

» Continental Europe Synchronous Area Separation on 24 July 2021

ICS Investigation Expert Panel » Final Report » 25 March 2022
Annexes



Disclaimer

The following Final Report, concerning the system event which occurred on 24 July 2021 in the Continental Europe Synchronous Area, has been prepared and issued by the Incident Classification Scale Investigation Expert Panel and is based on information as known on 25 March 2022. The individuals having prepared this Report, as any other ENTSO-E member, including its agents or representatives, shall not be liable in whatever manner for the content of this Report, nor for any conclusion whatsoever that any person or third party could draw from said Report.

Equally, ACER and national regulatory authorities accept no responsibility or liability whatsoever with regard

to the content of this Report, nor for any conclusions whatsoever that any person or third party could draw from said Report.

It is not the intention of the Expert Panel to express judgments which may prejudice the assessment of liability of any TSO, third party or person. Even if not explicitly stated, the analyses made in this Final Report and the simulations are based on information provided by the TSOs. No audit has been made. Everything expressed in this Report refers to the specific events, and its findings will not constitute any binding general reference to the involved TSOs or other parties mentioned in the report.

Expert Panel Members

Maurice Dierick	Swissgrid, Expert Panel Chair	Laurent Rosseel	RTE & ENTSO-E Steering Group Operations Convenor & ICS representative
Tahir Kapetanovic	APG & Chair of the ENTSO-E System Operations Committee	Kacper Kepka	ENTSO-E Secretariat
Albino Marques	REN & ENTSO-E Regional Group CE Convenor & Representative of TSO at system separation time	Uros Gabrijel	ACER
David Alvira Baeza	REE & Representative of TSO at system separation time	Jacques de Saint-Pierre	CRE, French NRA
Laurent Lamy	RTE & Representative of TSO at system separation time	Pierrick Muller	CRE, French NRA
Frank Reyer	Amprion & Representative of Regional Group CE	Cyprien Videlaïne	CRE, French NRA
Jonathan Boyer	Coreso	José Capelo	ERSE, Portuguese NRA
Uwe Zimmermann	TSCNET	Virginia Garcia	CNMC, Spanish NRA
		Jochen Gerlach	BnetzA, German NRA
		Nicolas Krieger	BnetzA, German





ENTSO-E Technical Experts Team

The [ENTSO-E Factual Report](#), which was the basis for the work of Expert Investigation Panel has been produced by the ENTSO-E Technical Experts' Team:

Maurice Dierick	Swissgrid	Giorgio Giannuzzi	Terna
Tahir Kapetanovic	APG	Walter Sattinger	Swissgrid
Albino Marques	REN	Asja Derviskadic	Swissgrid
David Alvira Baeza	REE	Laurent Rosseel	RTE
Laurent Lamy	RTE	Paulo Marques	REN
Frank Reyer	Amprion	Vieira Couto	REN
Christoph Schneiders	Amprion	Nicolas Kitten	RTE
Florian Bennewitz	Amprion	Agustin Diaz Garcia	REE
Bernard Malfliet	Elia	Jorge Hidalgo López	REE
Róisín Mossop	Coreso	Javier Pérez	REE
Jonathan Boyer	Coreso	Carla Wolf	APG
Mohamed El Jafoufi	Elia	Ioannis Theologitis	ENTSO-E
Nikola Obradovic	EMS	Kacper Kepka	ENTSO-E
Uwe Zimmermann	TSCNET		



ANNEXES

Annex 1 – LFDD Recordings



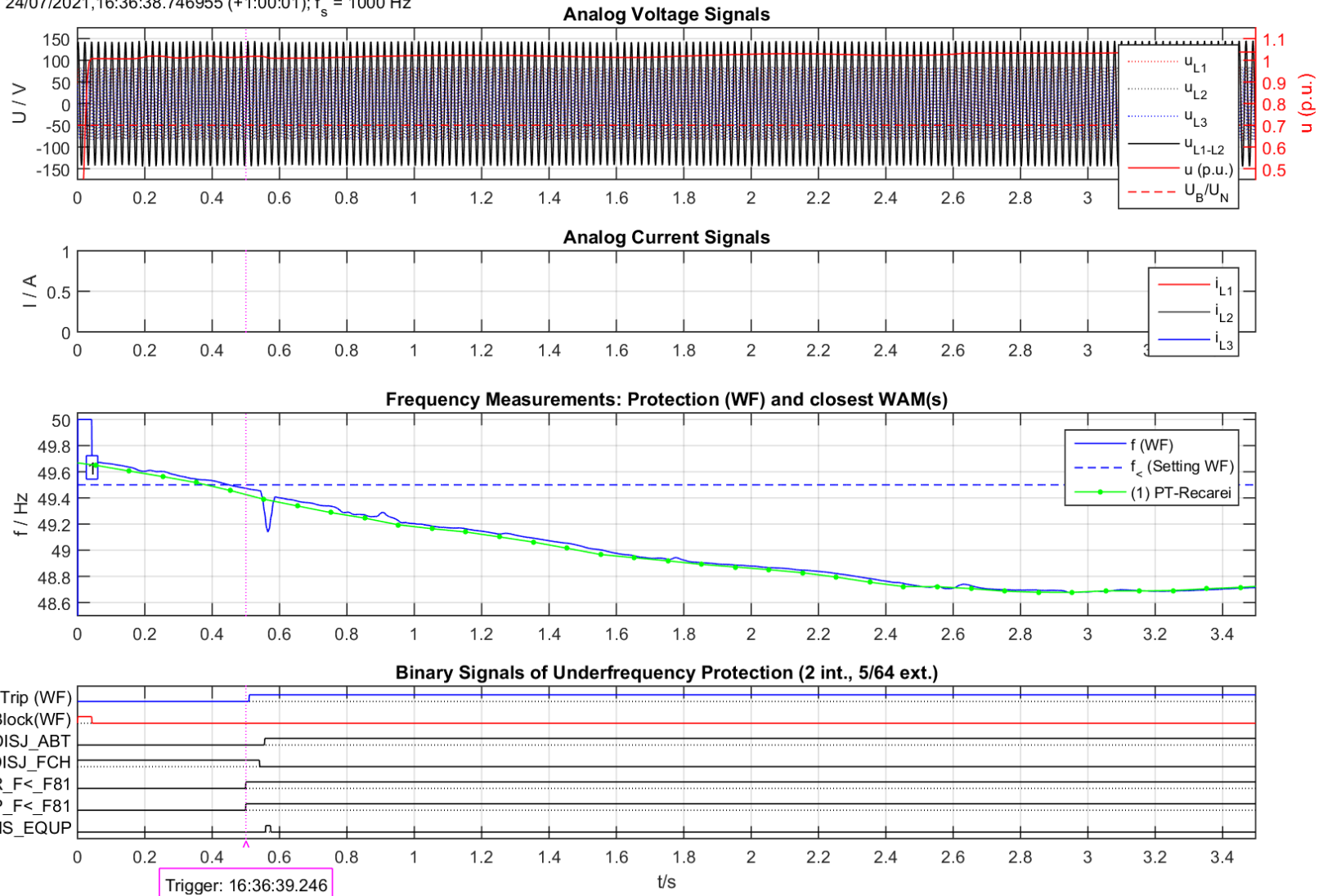
Underfrequency Protection Evaluation - Sim.Nr. 1/18 [1]

Mogadouro PT: Station Y - Device

(File: 20210724_Portugal_DG_oscillography\20210724_Portugal_DG_oscillography)

Start: 24/07/2021,16:36:38.746955 (+1:00:01); $f_s = 1000$ Hz

Protection (WF): $f_c = 49.50$ Hz; $U_B/U_N = 0.70$ [V8M5]



27.01.2022 21:22:19 / W. Fromm

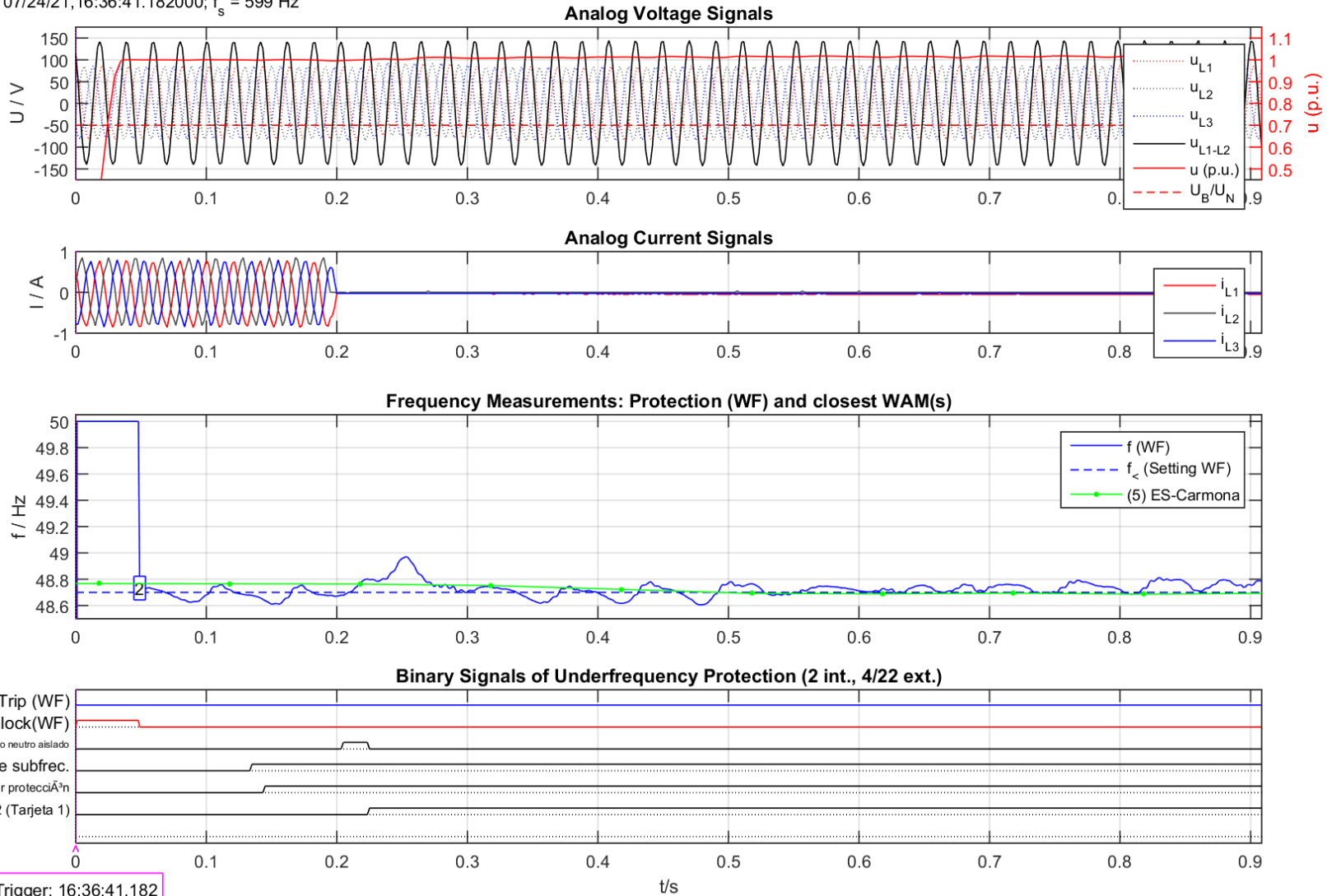
Annex 1: COMTRADE measurement evaluation Mogadouro LFDD relay



