ON Semiconductor®

NCP1602/22 SAFETY TESTS

Pin2Pin shorting + Pin Opening + Bypass Diode Shorting

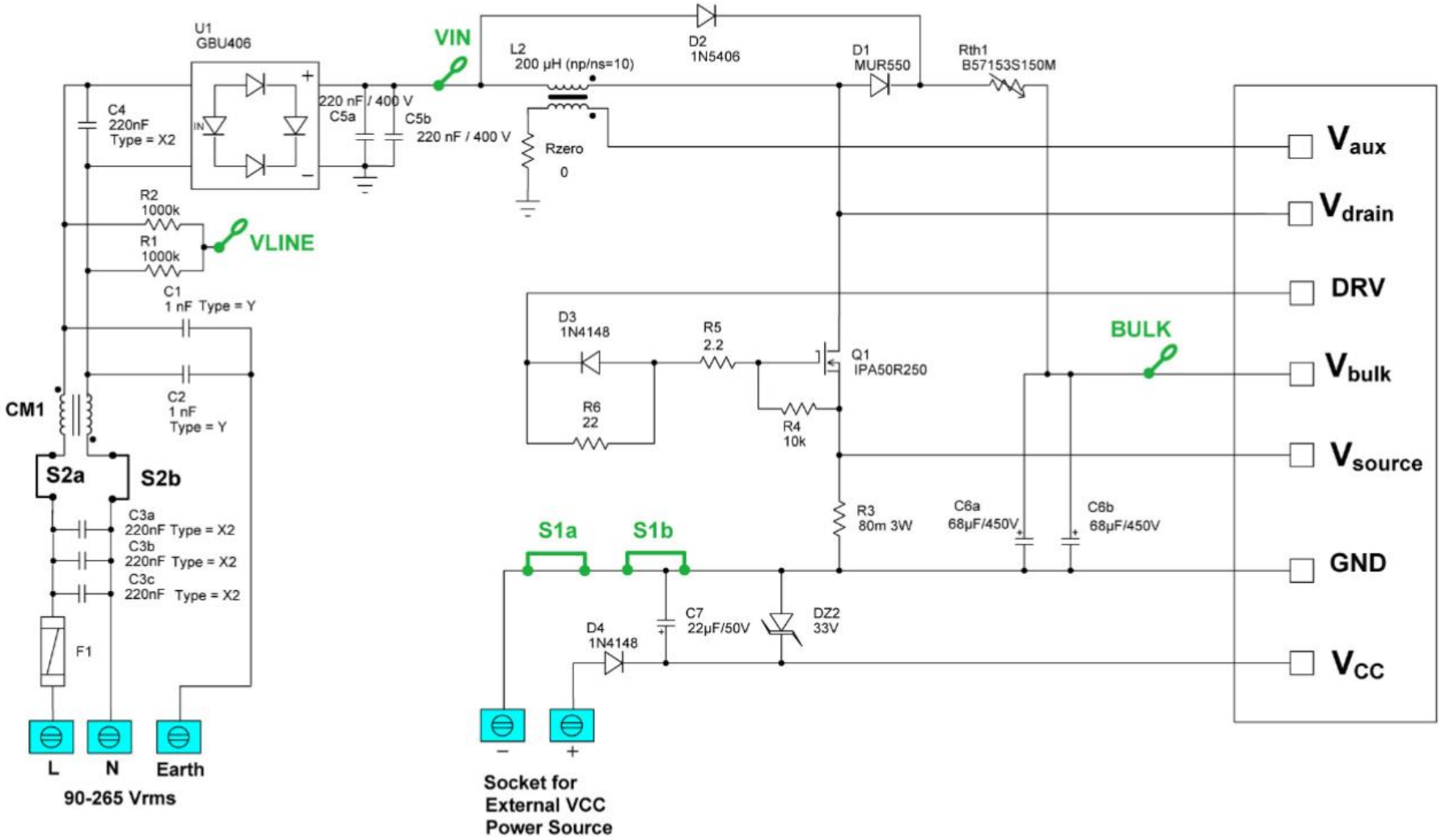
Foreword

This document covers the « Safety Test » for both NCP1602 and NCP1622.
The fact that the measurements have been performed on the NCP1602 applies also for the NCP1622 as the NCP1622 is a spin-out of the NCP1602 and has the same pin-out & layout , the difference being in some internal system parameters having different values.

