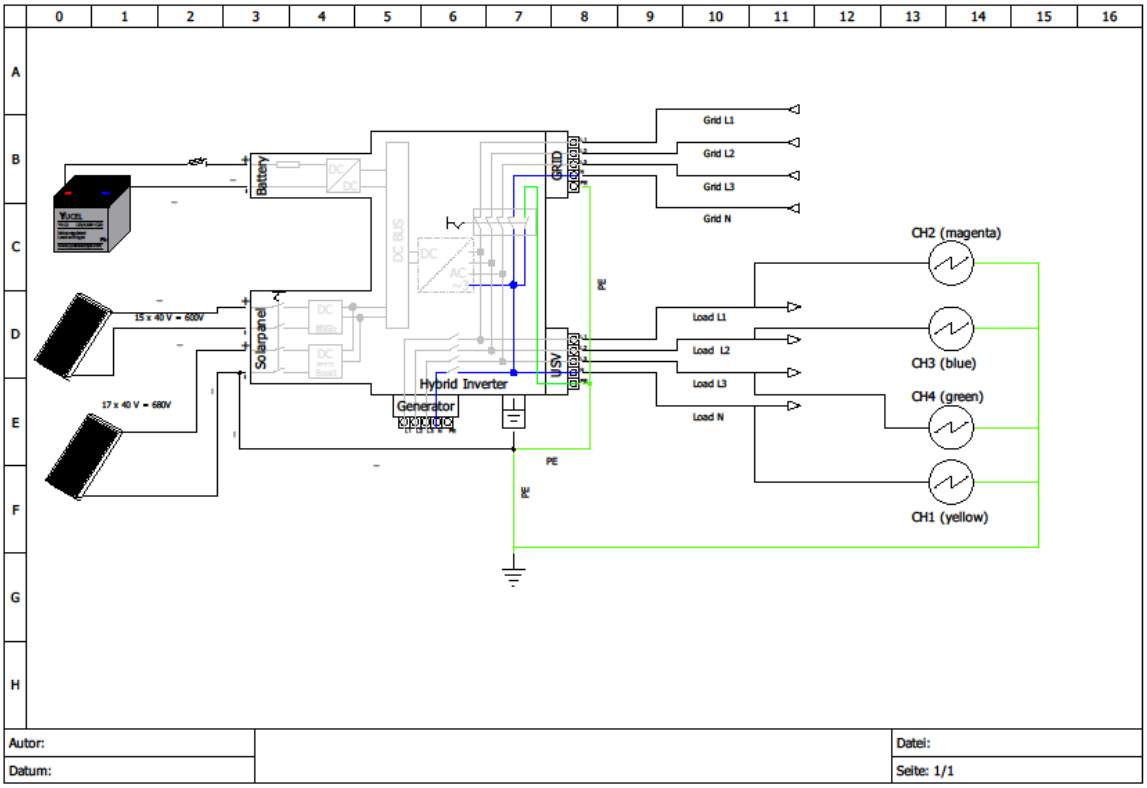

Figure 2 - measurement setup with probes

The following figure shows one disconnection process with the load attached between L1 and neutral point on load side. It can be seen that the voltage between neutral point and earth is rising to 100V. This star point shift will damage electrical devices. The neutral point on grid side shall only be disconnected if the PE-N relay is closed inside the Deye inverter.

