FUNDACIÓN TECNALIA RESEARCH & INNOVATION

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Test Report No. B126-11-CD-01E

Tests specified by the customer

TEST SAMPLE:	CURRENT TRANSFORMER
DESIGNATION:	CA-123
MANUFACTURER:	ELECTROTÉCNICA ARTECHE HNOS, S.A
REQUESTED BY:	ELECTROTÉCNICA ARTECHE HNOS, S.A Derio Bidea, 28 – 48100 MUNGIA (BIZKAIA)
STANDARD	Sn-16.1g and IEC 60044-1:1996+A1 2000 +A2:2002
RECEPTION DATE:	September 13th 2011
TESTS DATE:	September 15th – 19th 2011
ISSUE DATE:	September 23th 2011

THE PRESENT REPORT CONSISTS OF:

No of pages: 15

Annex : 15

tecnalia
This document is a copy in pdf of the original Report, as requested by the client

Test Chief / High Voltage Area	Head of Electrical Equipment Laboratory
	
Estíbaliz Montes	Luis Martínez

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Annex PHOTOGRAPHS
OSCILOGRAMME
IMPULSES

1. DESIGNATION OF THE TEST OBJECT

CURRENT TRANSFORMER.

The characteristics of the test object, provided by the manufacturer, are the following:

Manufacturer:	ARTECHE	
Type	CA-123	
Serial No.:	11006584/15	
Manufacturing year:	2011	
Ratio:	10 / 5 – 5 A	
Primary terminal markings:	H1	H2
Rated primary current, Ipn:	10 A	
Secondary terminal markings:	X1-X2	Y1-Y2
Rated secondary current, Isn:	5 A	5 A
Rated output:	10 VA	10 VA
Accuracy class:	0.2	0.2
Extended rated current:	120%	
Rated insulation level:	123/185/450 kV	
Rated short-time thermal current, Ith:	0.8 kA - 1 s	
Rated dynamic current, Idyn:	2 kA	
Rated frequency:	60 Hz	

See photographs of the test object and its rating plate in the annex.

2. TESTS PERFORMED. STANDARD

The test sequence has been the following:

TEST	TYPE/ROUTINE
Withstand test between the current transformer's terminals	Type
Wet test	Type
Short-time current test	Type

The tests have been carried out according to customer's specifications and according to the following standard:

- **Standard technical specification. Hydro-Quebec TransÉnergie. Energy transport expertise and technical support. Energy transport apparatus. "Testing of instrument transformers 26,4 kV to 765 kV. SN-16.1g July 2003"**

- **IEC 60044-1:1996 + A1:2000 + A2:2002, "Instrument transformers. Part 1: Current Transformers".**

Quoted standard:

- IEC 60060-1:1989, "High-voltage test techniques - Part 1: General definitions and test requirements".
- IEC 60270: 2000, "High-voltage test techniques - Partial discharge measurements".

The calculation of the uncertainties of the measurements is available.

3. RECEPTION PLACE AND TESTING PLACE

All the tests have been performed at TECNALIA's installations except the routine tests performed after the short-circuit test that have been performed in ARTECHE's installations in Munguia.

4. TYPE TESTS

4.1. Withstand test between the current transformer's terminals

4.1.1. Test method

The protection device of the primary winding must be removed for the test. The test consists in applying 5 positive impulses and 5 negative impulses on each terminal of the primary winding. The test voltage must be equal to 130% of the lightning impulse protection level of the voltage limited device installed.

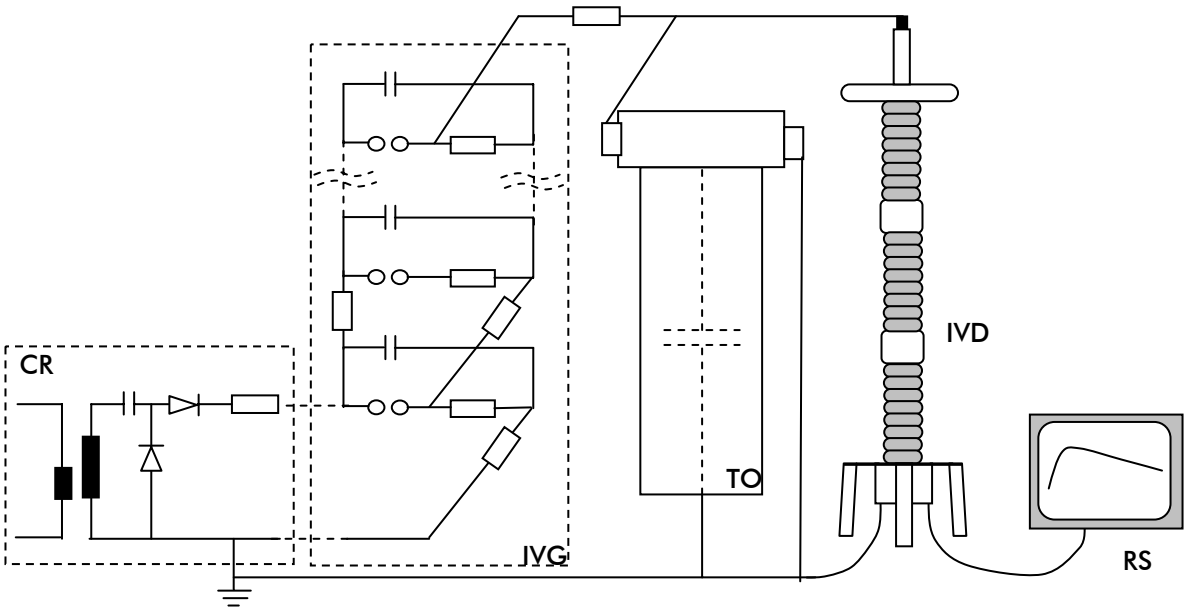
The wave shape must be the closest to the standard wave shape 1,2 μs (±30%)/50 μs(±20%). Considering the low impedance of the winding, it can be difficult to obtain a waveform having a 50 μs tail time due to testing laboratory limitations. Regarding the wave shape an agreement with the customer is reached.

Ambient air conditions during the test:

Temperature:	24.4 ºC
Pressure:	101.7 kPa
Relative humidity:	55 %

Applied impulses can be seen in the annex.

The scheme of the test is the following:



CR: Charging rectifier
IVG: Impulse voltage generator
TO: Test object
IVD: Impulse voltage divider
RS: Recording system

4.1.2. Result

Result: **CORRECT**.

4.2. Wet test

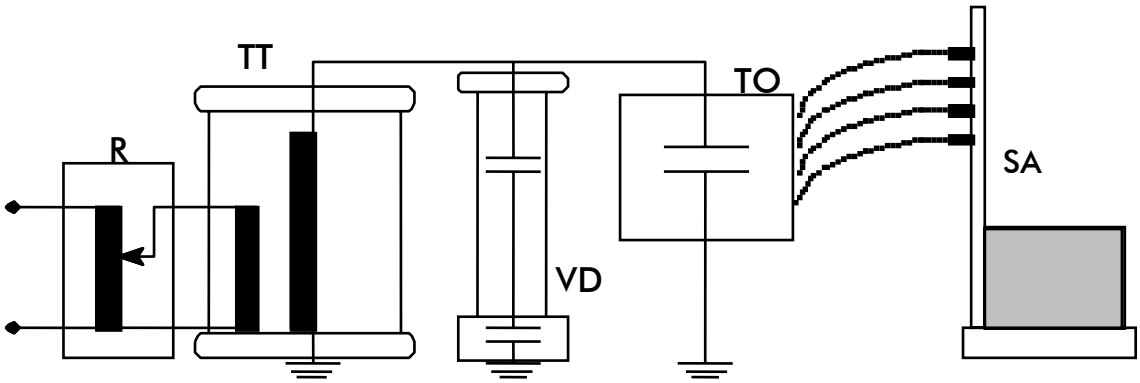
4.2.1. Test method

The wet test has been carried out in accordance with the Standard IEC 60060-1.

The voltage test is applied between the terminals of the primary winding connected together and earth. The frame and the terminals of secondary windings are connected together and to earth.

Test voltage:	**185 kV**
Test duration:	60 s
Test voltage frequency:	50 Hz

Test scheme is represented in the following figure:



R: Regulator
TT: Test Transformer
VD: Voltage divider
TO: Test object
SA: Spray apparatus

According to the standard the test object is pre-wetted initially for 15 min under the specified wetting conditions, and these conditions remain within the specified tolerances throughout the test which is performed without interrupting the wetting.

Precipitation conditions during the test (and standard conditions):

Characteristic	Test	Standard
Precipitation rate – vertical component: mm/min	1.7	1.0 to 2.0
Precipitation rate – horizontal component: mm/min	1.5	1.0 to 2.0
Limit for any individual measurement: mm/min	Correct	±0.5 from average
Temperature of water:ºC	22	mb. temp. ±15 ºC
Resistivity of water:Ωm	105.4	100 ±15 Ωm

Before the test, test object is in dry and clean conditions.

Ambient air conditions during the test have been the following.

Temperature:	24.3 ºC
Pressure:	101.2 kPa
Relative humidity:	56 %

Atmospheric correction factor, K_t, has been considered equal to unity.

4.2.2. Result

Result: **CORRECT.** No disruptive discharge occurs on the test object during the test.

4.3. Short-circuit withstand test

4.3.1. Test method

The thermal test is done by circulating the rated short-circuit current I_{th} in the primary winding for a time of one second or until the product I^2t is at least equal to I^2_{th} reached equivalent. The maximal duration of the test must be 5 seconds.

The dynamic tests must be done by applying, during 0.017 second, an asymmetric current whose first peak is equal to the rated dynamic current whose first peak is equal to the rated dynamic current defined in the standard technical specification for the supply.

The transformer is considered to pass the test successfully if the following conditions are fulfilled:

- The transformer did not sustain any apparent damage
- The accuracy did not change significantly
- The repetition of the routine tests do not show any drop in the performance or failure of the apparatus

Rated values for the test are the following:

Rated short-time thermal current. I_{th}: 0.8 kA - 1 s
Rated dynamic current. I_{dyn}: 2 kA

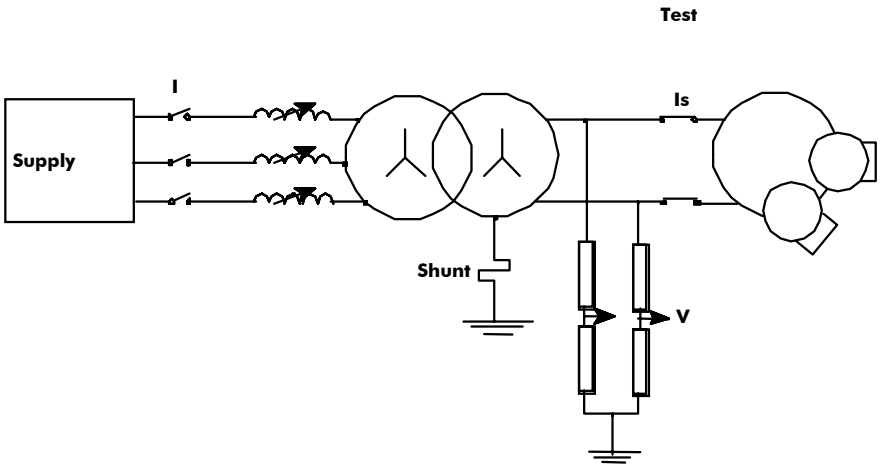
See oscilogram in the annex of the report.