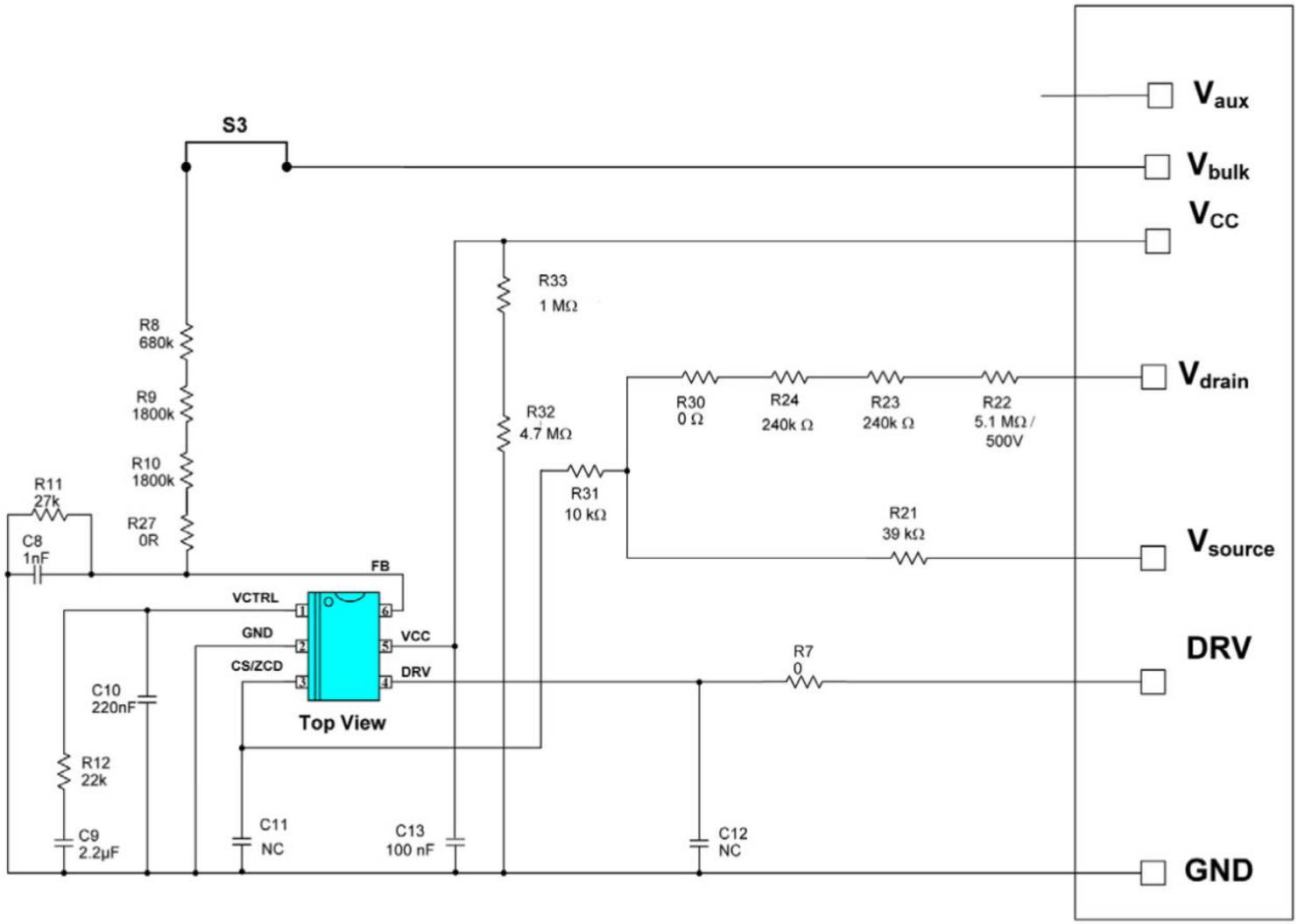
Pin to Pin Short Testing Conditions

- NCP1602-AEC on Standard Evaluation Board (Power MOSFET drain voltage used for ZCD)
- $V_{CC,board}$ = 15 V w/ 50mA current clamp
- V_{mains} = 115 V , F_{mains} = 60 Hz, I_{LIM}=5.5 A_{rms}
- V_{bulk} = 395V , I_{load} = 0.4 A
- Application is turned-on and after steady state is reached a pin-x to pin-y short is applied and controller behaviour is observed