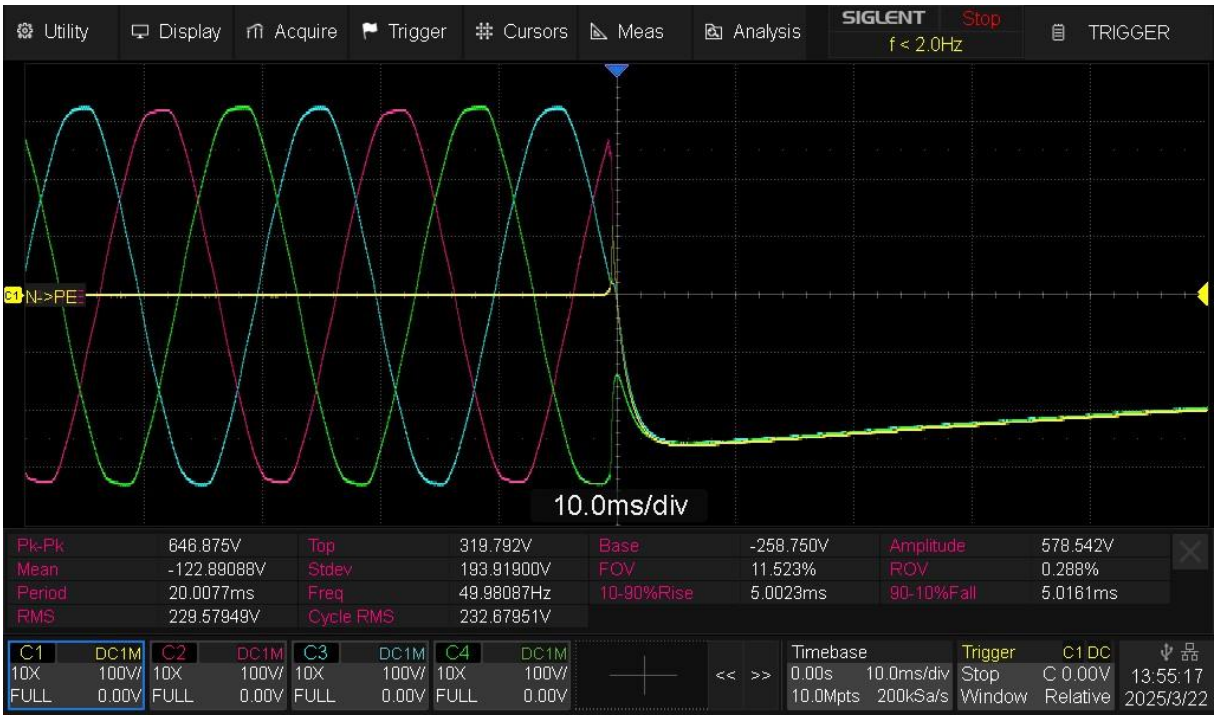

Figure 3 - Star point shift when inverter shuts down after settings change

Off-grid case:

Here I simply switch off the three-phase grid with the circuit breaker. The following scope picture shows an overview of the complete process with disconnecting and reconnecting to grid. The left red box can be seen in detail in Figure 5. The right red box is zoomed in in Figure 6.

The whole procedure is also available as a video: Video Offgrid Case

Figure 4 – Overview

During grid loss there is a phase of 40ms where the neutral point on grid side is disconnected and the PE-N relay is not closed. The voltage between neutral point and earth potential increases up to ~60V.