Taking into account the requirements of the customer, the resistances of the primary and secondary windings have been measured before and after the short circuit test. Obtained results have been the following:

	BEFORE (mΩ)	AFTER (mΩ)
X1-X2	129.09	129.5
Y1-Y2	128.15	134.4
H1-H2	129.8	132

Measurements have been performed with a current of 1A and with an ambient temperature of 26ºC.

Test circuit



Results

Registered values

Oscillogram No.	2
Short-time r.m.s. current Ith (kA)	0.828
Short-time peak value current. Idyn (kA)	2.112
Duration (s)	1.009
Joule integral I^2t ($AAs.10^5$)	7.18
Frequency (Hz)	50
Temperature (ºC)	25

Result: **CORRECT**. According to the following verifications:

4.3.2. Verifications

a) Visual check of the transformer

Result: **CORRECT**. The transformer is not visibly damaged and the insulation next to the surface of the conductor does not show significant deterioration.

b) Dielectric tests

Power-frequency withstand test on the primary winding

The voltage test is applied between the terminals of the primary winding connected together and earth. The frame and the terminals of secondary windings are connected to earth.

Test voltage value:	**185 kV**
Test voltage frequency:	50 Hz
Test duration:	60 s

Result: **CORRECT**. There are neither disruptive discharges nor damage in the insulation.

Power-frequency withstand test on the secondary windings

The test voltage is applied successively between the terminals of each secondary winding connected together and earth. The frame, the primary winding and the other secondary windings are connected to earth.

Test voltage value:	**3 kV**
Test voltage frequency:	50 Hz
Test duration:	72 s

Result: **CORRECT**. There are neither disruptive discharges nor damage in the insulation.

Partial discharge measurement

The partial discharge test voltage is reached while decreasing the voltage after the pre-stress voltage with a value of 90% of the power frequency withstand voltage test (pre-stress 166.5 kV,60 s).

After reaching this voltage value the voltage is decreased without interruption at the partial discharges test voltage and maintained at this level for a minimal duration of ten minutes. At each minute, the partial discharges level is recorded.

The maximal partial discharges level measured at the specified voltage for the partial discharges test must not exceed 10 pC-. Partial discharges voltage level has been specified by the customer in 148 kV.

Test voltage (kV)	Test frequency(Hz)	Total duration of voltage (s)	Measurement (pC)	Admissible level (pC)
148	50	60	4.562	10
148	50	120	4.650	10
148	50	180	4.252	10
148	50	240	4.541	10
148	50	300	4.452	10
148	50	360	4.910	10
148	50	420	4.834	10
148	50	480	4.970	10
148	50	540	4.996	10
148	50	600	5.625	10

Background noise: 3pC

Result: **CORRECT**, the measured partial discharge levels do not exceed the limits specified in the specification.

Inter-turn overvoltage test

The test is performed according to procedure B: with the primary winding open-circuited, the prescribed test voltage (at some suitable frequency) is applied successively to the terminals of each secondary windings for 60 s, providing that the r.m.s. value of the secondary current does not exceed the rated extended current.

The value of the test frequency shall not be greater than 400 Hz. In this case test values have been:

Test frequency 400 Hz
Test duration 15 s

At this frequency, if the voltage value achieved at the rated extended secondary current 6 A) is lower than 4.5 kV peak). The obtained voltage is to be regarded as the test voltage.

Secondary	Primary (A)	Voltage (kV)
X1-X2	6	0.89
Y1-Y2	6	0.91

Result: **CORRECT**. Measured values fulfil with the values of the standard.

Measurement of the capacity and dielectric dissipation factor

The measurement of the capacitance and the dielectric dissipation factor must be carried out at 10 kV and at Um/√3 in accordance with IEC 60044-1 in which it is stated that the measurement of the capacity and dielectric dissipation factor must be done after the power frequency test on the primary winding. Voltage test is applied between the short circuited terminals of the primary winding and earth. Secondary windings and metallic frame will be connected to measuring bridge.

Obtained results were the following:

Test voltage (kV)	Frequency (Hz)	Capacity (pF)	Dissipation factor
71	50	718	0.1917
10	50	718	0.1834

Measurements have been performed at an ambient temperature of 25ºC.

c) Repetition of determination of current error and phase displacement

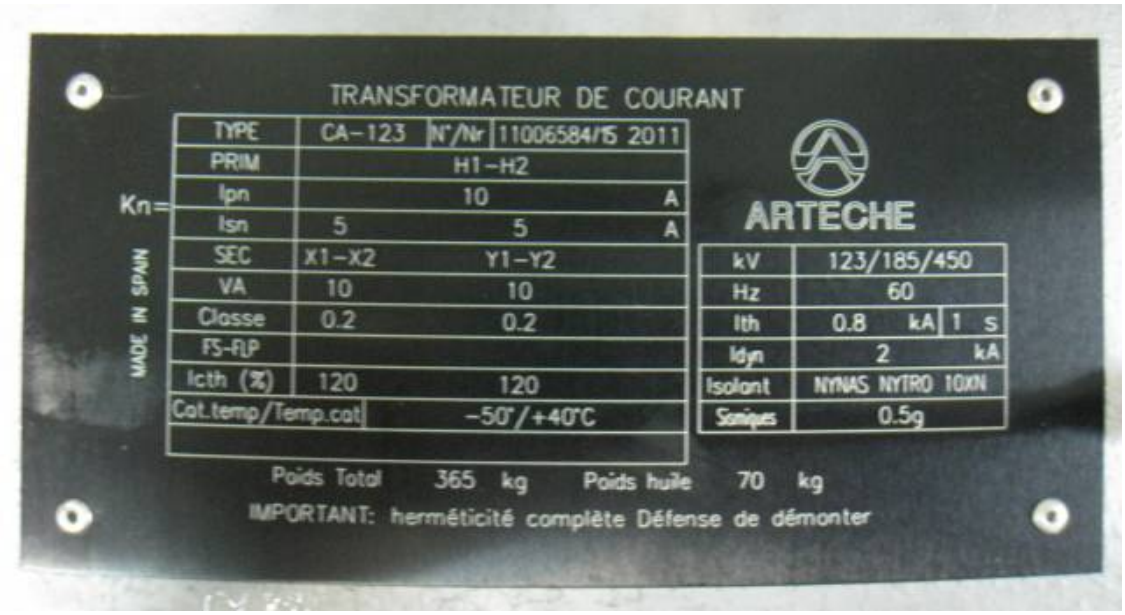
Burden (VA)	In(%)		X1-X2 Cl 0,2			
			Intensity error (%)		Phase displacement (min)	
			Measured	Limit	Measured	Limit
2.5 (25%)	120	before	0.14	±0.1	2	±5
		after	0.12		3	
		difference	0.02		-1	
	5	before	0.15	±0.175	6	±7.5
		after	0.12		7	
		difference	0.03		-1	
10 (100%)	120	before	0.04	±0.1	1	±5
		after	0.02		2	
		difference	0.02		-1	
	100	before	0.03	±0.1	1	±5
		after	0.01		1	
		difference	0.02		0	
	20	before	-0.03	±0.1	4	±5
		after	-0.05		5	
		difference	0.02		-1	
	5	before	-0.06	±0.175	7	±7.5
		after	-0.08		9	
		difference	0.02		-2	

Burden (VA)	In(%)		Y1-Y2 CL 0.2			
			Intensity error (%)		Phase displacement (min)	
			Measured	Limit	Measured	Límite
2.5 (25%)	120	before	0.13	±0.1	2	±5
		after	0.12		2	
		difference	0.01		0	
	5	before	0.14	±0.175	6	±7.5
		after	0.12		7	
		difference	0.02		-1	
10 (100%)	120	before	0.05	±0.1	1	±5
		after	0.04		1	
		difference	0.01		0	
	100	before	0.04	±0.1	1	±5
		after	0.03		1	
		difference	0.01		0	
	20	before	-0.02	±0.1	4	±5
		after	-0.04		4	
		difference	0.02		0	
	5	before	-0.05	±0.175	7	±7.5
		after	-0.07		8	
		difference	0.02		-1	

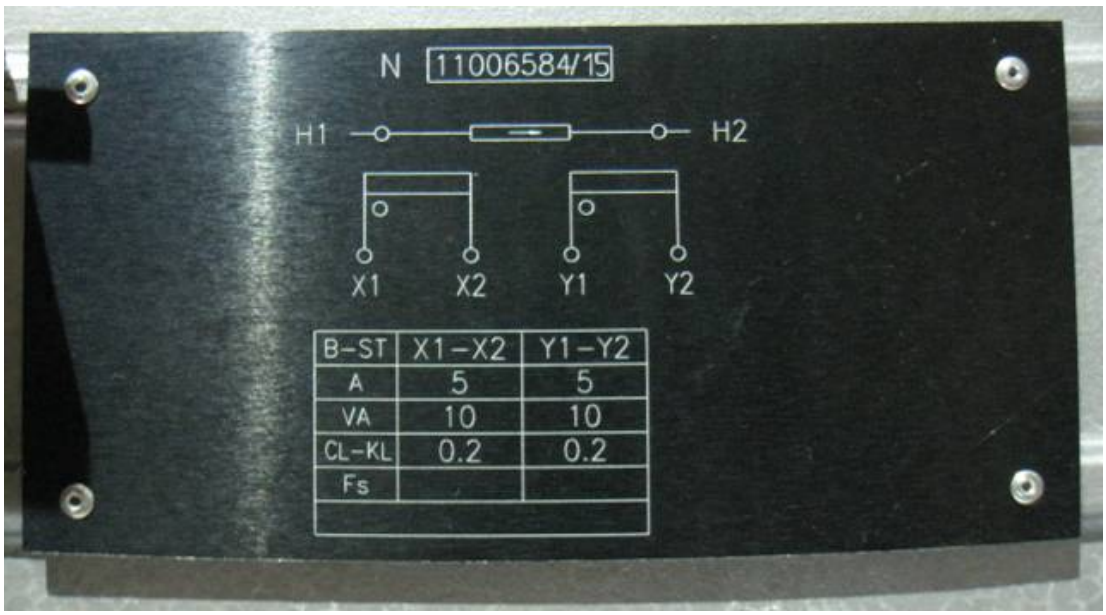
Result: **CORRECT**. The errors after demagnetization do not differ from those recorded before the tests by more than half the limits of error appropriate to its accuracy class.

