


LYRA 501

USER'S MANUAL

DORADO ENERGY

Belgrade, February 2005

CONTENTS

1 GENERAL

1.1. IMPORTANT NOTICES

- Voltage on flash lamp contacts may exceed 30kV during the ignition cycle. This is not a measuring point.
- Low intensity emission of light from lamp – simmer light – is the only sign that simmer current exists. In this case the voltage on flash lamp contacts is approximately 50V.

WARNING: If the main switch is turned on, and simmer current does not flow through the flash lamp, voltage on its contacts is extremely dangerous – 400 V dc.

- **Measuring equipment (oscilloscope, PC, scope cards, etc) must be disconnected from earth during operation.**
  Lyra 501 is a fully insulated device. Nevertheless, connecting some points to the earth potential via probe contacts may form inductive loop with large area. This action may cause very strong high frequency radiation which will produce the illegal operation code situations on the digital logic of the connected equipment.
- Protection against electric shock is achieved by protective earth. Continuity of the earthing circuitry is vital for the safe operation of the machine. Never operate the device with the earth conductor disconnected.
- Leakage current may exceed 3.5mA

2 TECHNICAL SPECIFICATIONS LYRA501

2.1. Input (mains)

Input voltage (single phase)	230Vac nominal
Input voltage range	165 to 275 Vac
Frequency range	45 to 55Hz*(1)
Input power	600W max.
Input current	10A max.
Inrush current	30A (peak)
Energy reserve	10 ms
Power factor (50 – 110% of nominal load)	0.99
Input current THD	<5%
Efficiency (20 – 110% of nominal load)	>90%*(2)

2.2. Output

Max. power – repetitive mode	500W
Max. single flash energy	300J*(see table 2)
Output current – (adjustable /150values)	0-150 A *(3)
Max. flash period – (100ms)	100ms
Max. total period – (turn on + turn off)	1000ms
Min. flash period	1ms*(4)
Min. total period – (Ton + Toff)	3ms
Max. flash frequency – (depending of adjusted periods and energy)	100Hz*(5)
Flash lamp voltage range	0 to 400Vdc
Simmer source voltage (open circuit)	400V
Simmer source voltage (during operation)	0-80V
Simmer source current (adjustable)	0-500mA
Igniter voltage (HF) – direct on lamp contacts	15kV*(6)
Switching frequency	200 kHz

2.3. Environmental conditions

Operating temperature range	0 to +55˚ C
Storage and transport temperature range	-45 to +85˚ C
Operating humidity (no condensation)	30 to 95%
Storage and transport humidity (no condensation)	10 to 95%

2.4. Mechanical characteristics

Weight	12 kg
Height	320mm
Width	165mm
Depth	390 mm

2.5. Dielectric strength (during 1 minute)

Between input and earth	2.1 kVdc
Between output and earth	2.1 kVdc
Between input and output	4 kVdc

2.6. Other specifications

Simmer source current regulation (analog)	0 - 500mA
Simmer source voltage regulation (internal)	200V - 400V
Current regulation I (8b DA)	0-150A
Frequency regulation (depending of sequence period duration)	0.1-100Hz
LCD display	2x16 char

***(1) –** Input voltage frequency is limited by galvanic insulation transformer. Safe frequency range is 45-55Hz. Wide-range input frequency capabilities are possible without this transformer.

***(2) -** During automatic repetition modes of operation.

***(3),*(4),*(5) -** Flashlamp current is constant during turn-on period. Duration of light emission may be adjusted between 0 and 100ms. Discharge current may be within 1 –150A range, adjusted with 1A step.
After the whole sequence comes Toff period. This value is crucial for calculating the frequency of automatic mode of operation. Toff range is 1 – 1000ms, adjustable with 10ms step.

	Min. value	Max. value	Step	Default
Flash current	0	150A	1A	0
Flash period	0	100ms	1ms	0
Turn-off time	10ms	10000ms	10ms	1000ms
Simmer current	0	500mA	analog	500mA
Simmer voltage	200V	400V	analog	400V

Table 1.

***(6) - Important note.** Flashlamp ignition voltage is about 30kV. This voltage occurs on the lamp contacts. Measuring of the lamp voltage is enabled from a connector on the back side of device. Those measuring points are connected before high voltage generator and are safe for standard measuring equipment. High voltage does not occur on this point.
For triggering and stable flow of simmer current as well as the main plasma channel it is necessary to place small conduction wire along the lamp tube. Ignition voltage occurs directly on the lamp ends, but this wire is important for plasma trajectory definition.
Also, this wire produces higher density of plasma tube.
Another way to make similar effect is to put lamp tube into one focus point of mirror made of conducting material. This mirror also has the light focusing function.

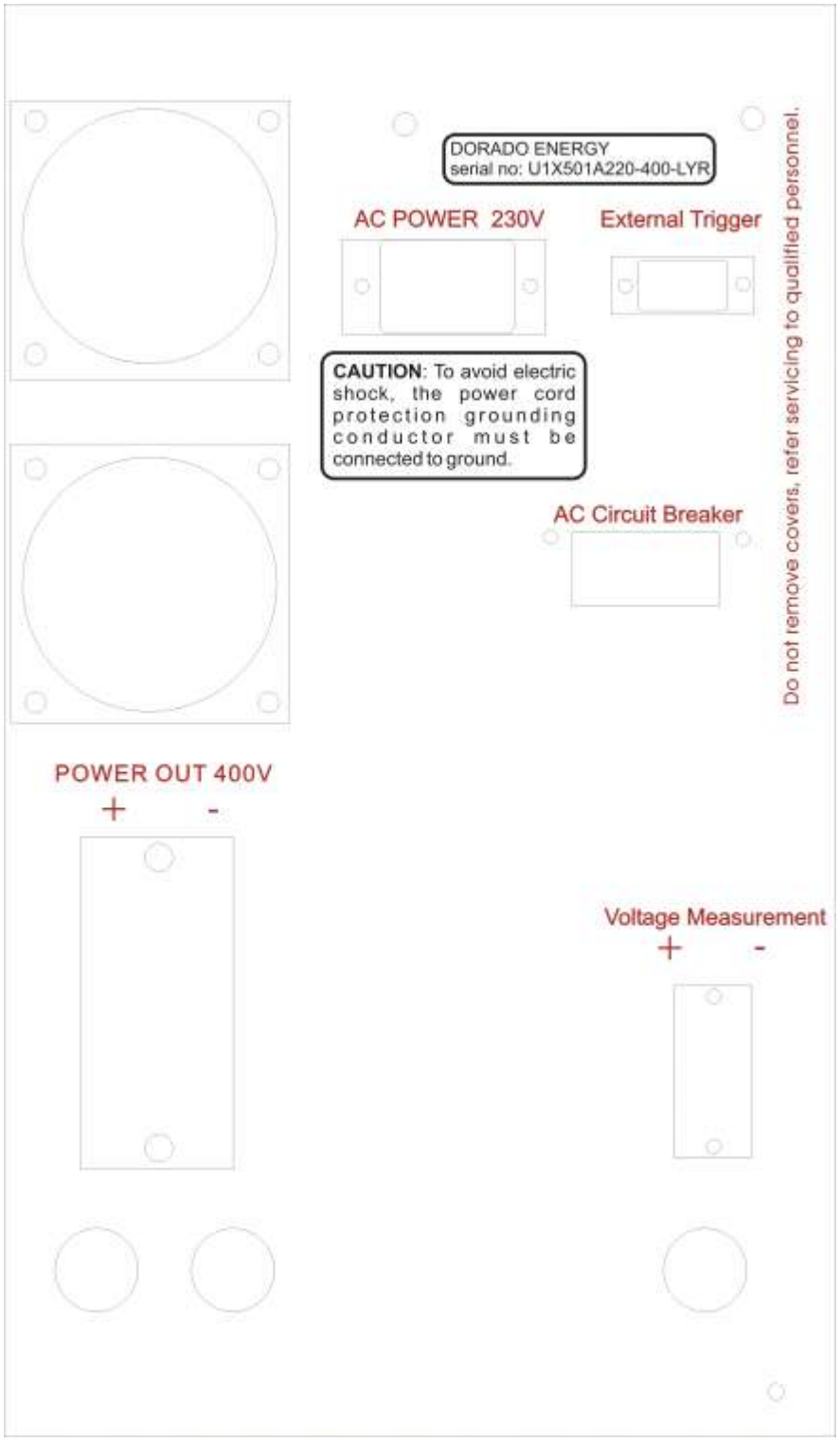
This wire can be placed along just one side of the lamp tube and may be very thin.

To eliminate this conductor it is necessary to inject 50kV HF pulse directly on the lamp contacts, with 100Hz repetition. This will make possible just the start of simmer current, but not the stable current flow and high density of plasma during other periods of operation. Also, the simmer plasma tube will be stable with more than 1500mA simmer current. In this case the voltage on lamp ends is about 55V.
The suggestion is to keep existing solution at this level of development.

***(7) Maximum operation ratings – see tables 2 and 3.**

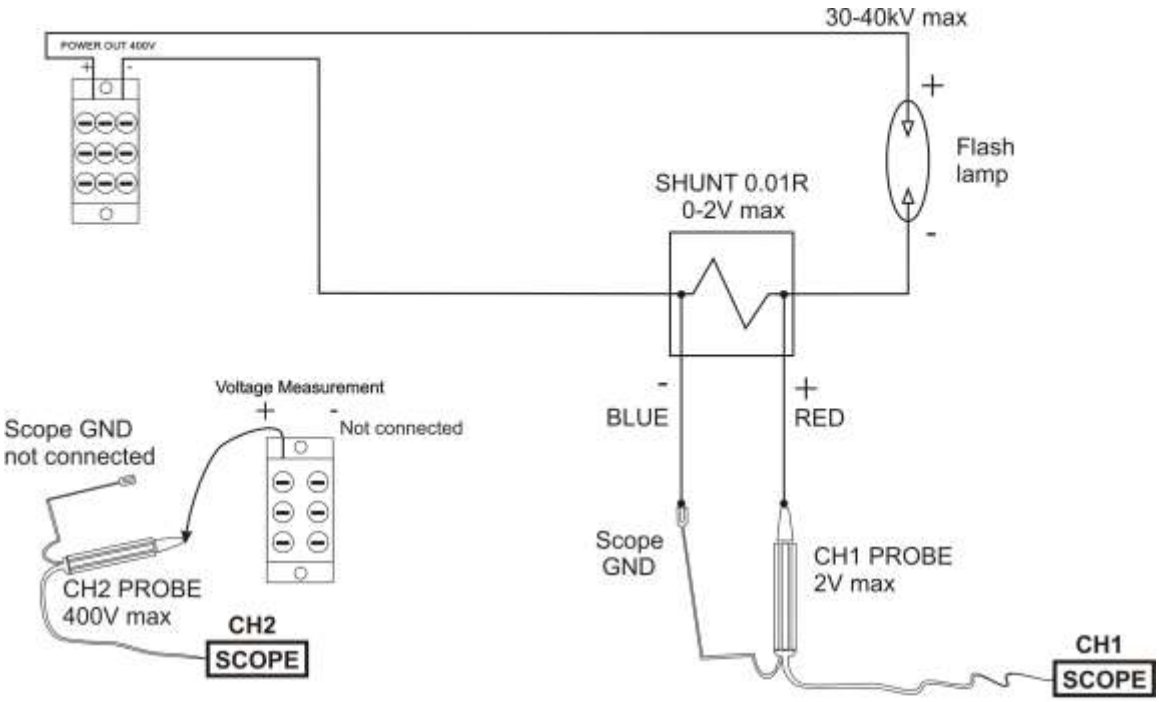
3 CONNECTIONS

3.1. BACK PLATE VIEW



Picture 1.

3.2. BLOCK DIAGRAM (CONNECTING)



Recommended **SCOPE**

TRIGGER ->CH2
SLOPE ->
CH1 -> 500mV/DIV /PROBE x1
CH2 -> 100V/DIV /PROBEx10

IMPORTANT NOTES:

- Voltage on + pin of flashlamp may exceed 30kV - this is not a measuring point.
- Open circuit voltage (while there is no simmer current) on lamp is 400V.