Underfrequency Protection Evaluation - Sim.Nr. 2/18 [2]

Fuentes Alcarria 400 kV: Station ZIV72289 - Device 21
 (File: Alcohete 703_Guadalajara2021-07-24T16_36_41Z.182000)
 Start: 07/24/21, 16:36:41.182000; $f_s = 599$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V13M5]



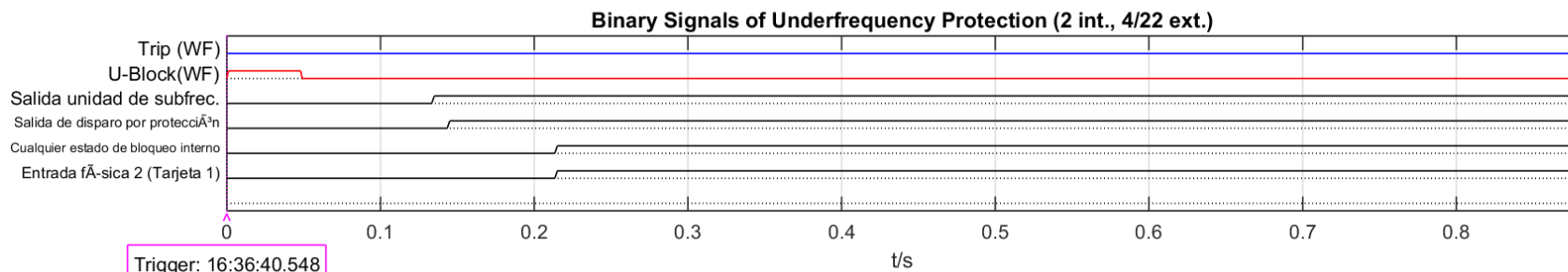
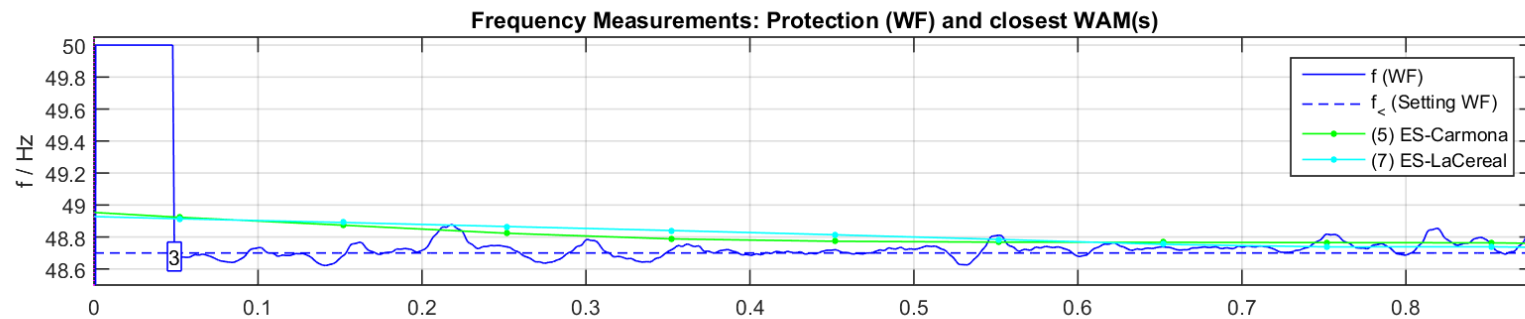
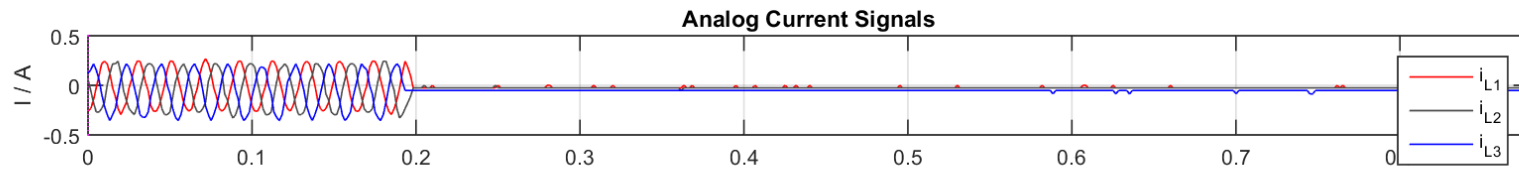
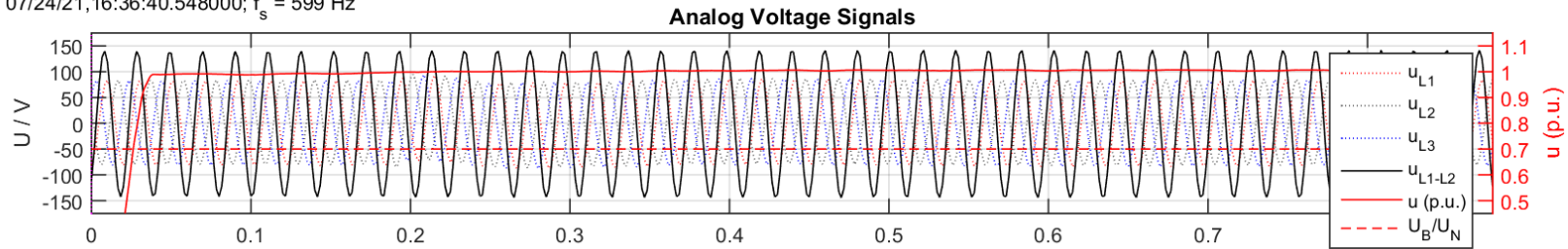
27.01.2022 21:22:23 / W. Fromm

Annex 2: COMTRADE measurement evaluation Fuentes Alcarria LFDD relay

Underfrequency Protection Evaluation - Sim.Nr. 3/18 [3]

Alarcos 220 kV: Station ZIV77207 - Device 35
 (File: Almuradiel 705_C Real\2021-07-24T16_36_40Z.548000)
 Start: 07/24/21, 16:36:40.548000; $f_s = 599$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V13M5]



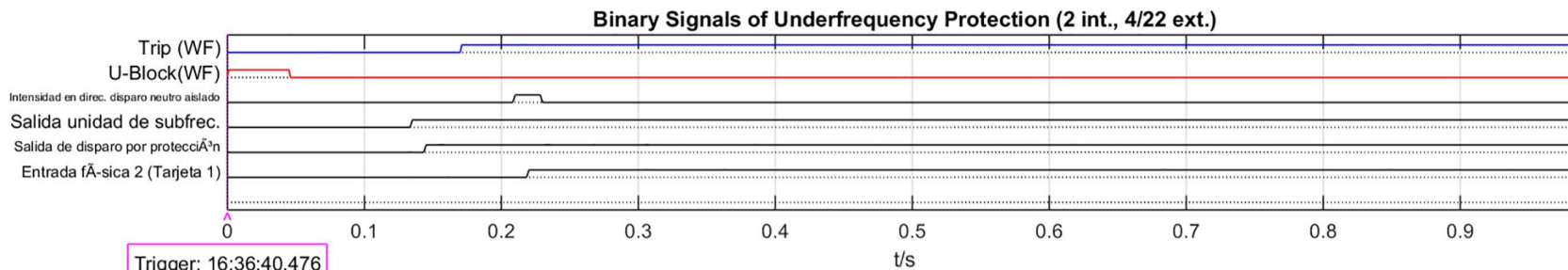
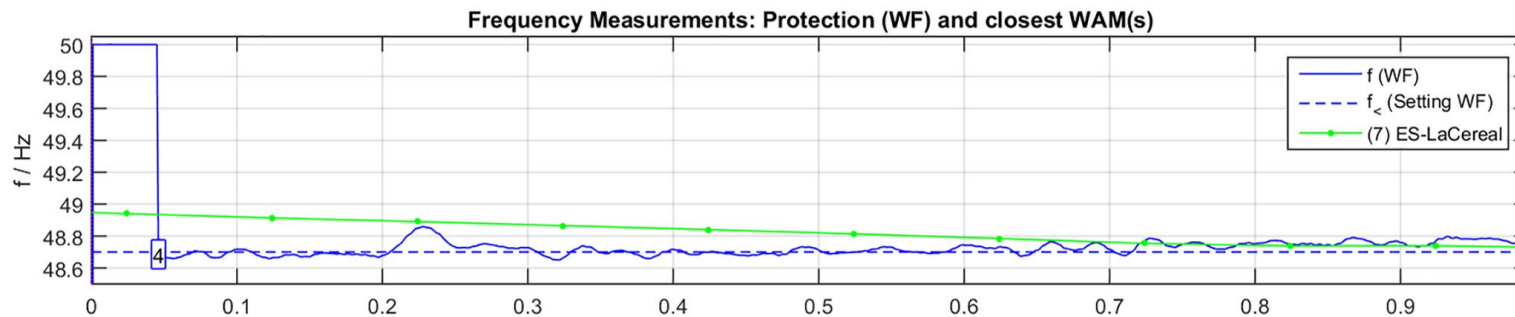
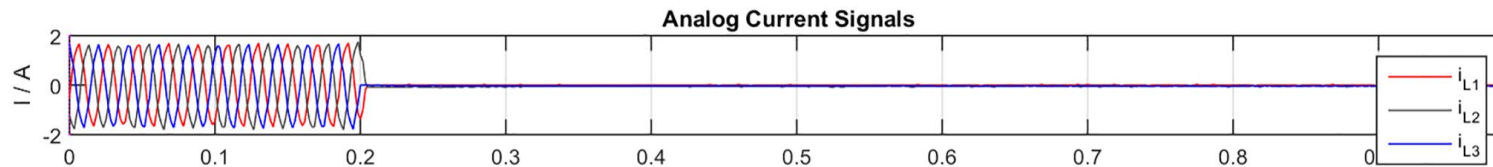
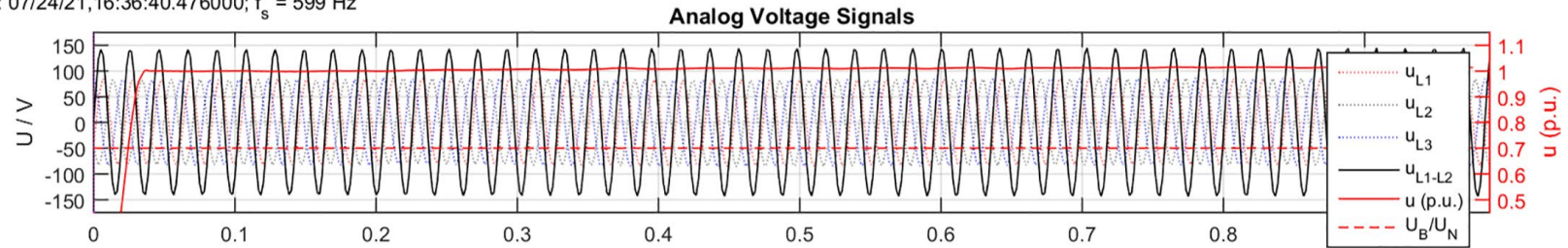
Trigger: 16:36:40.548