5. SUMMARY OF RESULTS

TEST	**RESULT**
Short-circuit withstand capability test	CORRECT
Wet test	CORRECT
Withstand test between the current transformer´s terminals	CORRECT



Ratings plate



Ratings plate

Lightning impulse test lay-out.

Short-circuit test lay-out.

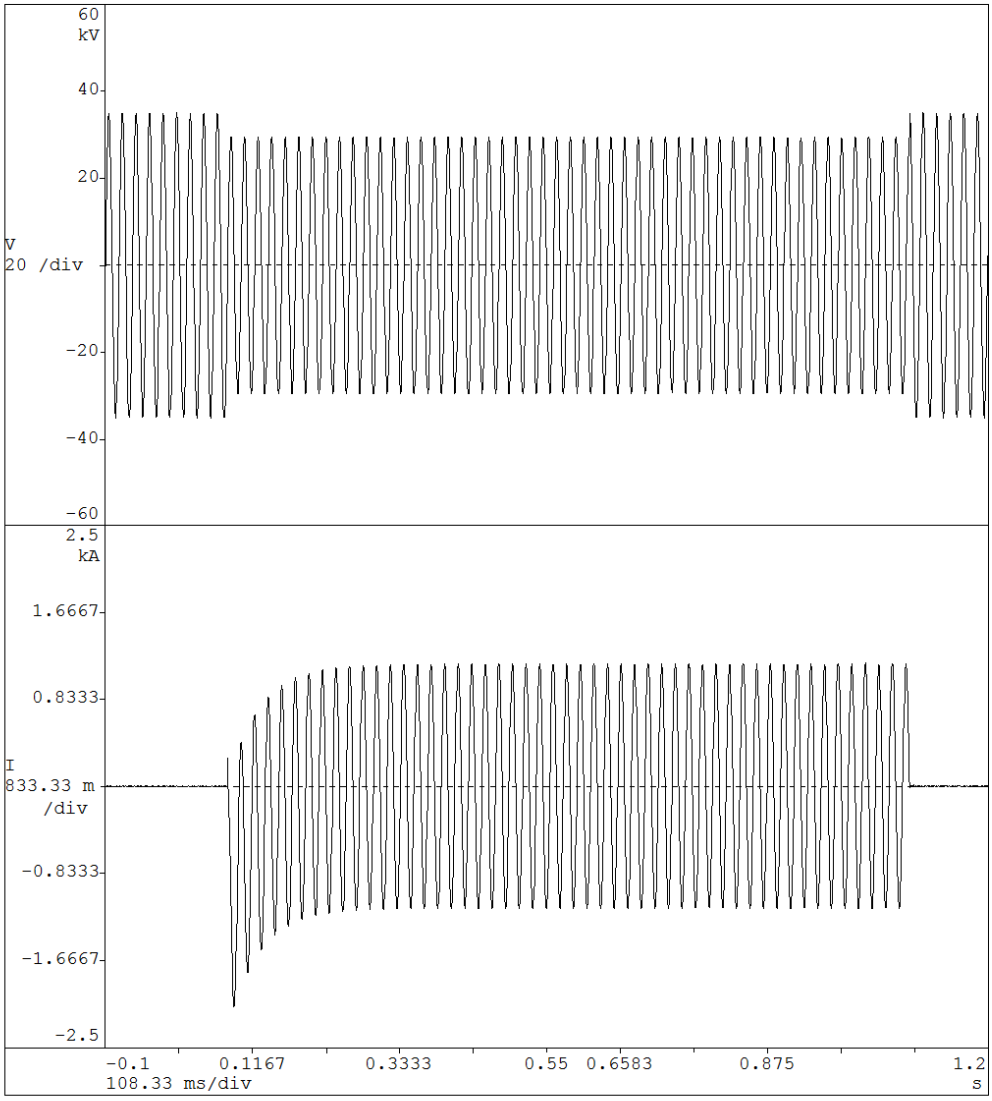
Routine tests in ARTECHE's installations.

$V_{(eficaz/RMS)}$	24.58 kV
$I_{(eficaz/RMS)}$	0.828 kA
$I_{(cresta/peak)}$	2.112 kA
$I^2 \cdot t$	7.18E+05 AAs
t_i	0.077 s
t_e	1.086 s
t_{total} $(t_e - t_i)$	1.009 s

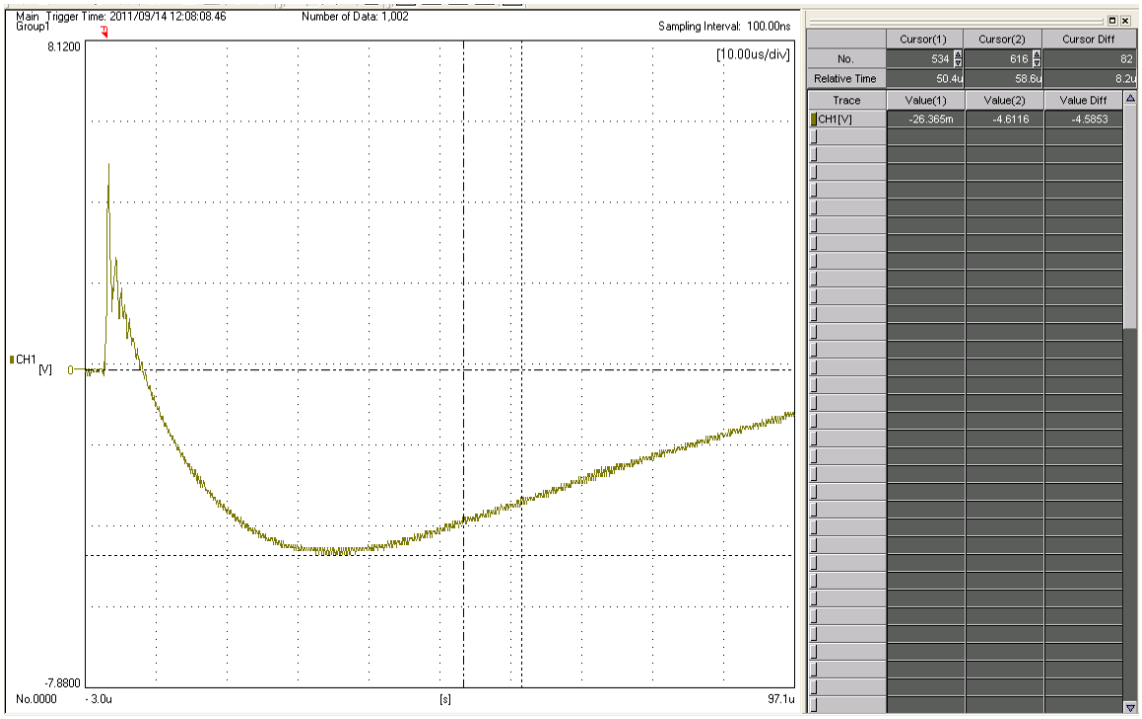
Fecha / Date: 16/09/11

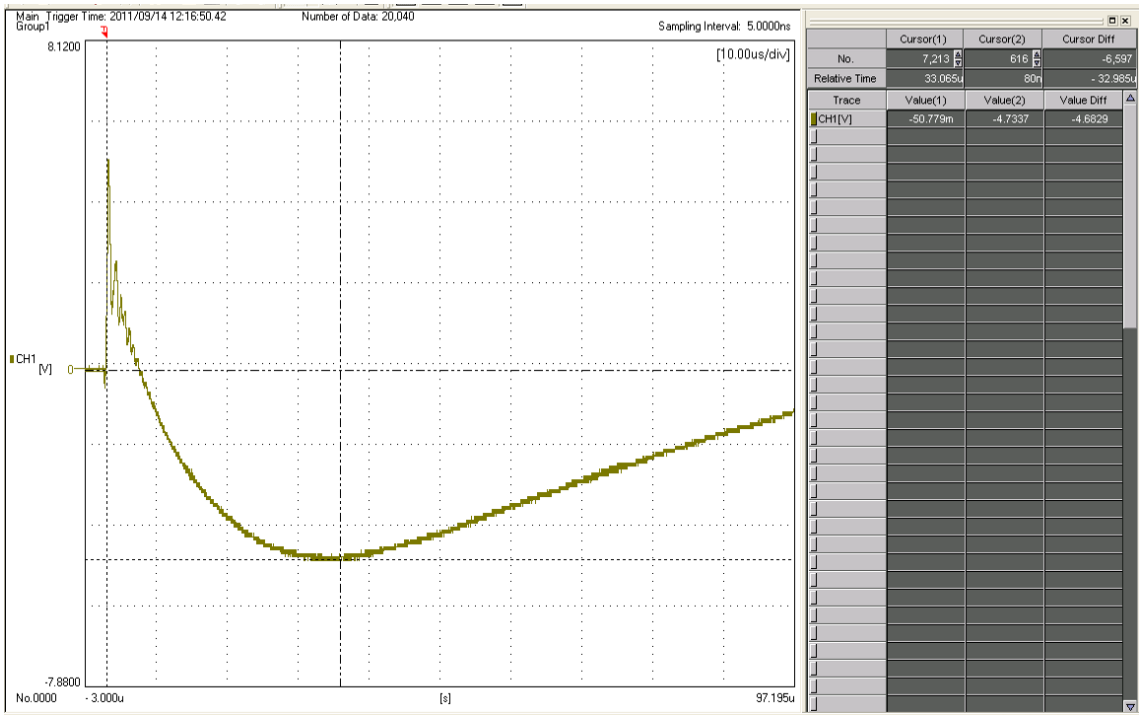
Nº EXPEDIENTE: B126-11-CD

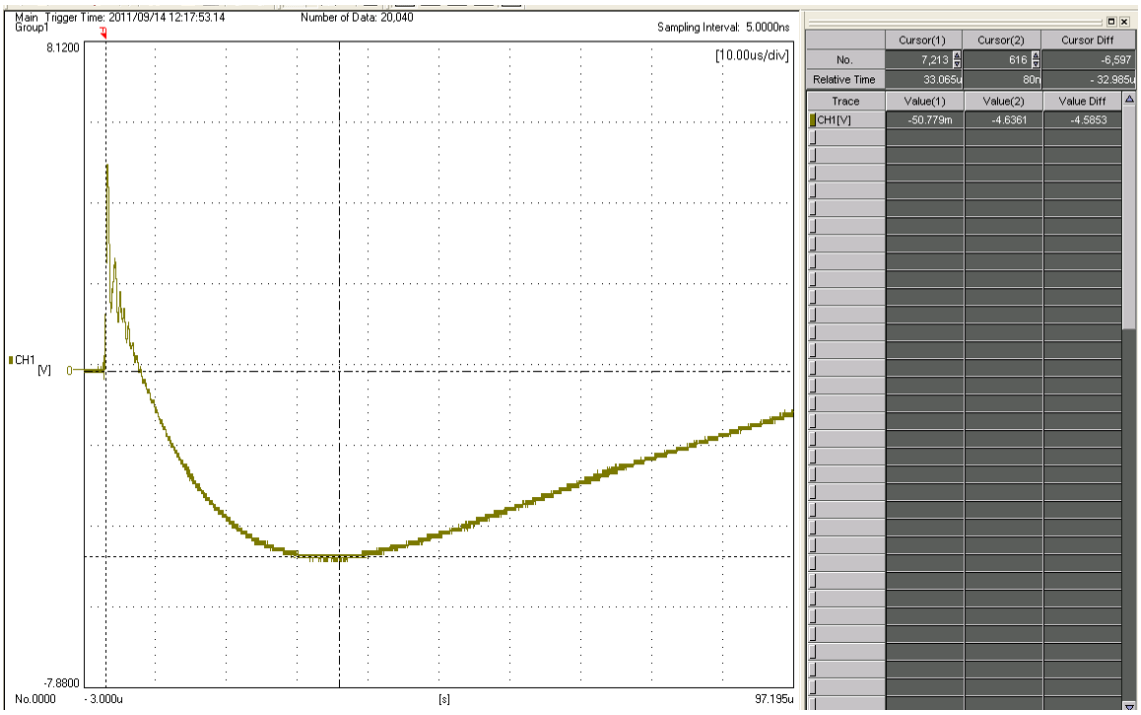
Nº OSCILOGRAMA: 2



H1. Negative pulses.