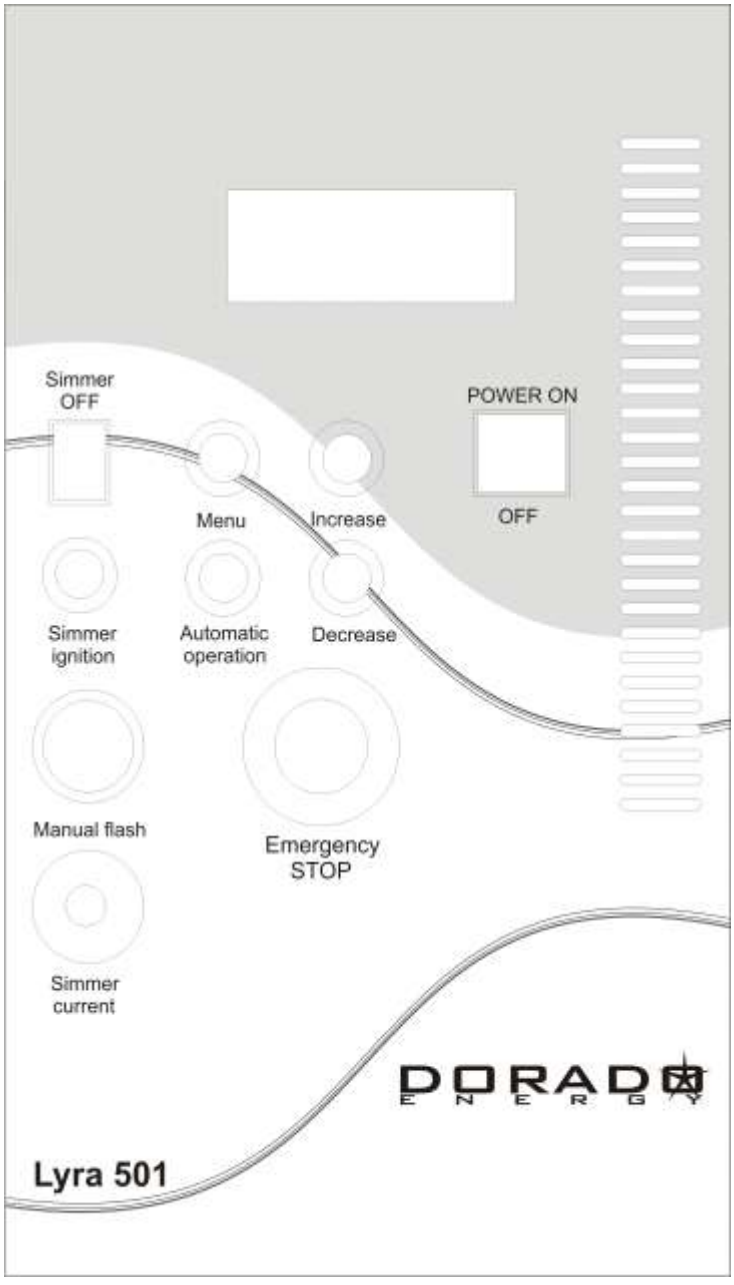
Picture 2.

4 MANAGING

4.1. GENERAL

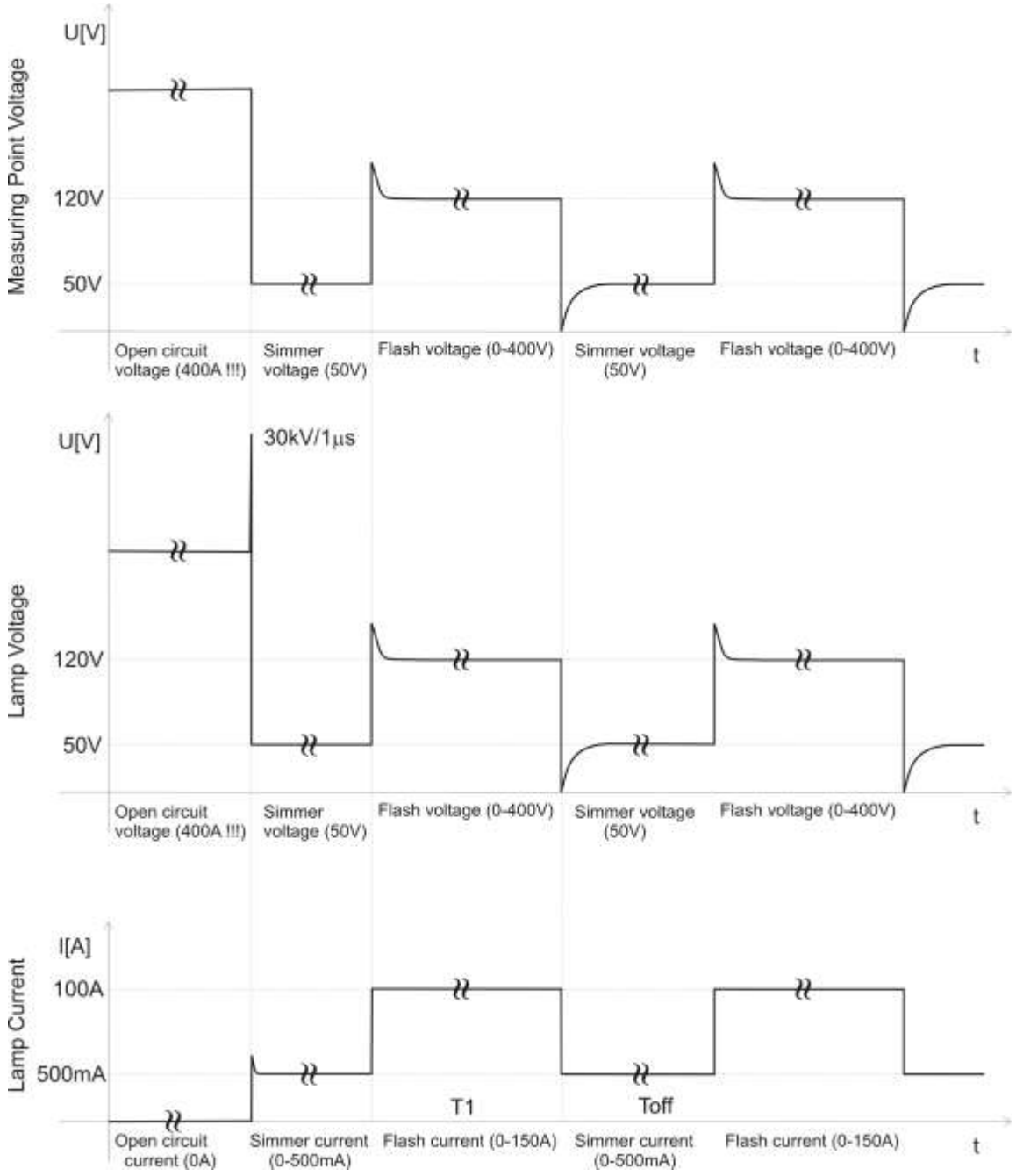
The first phase in managing the Lyra501 is the setup of parameters, manually, via the keyboard. The second phase is the starting of flash cycle, which is possible to be done by pressing either of the “Automatic operation” switch or “Manual flash” or by the remote trigger.

4.2. FRONT PLATE VIEW



Picture3.

4.3. EXPLANATION



Picture 4.

4.3. EXPLANATION

4.3.1. STARTING PROCEDURE

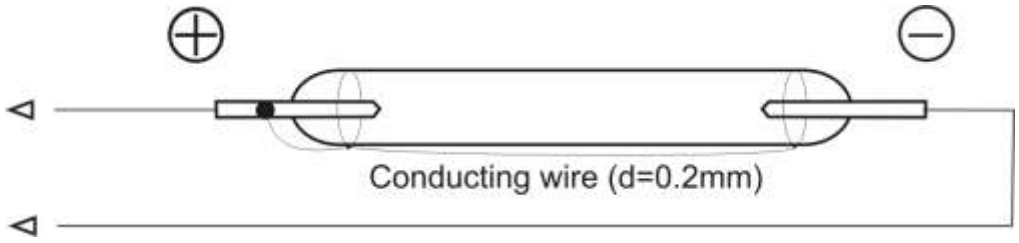
- Connect the device, lamp and measuring instruments as described in chapter 3.
- Turn on the automatic circuit breakers on the back panel and the "Emergency stop" key (turn clock-wise and let it come forward).
- Turn on the "Power on/off" switch.
  The display will show welcome screen:

  The lamp voltage is now 400V/DC.
- Set simmer current to maximum (recommended) of 500mA, by rotating the "Simmer current" button all the way to the right.
- Push the simmer ignition key. This action should initiate simmer current through the flash lamp, and low intensity light radiation should be visible. If this does not occur, check the value of the defined simmer current (must be 500mA – button turned all the way to the right) and push ignition key again.

Stability of plasma during simmer discharge depends on the simmer current intensity. Of the low value of this current is chosen, plasma may disappear after the flash period T1. In that case, it must be started manually.

IMPORTANT: During ignition process – starting the simmer current – both the "Automatic Operation" switch and the "Manual Flash" key must be turned off, otherwise a no operation display will be shown. High voltage/high frequency ignition cycle may produce HF noise and illegal op-code reset of the main processor unit.



Picture 5.

- Placing a conducting wire of 0.2mm in diameter near the flash lamp surface is also very important for the plasma flow's stability. This wire must be installed properly – see picture no. 5.
- Greater values of the simmer current (300-500mA) will generate a stable simmer arc. Thus, dissipation of over 10W may increase the lamp

temperature, because the dissipation exists even during T_{off} period of the flash cycle. **Nevertheless, maximum value of simmer current is recommended for use in laboratory conditions.**

- Minimal value of the simmer current, necessary for the stable plasma flowing, depends on many parameters: temperature of the plasma gas, position of the conduction wire along the lamp tube. Gas pressure, gas mixture, geometry of electrodes and tube, electrode material, et al. The lowest value of this current may be experimentally defined for each type of flash lamp.
- Only after the simmer plasma flow has been stabilized, the user can continue with the programming procedure.

4.3.2. PROGRAMMING PROCEDURE

The starting display of the programming procedure is the welcome screen:

By pressing the key “Menu”, the user can go through the set-up screens, allowing him to adjust the flash parameters.

- Flash cycle modes

Lyra501 allows two types of flash cycle modes with different maximum operating values, which can be programmed via keyboard.

After the welcome screen, the first push of the “Menu” key leads user to the flash cycle mode selection screen.

The preset value for this is “R” for Repetitive mode of operation. “Increase” or “Decrease” key will change the chosen mode and new screen will be:

designating the single flash mode of operation.

Maximum values of predetermined parameters for repetitive mode operation are as follows in Table 2. The appropriate values for single mode are in Table 3.

Flash current	Flash voltage	Duration	Energy	Power
120A	250V	5ms	150J	300W
100A	200V	15ms	300J	500W
80A	166V	25ms	385J	500W
70A	130V	50ms	450J	500W
50A	100V	100ms	500J	500W

Table 2.

Flash current	Flash voltage	Duration	Energy	Power
150A	250V	5ms	190J	300W
100A	200V	30ms	300J	500W
80A	166V	40ms	400J	500W
70A	130V	50ms	450J	500W
50A	100V	100ms	500J	500W

Table 3.

In single mode, the value Toff is set to 10seconds and can not be user-modified.

- Flash current

The next push on “Menu” key will take user to the current determination screen.

“Increase” or “Decrease” key will change the present value of current.

- Flash duration / duration of defined current

“Increase” or “Decrease” key will change the present value of flash duration.

- Pause/Frequency setting

Flash frequency is not defined directly. User defines period Toff in the flash cycle (see picture no 4). Flash frequency depends on T1 and Toff, and must be calculated.

Maximum frequency of flash cycles is 10Hz (T1+Toff=100ms).

Lyra501 allows demo mode of operation, where T1+Toff is less than 100ms, if the flash current the user has set is less or equal to 100A. This mode is entered automatically, whenever the value of T1+Toff is set to less than 100ms. In this case, the flash duration is set to the default value of 1ms. Total output power with these 100A/1ms pulses on 100Hz frequency will be 1000-1400 W. Duration of this emission is limited and can not exceed 1 second, with a pause after it of 5 seconds. These values are defined automatically. This operation will not cause damages on a 300W/150J flash lamp. Demo operation starts by pressing the “Automatic operation” key. The following screen appears:

After one second of demo operation has elapsed, the following screen is displayed:

And, until the user unpresses the “Automatic operation”, the following screens appear:

4.3.3. FLASH CYCLE STARTING PROCEDURE

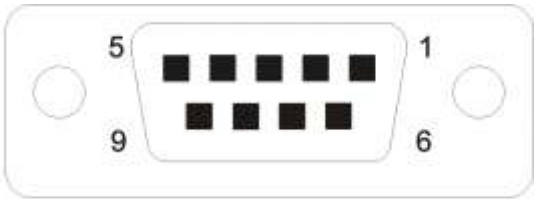
- Check all power and measuring connections.
- Confirm the presence of simmer light radiation.
- Confirm the programmed parameters
- Start the flash cycle:
    - By pushing “Manual Flash” key for single flash mode operation. If the operation mode is set to “R” and “Manual Flash” is pressed, the programmed cycle will only be active while the key is actually pressed. The following screen will appear:

    - By pushing “Automatic Operation” (blue) switch for repetitive flash mode operation. The programmed cycle will be active until this switch is turned off. The following screen will appear:

    - Remote trigger: The programmed cycle will be active while voltage of 5-20V is present on 9P-SUBD connector on the back plate as shown on picture 6



Pin 1-5 to the positive end (5-20V)
Pin 6-9 to the negative end

Picture 6.

4.3.4. MESSAGES AND WARNINGS

All parameters must be defined within the limited values defined in Tables 1 and 2 in chapter 4.3.2.

In case some of the parameters exceed the limits, following error messages may appear.

If the above screen appears, one or more values are out of the range as defined in Tables 2 and 3. Try adjusting a lower flash period.

If the above screen appears, one or more values are out of the range as defined in Tables 2 and 3. Try adjusting a longer pause period.