27.01.2022 21:22:26 / W. Fromm

Underfrequency Protection Evaluation - Sim.Nr. 4/18 [4]

Arganda 220 kV: Station ZIV77319 - Device 102
 (File: Arganda 702_Madrid\2021-07-24T16_36_40Z.476000)
 Start: 07/24/21, 16:36:40.476000; $f_s = 599$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V13M5]

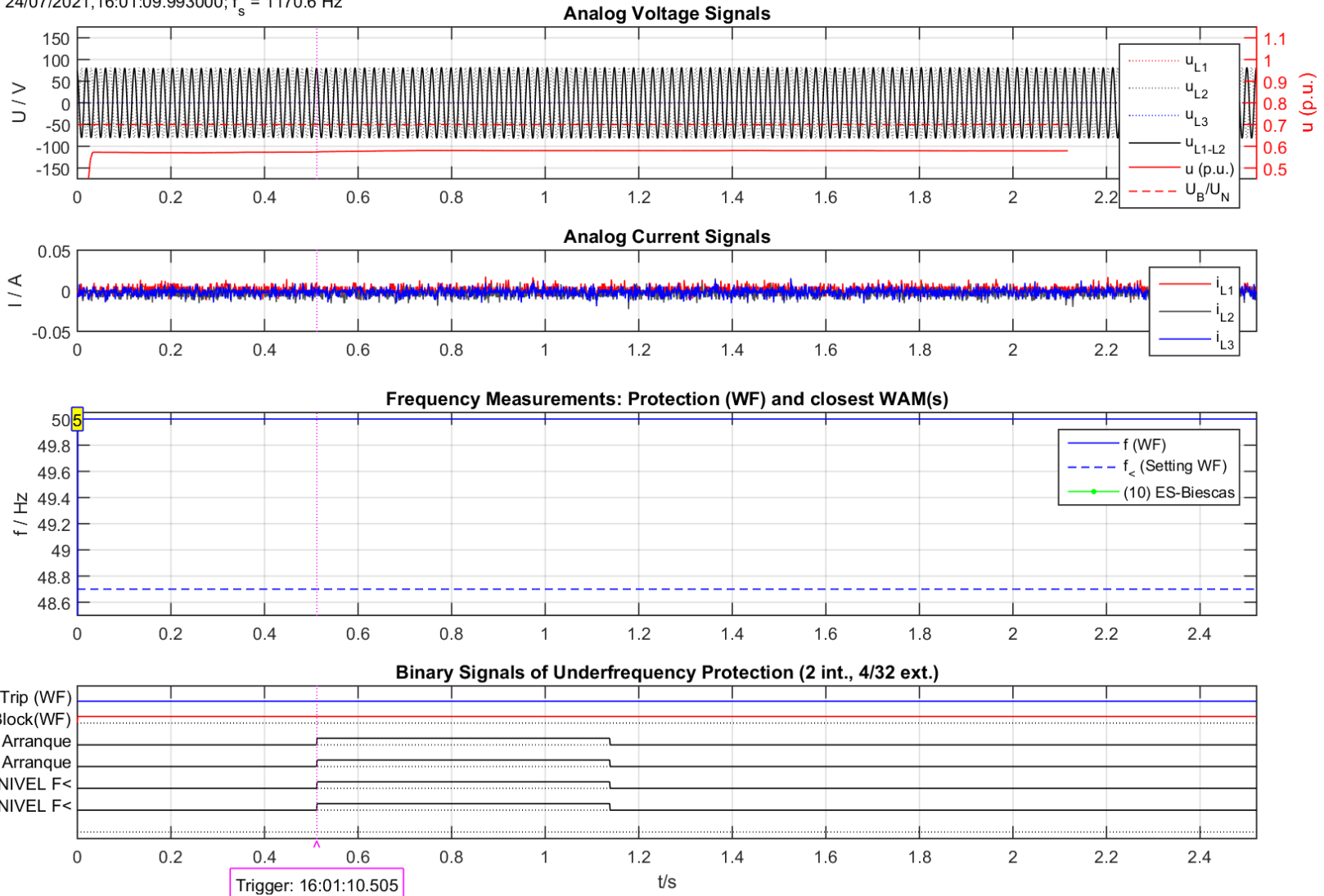


27.01.2022 21:22:29 / W. Fromm

Underfrequency Protection Evaluation - Sim.Nr. 5/18 [5]

Cinca 220 kV: Station SE CINCA - Device 1
 (File: CINCA TR1 TR2 TR4 110_25kV\24.07.21 16.01.10.000.000)
 Start: 24/07/2021,16:01:09.993000; $f_s = 1170.6$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V7M5]



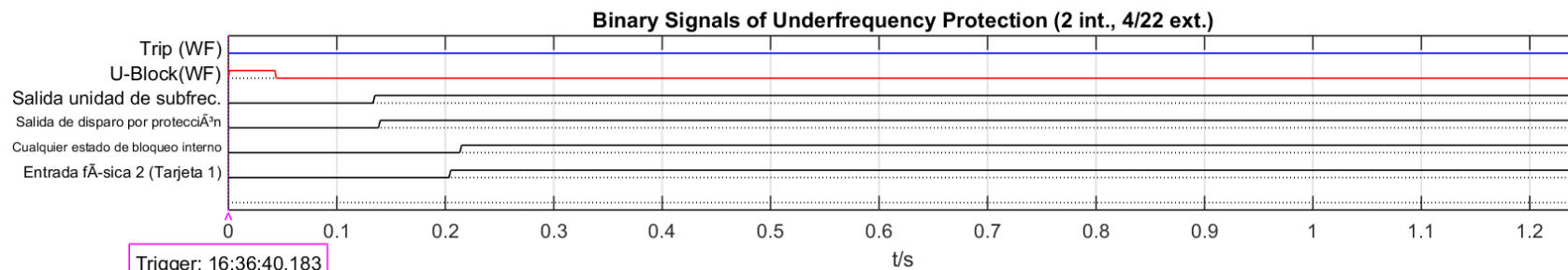
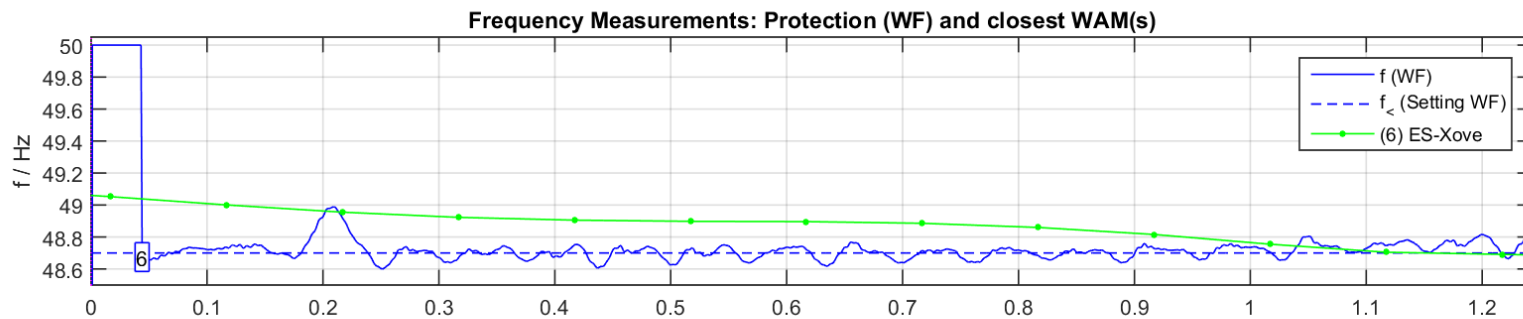
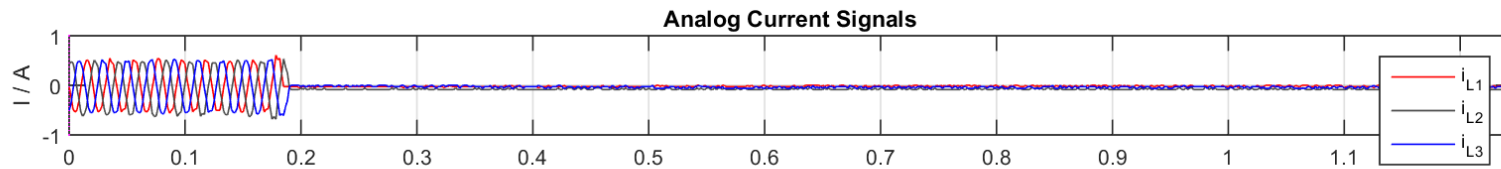
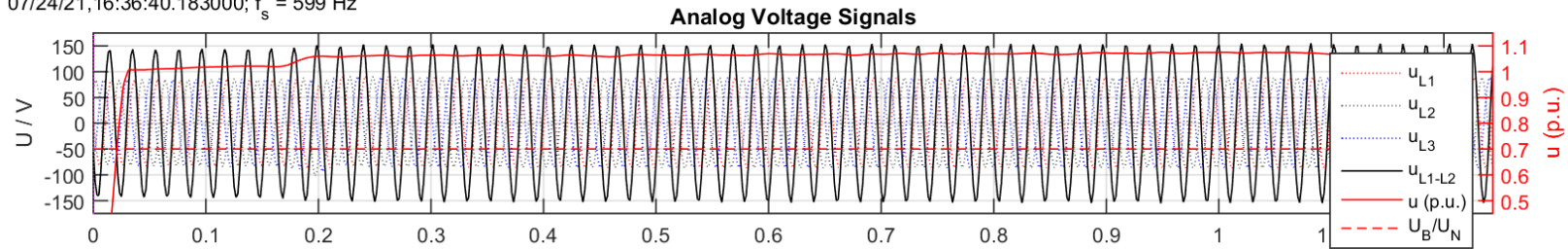
27.01.2022 21:22:38 / W. Fromm



Underfrequency Protection Evaluation - Sim.Nr. 6/18 [6]