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8.1200
CH1
[V]
0
-7.8800
No.0000
-3.000u
[s]
97.195u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
33.065u
80n
-32.985u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
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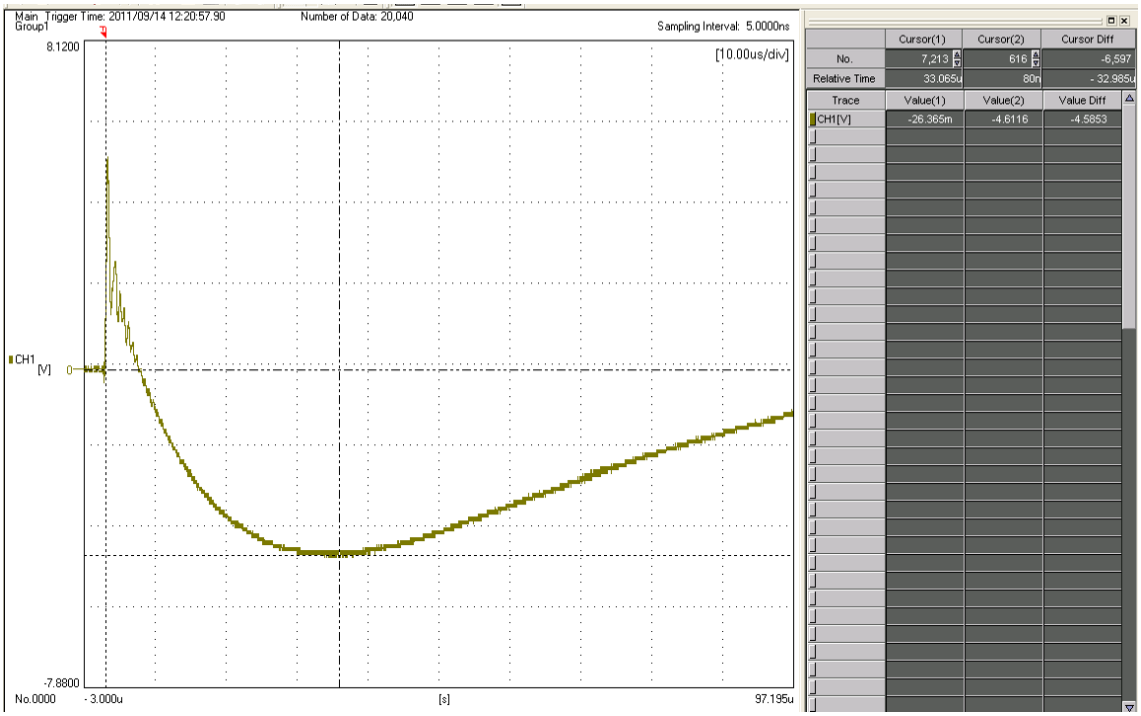
-4.6361
-4.5853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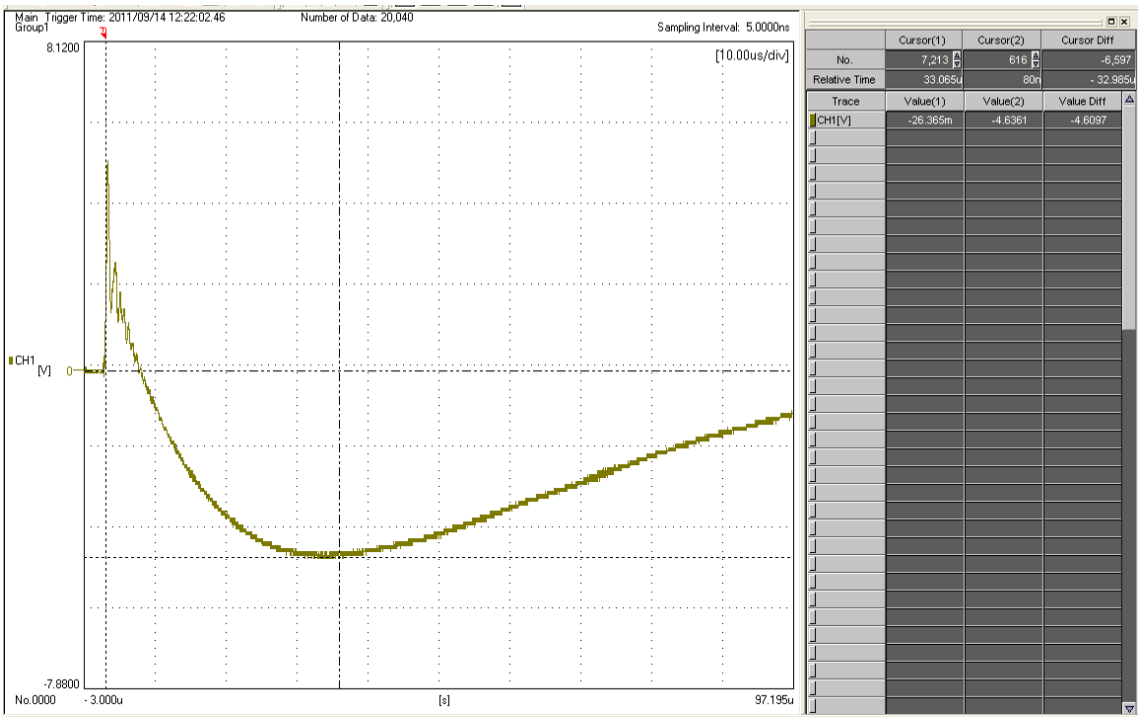
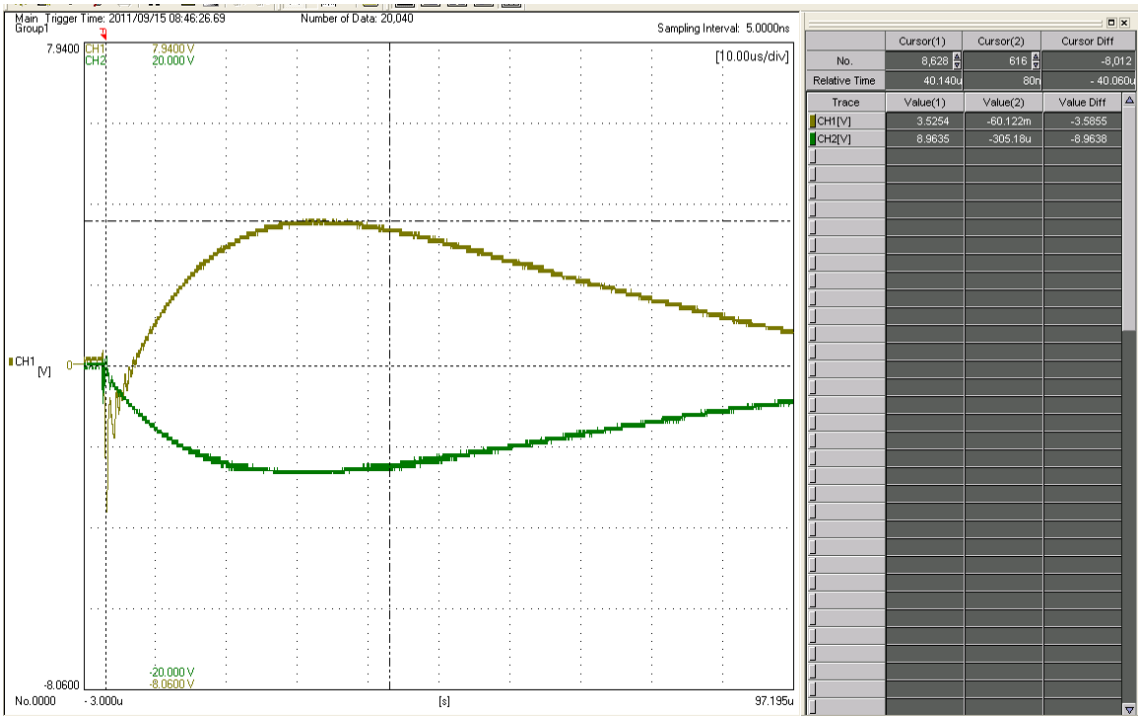
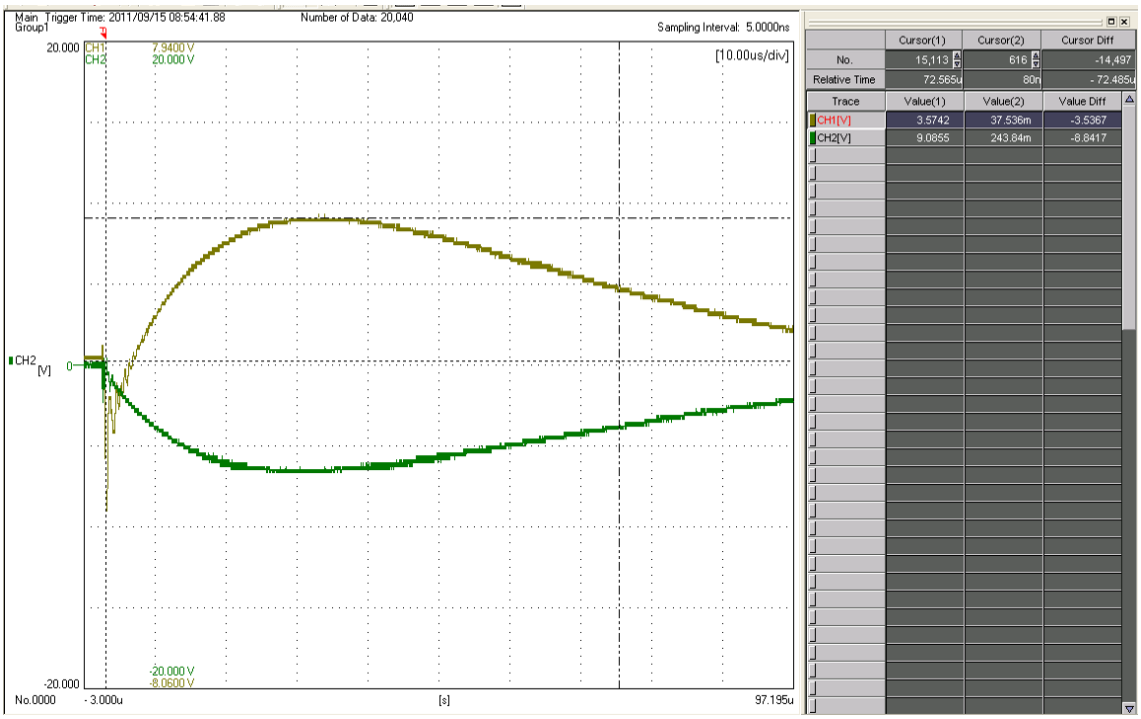
8.1200
CH1
[V]
0
-7.8800
No.0000
-3.000u
[s]
97.195u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
33.065u
80n
-32.985u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
-26.365m
-4.6116
-4.5853



H1. Positive pulses.