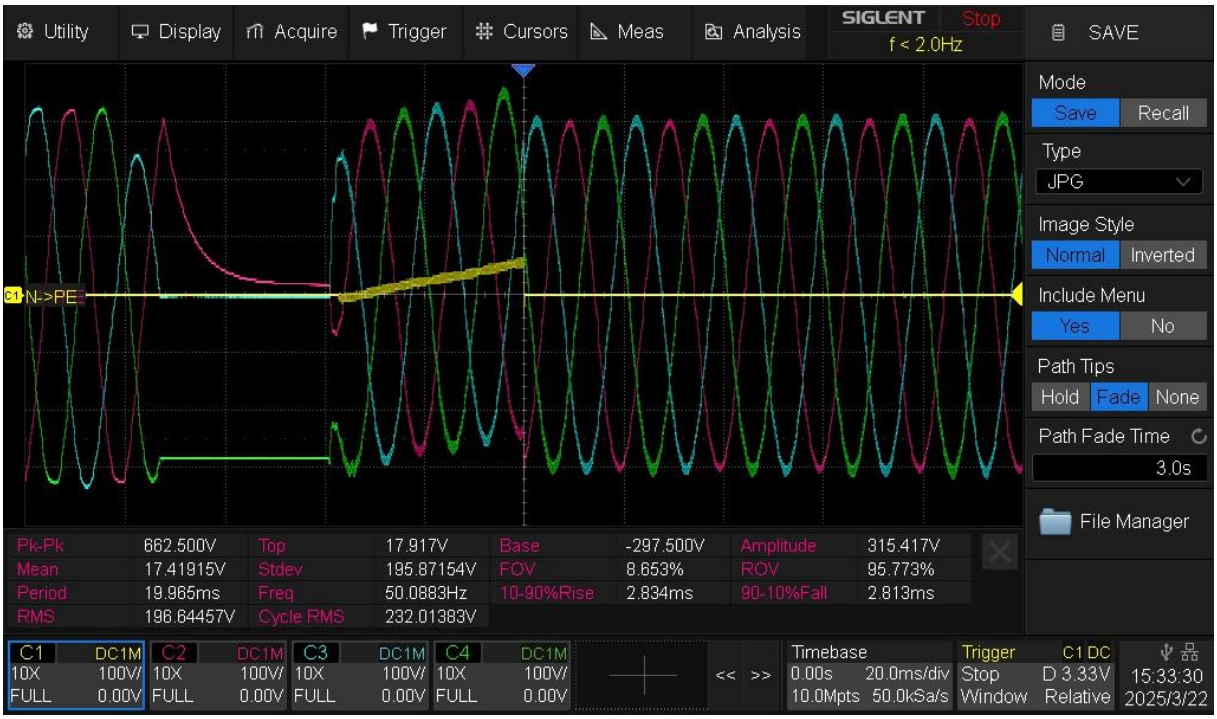

Figure 5 - Detail 1 (grid loss)

During grid reconnection there is a phase of 600 ms where the neutral point on grid side is disconnected and the PE-N relay is opened. The voltage between neutral point and earth potential increases up to ~270V.

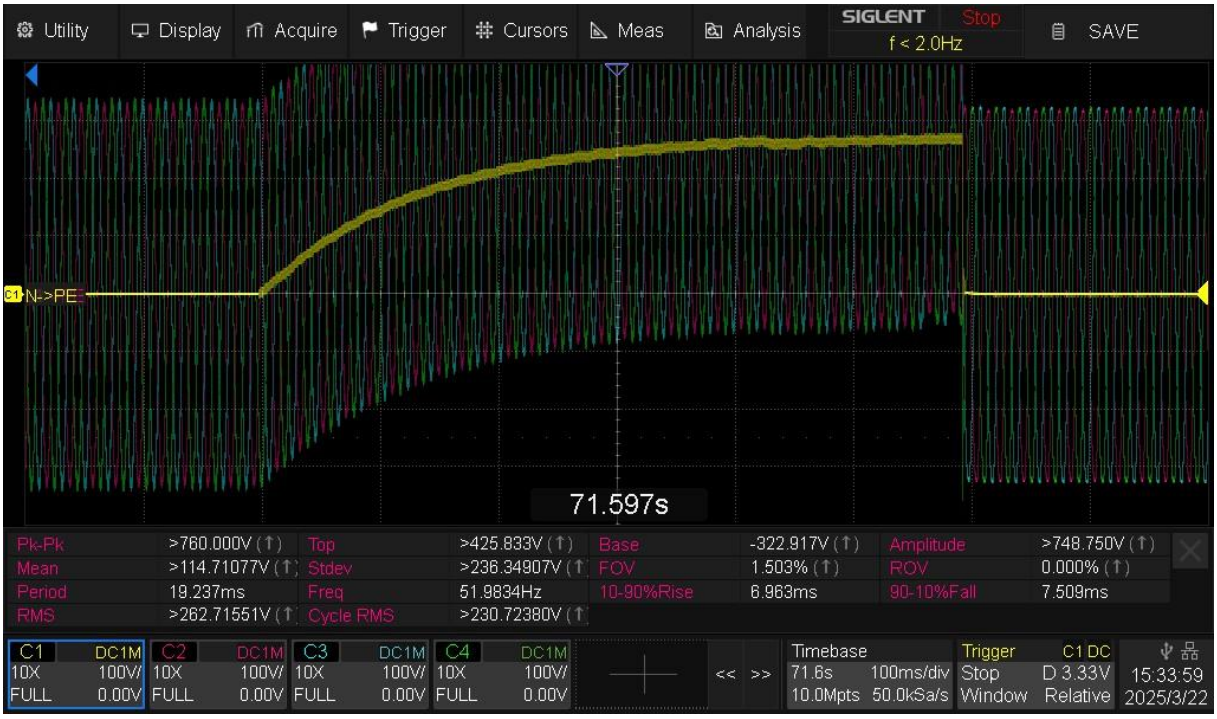

Figure 6 - Detail 2 (PE-N relay opening)

