

**RESEARCH CENTRE FOR TESTS AND DEVELOPMENT
SURGE CURRENT
AND HIGH VOLTAGE LABORATORY
ELEMKO SA**

TEST REPORT

ALUMINUM ALLOY BRIDGING COMPONENT

MADE BY KRANSTEINER GmbH

FOR USE IN EXTERNAL LIGHTNING PROTECTION SYSTEMS

AS A BRIDGING COMPONENT CONNECTION (B9)

IMPULSE CURRENT WITHSTAND CAPABILITY OF 50kA (CLASS N)

REPORT NUMBER: 30635

EN 50164 – 1 and its updates upon the date of issue of the present test report



TEST REPORT

SUBJECT

Description and results presentation of laboratory type testing of An aluminium alloy bridging componnt made by KRANSTEINER GmbH for use in external Lightning Protection Systems (LPS) above ground. The bridging component was tested in connection (B9), connecting two aluminium profiles, according to European Standard EN 50164-1 and its updates upon the date of issue of the test present report. The bridging component was subjected to all the tests required by the Standard. These tests are referenced in detail in paragraph C of the present test report.

CUSTOMER REQUEST NUMBER:	033/2007
CUSTOMER NAME:	KRANSTEINER GmbH
ADDRESS :	WUERZBURGER STR 4, A 4600 WELS / AUSTRIA
SPECIMENT CONDITION DURING DELIVERY:	GOOD
SPECIMENT DELIVERY DATE:	29 JANUARY 2007
TEST INITIATION DATE:	29 JANUARY 2007
TEST CLOSING DATE:	8 FEBRUARY 2007
REPORT ISSUE DATE:	2 MARCH 2007
TEST REPORT PAGE NUMBER:	15

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ABBREVIATIONS

CENELEC : European Committee for Electrotechnical Standardisation.
LPS : Lightning Protection Systems
EN : European Norm

EXPERIMENTAL APPARATUS USED DURING THIS TEST

1. *Environmental ageing chamber HK400-BE, for salt mist and sulphurous atmosphere tests*
2. *OHAUS Digital scale type SC2020 (200 ±0.01gr), serial nr. BJ379803.*
3. *pH Meter serial nr. 01180009.*
4. *Digital scale (200 ±0.01gr), serial nr. BJ379803.*
5. *Digital micro-ohmmeter, 2kΩ-100nΩ in six ranges. serial nr. 6111-428/020202/1987*
6. *Impulse current generator 0-100kA, 0-65C, 0-187kJ.*
7. *Shunt 1 mΩ, sensitivity 2,21A/V.*
8. *Stanford Research Systems, 4-channel trigger / delay pulse generator serial nr. 09720.*
9. *2-channel, digital phosphor storage oscilloscope serial nr. B014001.*

A. GENERAL

According to CENELEC, all the metallic connection components that are used in a LPS must successfully pass tests, as specified in European Standard EN 50164-1 and its updates. The purpose of the tests is to monitor the design suitability of any kind of metallic connection components such as connectors, clamps, bonding and bridging components in combination with extended metal items. This is achieved by exposing the assembled conductor-conductor specimens initially in a polluted environmental conditions, and then subjecting them to a number of negative polarity impulse current strokes.