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20.000
CH1: 7.9400 V
CH2: 20.000 V
CH2 [V]
0
-20.000
-20.000 V
-8.0600 V
No.0000
- 3.000u
[s]
97.195u
Cursor(1)
Cursor(2)
Cursor Diff
No.
15,113
616
-14,497
Relative Time
72.565u
80n
- 72.485u
Trace
Value(1)
Value(2)
Value Diff
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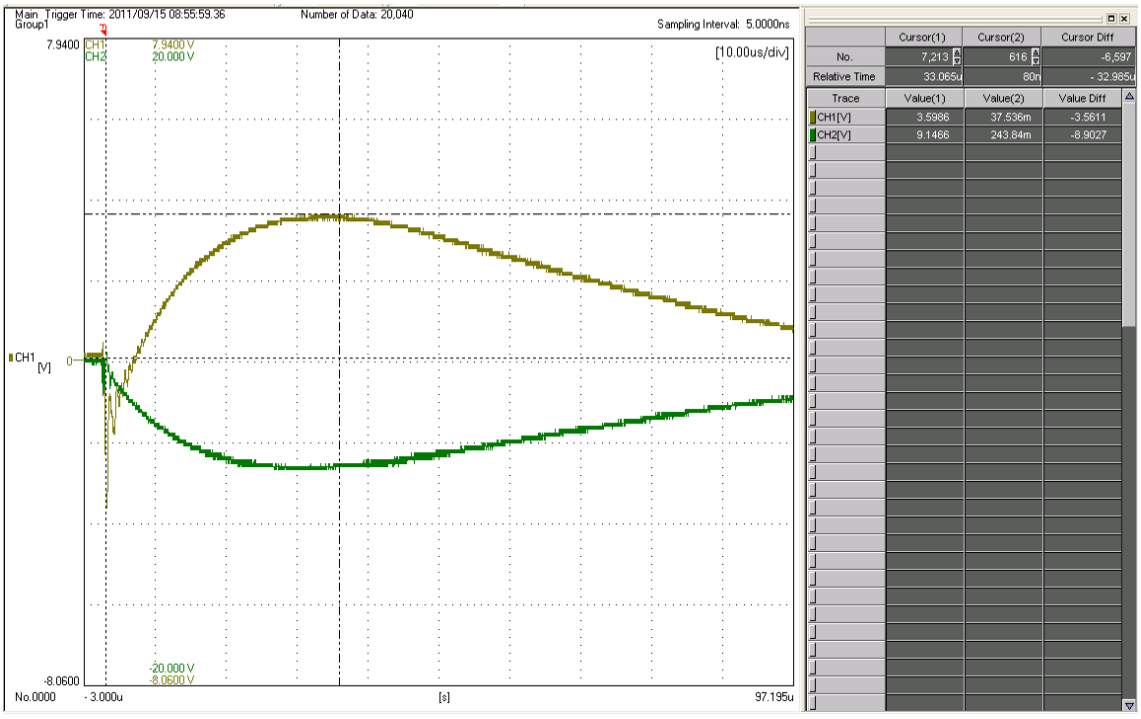
CH2[V]
9.0855
243.84m
-8.8417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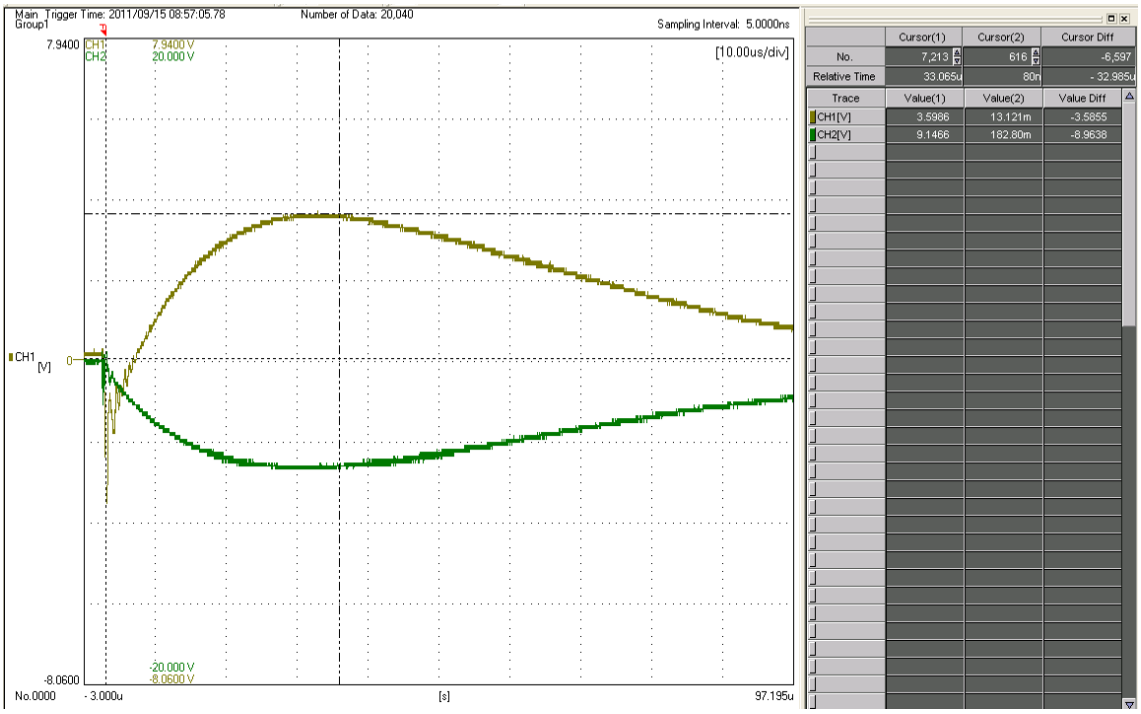
7.9400
CH1: 7.9400 V
CH2: 20.000 V
CH1 [V]
0
-8.0600
-20.000 V
-8.0600 V
No.0000
- 3.000u
[s]
97.195u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
33.065u
80n
- 32.985u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
3.5986
37.536m
-3.5611
CH2[V]
9.1466
243.84m