Zamora 220 kV: Station ZIV73842 - Device 55
 (File: Cobreros 707_Zamora\2021-07-24T16_36_40Z.183000)
 Start: 07/24/21, 16:36:40.183000; $f_s = 599$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V13M5]



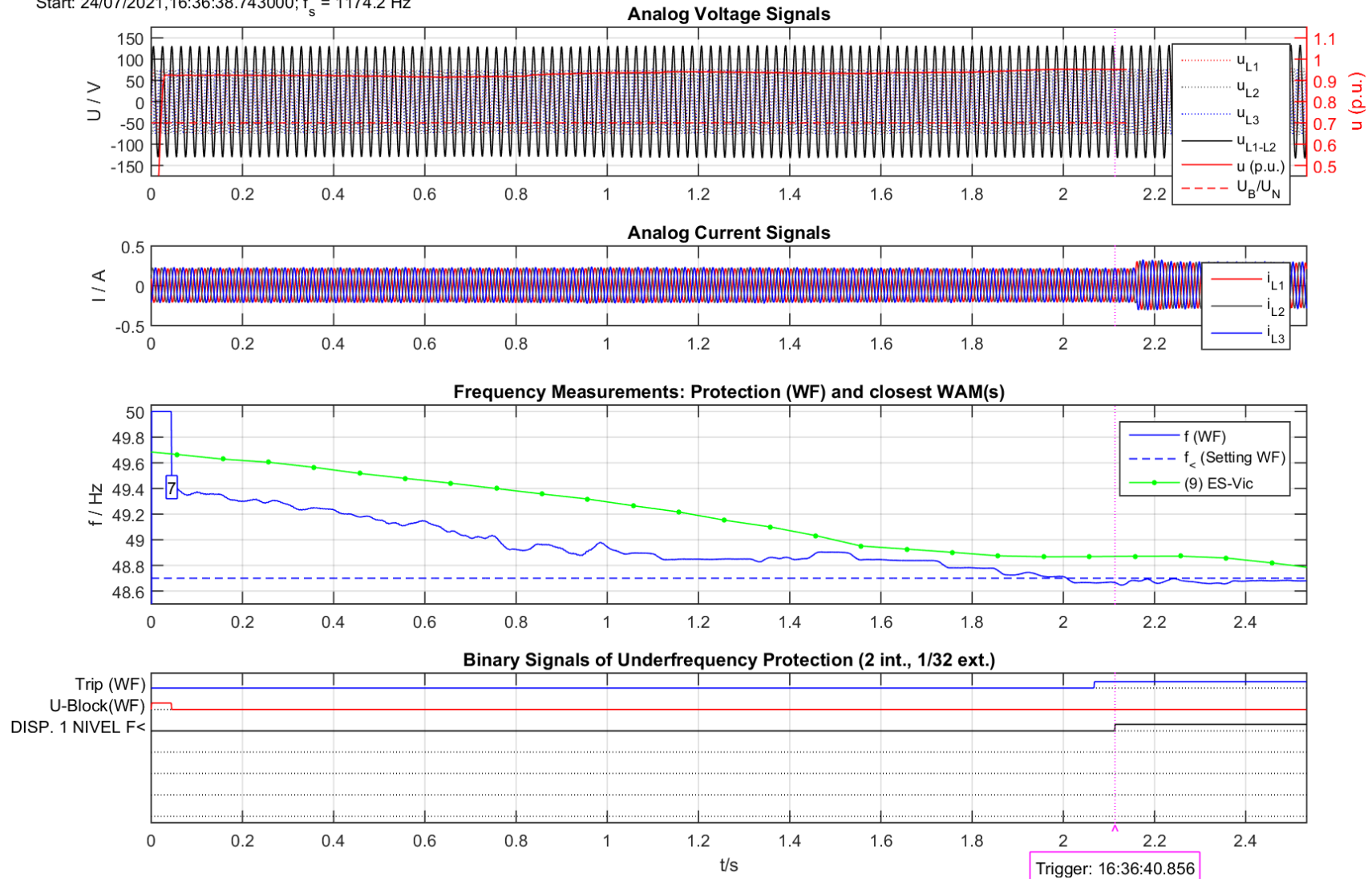
Trigger: 16:36:40.183

27.01.2022 21:22:41 / W. Fromm

Underfrequency Protection Evaluation - Sim.Nr. 7/18 [7]

Collblanc 220 kV: Station SE COLLBLANC - Device 1
 (File: COLLBLANC ATR1 220_110_25\24.07.21 16.36.40.000.000)
 Start: 24/07/2021,16:36:38.743000; $f_s = 1174.2$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V7M5]



27.01.2022 21:22:50 / W. Fromm

Annex 7: COMTRADE measurement evaluation Collblanc LFDD relay



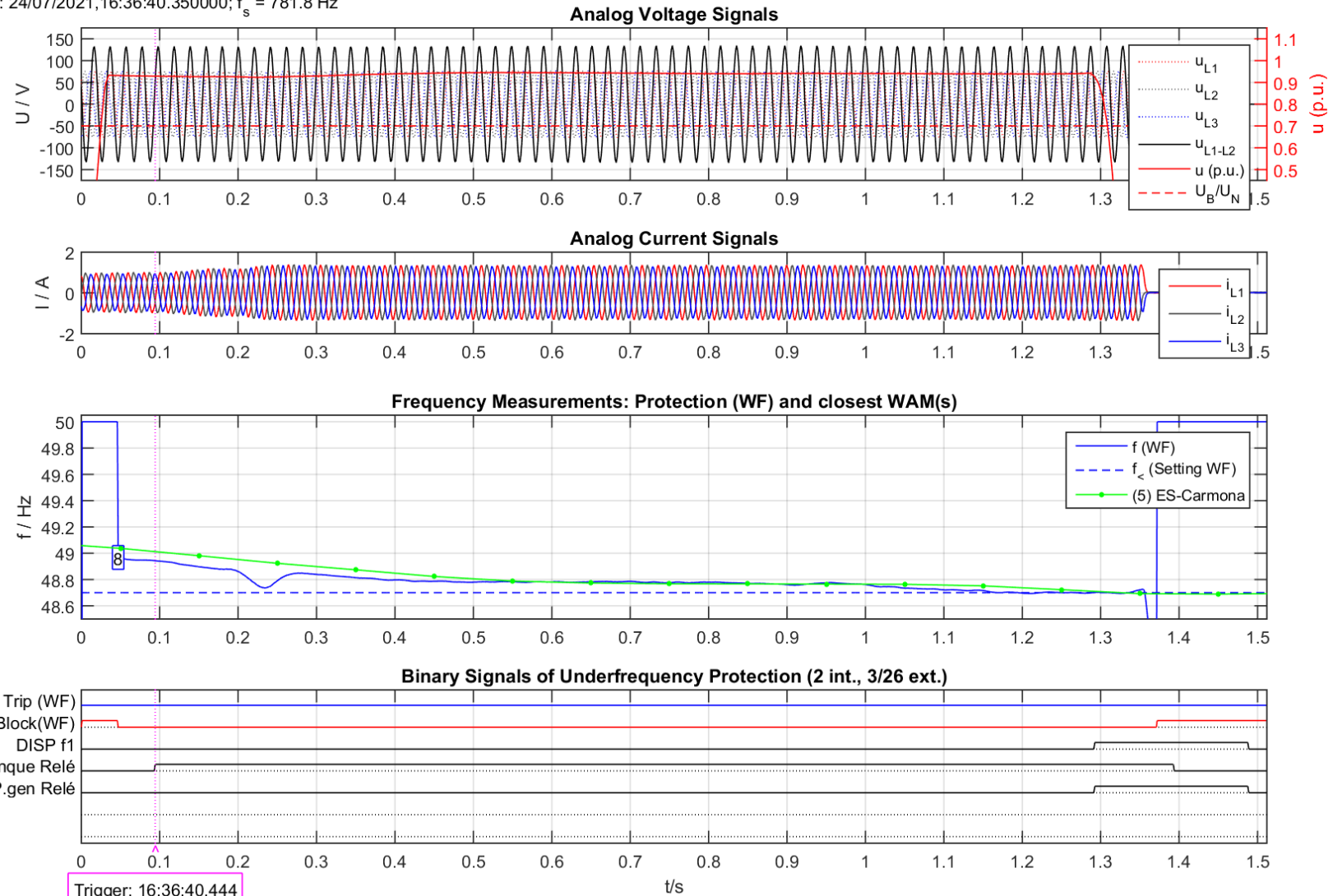
Underfrequency Protection Evaluation - Sim.Nr. 8/18 [8]

Mérida 220 kV: Station Olivenza Trafo 1 7SJ621 V4.4 Var 1 - Device 001060

Protection (WF): $f_{\zeta} = 48.70$ Hz; $U_B/U_N = 0.70$ [V10M5]

(File: OLIVENZA TR1 66_20\Olivenza TR1)