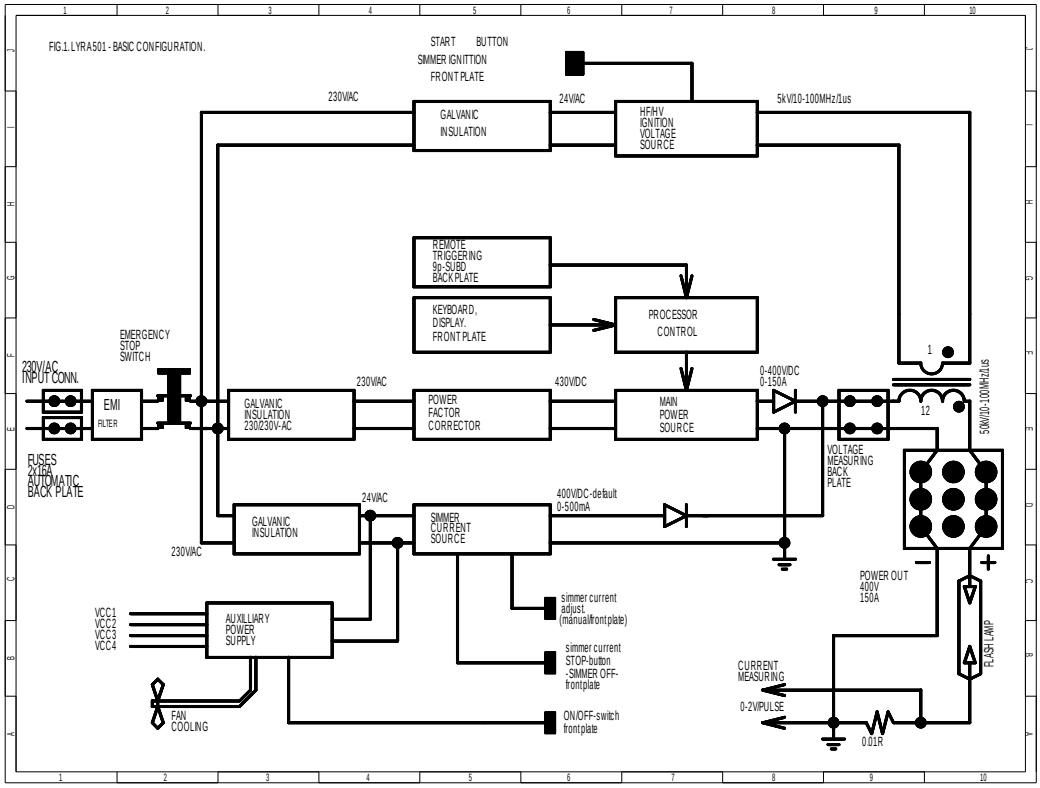
Define a lower value for current for the chosen mode and flash duration.

Total power exceeds 500W, define longer Toff period.

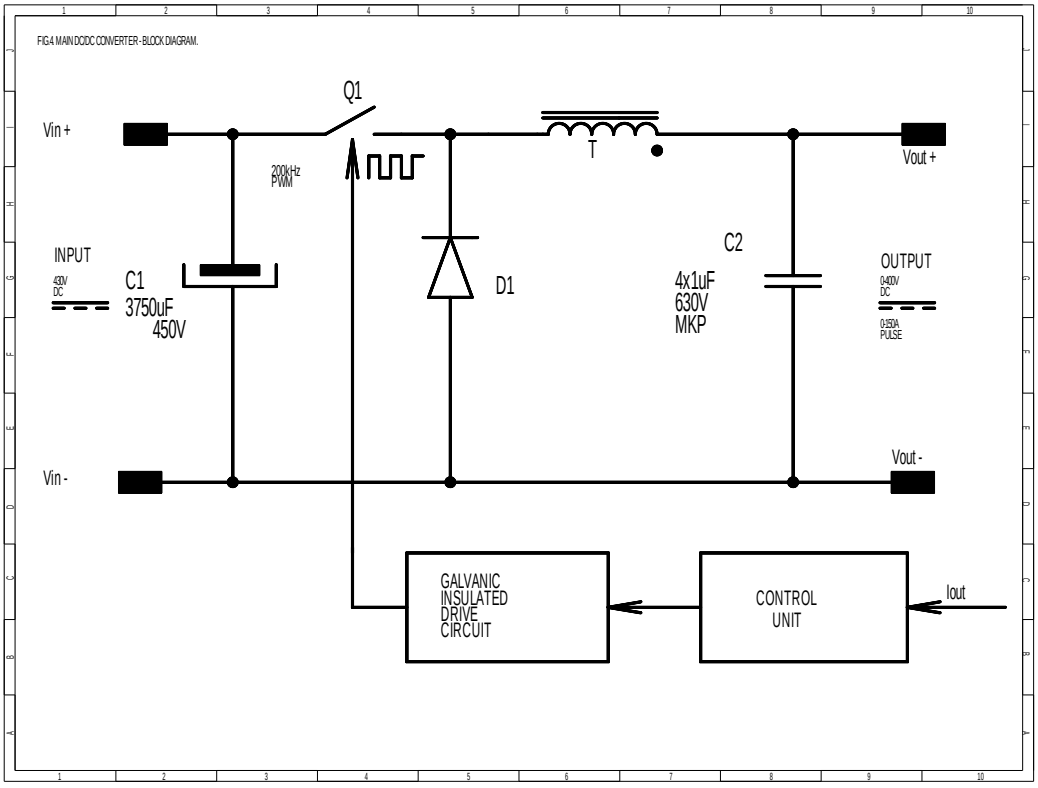
Flash energy exceeds maximum value for the chosen operation mode. Define a shorter T1 period, or lower flash current.

