SHIFTING THE LIMITS

Wels, February 13th 2015

RIDE-THROUGH CAPABILITIES FRONIUS GALVO 1.5-1 – 3.1-1

Fronius International GmbH

hereby confirms, that the inverters

/ **Fronius Galvo 1.5-1, 2.0-1, 2.5-1, 3.1-1**

Are capable of meeting the following ride-through and trip settings:

Operating Region	Range (Hz)	Operating Mode	Duration (s)	
			Ride Through	Trip
OF2	f > 64	Trip		0.1667
OF1	63 < f < =64	Ride Through	20	21
NOH	63 >= f > 60	Normal Operation	Indefinite	Indefinite
NOL	57 <= f < = 60	Normal Operation	Indefinite	Indefinite
UF1	56 <= f < 57	Ride Through	20	21
UF2	f < 56	Trip		0.01667

Operating Region	Range (%)	Operating Mode	Duration (s)	
			Ride Through	Trip
OV2	V > 120	Trip		0.1667
OV1	120 >= V > 110	Ride Through	.92	1
NOH	110 >= V > 100	Normal Operation	Indefinite	Indefinite
NOL	100 >= V >= 88	Normal Operation	Indefinite	Indefinite
UV1	88 > V >= 70	Ride Through	20	21
UV2	70 > V >= 50	Ride Through	20[1]	21
UV3	V < 50	Permissive Operation		0.5

Note 1: Rapid changes in voltage below 70% L-L generally result in loss of output. Slower ramps can allow inverter to remain on below 70%. The unit is capable of riding through all voltage drops of 50% L-N. Full LVRT functionality will be added via software in 2015.

Additionally, the inverters can meet Return to Service requirements of 60.1 ≥ f ≥ 59.9, 110 ≥ V ≥ 88 and 300 – 600s. The inverters can meet frequency ride-through requirements in the range of 45 – 65 Hz.

At a voltage drop down to 70% L-L of the nominal voltage the inverter is capable of staying connected for at least 21 sec. At a voltage drop down to 50% L-N of the nominal voltage the inverter is capable of staying connected for at least 21 sec.

At a frequency drop down to 50 Hz the inverter is capable of staying connected for at least 21 sec. At a frequency rise of 65 Hz the inverter is capable of staying connected for at least 21 sec.

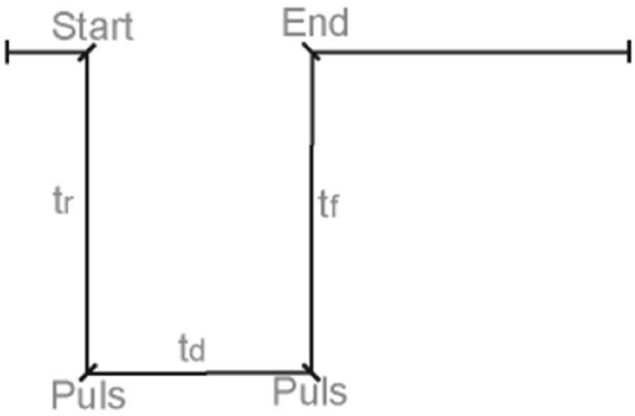
The trip limits of the inverter have to be set in a way not contradicting this behavior.

To demonstrate this behavior test results are shown in this certificate.

Test Data

Fronius has collected test data on a representative sample of the Galvo 3.1-1 to verify ride-through behavior based on voltage and frequency variation tests described as follows. Other Galvo power classes were not tested as the hardware is the same as the model tested (only peak power output differs).

Each test uses an AC grid simulator to achieve a step or ramp function depicted at right.



Voltage Ride-Through Test

Model: Fronius Galvo 3.1-1 (Setup 240N)