Start: 24/07/2021,16:36:40.350000; $f_s = 781.8$ Hz

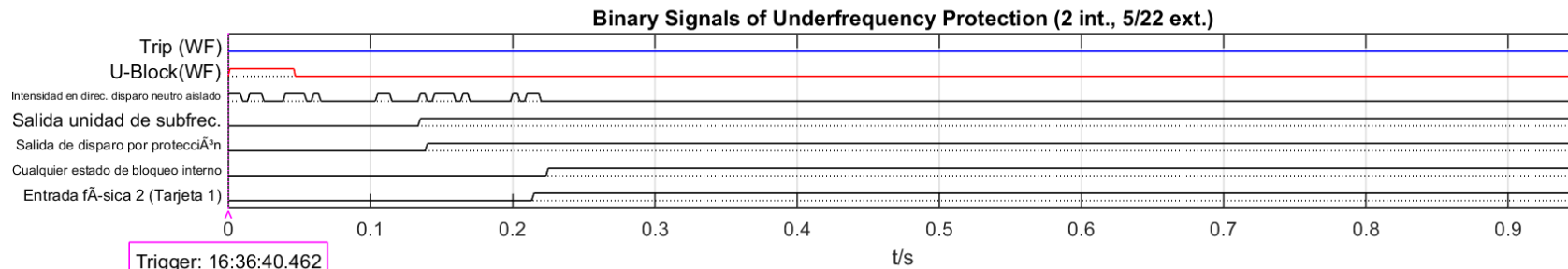
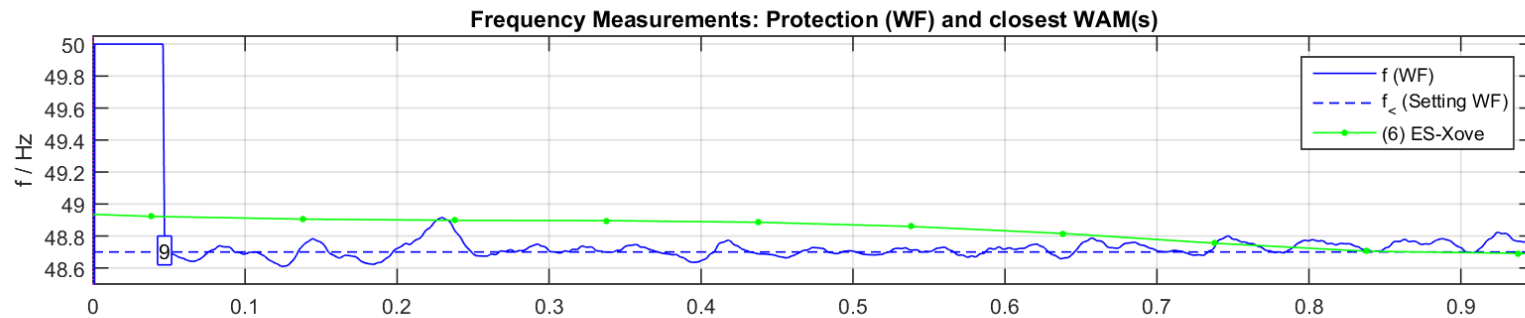
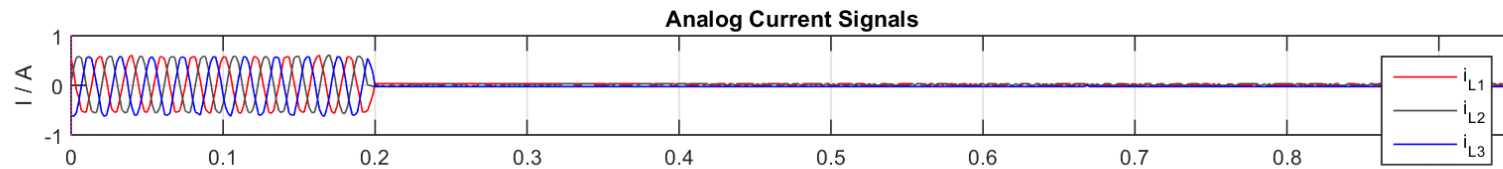
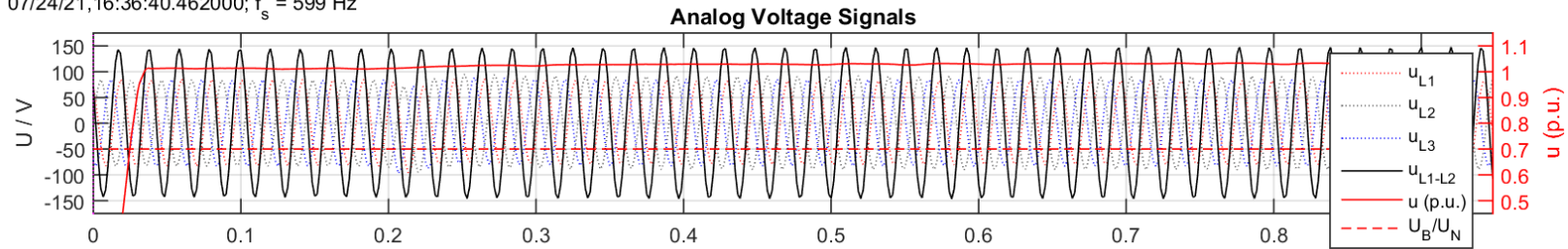


27.01.2022 21:22:55 / W. Fromm

Underfrequency Protection Evaluation - Sim.Nr. 9/18 [9]

Tordesillas 220 kV: Station ZIV91610 - Device 22
 (File: Otero Herreros 703_Segovia\2021-07-24T16_36_40Z.462000)
 Start: 07/24/21, 16:36:40.462000; $f_s = 599$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V13M5]



Trigger: 16:36:40.462

27.01.2022 21:22:58 / W. Fromm

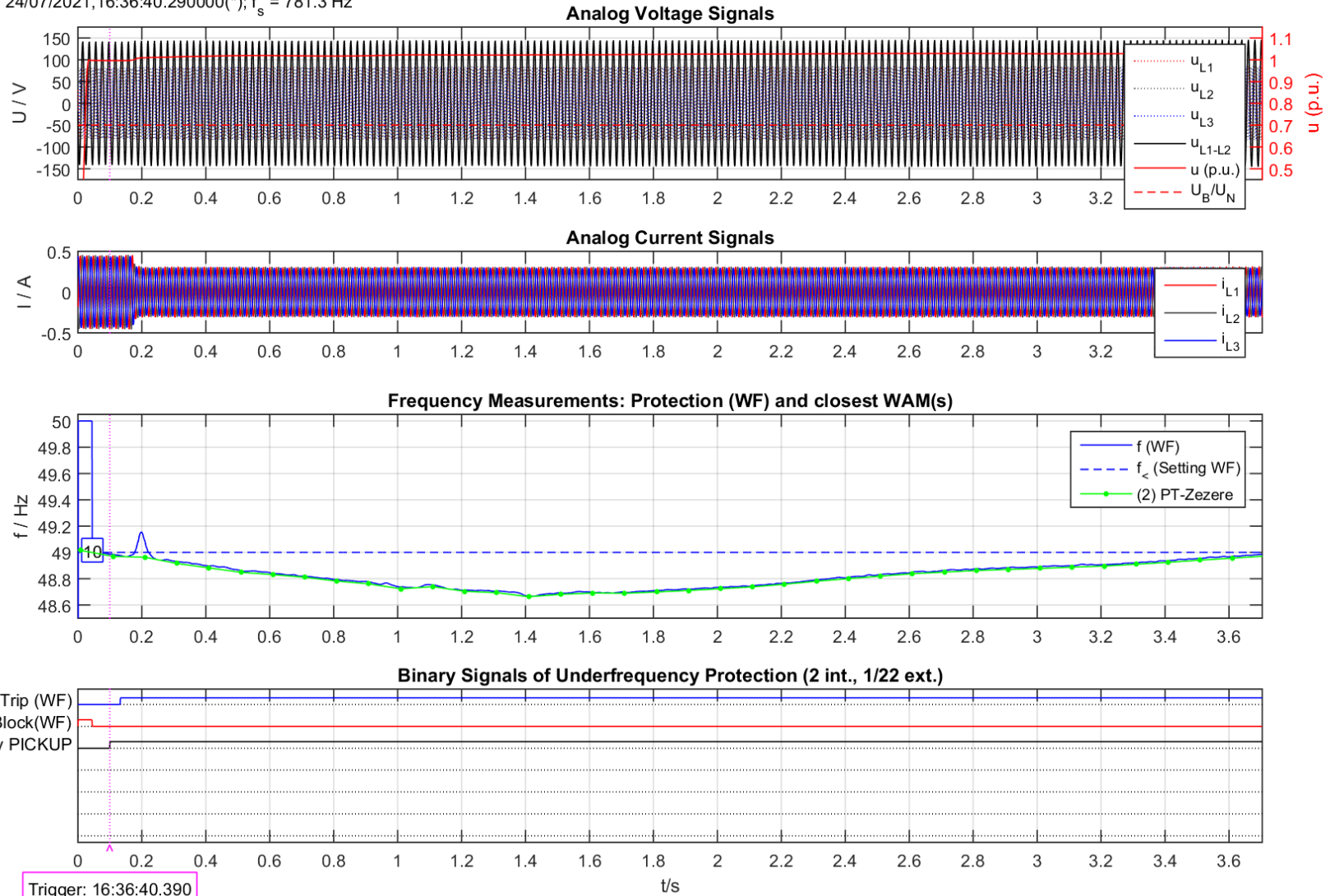
Underfrequency Protection Evaluation - Sim.Nr. 10/18 [10]

Zezere: Station MT11_TP1 - Device

(File: Portugal_HVMVsubstation_frequencyloadshedding_49Hz\CT000592)

Start: 24/07/2021,16:36:40.290000(*); $f_s = 781.3$ Hz

Protection (WF): $f_c = 49.00$ Hz; $U_B/U_N = 0.70$ [V10M5]



Trigger: 16:36:40.390

27.01.2022 21:23:04 / W. Fromm



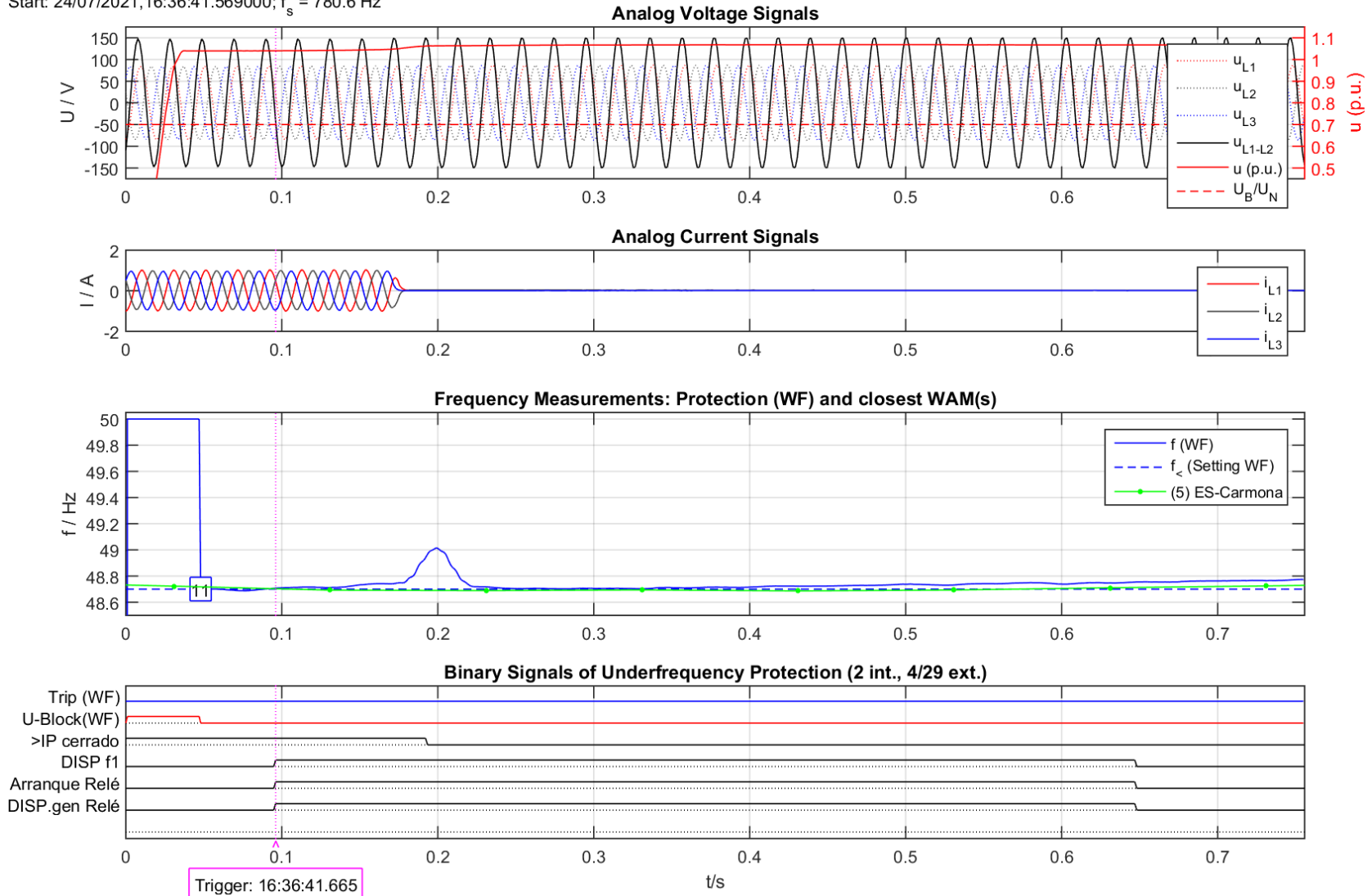
Underfrequency Protection Evaluation - Sim.Nr. 11/18 [11]