Evaluation Board Schematic (Power)

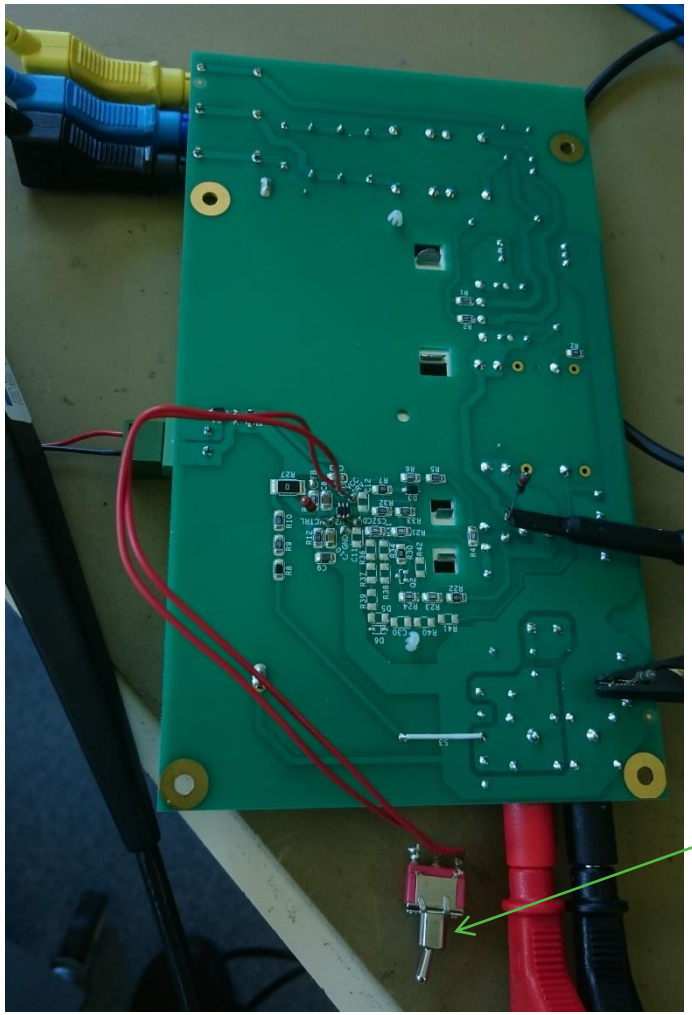


Evaluation Board Schematic (Control)



Pin to Pin SHORT Tests

NCP1602 EVB Under Pin2Pin Short Test



The Evaluation Board used is the standard one (available trough www.onsemi.com) , and two wires are soldered to the pins to be shorted and to a manual switch.

This switch does the pin to pin short

15 Pin to Pin short tests to be done

	VCTRL pin1	GND pin2	CSZCD pin3	DRV pin4	VCC pin5	FB pin6
VCTRL pin1		X	X	X	X	X
GND pin2			X	X	X	X
CSZCD pin3				X	X	X
DRV pin4					X	X
VCC pin5						X
FB pin6						