B. TEST REQUIREMENTS ACCORDING TO STANDARD BS EN 50164-1 AND ACCEPTANCE CRITERIA.

1. GENERAL

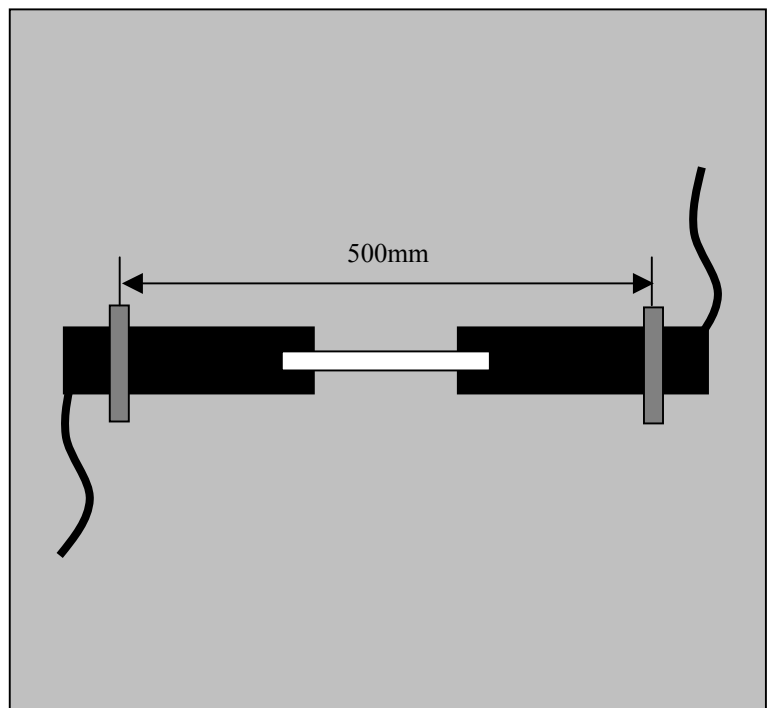
Tests shall be carried out with initially three (3) specimens according to EN 50164-1/§6.1.

After the completion of the environmental and electrical tests, if all three (3) specimens have been found to fulfil the standard acceptance criteria, it is assumed that the specific type of tested component is valid to be used in a LPS. Therefore the test procedure is terminated without using the remaining three (3) specimens.

In the event that one (1) of the three (3) tested specimens does not satisfy a test criterion due an assembly or manufacturing fault, that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests which follow shall be carried out in the required sequence on another full set of three (3) specimens, all of which shall comply with the requirements. If this second set of three (3) specimens satisfy the acceptance criteria, then the specific type of tested component is considered appropriate to be used in a LPS.

If however one (1) of the second set of three (3) specimens does not satisfy a test, the specific component under test is not deemed valid to be used in a LPS.

The required tests are performed in bridging component for (B9) arrangement, according to EN 50164-1/Annex B, bonding two aluminium profiles. The tightening torque is not required since the specific bridging component is using as connection elements parts of the two aluminium profiles.



B9: Bridging component arrangement

2. Tests –Acceptance Criteria

2.1 Environmental ageing

The specimens are then subjected:

To a salt mist cycling ageing test for 3 days in a constant temperature chamber according to EN 50164-1 / Annex C1.

To a Humid sulphurous atmosphere ageing for 7 days in a constant temperature chamber according to EN 50164-2 / Annex C2.

2.2 Electrical Tests

After environmental testing, the specimens are subjected to an impulse current with a peak current magnitude, specific energy and time duration for a specific current withstand capability (class N or H), in accordance with EN 50164-1/§6.3. Following the termination of the impulse current tests, the connection components should fulfil the following requirements:

- They should not exhibit any cracks as seen with normal or corrected vision without magnification, as well as no loose part or deformation that may impair its normal use (§6.3).
- They should have a contact resistance equal to or less than $1\text{m}\Omega$ (§6.3). The contact resistance is measured as close as possible to the connection component with a DC current source of at least 10A
- Torque requirements are not applicable (bridging component is using natural components of the two aluminium profiles as stated by the manufacturer – no extra bonding part such as screws or nuts is required)

C. PERFORMED TESTS

After the assembly procedure (§B1) is completed, the specimens are subjected to a combination of environmental ageing and electrical tests as presented in §B2. These are as follows:

1. Environmental ageing

For connection components that are designed to exclusively embedded in concrete, the above described environmental ageing procedure is not necessary (BS EN 50164-1/§6.2.2.2).