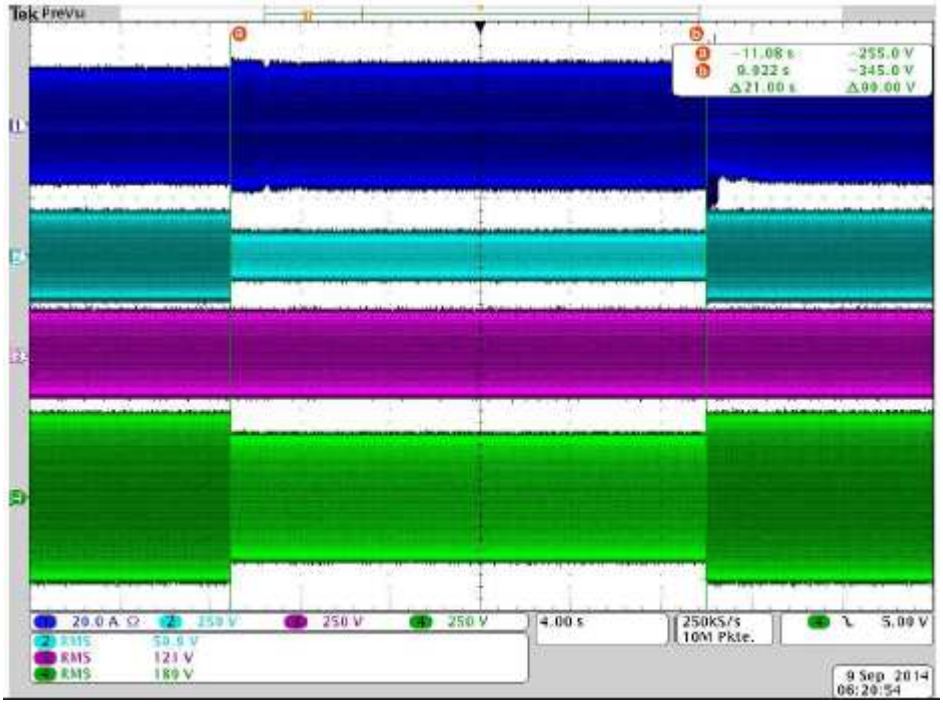
Test Conditions: 240VAC (phase to phase), 60Hz, 3100W output

Step:

Start: 120V (Phase to Neutral) t_r: 0s
Pulse: 60V (Phase to Neutral) t_d: 21s
End: 120V (Phase to Neutral) t_f: 0s

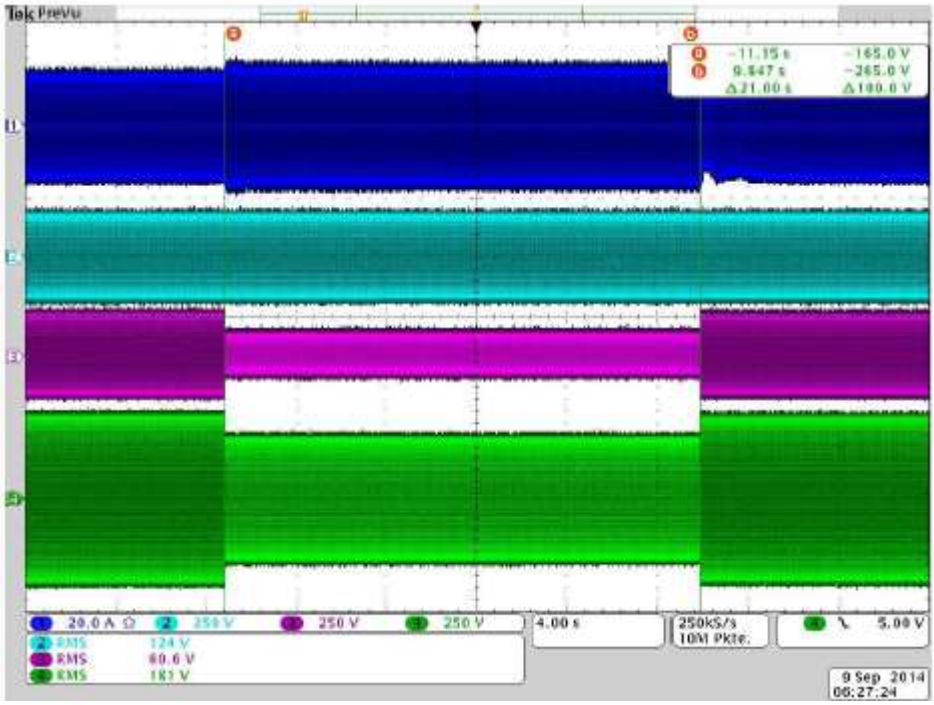
Oscillograms:

TEST L1



Chanel 1: Current on Phase 1
Chanel 2: Voltage Phase 1 to Neutral
Chanel 3: Voltage Phase 2 to Neutral
Chanel 4: Voltage Phase 1 to Phase 2

TEST L2



Chanel 1: Current on Phase 1
Chanel 2: Voltage Phase 1 to Neutral
Chanel 3: Voltage Phase 2 to Neutral
Chanel 4: Voltage Phase 1 to Phase 2