Pin to Pin Short test Result

Pin-x to Pin-y Short	Application Behaviour	Smoke or Flame ?
GND - VCTRL	Shorting VCTRL pin to GND discharges the VCTRL pin voltage to 0V. The controller being designed such as when VCTRL voltage goes under 0.5V (Static OVP threshold) the DRV pin is disabled (no switching) and controller is shut down when VCTRL reaches a few tenths of mV (VCTRL,dis) . No more current is sent to the bulk capacitor by the boost which is discharged by the load current. down to Vmains*sqrt(2)	NO
GND - CSZCD	When CSZCD pin is shorted to GND, the ZCD comparator can not be triggered to indicate the end of inductor demagnetization, an internal 200-µs watchdog timer initiates the next drive pulse. At the end of this delay, the circuit senses the CS/ZCD pin impedance to detect a possible grounding of this pin (which is the case) and prevent operation by stopping the switching.	NO
GND - DRV	When DRV pin is shorted to GND, within one switching cycle drain stops switching, Rsense current is zero so CSZCD pin voltage becomes a constant voltage which results in ZCD not triggering . An internal 200-µs watchdog timer initiates the next drive pulse, which is not seen by the gate of the power mosfet, but as the demag (ZCD) does not work, the 200-us watchdog timer continues to try staring a new cycle witout success. The DRV driver does not consume significant current from VCC because it is only a on-time each 200us.The controller constantly starts the 200-us watchdog timer initiates the next drive pulse which is not seen at the DRV pin because the pin is shorted to GND	NO
GND - FB	UVP protection stops the controller because FB pin shorted to GND goes under the UVP threshold as a concequence the controller is shut down (no more switching)	NO
VCTRL - CSZCD	Because of « the short » impedance, it is a constant VCTRL voltage which is forced into the CSZCD pin. The ZCD pin not seeing a scaled down Power MOSFET drain voltage and Rsense*Iind during ontime can not work normally. OVS is triggered resulting in 800us timer triggerred (no DRV during 800us) This results in not enough power sent to bulk capacitance which in turns increases VCTRL voltage and OVS and/or OVP2 continue to be triggered are triggered by high CSZCD voltage which results in DRV trying to restart every 800us.	NO

Pin to Pin Short test Result Cont'd

Pin-x to Pin-y Short	Application Behaviour	Smoke or Flame ?
DRV - VCTRL	As soon as the short is applied beween VCTRL Pin and DRV pin, the DRV driver wins over the OTA and pulls down the VCTRL pin to zero volts which results in both disabling the switching because VCTRL voltage is pulled under static OVP threshold (0.5V) and disabling the controller because VCTRL falls under VCTRL,dis (few tenths of mV disable threshold).The controller beeing disabled, DRV stops switching and VCTRL voltage stays at 0 volts.	NO
DRV - CSZCD	As soon as the short is applied beween CSZCD Pin and DRV pin, the DRV driver wins over the CSZCD resistor divider and pulls up the CSZCD pin above OVS threshold which disables the DRV activity during 800us . When the new on-time cycle retarts , there is no ZCD posible detection, the CS pin impedance is tested , seen as a short and DRV is disabled as a consequence, the controller stops switching.	NO
DRV - FB	The low ouput impedance of the DRV pin pulls down the FB pin which voltage goes under the UVP threshold and the controller is disabled (swicthing is stoped)	NO
FB - VCTRL	The controller does not stop switching. The OTA forces VCTRL=2.5V so there is no more Vbulk voltage regulation. Depending on the load current, OVP2 protects the ouput volatge of the the PFC controller which can not be protected by OVP as the FB voltage is no more linked to output voltage because of the short. OVP2 protection works because overvoltage is sensed thru the CSZCD pin which is not affected by the short.	NO
FB - CSZCD	The CSZCD pin is pertubated by the short to the FB pin in such a way that OVS or OCP followed by no ZCD detection is constantly triggering. As the two faults are associated with DRV disabled during 800us before trying a new on-time, we doe see this on the Vdrain signal.The controller is not indeed shut down but small energy is sent to the output. There is a risk at low or zero load of the output voltage rising slowly because OVP2 protection is sending a small amount of energy to the output cap, and not being limited because OVP which is based on FB .	NO

Pin to Pin Short test Result Cont'd

Pin-x to Pin-y Short	Application Behaviour	Smoke or Flame ?
VCC - VCTRL	VCTRL internal is forced to its maximum value , breaks the regulation loop and forces maximum on-time. Icc=17mV is consumed from the external VCC supply by the VCTRL clamping circuitry (VCTRL,clamp=12.5V) OVS triggers and Vbulk rises to 406V. In case of low PFC load OVP protection will trigger and avoid the output volatge to go to high and blow-up the output capacitor.	NO
VCC - GND	50mA are drawn from external VCC (clamp current=50mA) and VCC goes down to 5.7V . Internal VCC going down to almost 0 Volts which is less than VCC,off and consequently the controller is turned off and circuit stops switching.	NO
VCC - CSZCD	Instead of varying like Vdarin volatge sacled down, the CSZCD voltage will be rised to a constant 12.5V which will be the clamp voltage of the pin. This high CSZCD voltage will cause permanent OCP/OVS/OVP2 condition. The controller stops because OCP causes STOP condition.	NO
VCC - DRV	DRV buffer works with a 12.5V internal supply. When VCC is applied to the DRV pin, the body diode of the pmos high side transistor of the DRV buffer is turned on and carries a current which goes up to the clamp current of the External VCC supply (50mA) . The external and internal VCC drop as the consequence of the supply clamp current reached and the internal VCC falling under VCC,on disables the controller and the switching activity stops. With higher VCC current clamp it is very likely the DRV driver will blow-up	NO
VCC – FB	FB goes from 2.5 V to 12.66V this FB level is much higher and all the time greater than fast OVP threshold and fast OVP cause a STOP condition in the controller internal logic. So the controller stops switching .	NO