5 APPENDIXES

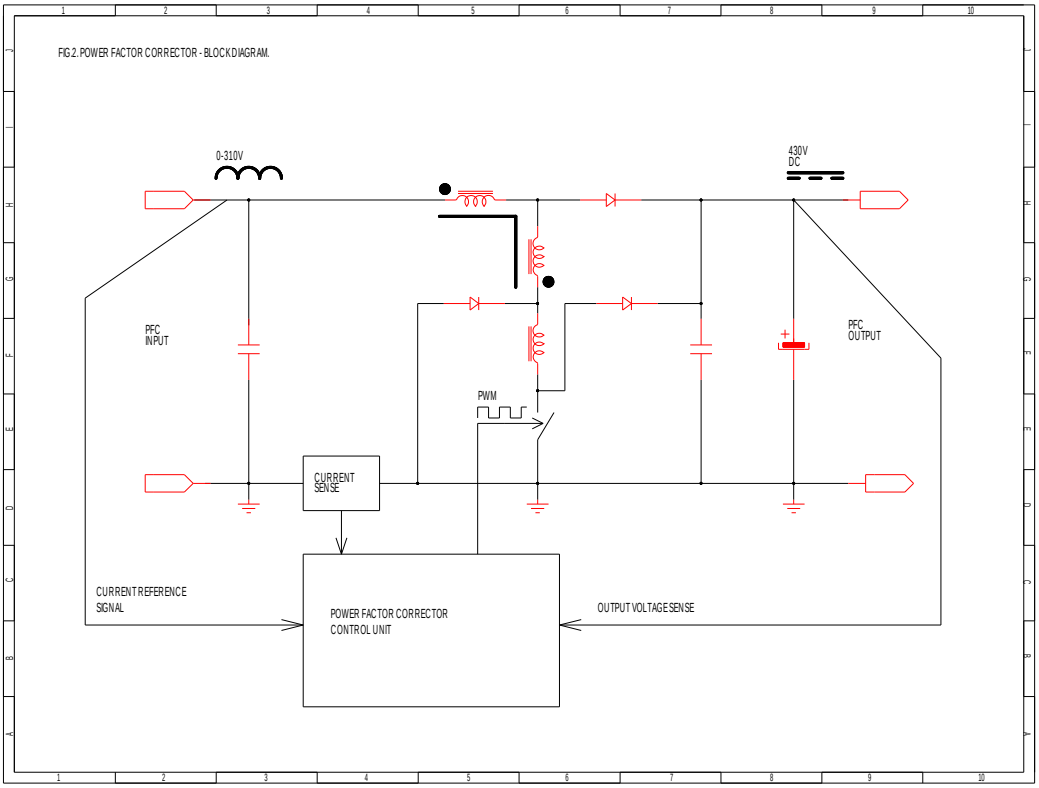
5.1. APPENDIX 1



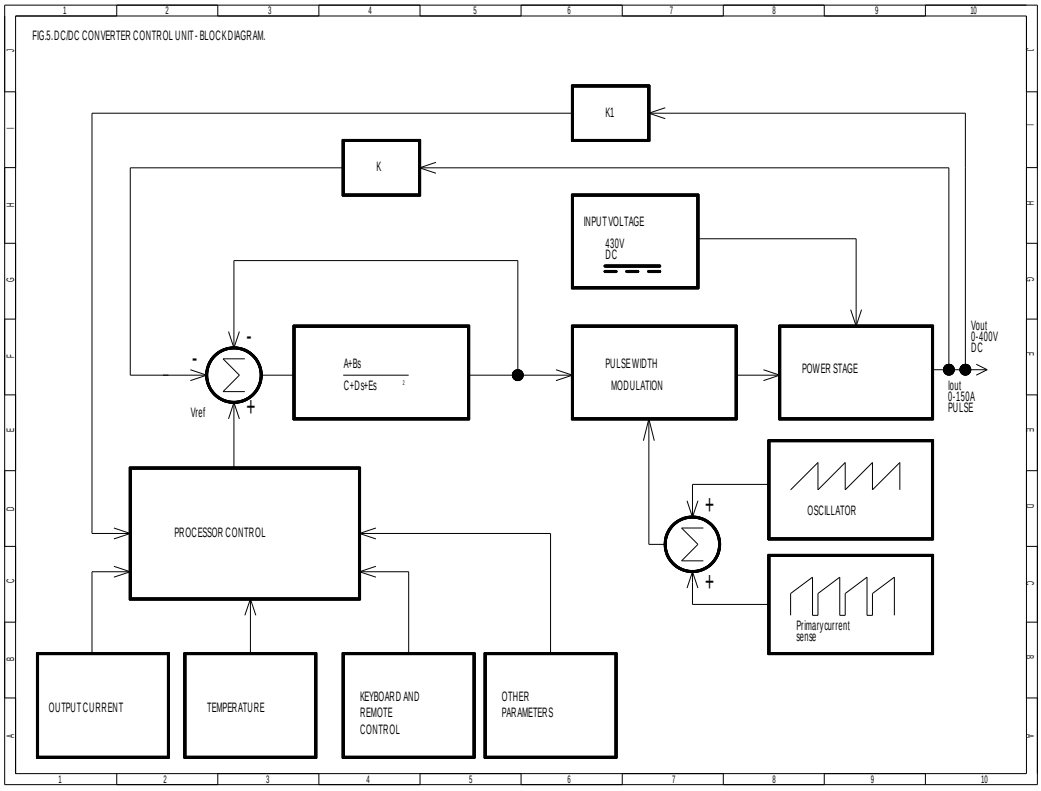
5.2. APPENDIX 2



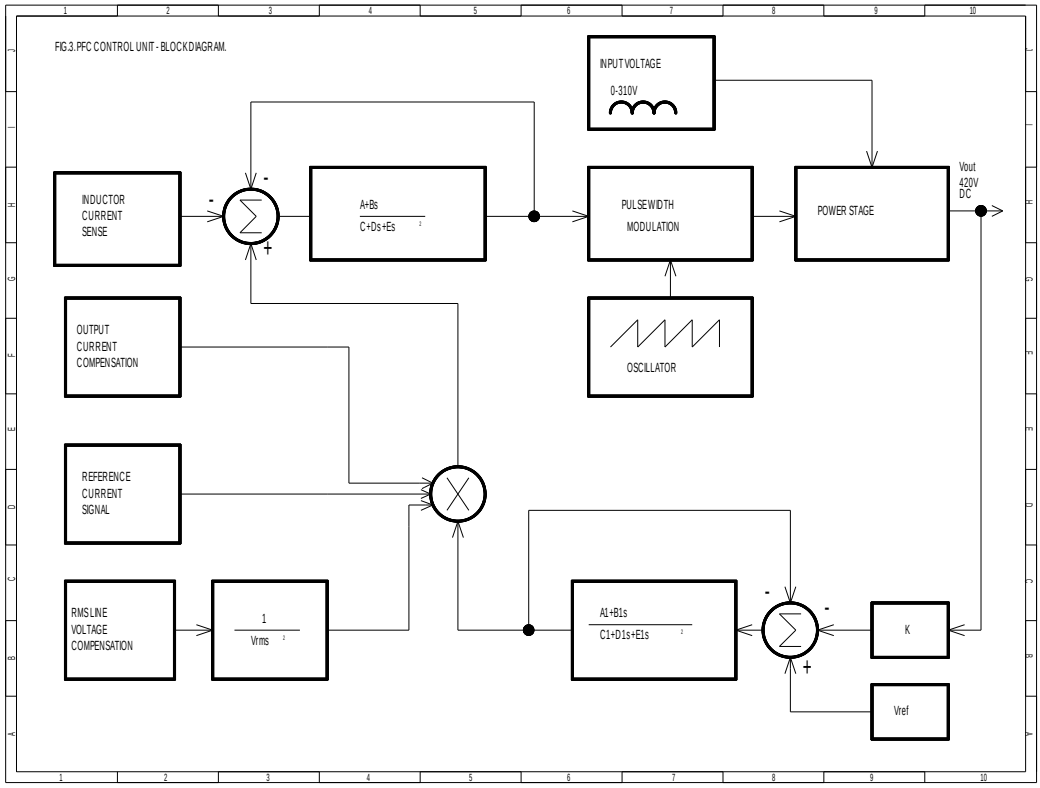
5.3. APPENDIX 3



5.4. APPENDIX 4

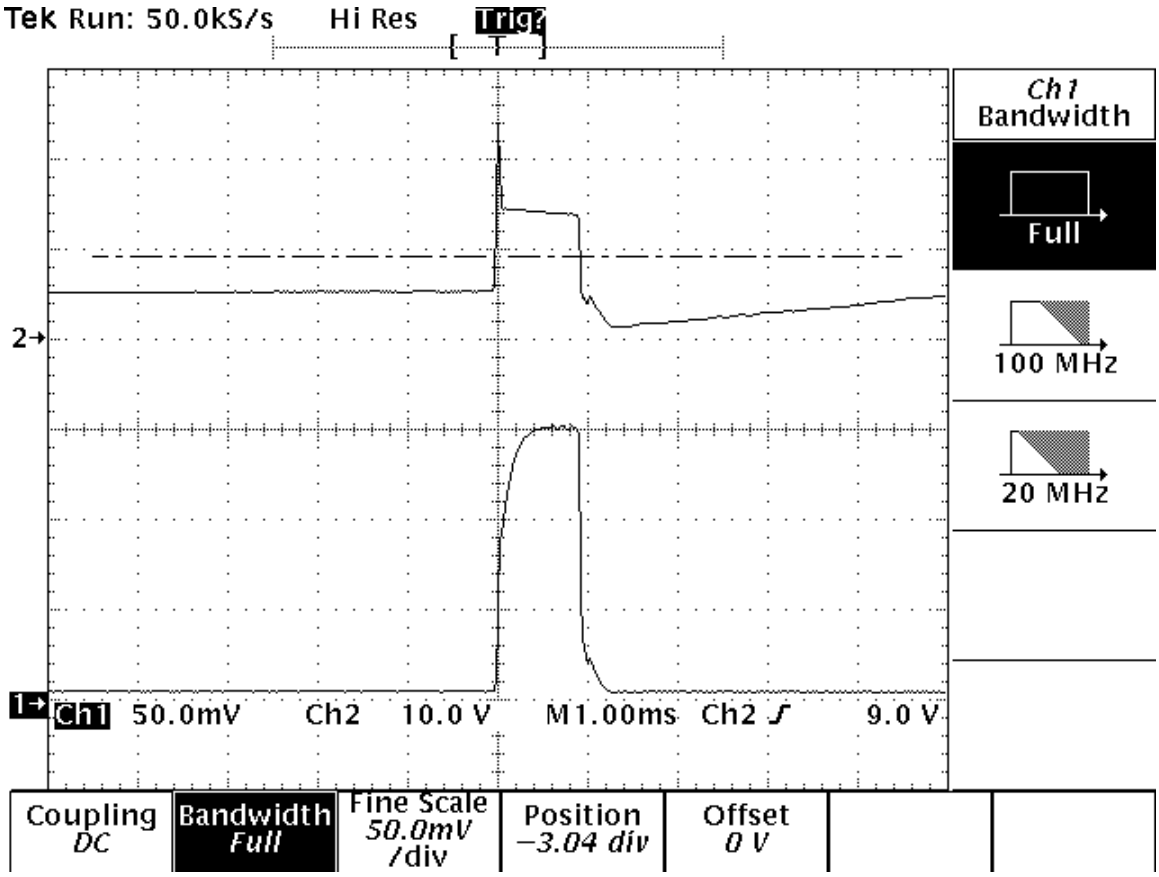


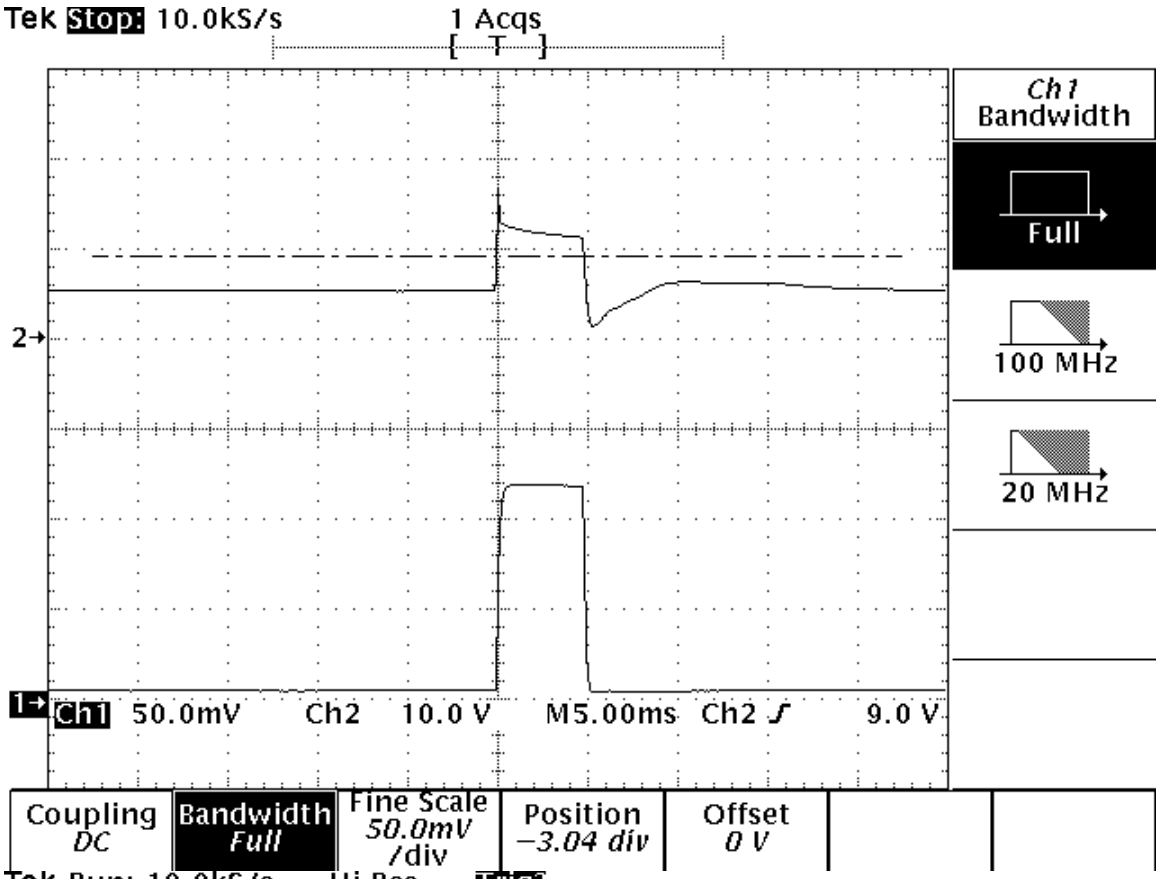
5.5. APPENDIX 5



5.6. APPENDIX 6

CH1 -> FLASH LAMP CURRENT – 0-150A
Measured with 0,001R non-inductive shunt
CH2 -> 100V/DIV FLASH LAMP VOLTAGE




Tek Stop: 10.0kS/s
1 Acqs
Ch1
Bandwidth
Full
100 MHz
20 MHz
2→
1→
Ch1 50.0mV
Ch2 10.0 V
M5.00ms Ch2 ƒ 9.0 V
Coupling
DC
Bandwidth
Full
Fine Scale
50.0mV
/div
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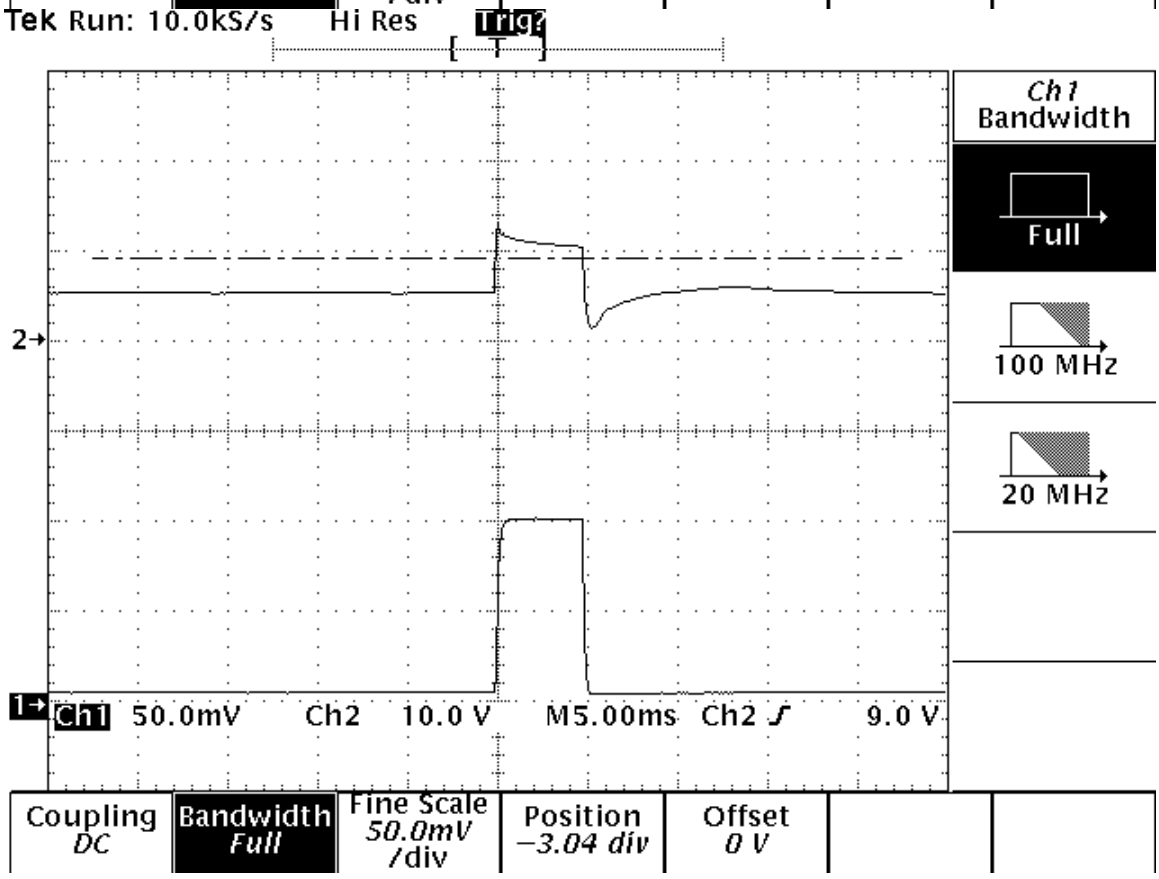
Offset
0 V


Tek Run: 10.0kS/s
Hi Res
Trig?
Ch1
Bandwidth
Full
100 MHz
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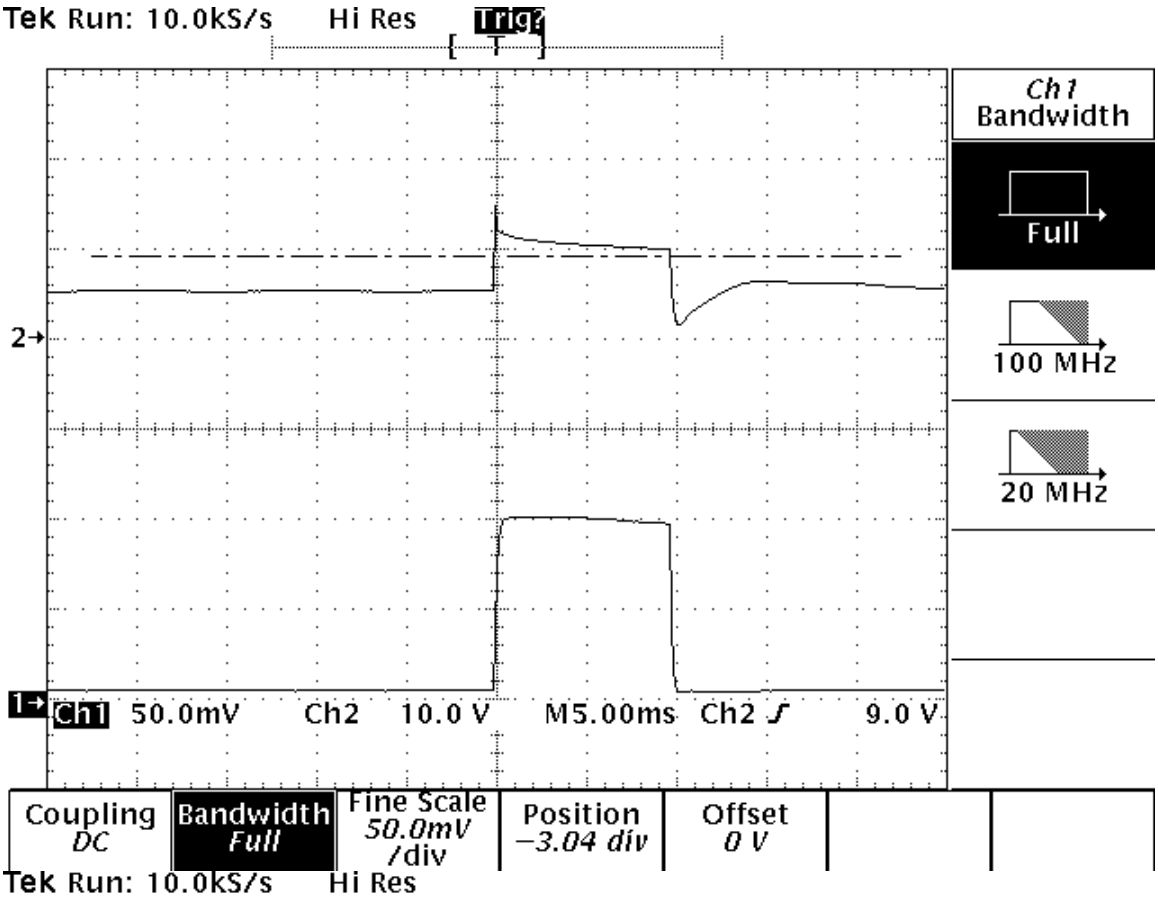
Ch1 50.0mV
Ch2 10.0 V
M5.00ms Ch2 ƒ 9.0 V
Coupling
DC
Bandwidth
Full
Fine Scale
50.0mV
/div
Position
−3.04 div
Offset
0 V