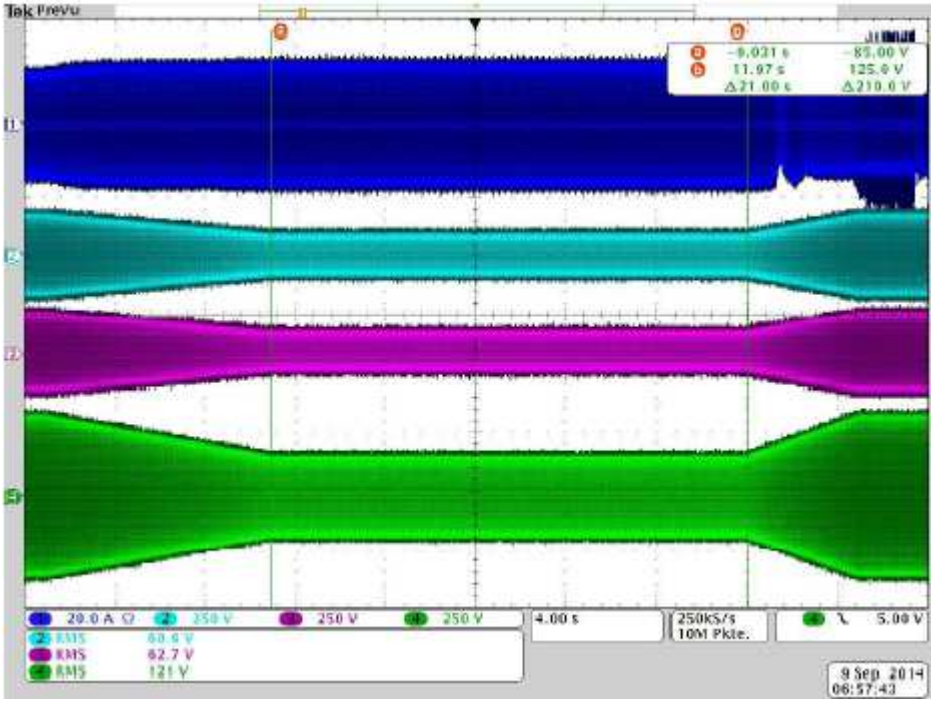
Model: Fronius Galvo 3.1-1 (Setup 240N)

Test Conditions: 240VAC (phase to phase), 60Hz, 3100W output

Ramp:

Start: 240V (Phase to Phase) t_r: 10s
Pulse: 120V (Phase to Phase) t_d: 21s
End: 240V (Phase to Phase) t_f: 5s

Oscillogram:



Chanel 1: Current on Phase 1
Chanel 2: Voltage Phase 1 to Neutral
Chanel 3: Voltage Phase 2 to Neutral
Chanel 4: Voltage Phase 1 to Phase 2

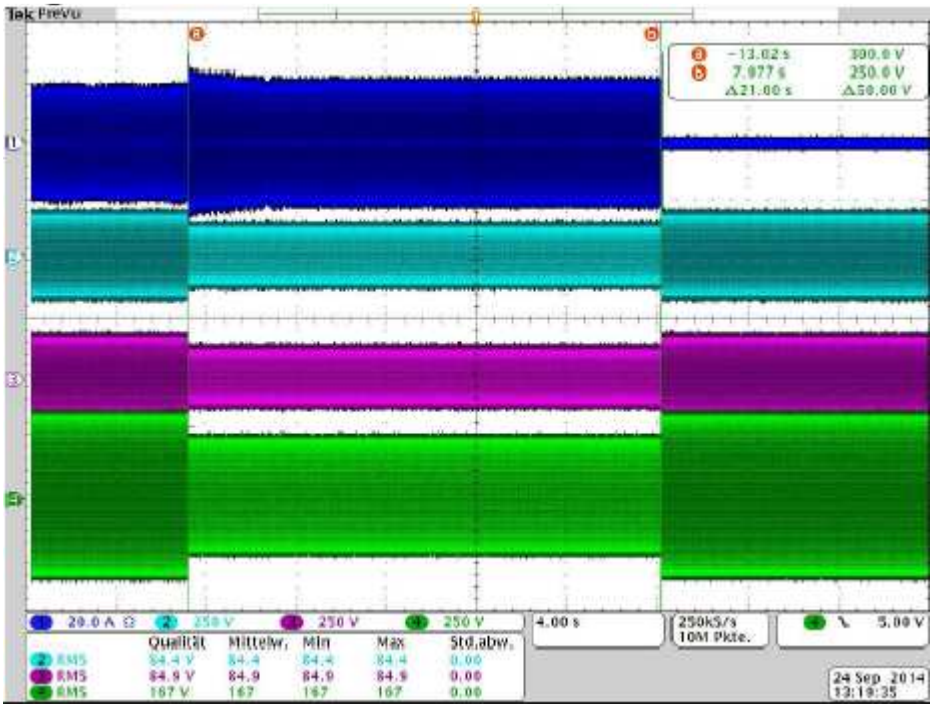
Model: Fronius Galvo 3.1-1 (Setup 240N)