Protections Triggering during Pin to Pin Short

Short Test	Stops Switching	VCTRL Static OVP	VCTRL dis	VCC,off	UVP	OCP plus No ZCD	CS short	OVP	OVS	OVP2	VCC/ICC/VCC pin
GND-VCTRL	YES	YES	YES								NTR
GND-CSZCD	YES						YES				NTR
GND-DRV (2)	YES										No extra Icc
GND-FB	YES				YES						NTR
VCTRL-CSZCD	**NO**								YES	YES	NTR
DRV-VCTRL	YES	YES	YES								NTR
DRV-CSZCD	YES					YES	YES		YES	YES	NTR
DRV-FB	YES				YES						NTR
FB-VCTRL	**NO**									YES	NTR
FB-CSZCD	**NO**					YES			YES		NTR
VCC-VCTRL	**NO**							YES(1)	YES		15V/17mA/12.5V
VCC-GND	YES			YES							5.7V/50mA/0V
VCC-CSZCD	YES					YES					15V/15mA/12.6V
VCC-DRV	YES			YES							15V/50mA/9.1V
VCC-FB	YES							YES			15V/16mA/12.7V

(1) In case of low PFC load

(2) The circuit tries to start each 200us and the DRV signal shorted to ground stops the « external switching)

Pin to Pin Short Results Summary:

All test passed

	VCTRL pin1	GND pin2	CSZCD pin3	DRV pin4	VCC pin5	FB pin6
VCTRL pin1		✓	✓	✓	✓	✓
GND pin2			✓	✓	✓	✓
CSZCD pin3				✓	✓	(2) ✓
DRV pin4					(1) ✓	✓
VCC pin5						✓
FB pin6						