-8.9027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7.9400
CH1
CH2
7.9400 V
20.000 V
CH1
[V]
0
-8.0600
-20.000 V
-8.0600 V
No.0000
-3.000u
[s]
97.195u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
33.065u
80n
-32.985u
Trace
Value(1)
Value(2)
Value Diff
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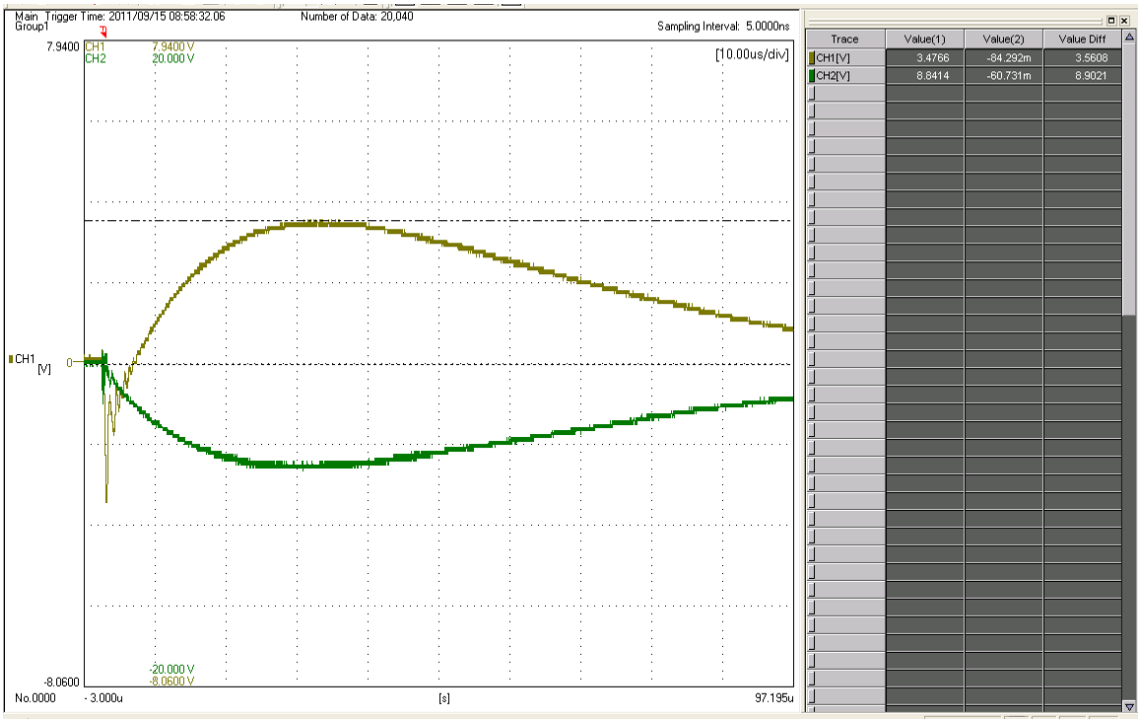
3.5986
13.121m
-3.5855
CH2[V]
9.1466
182.80m
-8.9638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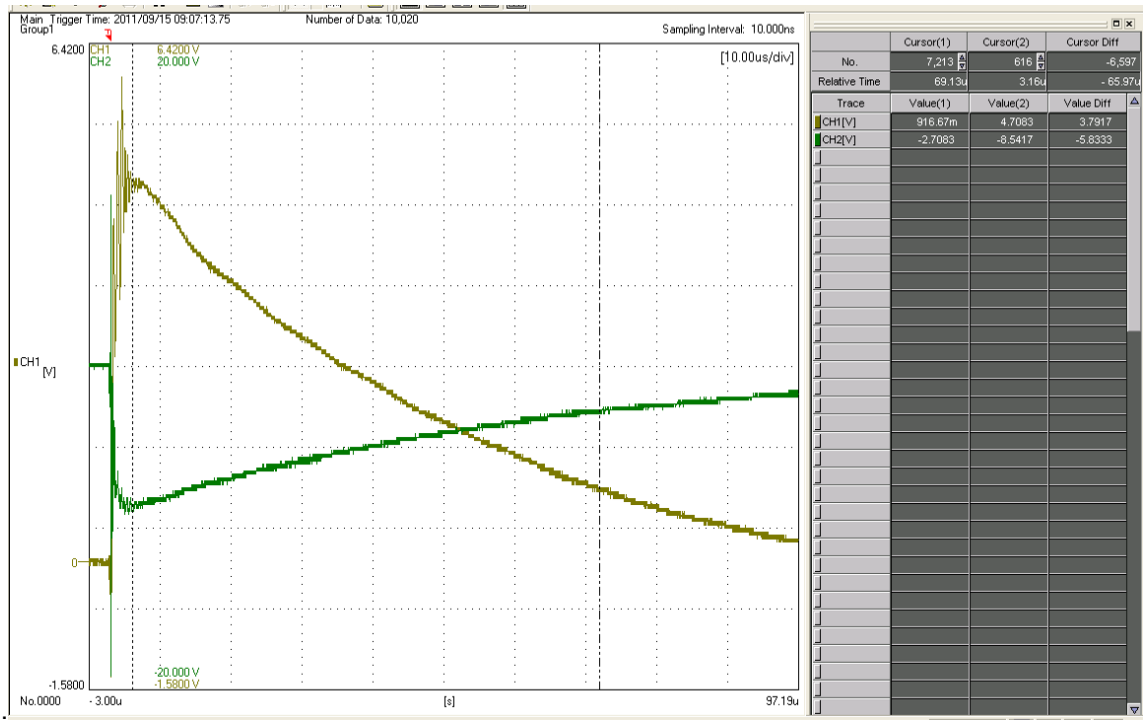
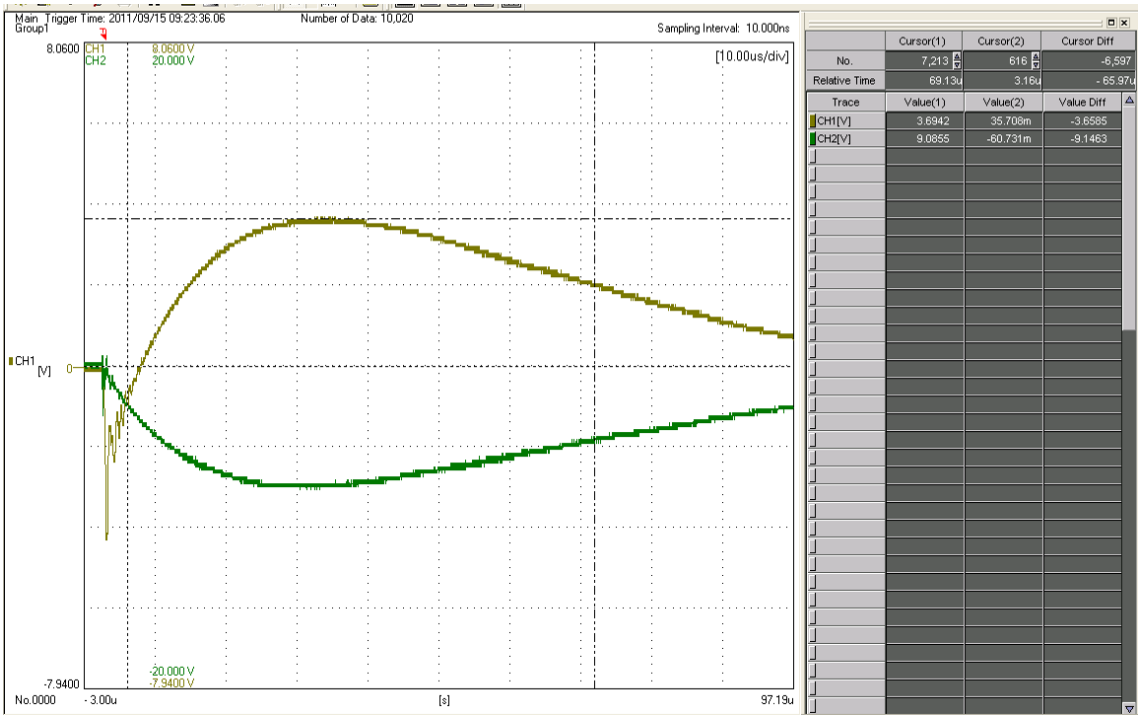
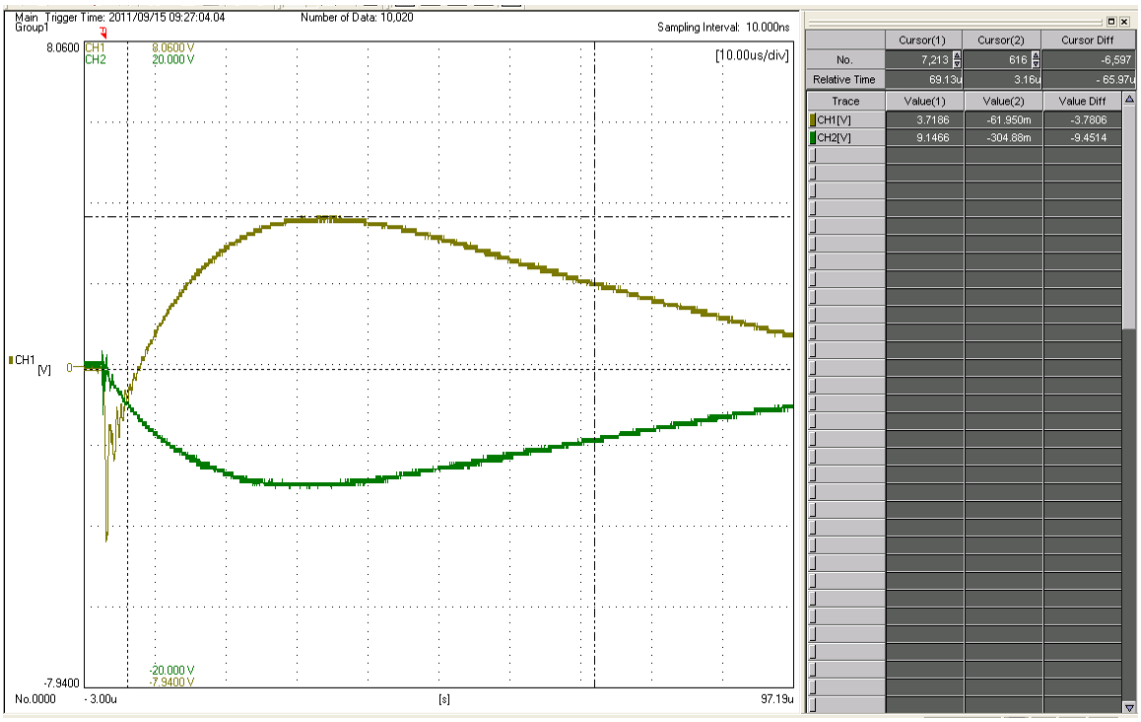
7.9400
CH1
CH2
7.9400 V
20.000 V
CH1
[V]
0
-8.0600
-20.000 V
-8.0600 V
No.0000
-3.000u
[s]
97.195u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
3.4766
-84.292m
3.5608
CH2[V]
8.8414
-60.731m
8.9021