Rocio 220 kV: Station Rocio Trafo 3 7SJ621 V4.4 Var - Device 002040

Protection (WF): $f_{\zeta} = 48.70$ Hz; $U_B/U_N = 0.70$ [V10M5]

(File: ROCIO 66 TR3 66_15\Rocio TR3 Oscilo)

Start: 24/07/2021, 16:36:41.569000; $f_s = 780.6$ Hz



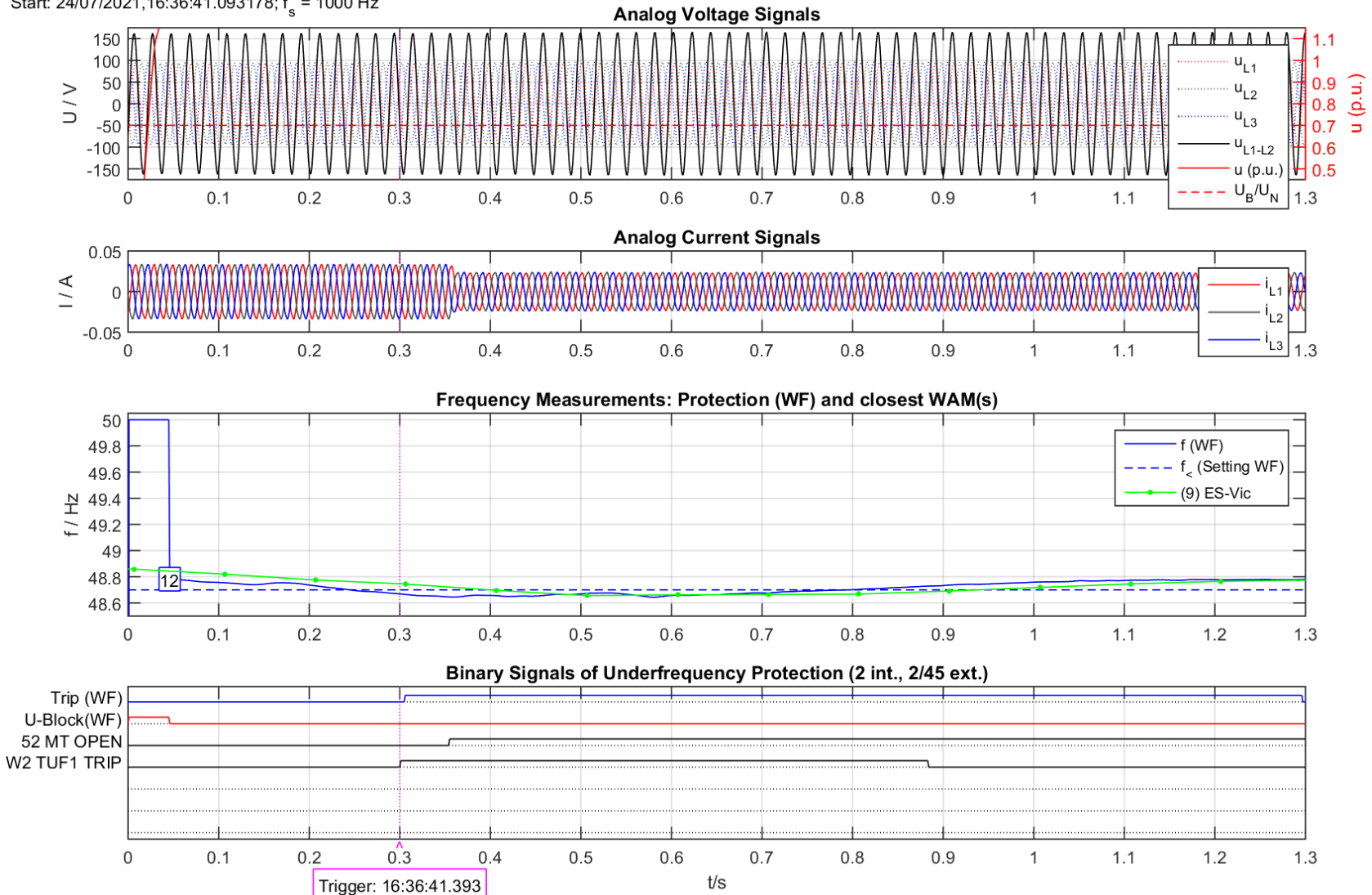
27.01.2022 21:23:08 / W. Fromm



Underfrequency Protection Evaluation - Sim.Nr. 12/18 [12]

Rubi 220 kV: Station RUBI - Device 1
 (File: RUBI TR3 220_66_25\AA1J1Q01A1202107243cc)
 Start: 24/07/2021, 16:36:41.093178; $f_s = 1000$ Hz

Protection (WF): $f_{\zeta} = 48.70$ Hz; $U_B/U_N = 0.70$ [V8M5]



27.01.2022 21:23:13 / W. Fromm

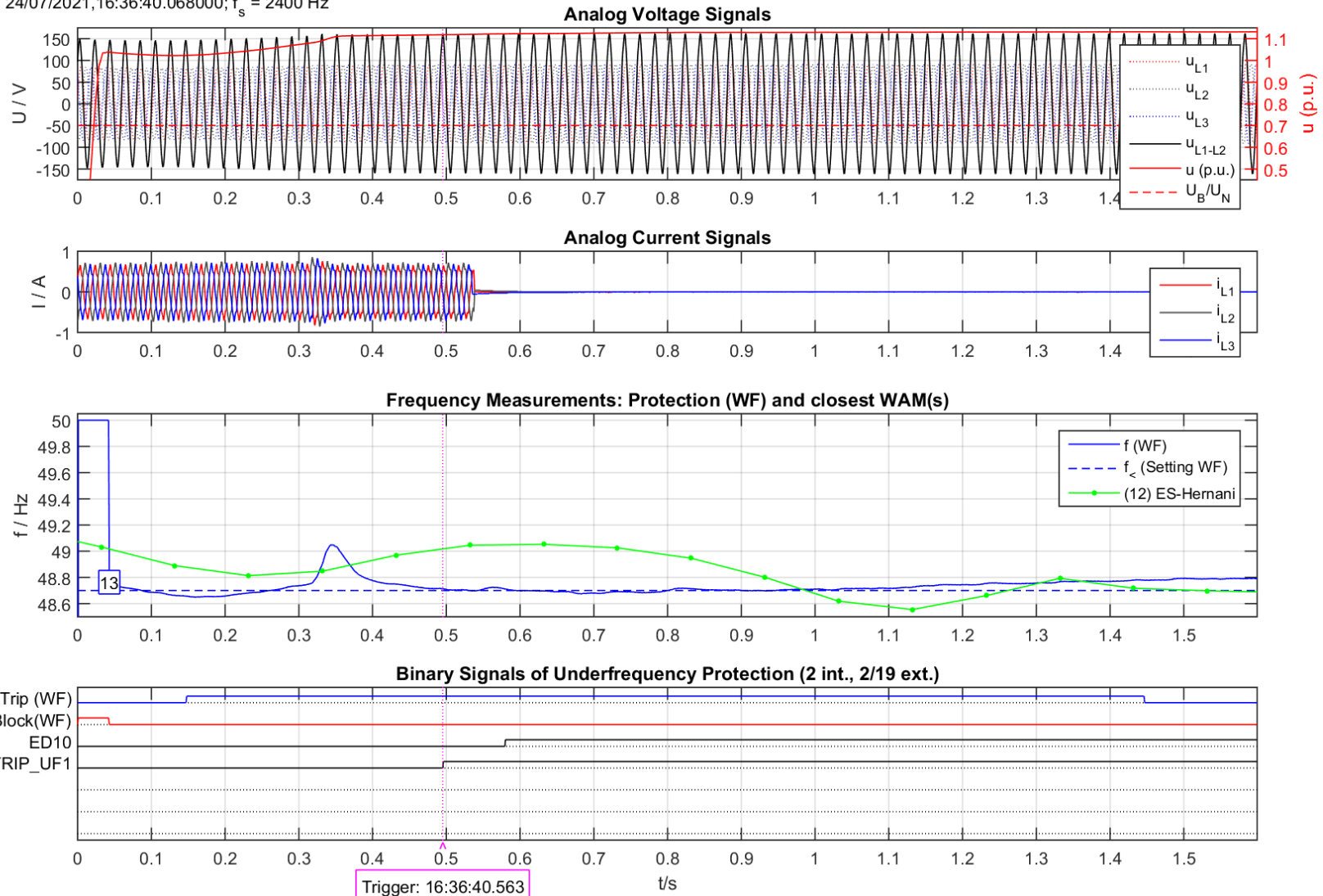
Annex 12: COMTRADE measurement evaluation Rubi LFDD relay



Underfrequency Protection Evaluation - Sim.Nr. 13/18 [13]

Cordovilla 220 kV: Station ST CORDOVILLA - Device #DRVD1N***201*C
 (File: ST CORDOVILLA POTASAS 66 kV\8DRVD1N220201SC.71711.20210724163640068)
 Start: 24/07/2021,16:36:40.068000; $f_s = 2400$ Hz

Protection (WF): $f_{\zeta} = 48.70$ Hz; $U_B/U_N = 0.70$ [V3M5]