Test Conditions: 240VAC (phase to phase), 60Hz, 3100W output

Ramp:

Start: 240V (Phase to Phase) t_r: 0s
Pulse: 167V (Phase to Phase) t_d: 21s
End: 240V (Phase to Phase) t_f: 0s

Oscillogram:



Chanel 1: Current on Phase 1
Chanel 2: Voltage Phase 1 to Neutral
Chanel 3: Voltage Phase 2 to Neutral
Chanel 4: Voltage Phase 1 to Phase 2

Conclusion:
After all tests the inverter did not stop feeding in but return to normal operation immediately. The requirement for a 70% Low Voltage Ride-Through is fulfilled. The requirement for 50% Ride-Through is fulfilled for L-N voltage drops and slower L-L voltage sags to 50%.

High Frequency Ride-Through Test

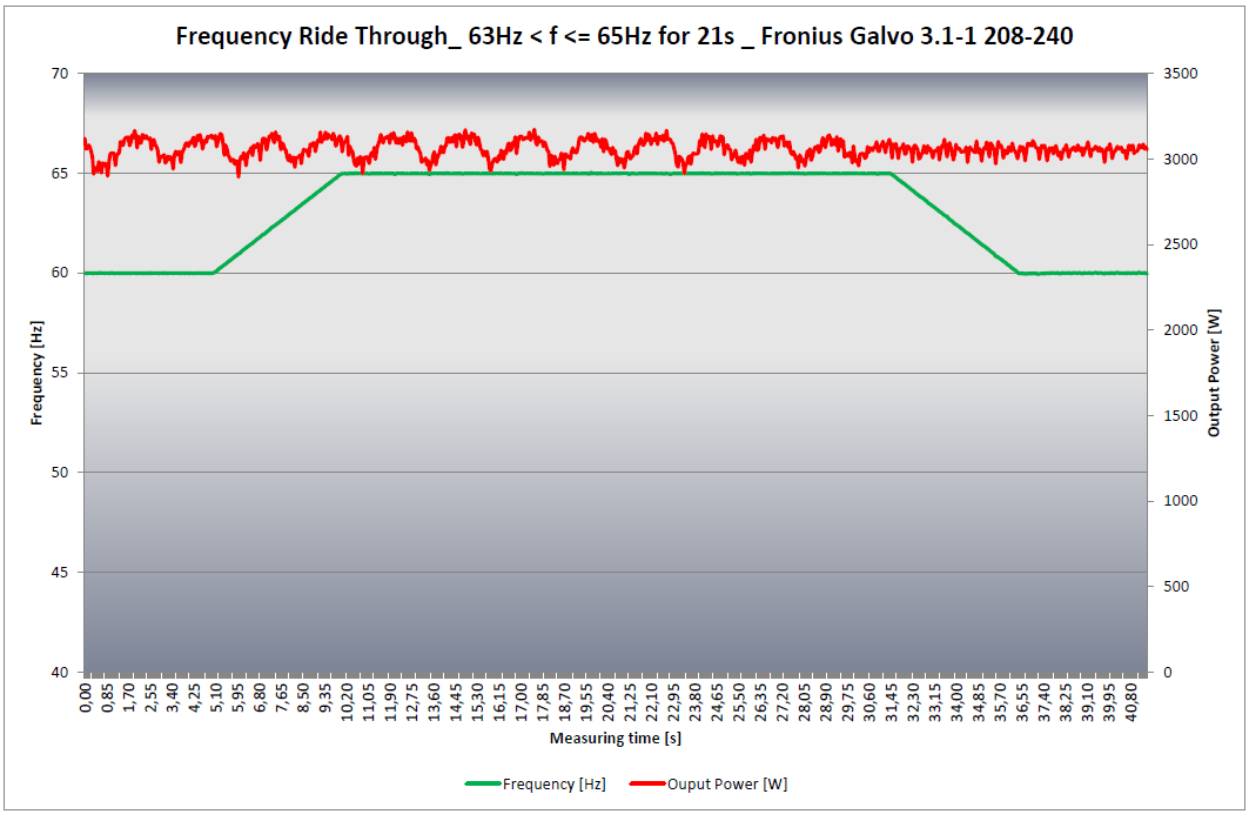
Model: Fronius Galvo 3.1-1 (Setup 240N)

Test Conditions: 240VAC (phase to phase), 60Hz, 3100W output

Ramp:

Start: 60 Hz t_r: 5s
Pulse: 65 Hz t_d: 21s
End: 60 Hz t_r: 5s

Oscillogram:



Conclusion:
After all tests the inverter did not stop feeding in but maintains normal operation. The requirements for High Frequency Ride-Through are fulfilled to 65Hz.