Verification of the behaviour of the voltage protection device



H2 Primary. Positive impulse.

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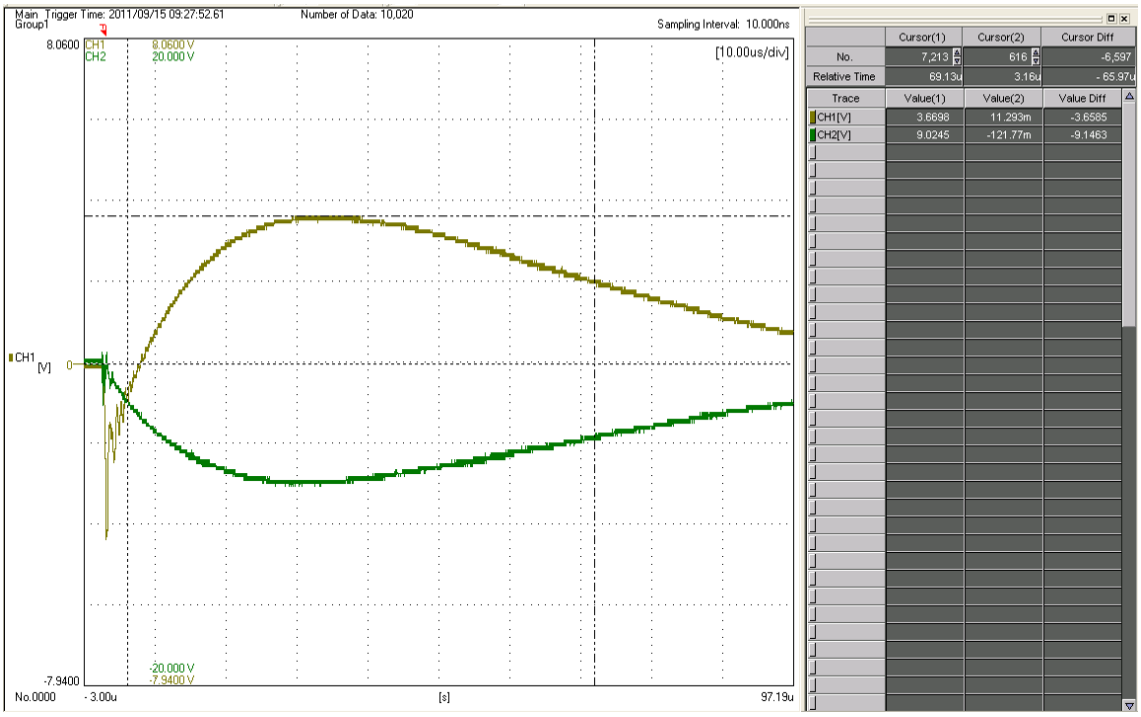
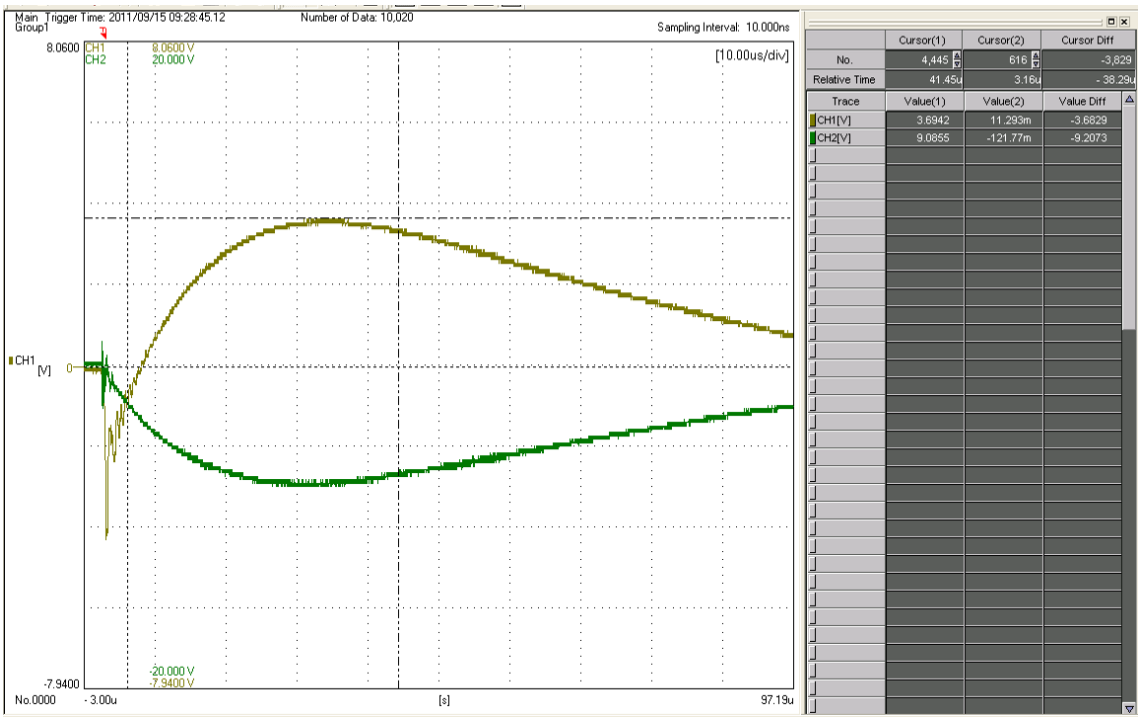
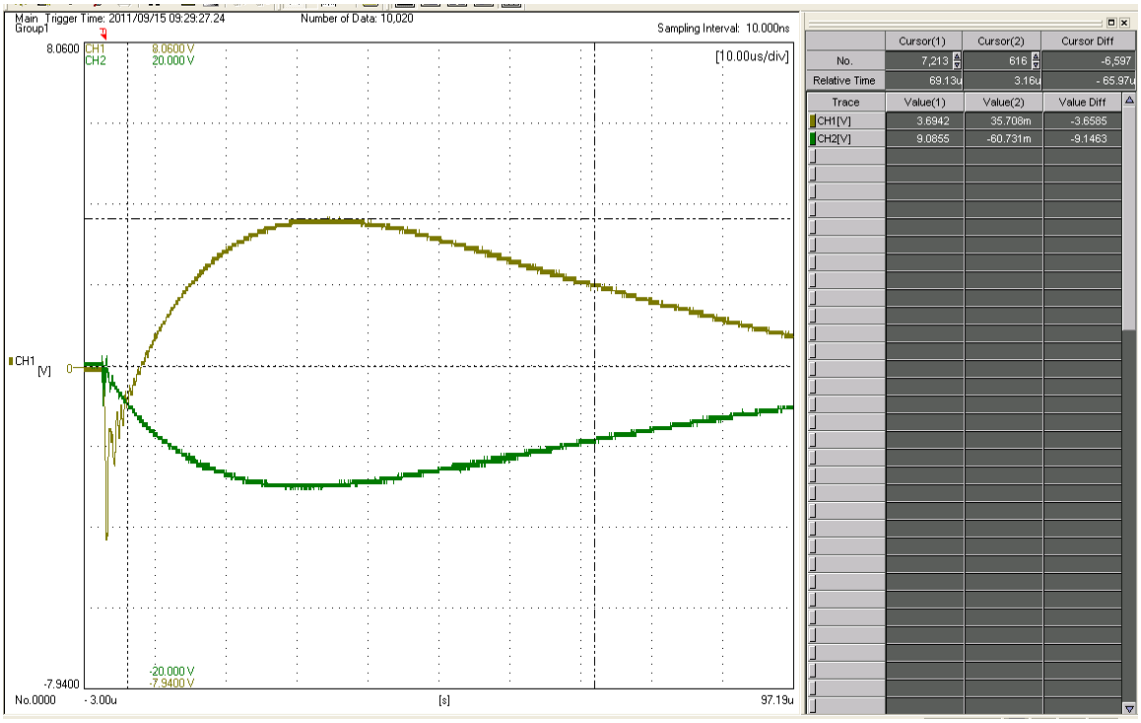
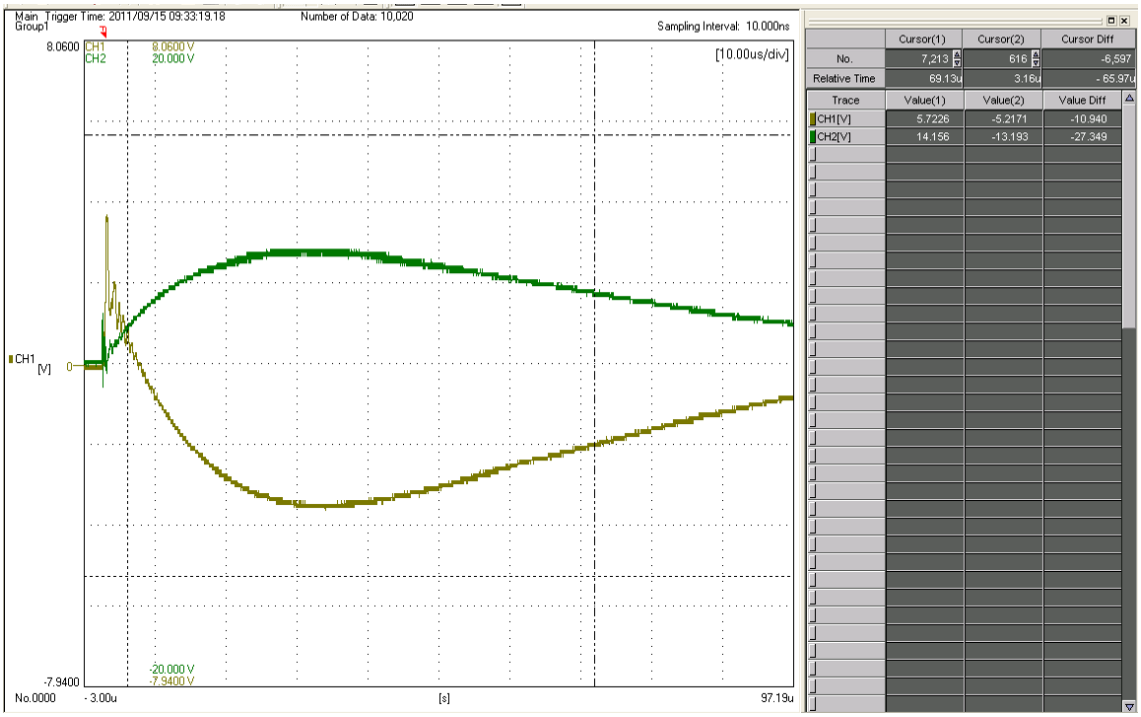
CH1
CH2
8.0600 V
20.000 V
CH1 [V]
0
-20.000 V
-7.9400 V
-7.9400
No.0000
-3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
69.13u
3.16u
- 65.97u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
3.7186
-61.950m
-3.7806
CH2[V]
9.1466
-304.88m
-9.4514

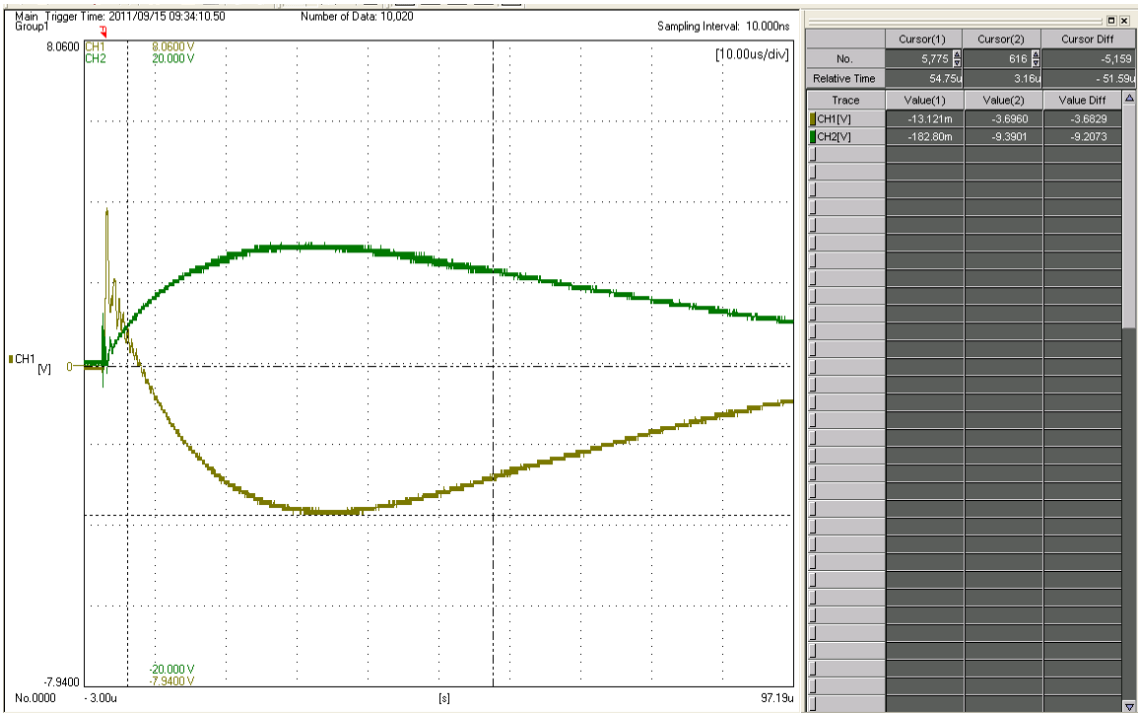

Main Trigger Time: 2011/09/15 09:27:52.61
Group1
Number of Data: 10,020
Sampling Interval: 10.000ns
[10.00us/div]
8.0600
CH1
CH2
8.0600 V
20.000 V
CH1 [V]
0
-20.000 V
-7.9400 V
-7.9400
No.0000
-3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
69.13u
3.16u
- 65.97u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
3.6698
11.293m
-3.6585
CH2[V]
9.0245
-121.77m
-9.1463