Tek Run: 10.0kS/s Hi Res
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Ch1
Bandwidth
Full
100 MHz
20 MHz
2→
1→
Ch1 50.0mV Ch2 10.0 V M5.00ms Ch2 ƒ 9.0 V
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DC
Bandwidth
Full
Fine Scale
50.0mV
/div
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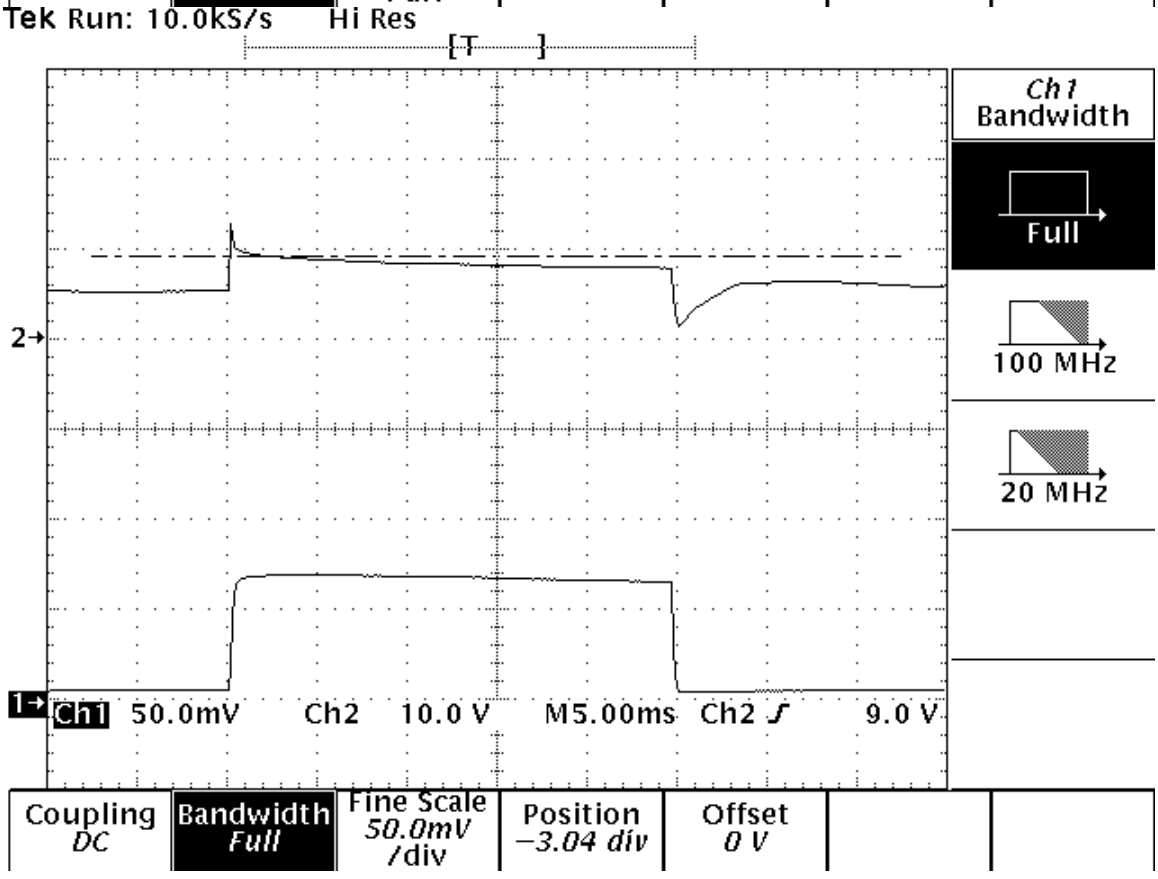
−3.04 div
Offset
0 V