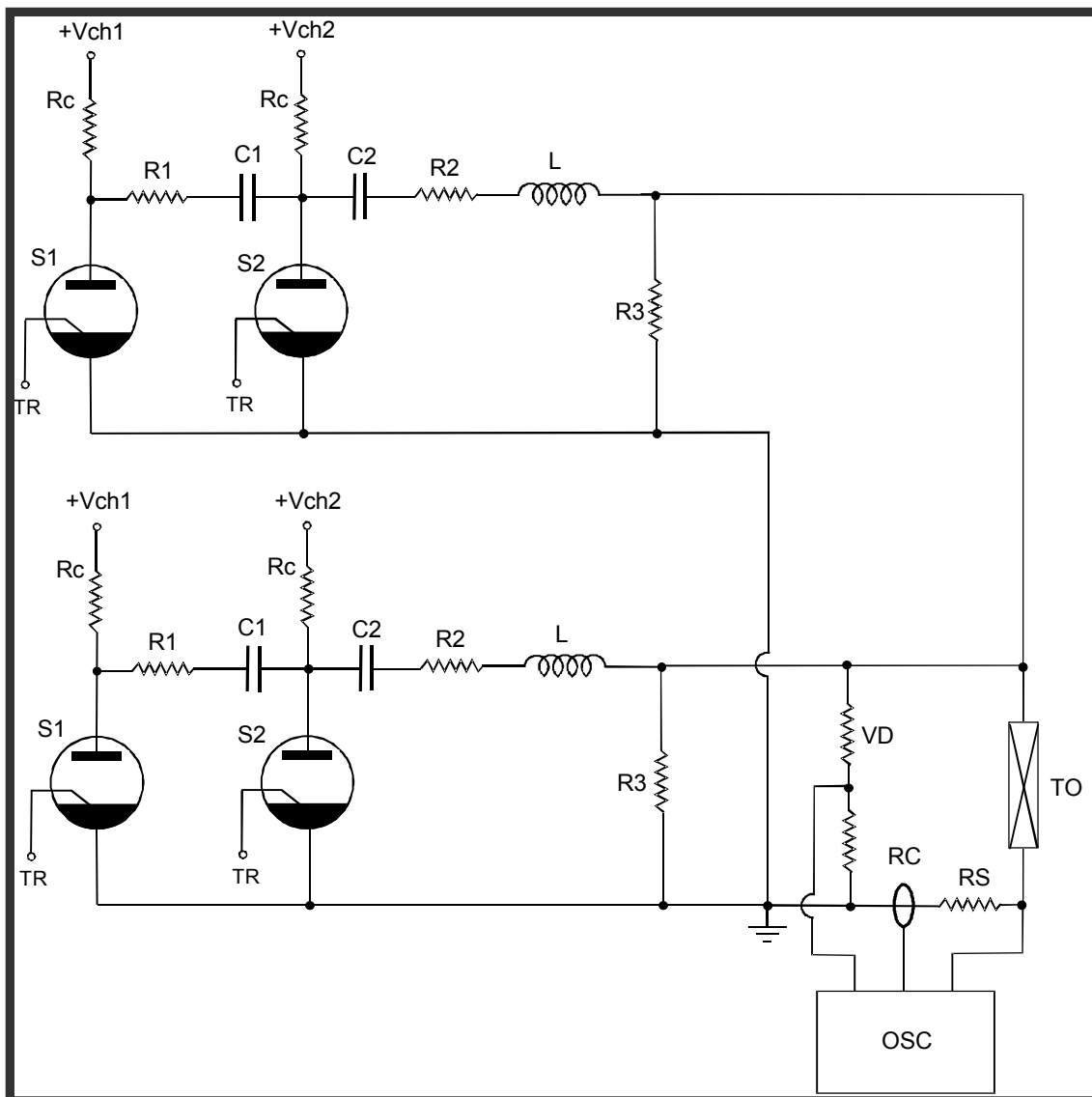
(Please refer to chapter F for the table of experimental results, and to chapter G for the test results summary report.)

2. Electrical Tests

Each specimen aged by the environmental tests, is subjected to three (3) subsequent impulse current strokes with a negative polarity. In order to test the specimens for a class N current withstand capability, the applied impulse current strokes should have a peak magnitude (I_p) of $50\text{kA} \pm 10\%$, and a specific energy content of $0,63\text{MJ}/\Omega \pm 20\%$ measured up to a waveform duration of 2ms (EN 50164-1/Table 1). The application of the three (3) impulse current strokes is performed in order to validate the specimen's capability to conduct with out damage the equivalent current magnitude and charge transfer of a lightning first stroke direct hit.

After the electrical tests are completed:

- A visual examination of the specimens is performed.
(Please refer to chapter F for the table of experimental results, and to chapter G for the test results summary report.)
- The connection resistance is measured as close as possible to the connection component, by means of a digital micro-ohmmeter, ($2\text{k}\Omega$ - $100\text{n}\Omega$) in six ranges.
(Please refer to chapter F for the table of experimental results, and to chapter G for the test results summary report.)