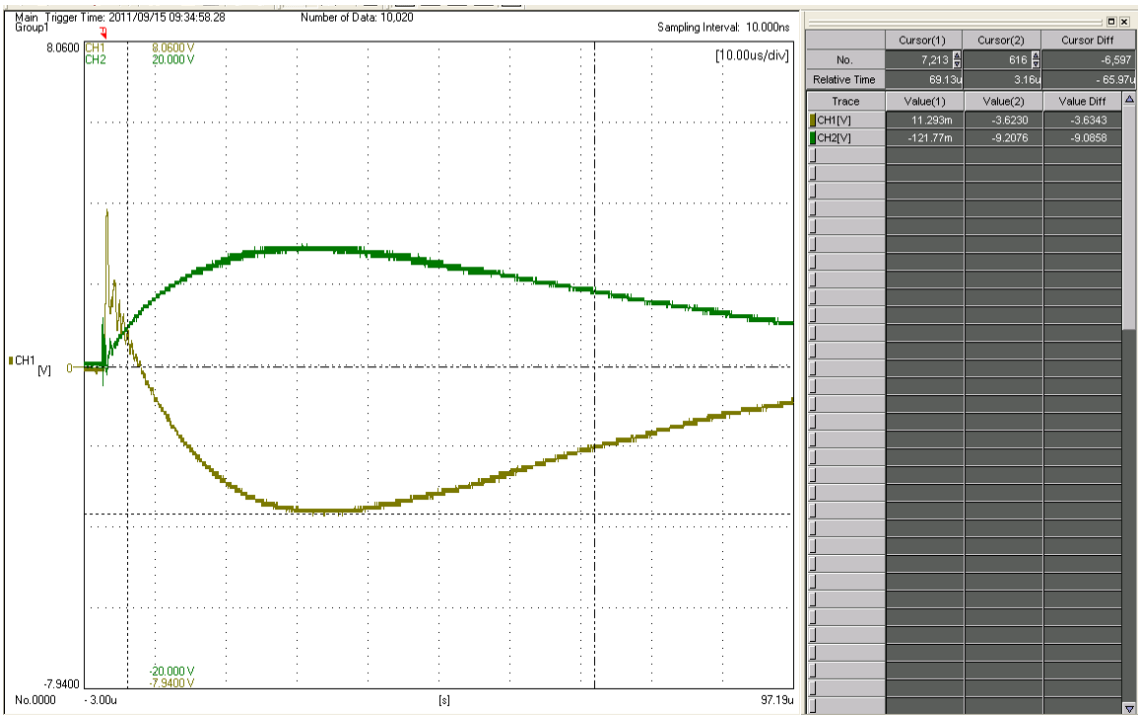

Main Trigger Time: 2011/09/15 09:28:45.12
Group1
Number of Data: 10,020
Sampling Interval: 10.000ns
8.0600
CH1
CH2
8.0600 V
20.000 V
[10.00us/div]
CH1
[V]
0
-20.000 V
-7.9400 V
-7.9400
No.0000
-3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
4,445
616
-3,829
Relative Time
41.45u
3.16u
-38.29u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
3.6942
11.293m
-3.6829
CH2[V]
9.0855
-121.77m
-9.2073

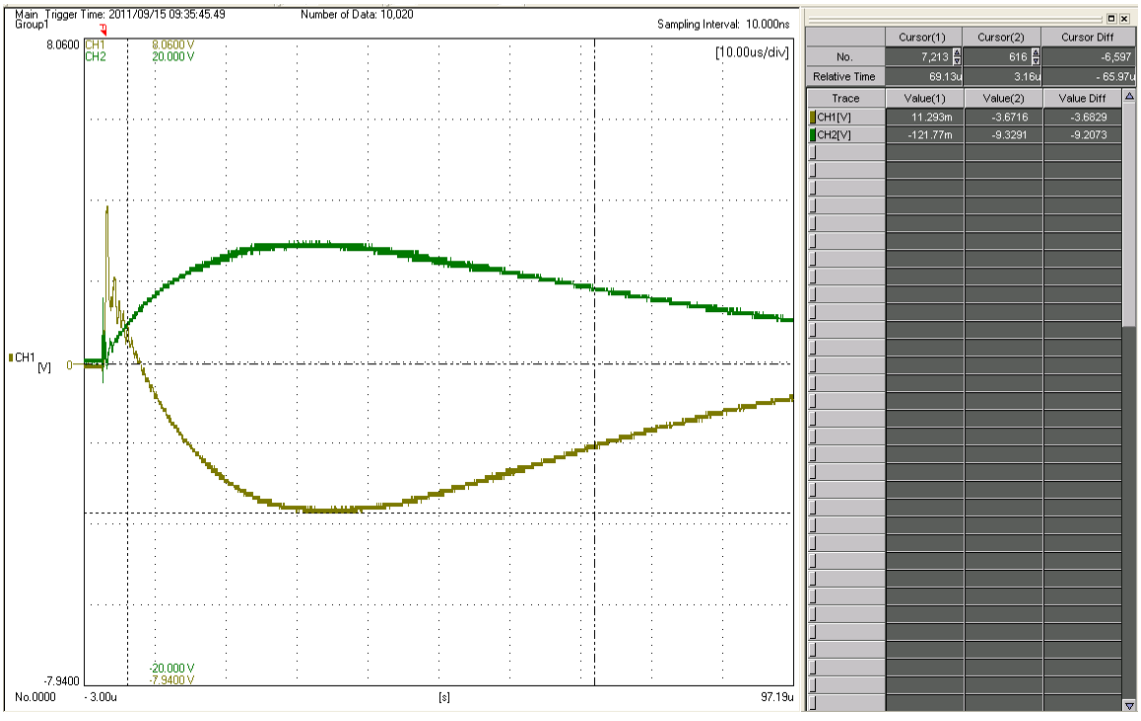

Main Trigger Time: 2011/09/15 09:29:27.24
Group1
Number of Data: 10,020
Sampling Interval: 10.000ns
8.0600
CH1
CH2
8.0600 V
20.000 V
[10.00us/div]
CH1
[V]
0
-20.000 V
-7.9400 V
-7.9400
No.0000
-3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
69.13u
3.16u
-65.97u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
3.6942
35.708m
-3.6585
CH2[V]
9.0855
-60.731m
-9.1463

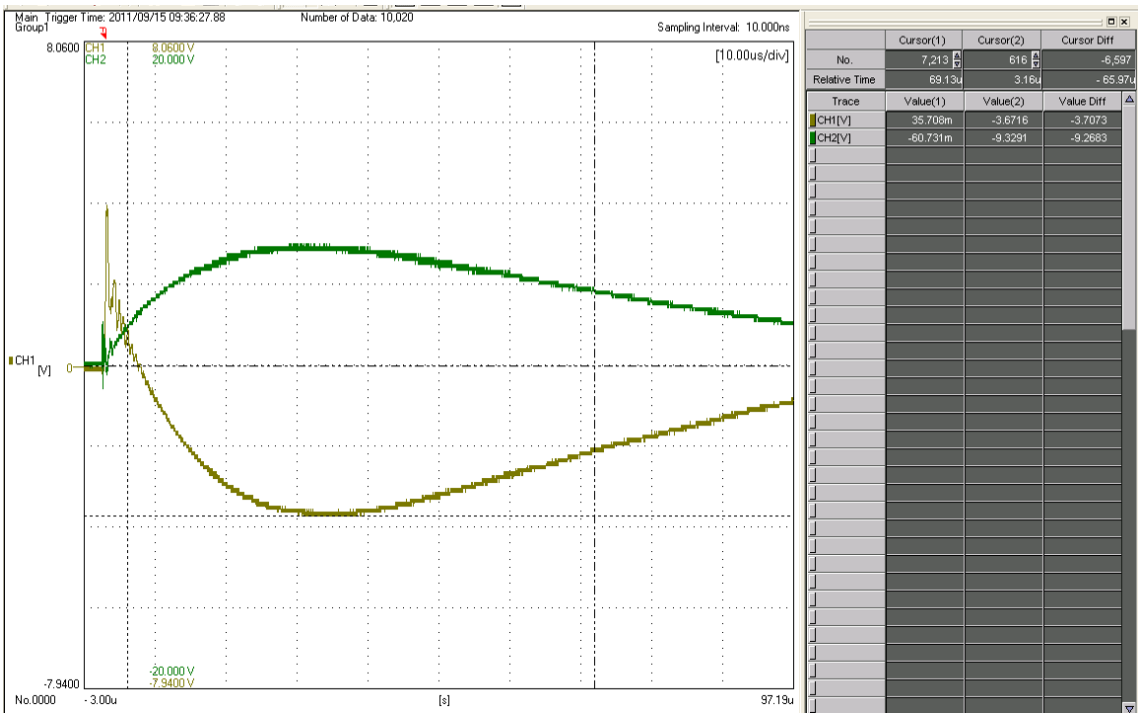
H2 Primary. Negative impulses.






Main Trigger Time: 2011/09/15 09:34:58.28
Group1
Number of Data: 10,020
Sampling Interval: 10.000ns
8.0600
CH1
CH2
8.0600 V
20.000 V
[10.00us/div]
CH1 [V]
0
-20.000 V
-7.9400 V
-7.9400
No.0000
- 3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
69.13u
3.16u
- 65.97u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
11.293m
-3.6230
-3.6343
CH2[V]
-121.77m
-9.2076
-9.0858


Main Trigger Time: 2011/09/15 09:35:45.49
Group1
Number of Data: 10,020
Sampling Interval: 10.000ns
8.0600
CH1
CH2
8.0600 V
20.000 V
[10.00us/div]
CH1 [V]
0
-20.000 V
-7.9400 V
-7.9400
No.0000
- 3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
69.13u
3.16u
- 65.97u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
11.293m
-3.6716
-3.6829
CH2[V]
-121.77m
-9.3291
-9.2073


Main Trigger Time: 2011/09/15 09:36:27.88
Group1
Number of Data: 10,020
Sampling Interval: 10.000ns
8.0600
CH1
CH2
8.0600 V
20.000 V
[10.00us/div]
CH1
[V]
0
-7.9400
-20.000 V
-7.9400 V
No.0000
-3.00u
[s]
97.19u
Cursor(1)
Cursor(2)
Cursor Diff
No.
7,213
616
-6,597
Relative Time
69.13u
3.16u
- 65.97u
Trace
Value(1)
Value(2)
Value Diff
CH1[V]
35.708m
-3.6716
-3.7073
CH2[V]
-60.731m
-9.3291
-9.2683