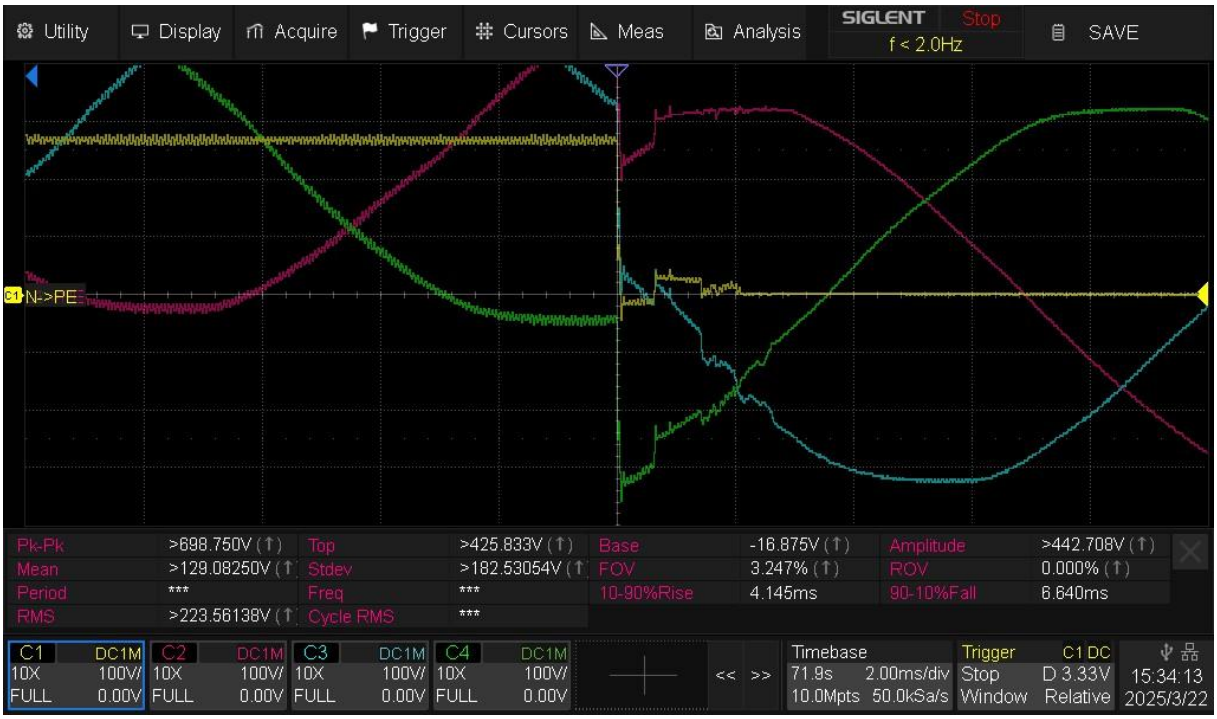

Figure 7 - Detail 3 (grid relays closing)

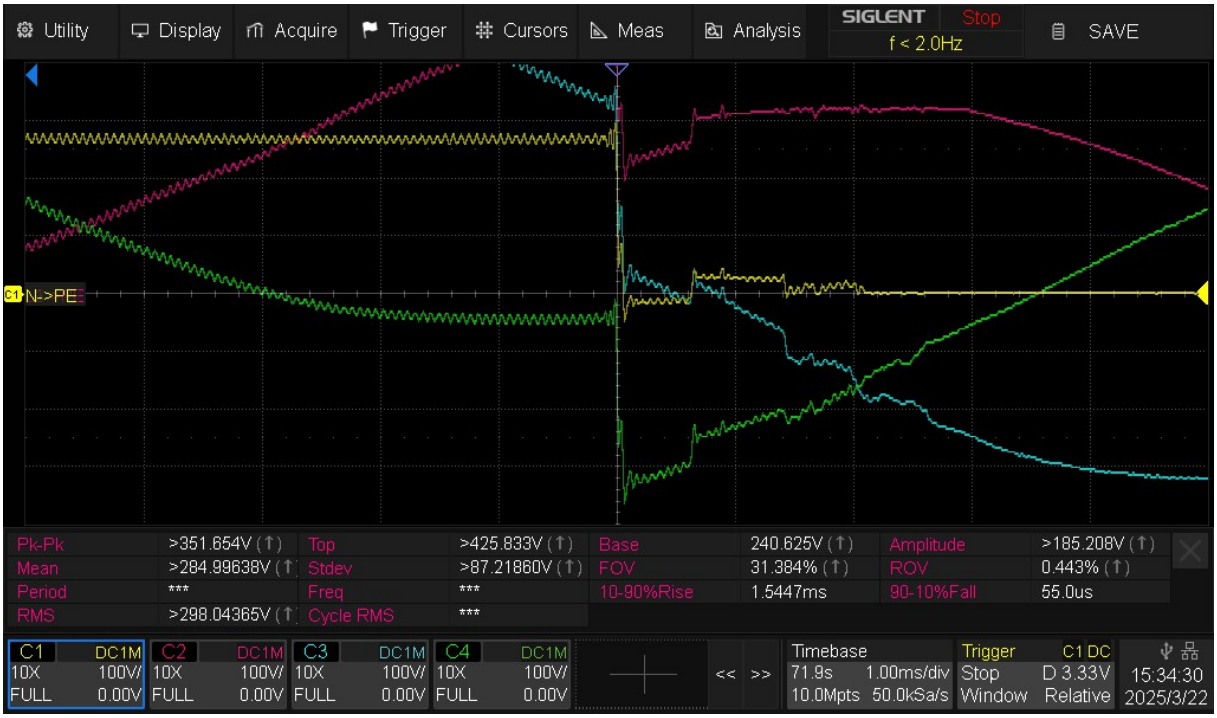

Figure 8 - Detail 4 (grid relays closing)