Vch1 :	Start bank charging voltage	L :	Stray inductance	VD :	Voltage Divider
Vch2 :	Sustain bank charging voltage	C1 :	Start Capacitor	RC :	Rogowski coil
Rc :	Charging Resistors	C2 :	Sustain Capacitor	RS :	Resistive shunt
R1 :	Start Resistor	S1 :	Start switches	TO :	Test object
R2 :	Sustain resistor	S2 :	Sustain switches	OCS :	Oscilloscope
R3 :	Bleeding resistor	TR :	Triggering module		

A schematic diagram of the 100kA impulse current generator.

D. EXPERIMENTAL APPARATUS



Figure 1: Photograph of the environmental ageing chamber HK400-BE used for salt mist and humid sulphurous atmosphere ageing for components used above ground



Figure 2: Photograph of the 100kA impulse current generator

E. ILLUSTRATION OF SPECIMENS



Figure 3: *Photograph of specimens before testing*

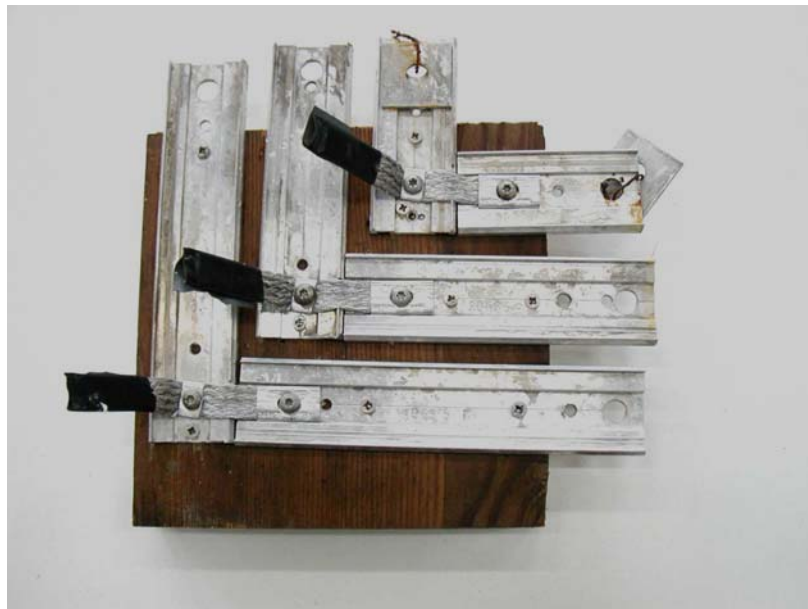


Figure 4: *Photograph of specimens after environmental testing*



Figure 5: *Photograph of specimens after environmental and electrical testing of 50kA (Class N)*


F. TABLE OF EXPERIMENTAL RESULTS

Test Registration Number	Specimen preparation		Impulse current tests					Final tests					Above ground tests						In-ground tests		Comments		
	Tightening Torque T1 (Nm)	Contact Resistance (μΩ)	Atmospheric conditions (Humidity –Temperature - Bar. Pressure)	Oscillogram Number	Peak impulse Current Ip (kA)	Specific Energy (MJ/Ω) (measured at a maximum duration of 2ms)	Impulse generator shot number	Resistance measurement		Torque Measurement		Visual check	Salt mist test (EN 60058-02-52)		Humid sulphurous atmosphere test (EN 6988)		Humid ammo-niacal atmos-phere test (EN ISO 6957)		EN 50164-1 annex D				
								Contact Resistance (μΩ)	Acceptance Criteria ($<1000\ \mu\Omega$)	Loosening torque T2 (Nm)	Acceptance criteria ($0,25\ T1 < T2 < 1,5T1$)	Acceptance criteria criteria for visual check (3)	Start	End	Start	End	Start	End	Start	End			
																						Criterion Satisfaction	Criterion Satisfaction
A	N/A	110	55% / 19°C / 995mbar	A1	48,5	0,54	3321	177,2	Y	N/A	N/A	Y	Specimen illustration after the stage preparation										OK
				A2	50	0,59	3322																
				A3	49,8	0,55	3323																
B	N/A	600		B1	50,2	0,52	3324	236,9	Y	N/A	N/A	Y									OK		
				B2	50,2	0,57	3325																
				B3	50,2	0,55	3326																
C	N/A	536		C1	50,5	0,57	3327	220,7	Y	N/A	N/A	Y									OK		
				C2	50,4	0,55	3328																
				C3	50,5	0,55	3329																