Low Frequency Ride-Through Test

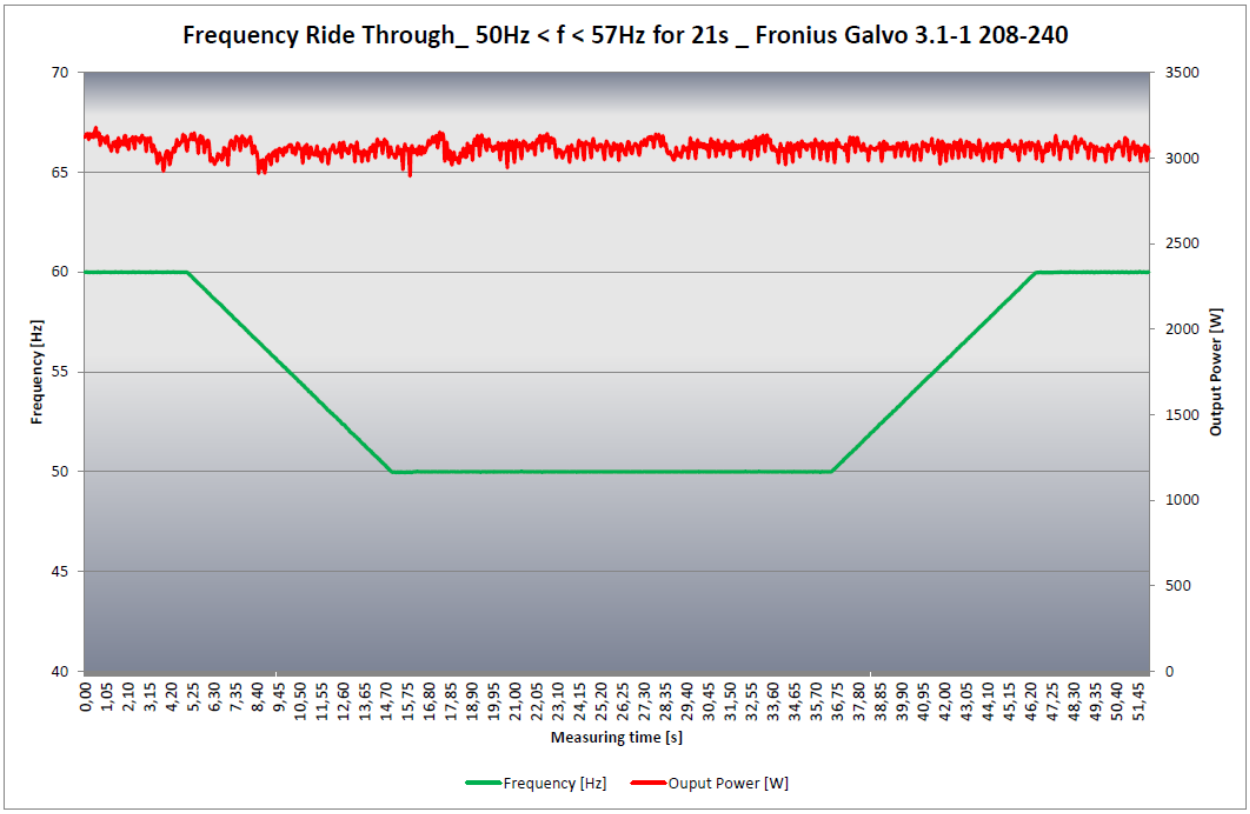
Model: Fronius Galvo 3.1-1 (Setup 240N)

Test Conditions: 240VAC (phase to phase), 60Hz, 3100W output

Ramp:

Start: 60 Hz t_r: 10s
Pulse: 50 Hz t_d: 20s
End: 60 Hz t_r: 10s

Oscillogram:



Conclusion:
After all tests the inverter did not stop feeding in but maintains normal operation. The requirements for Low Frequency Ride-Through are fulfilled to 50Hz.

Fronius International GmbH
Solar Energy Division
Froniusplatz 1
A-4600 Wels

DI Thomas Mühlberger