Settings change:

Here I activate/deactivate the 'Parallel Bat1&Bat2' option. The inverter switches off completely once, then starts up again. The whole procedure is also available as a video: Video Settings Change

After a settings change, the hybrid inverter shuts completely off. The PE-N relay is not closed. About 36s later, the inverter starts up. Before reconnecting to grid, the PE-N relay is opened for about 2s.

Figure 9 - Settings change (overview)

Figure 10 - Settings change (inverter off)

Before starting up, the PE-N relay is opened again for ~40ms. There is no reason to open the PE-N relay for a short time.

Figure 11 - Settings change (inverter restart offgrid)

Before reconnecting to grid again, the PE-N relay is opened for ~1300ms. The neutral point is increased again for ~270V against to earth.

Figure 12 - Settings change (reconnect to grid 1)

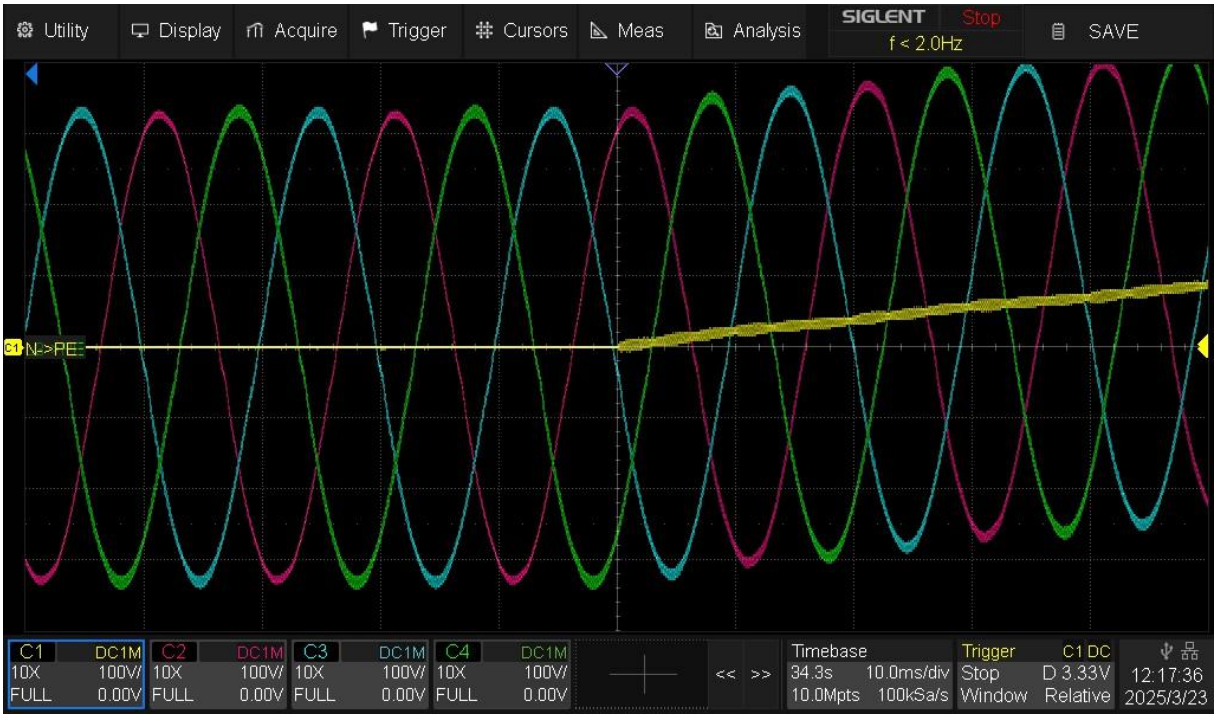

Figure 13- Settings change (reconnect to grid 2)

Figure 14- Settings change (reconnect to grid 3)

Figure 15- Settings change (reconnect to grid 4)