27.01.2022 21:23:17 / W. Fromm

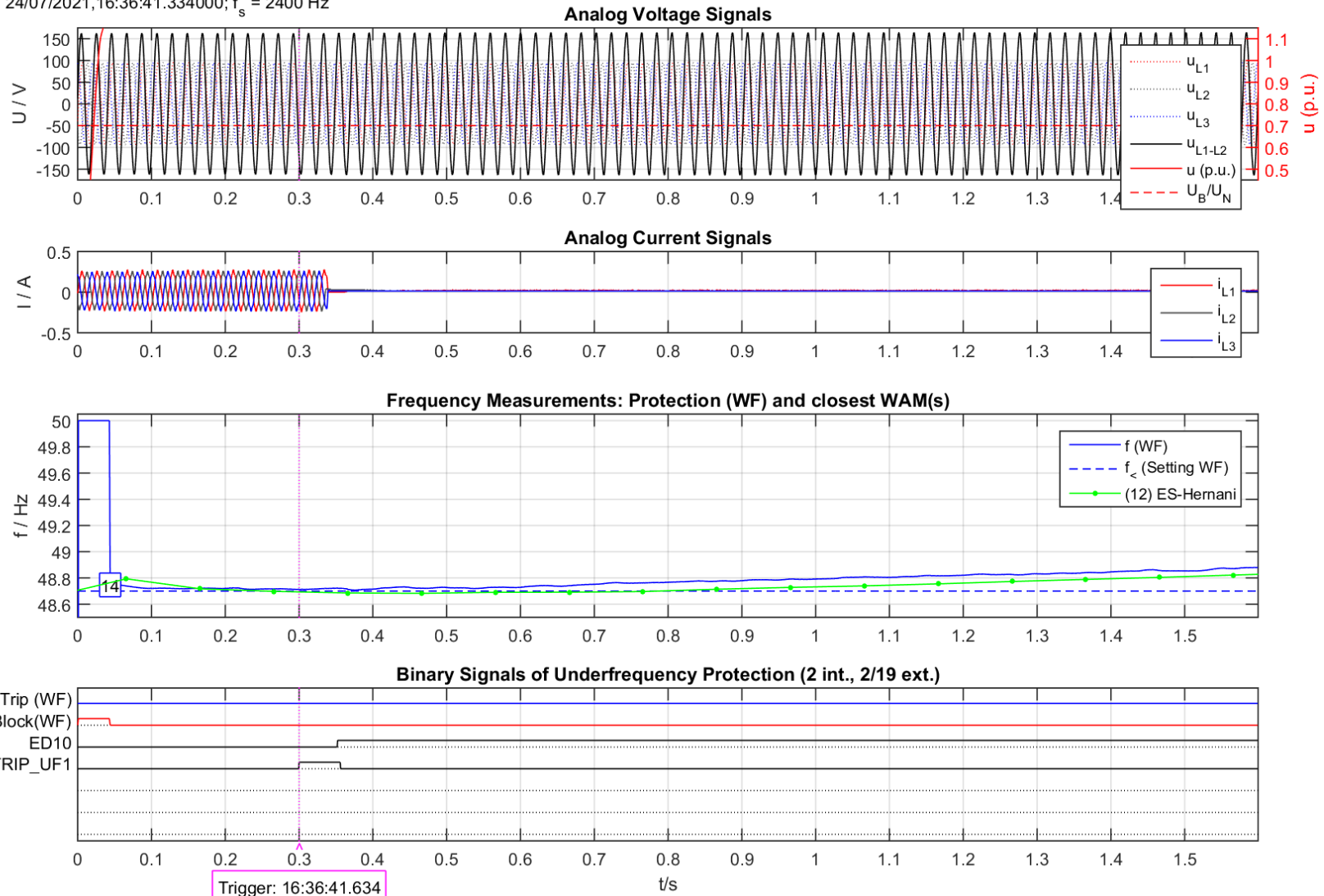
Annex 13: COMTRADE measurement evaluation Cordovilla LFDD relay



Underfrequency Protection Evaluation - Sim.Nr. 14/18 [14]

La Serna 220 kV: Station ST LA SERNA - Device #DRVD1N***211*K
 (File: ST LA SERNA LLABRADAS 1 66KV\8DRVD1N220211SK.67842.20210724163641334)
 Start: 24/07/2021,16:36:41.334000; $f_s = 2400$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V3M5]



27.01.2022 21:23:27 / W. Fromm

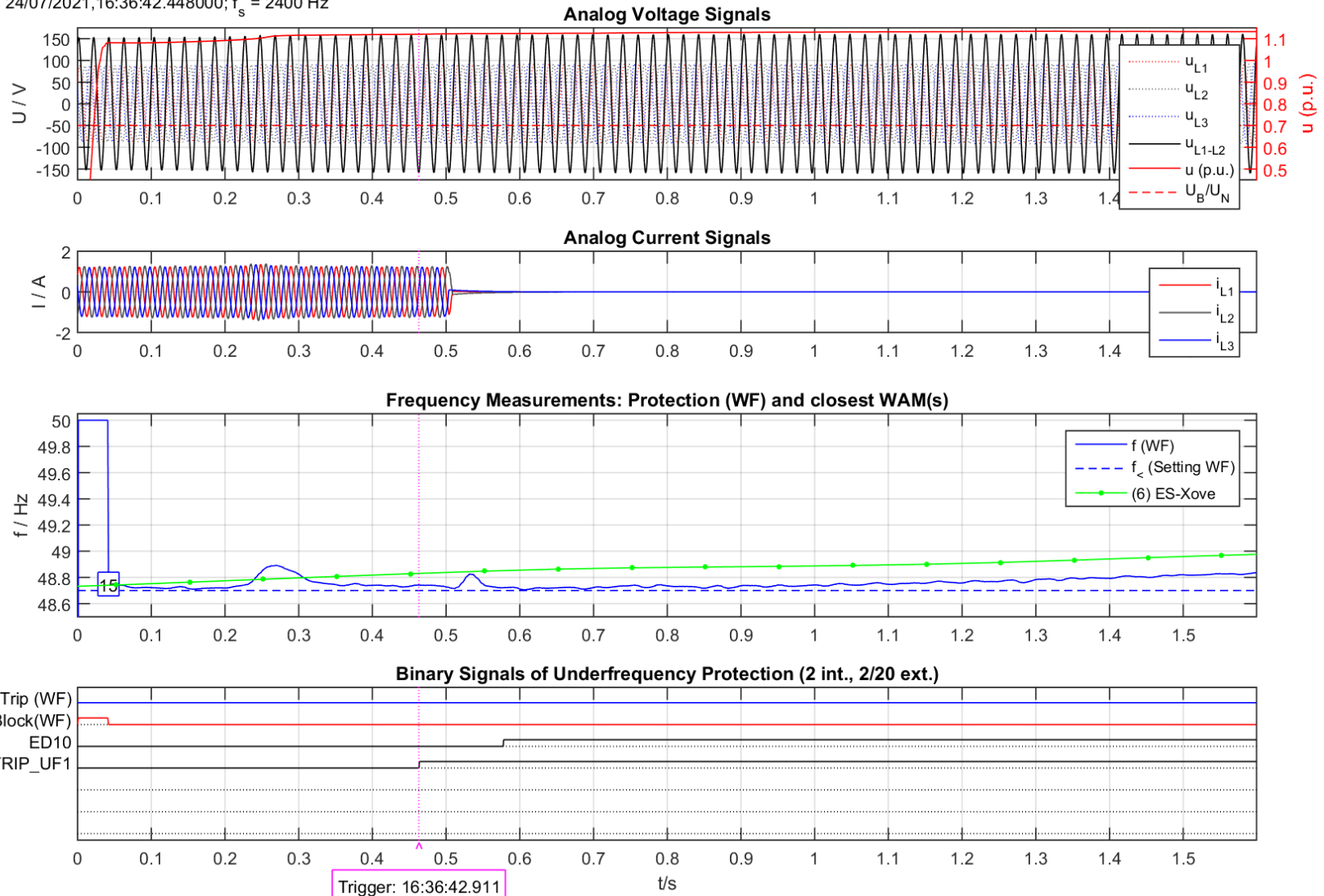
Annex 14: COMTRADE measurement evaluation La Serna LFDD relay



Underfrequency Protection Evaluation - Sim.Nr. 15/18 [15]

Palencia 220 kV: Station PALENCIA 04L ZAR - Device #DRVD1N***211*K
 (File: ST PALENCIA LZARATAN 45KV\8DRVD1N220211SK.77632.20210724163642448)
 Start: 24/07/2021,16:36:42.448000; $f_s = 2400$ Hz

Protection (WF): $f_{\zeta} = 48.70$ Hz; $U_B/U_N = 0.70$ [V3M5]



27.01.2022 21:23:35 / W. Fromm

Annex 15: COMTRADE measurement evaluation Palencia LFDD relay



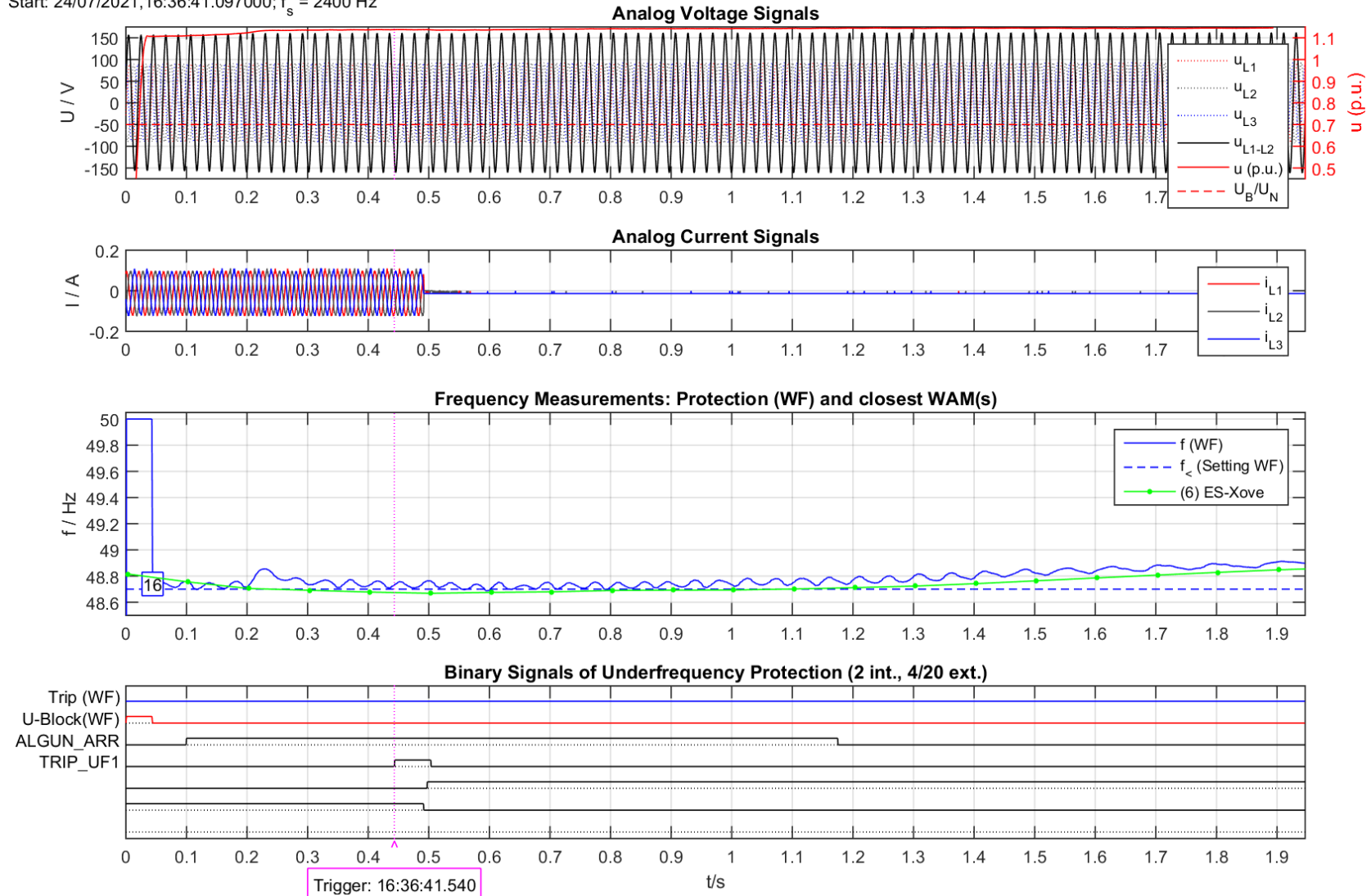
Underfrequency Protection Evaluation - Sim.Nr. 16/18 [16]