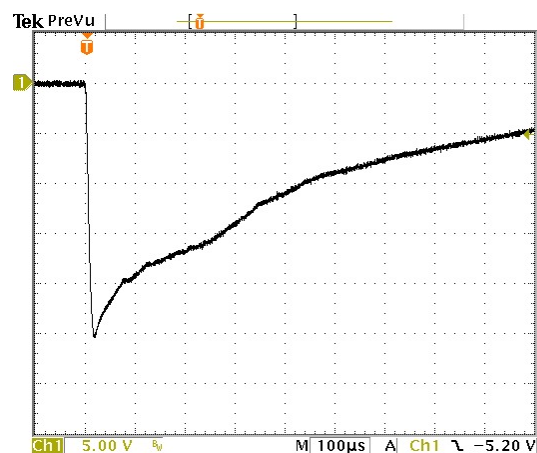
Y⁽¹⁾: Yes. N⁽²⁾: No. Visual Check Acceptance Criterion⁽³⁾: The connection components should not exhibit any cracks to normal or corrected vision without magnification, or have any loose parts or deformation impairing their normal use (BS EN 50164-1 §6.3). N/A: Not Applicable

G. TESTS RESULT SUMMARY

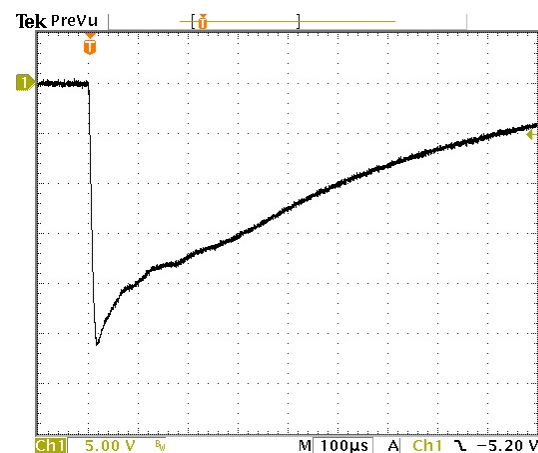
Test Registration Number	COMMENTS
30635A	The three bridging components samples submitted for tests by KRANSTEINER GmbH made out of aluminium alloy, which have been subjected to a class N impulse current electrical test as per EN 50164-1/6.3, has met the criteria according to 50164-1/6.3 for the bridging component (torque requirement was not applicable) as per arrangement B9 according to EN 50164-1, Annex B. Test results regarding this specimen are displayed analytically in the previous page. (Table of experimental results).
30635B	
30635C	

	Laboratory Technical Director
NAME	Dr. N. Kokkinos Electrical Engineer BSc, MSc, PhD
SIGNATURE	

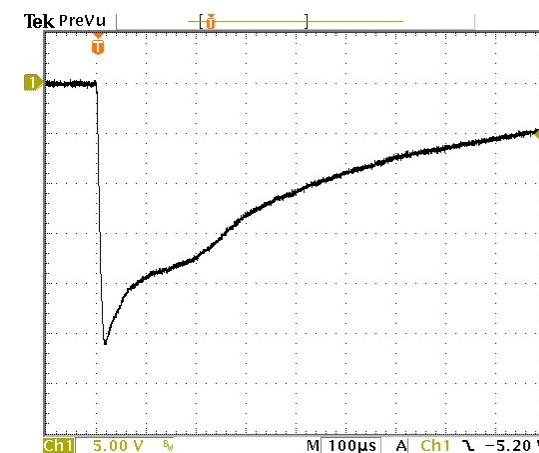
I. OSCILLOSCOPE RECORDINGS OF THE IMPULSE CURRENT TESTS AT 50 kA