Tek Run: 10.0kS/s Hi Res
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Bandwidth
Full
100 MHz
20 MHz
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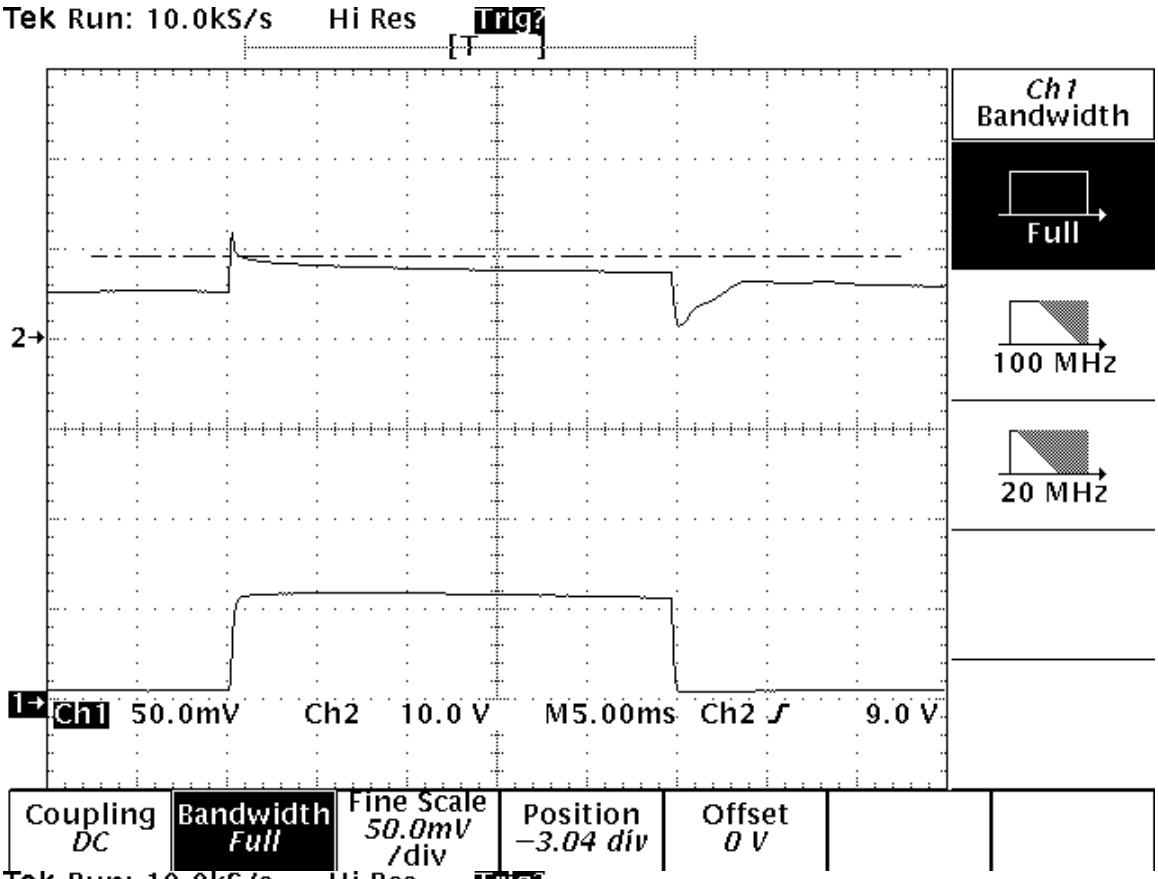
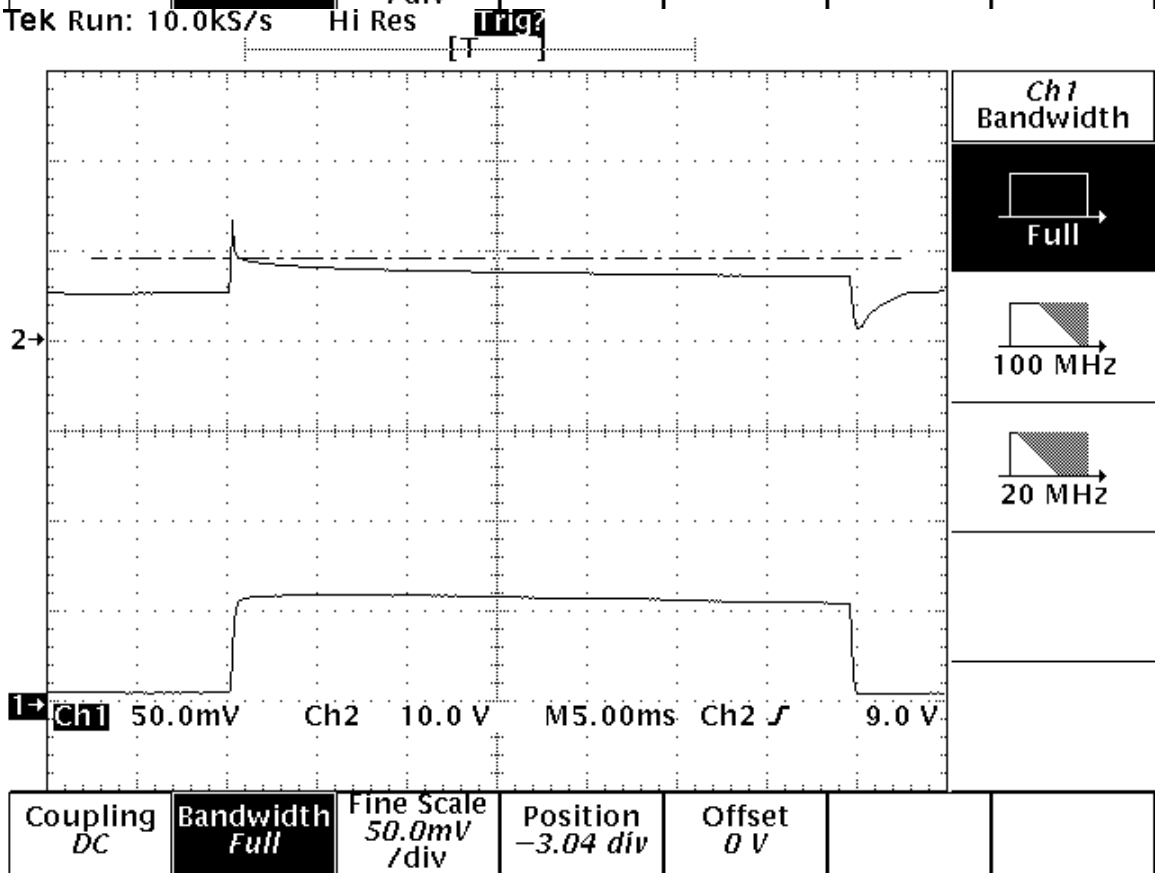
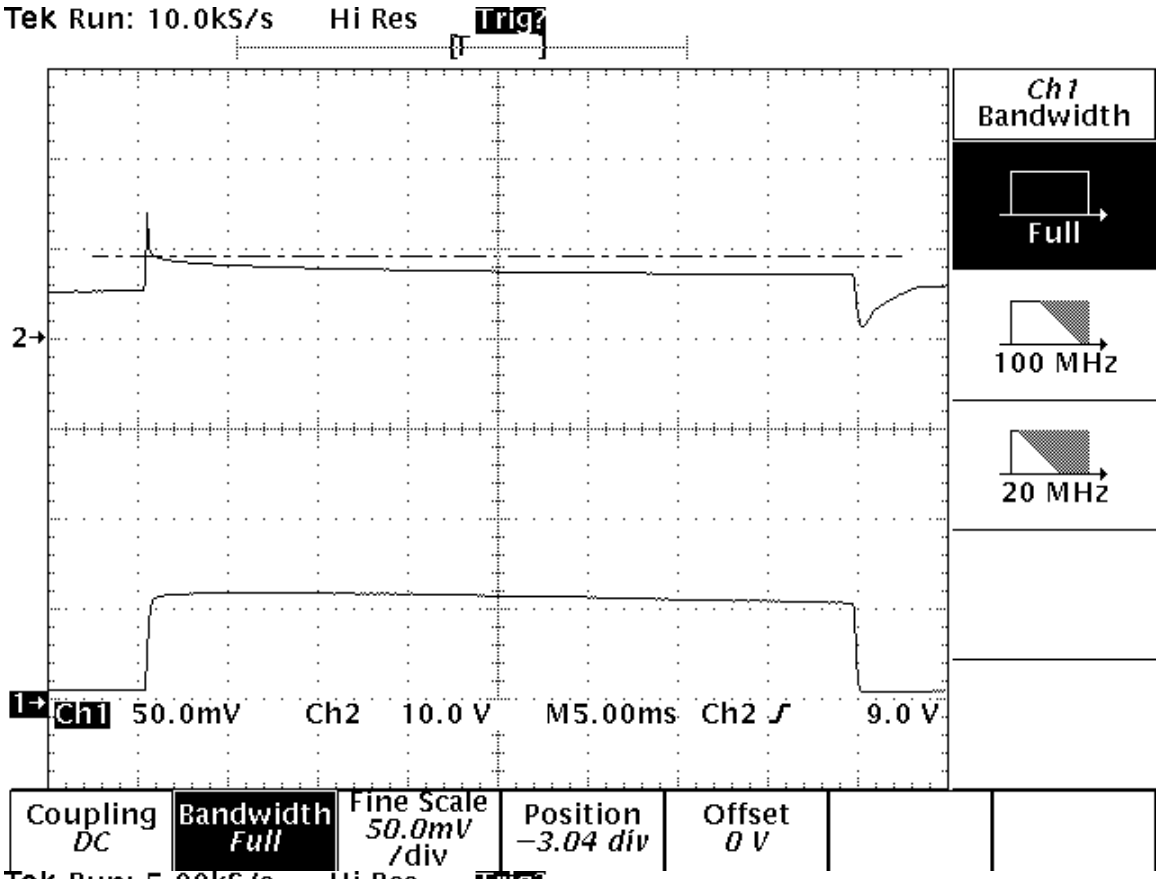
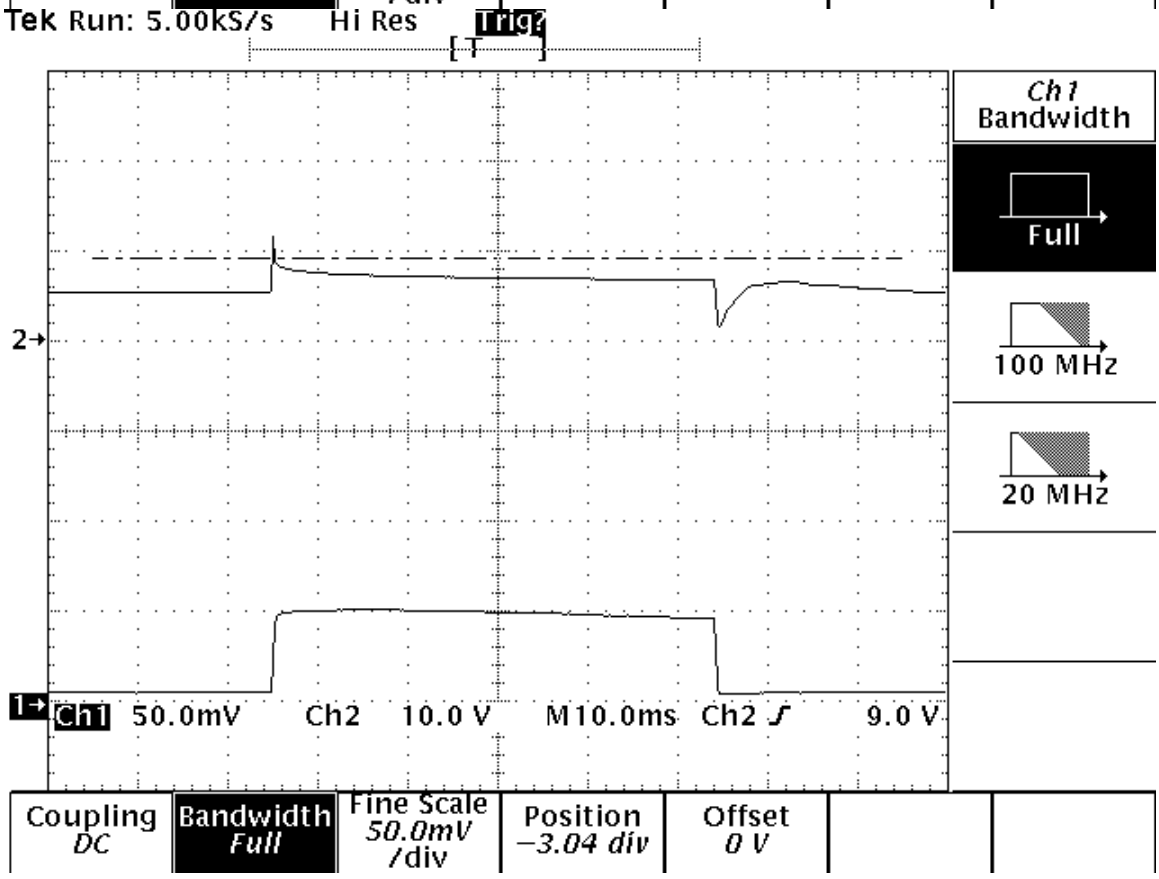
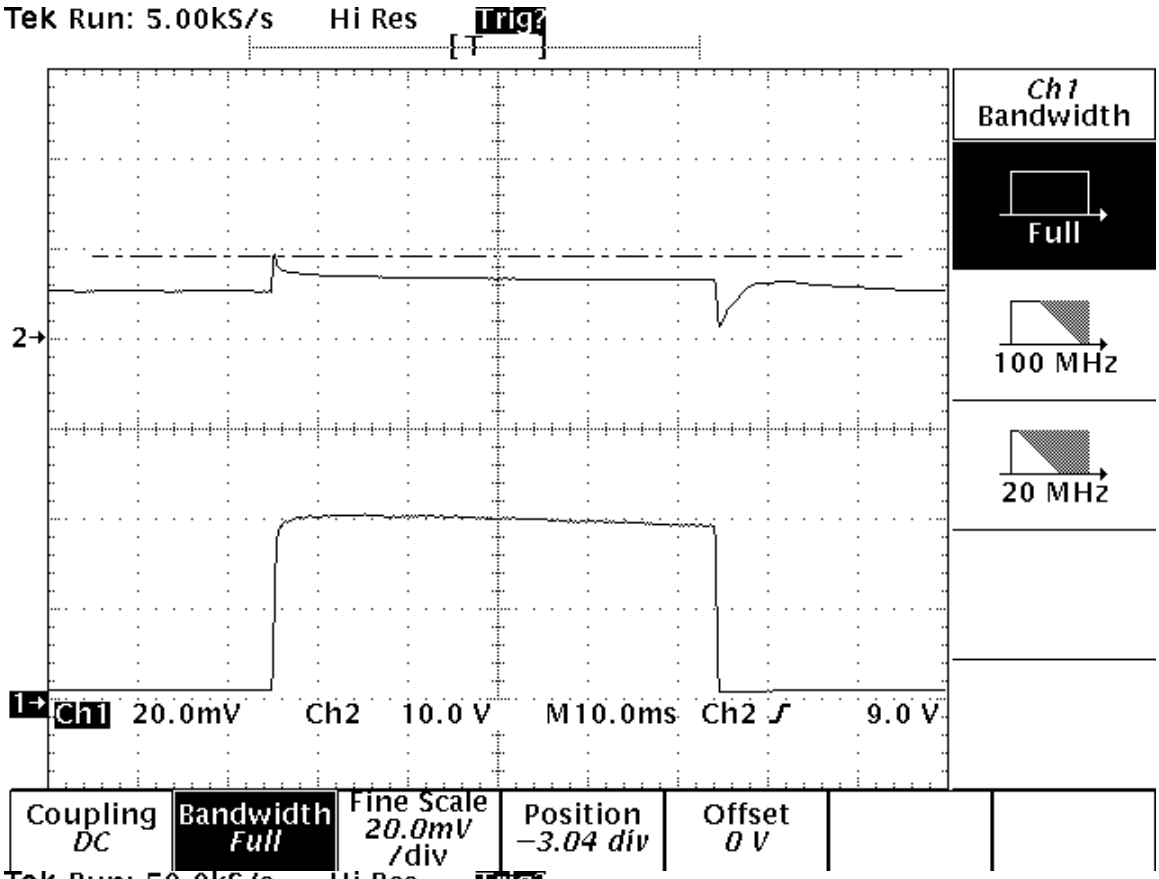
Ch1 50.0mV Ch2 10.0 V M5.00ms Ch2 ƒ 9.0 V
Coupling
DC
Bandwidth
Full
Fine Scale
50.0mV
/div
Position
−3.04 div
Offset
0 V

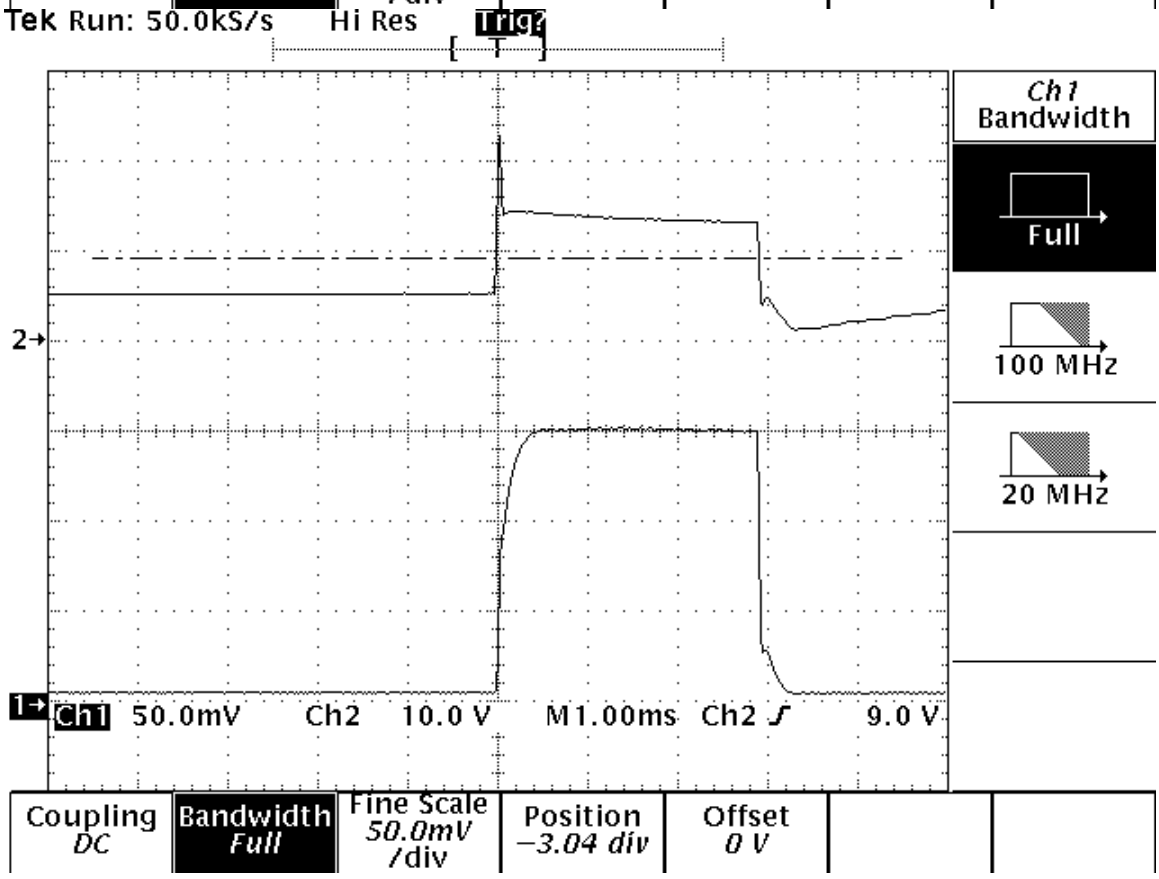

Tek Run: 10.0kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
Ch1 50.0mV Ch2 10.0 V M5.00ms Ch2 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V