Renedo 220 kV: Station RENEDO-LAGUNA-2-45KV - Device 7DRVD1N***311*K

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V3M5]

(File: ST RENEDO LLAGUNA 2 45KV7DRVD1N220311QK.90317.20210724163641097)

Start: 24/07/2021,16:36:41.097000; $f_s = 2400$ Hz



27.01.2022 21:23:45 / W. Fromm

Annex 16: COMTRADE measurement evaluation Renedo LFDD relay

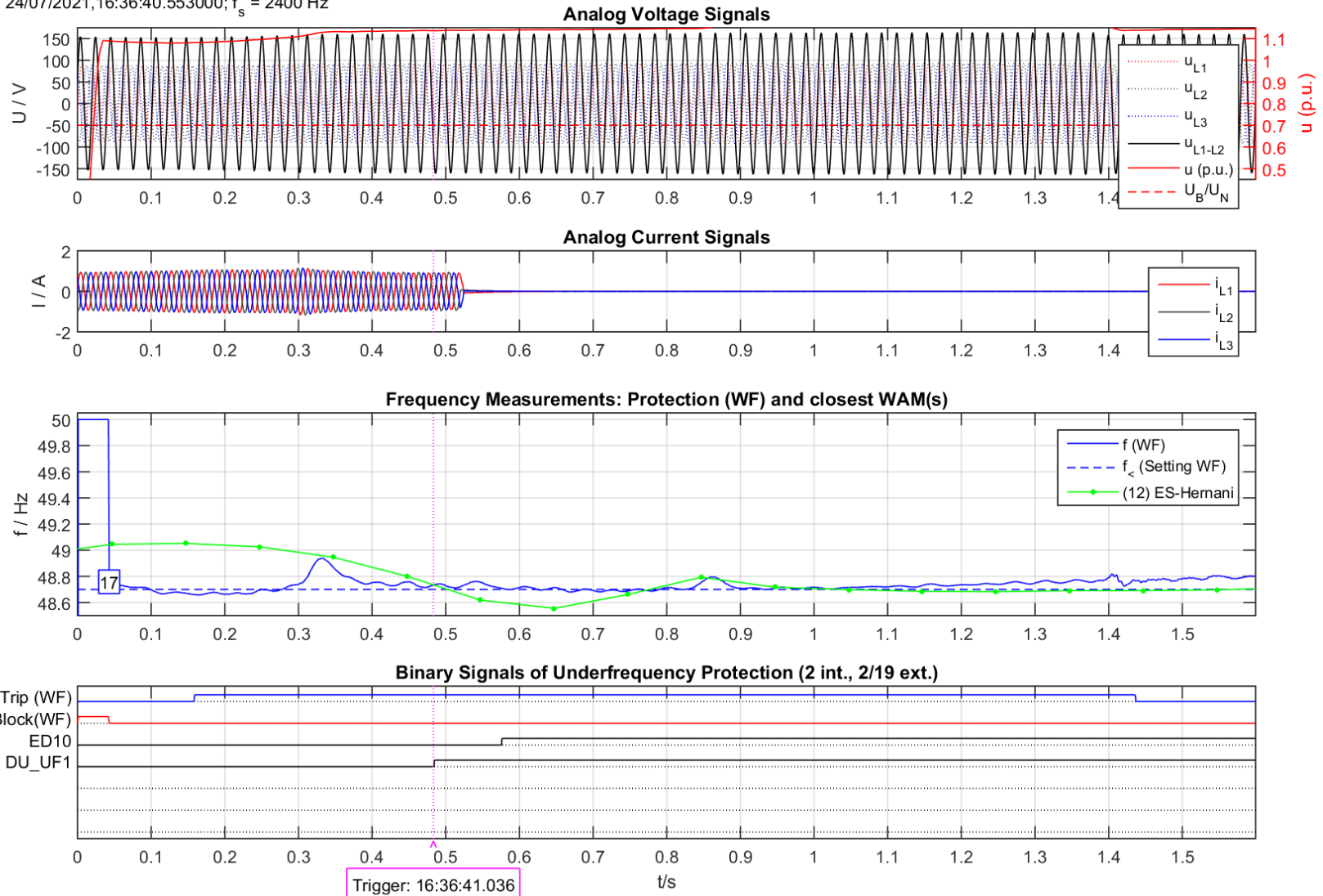
Underfrequency Protection Evaluation - Sim.Nr. 17/18 [17]

Villimar 220 kV: Station VILLIM 04L Gamonal 1 - Device #DRVD1N***201*C

(File: ST VILLIMAR LGAMONAL45KV\8DRVD1N220201SC.72450.20210724163640553)

Start: 24/07/2021,16:36:40.553000; $f_s = 2400$ Hz

Protection (WF): $f_c = 48.70$ Hz; $U_B/U_N = 0.70$ [V3M5]



27.01.2022 21:23:53 / W. Fromm

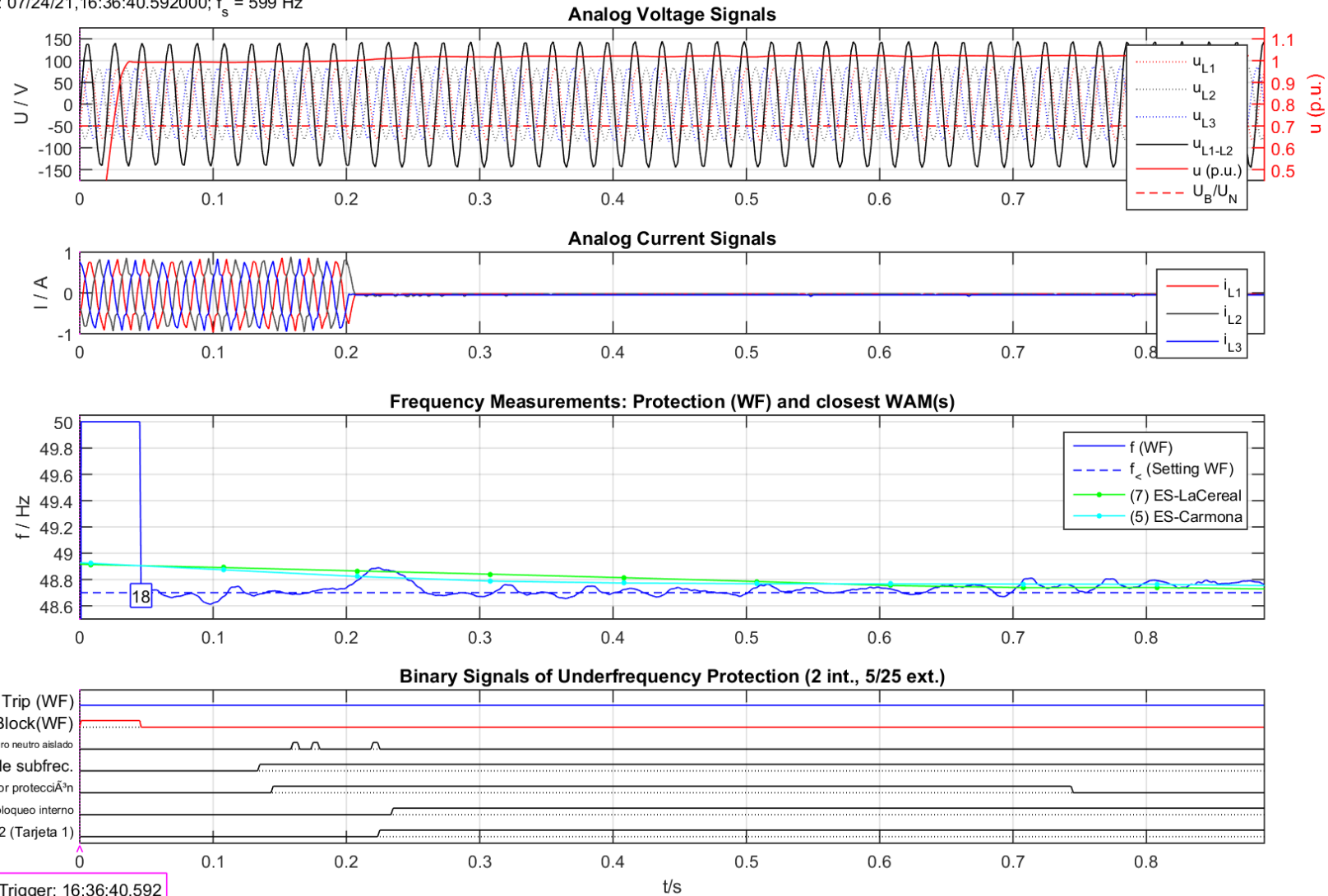
Annex 17: COMTRADE measurement evaluation Villimar LFDD relay



Underfrequency Protection Evaluation - Sim.Nr. 18/18 [18]

Madrdejos 220 kV: Station ZIV51609 - Device 31
 (File: Tomelloso 702_C Real\2021-07-24T16_36_40Z.592000)
 Start: 07/24/21, 16:36:40.592000; $f_s = 599$ Hz

Protection (WF): $f_{\zeta} = 48.70$ Hz; $U_B/U_N = 0.70$ [V13M5]



Trigger: 16:36:40.592

27.01.2022 21:23:57 / W. Fromm

Publisher

The Expert Panel on the separation
of the Continental Europe Synchronous
Area of 24 July 2021

info@entsoe.eu
info@acer.europa.eu

Design

DreiDreizehn GmbH, Berlin
www.313.de

Images

Cover: courtesy of RTE
p. 3: courtesy of APG
p. 4: iStockphoto.com

Publishing date

25 March 2022