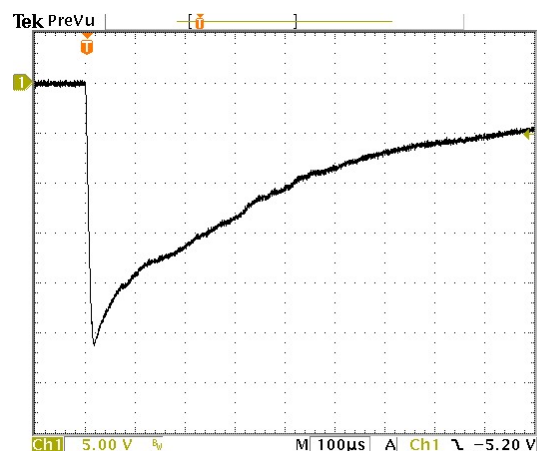
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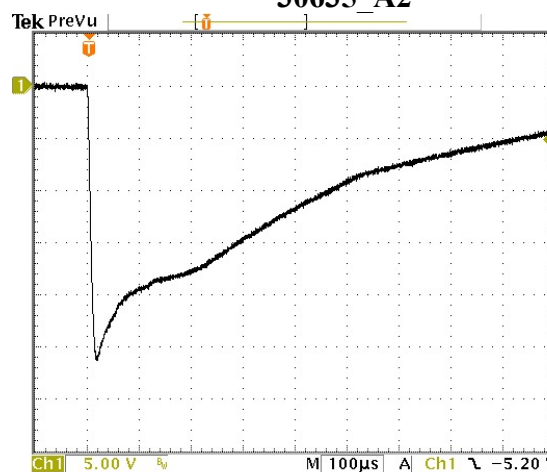
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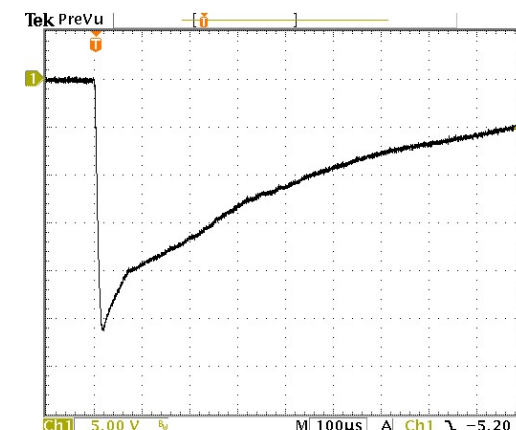
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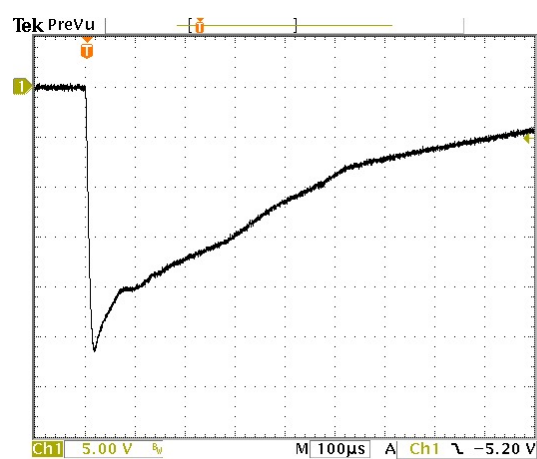
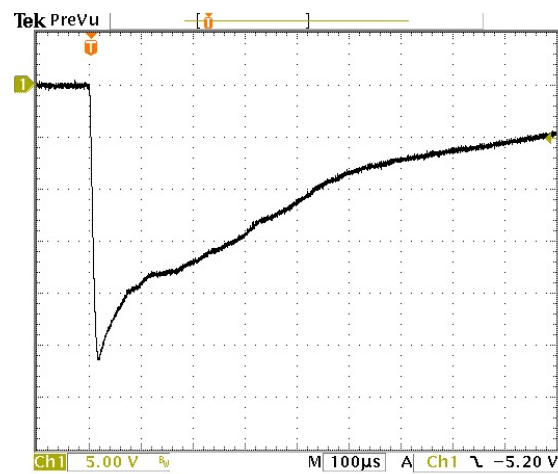
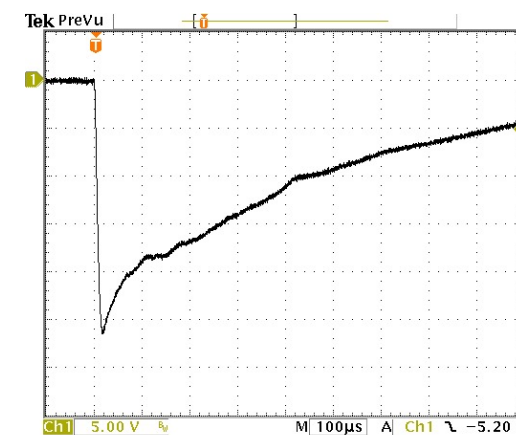
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