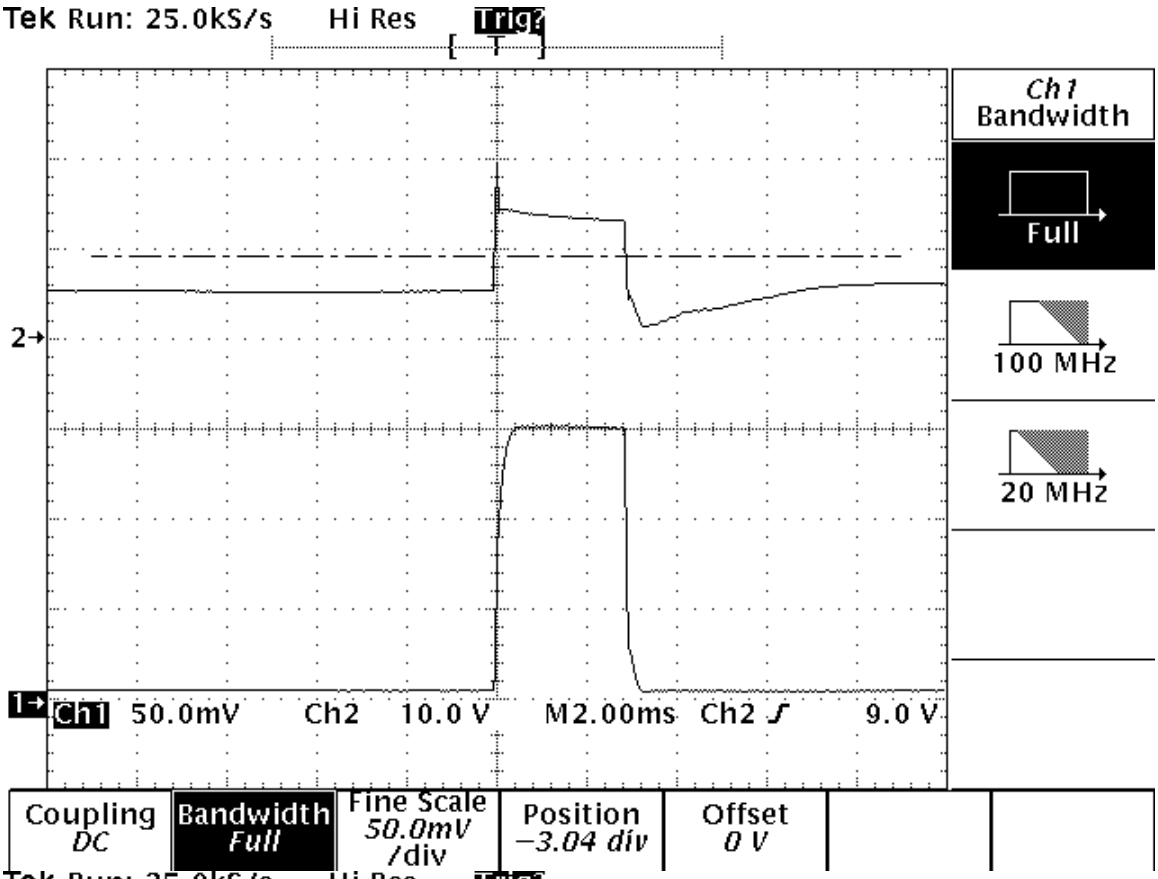

Tek Run: 10.0kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
Ch1 50.0mV Ch2 10.0 V M5.00ms Ch2 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V

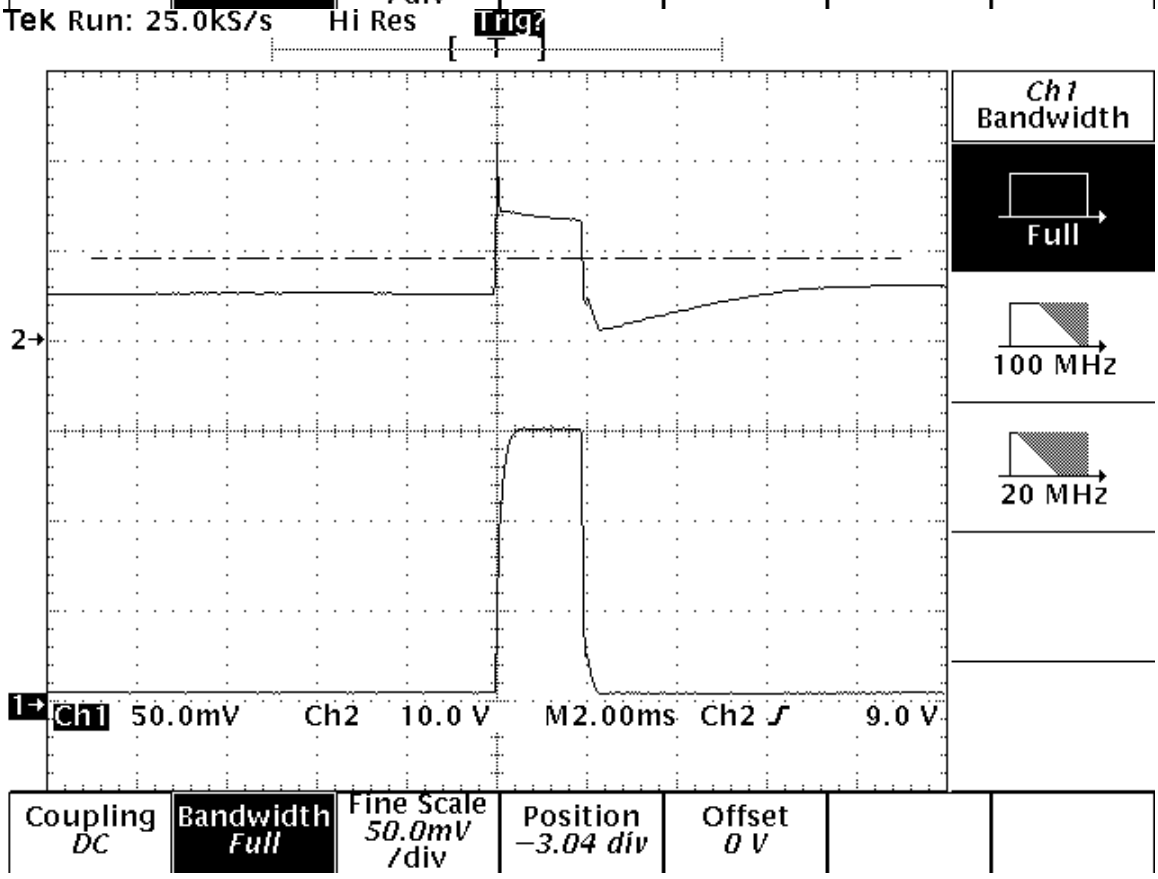

Tek Run: 10.0kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
2→
1→ Ch1 50.0mV Ch2 10.0 V M5.00ms Ch2 ƒ 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V


Tek Run: 5.00kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
2→
1→ Ch1 50.0mV Ch2 10.0 V M10.0ms Ch2 ƒ 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V


Tek Run: 5.00kS/s Hi Res
Trig?
Ch1
Bandwidth
Full
100 MHz
20 MHz
2→
1→
Ch1 20.0mV Ch2 10.0 V M10.0ms Ch2 ƒ 9.0 V
Coupling
DC
Bandwidth
Full
Fine Scale
20.0mV
/div
Position
−3.04 div
Offset
0 V

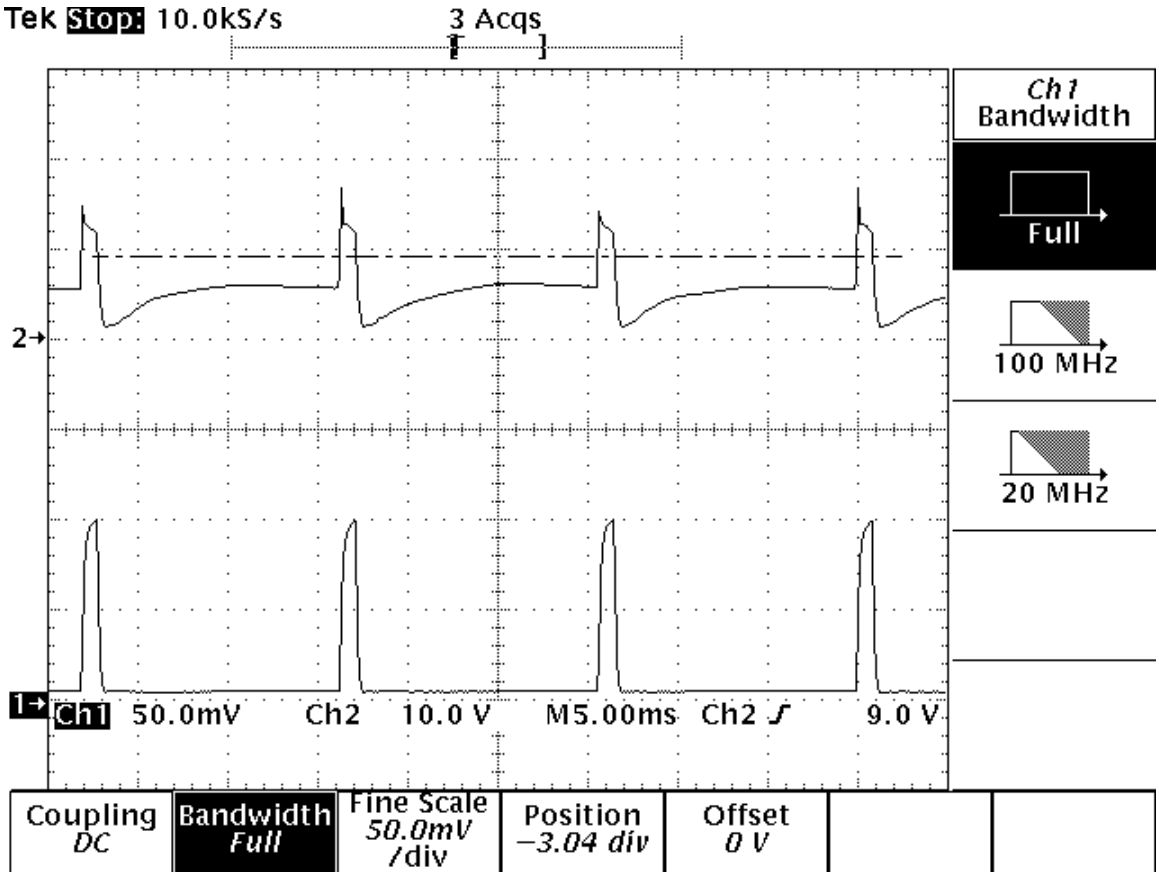

Tek Run: 50.0kS/s Hi Res
Trig?
Ch1
Bandwidth
Full
100 MHz
20 MHz
2→
1→
Ch1 50.0mV Ch2 10.0 V M1.00ms Ch2 ƒ 9.0 V
Coupling
DC
Bandwidth
Full
Fine Scale
50.0mV
/div
Position
−3.04 div
Offset
0 V

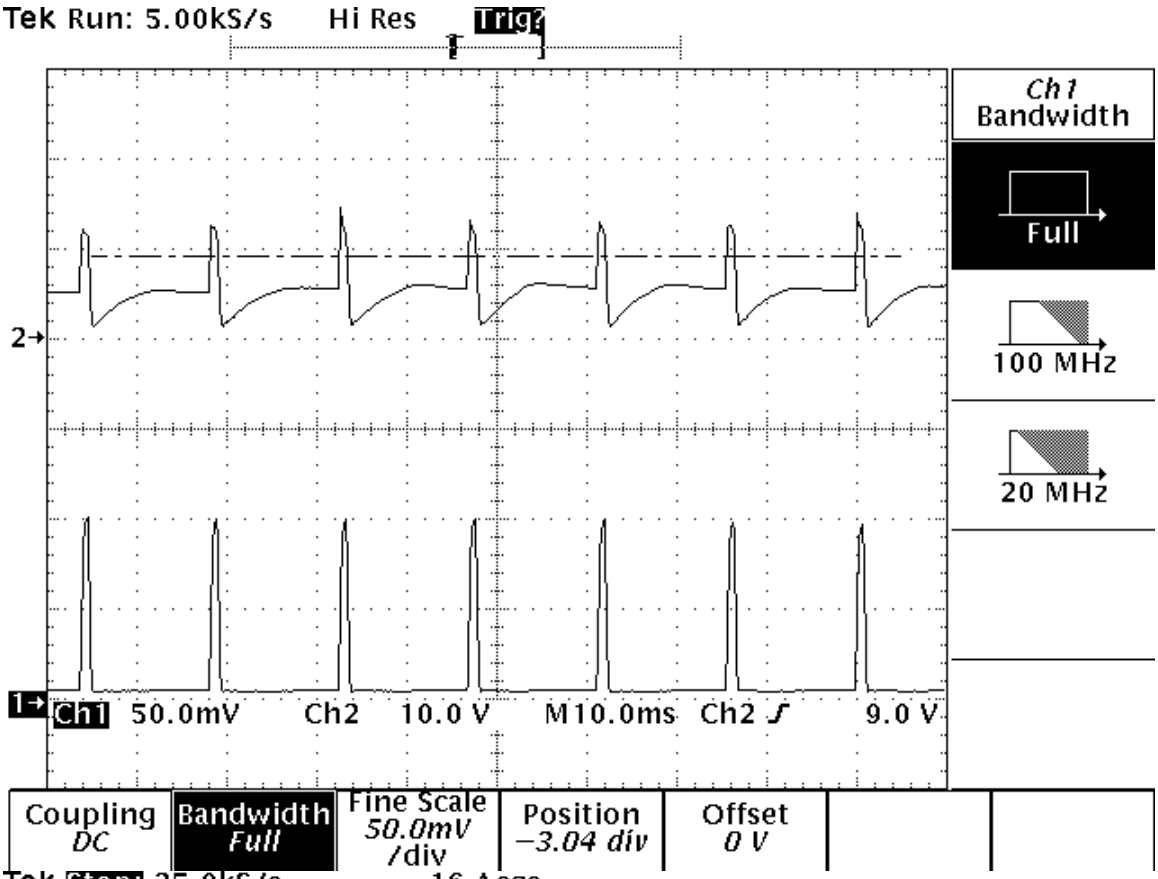

Tek Run: 25.0kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
2→
1→ Ch1 50.0mV Ch2 10.0 V M2.00ms Ch2 ƒ 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V

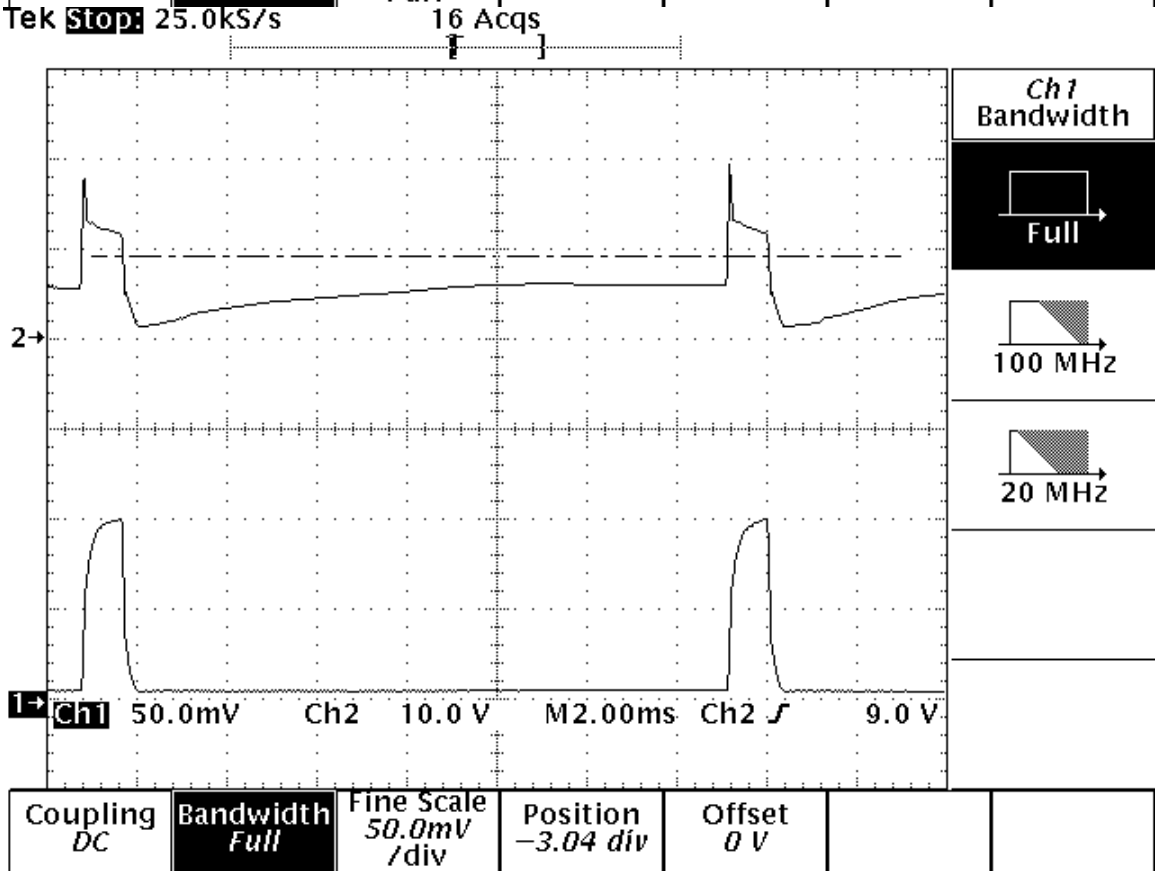

Tek Run: 25.0kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
2→
1→ Ch1 50.0mV Ch2 10.0 V M2.00ms Ch2 ƒ 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V

5.7. APPENDIX 7 – HIGH FREQUENCY OPERATION

CH1 -> FLASH LAMP CURRENT – 0-150A
Measured with 0,001R non-inductive shunt
CH2 -> 100V/DIV FLASH LAMP VOLTAGE

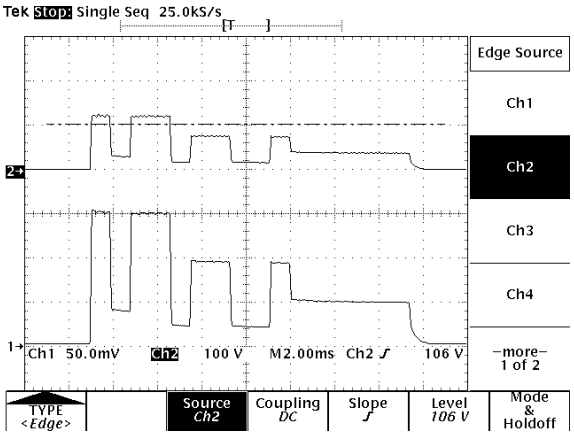


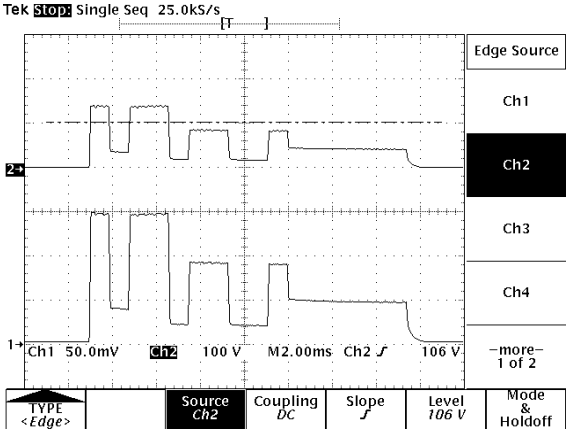

Tek Run: 5.00kS/s Hi Res Trig?
Ch1 Bandwidth
Full
100 MHz
20 MHz
2→
1→ Ch1 50.0mV Ch2 10.0 V M10.0ms Ch2 ƒ 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V

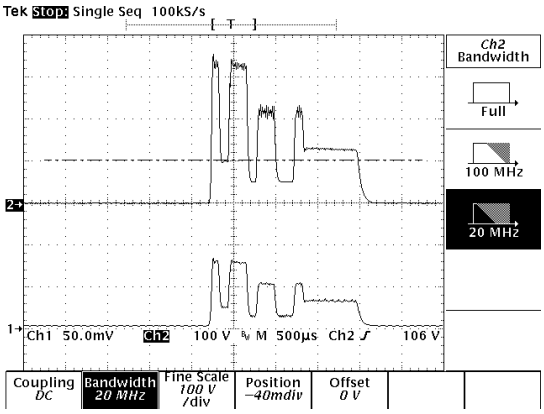

Tek Stop: 25.0kS/s 16 Acqs
Ch1 Bandwidth
Full
100 MHz
20 MHz
2→
1→ Ch1 50.0mV Ch2 10.0 V M2.00ms Ch2 ƒ 9.0 V
Coupling DC
Bandwidth Full
Fine Scale 50.0mV /div
Position −3.04 div
Offset 0 V

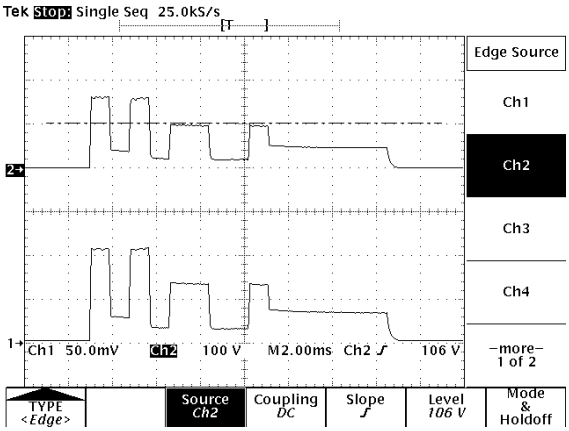
6 LATEST MODIFICATIONS AND UPGRADES

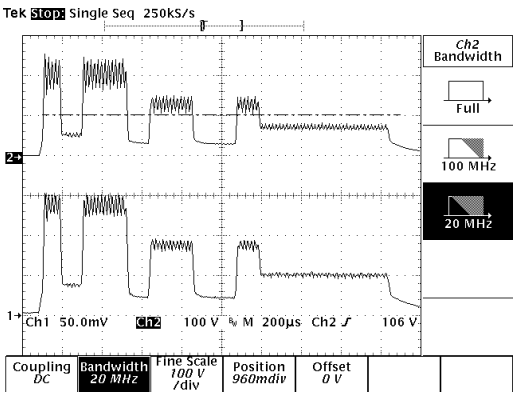
Dynamic performances of the device enable the operation on higher frequencies and sleewrate of flash current. In this way, the output current can be shaped to any form desired within the limits described in this chapter. During the flash cycle, the current is divided into several segments, each with its own duration and intensity. The graphs shown below are waveforms of flash current with the same form, but proportionally different total and individual duration times. It is obvious that current may grow from 0 to 150A in 10µs. That means that the maximum frequency of light radiation may exceed 20kHz with full current fluctuation. The software and hardware enabling such operation is under testing, and will be available in April 2005.

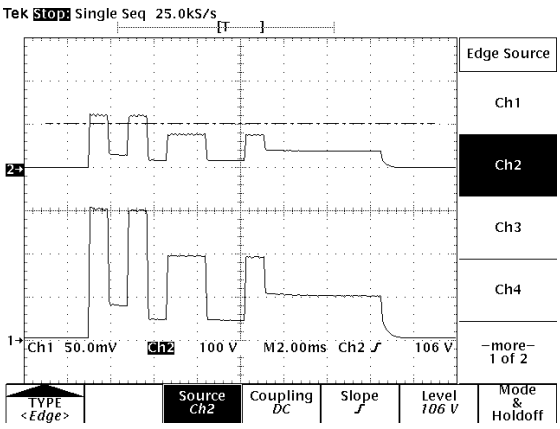






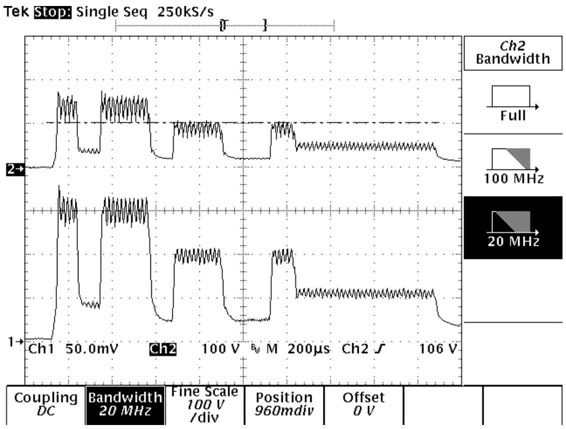


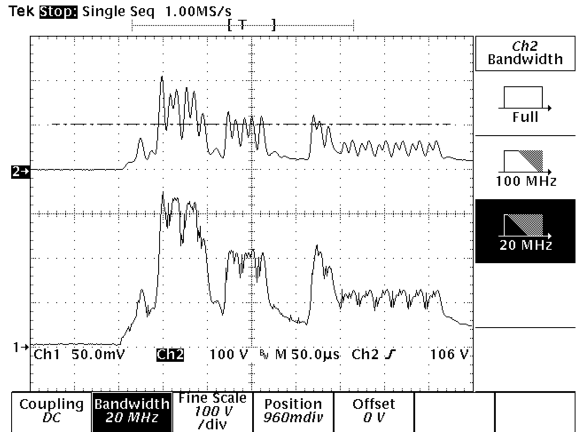


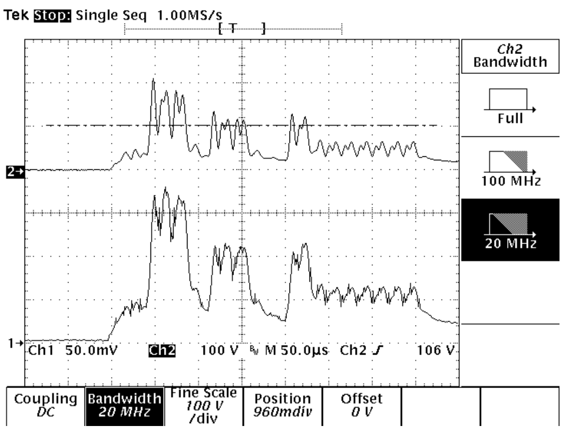


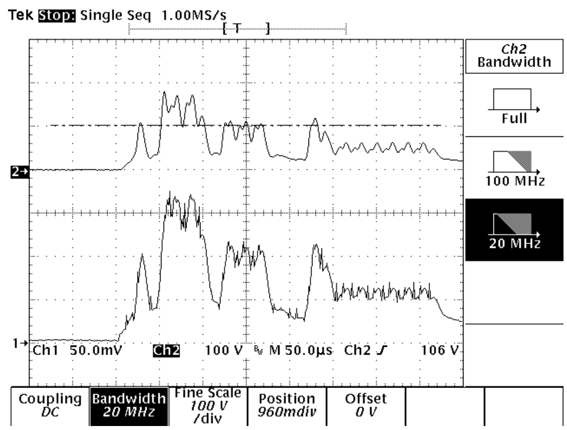
Time base - 200us/2ms
Ch1 - 50A/div; (measured with 0.001R non-inductive shunt)
Lamp current - 0 to 150A
Ch2 - 100V/div
Lamp voltage - 0 to 400V

Output current waveform is predefined by processor.









Time base - 50us/200us
Ch1 - 50A/div; (measured with 0.001R non-inductive shunt)
Lamp current - 0 to 150A
Ch2 - 100V/div
Lamp voltage - 0 to 400V

Output current waveform is predefined by processor.