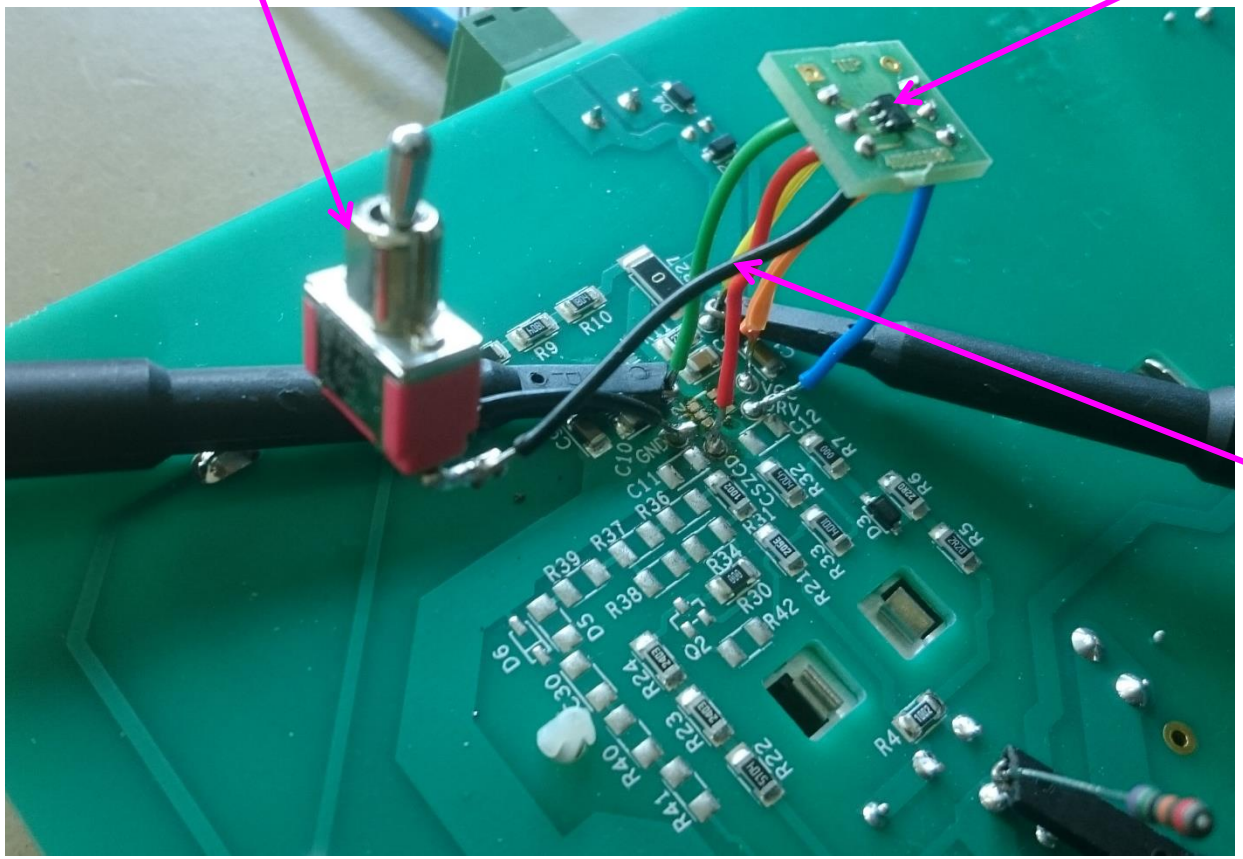
(1) Possible blow-up of the DRV driver if Icc goes above 50mA
(2) Possible output voltage to go above output capacitor destruction voltage in case of very low PFC load

Open Pin SHORT Tests

NCP1602 EVB Under Pin Opening Test

A simple manual switch is used to connect the GND pin or to disconnect the GND pin (Open or floating pin)

The NCP1602 cannot be directly soldered onto the evaluation board and is sodered onto this TSOP-6 to DIL daughter board which is connected to the Evaluation Board by the colored wires.



Black wire is The IC GND

Pin Opening (Floating) Test Result

Pin-x Opening	Application Behaviour	Smoke or Flame ?
GND (2)	A cycle by cycle internal circuitry senses the impedance of GND pin and disables the DRV pin (stops the switching) in case GND pin is left open.	NO
FB (6)	If the FB pin is left open, an internal 200-nA current source pulls-down the FB pin voltage which falls under UVP threshold and disables the controller (switching stops)	NO
VCTRL (1)	If VCTRL pin is left open, there is no more compensation network and only the VCTRL to GND parasitic capacitor (approx 10pF) is left. The controller does not stop switching and performs a poor Vbulk regulation with large signal VCTRL voltage oscillation , vesukting in bad PF.	NO
VCC (5)	If VCC pin is left open, it is immediately dischaged under the $V_{cc,on}$ level and the controller is turned off (switching stops)	NO
DRV (4)	If DRV pin is left open, the power MOSFET gate is no more connected to the controller and the external gate to source resistor forces Vgs=0V (MOSFET is off) . As a consequence of the MOSFET beeing off, the swiching is stoped (not the switching of DRV pin) and Vbulk is discharged by the load current.	NO
CSZCD (3)	If CSZCD pin is left open, an internal circuitry senses this condition and disables the DRV pin (switching stops)	NO

Protections Triggering during Pin Opening (floating) Test

Opening Test	Stops Switching	Open GND Detection	CSZCD Open detection	VCTRL Static OVP	VCTRL dis	VCC,off	UVP	OCP plus No ZCD	CS short	OVP	OVS	OVP2
GND (2)	YES	YES			YES							
FB (6)	YES				YES		YES					
VCTRL (1)	NO											
VCC (5)	YES				YES	YES						
DRV (4)	YES											
CSZCD (3)	YES		YES									

Open Pin Test Results Summary:

All tests passed

Pin forced/left Open	Result
GND (2)	✓
FB (6)	✓
VCTRL (1)	✓
VCC (5)	✓
DRV (4)	✓
CSZCD (3)	✓

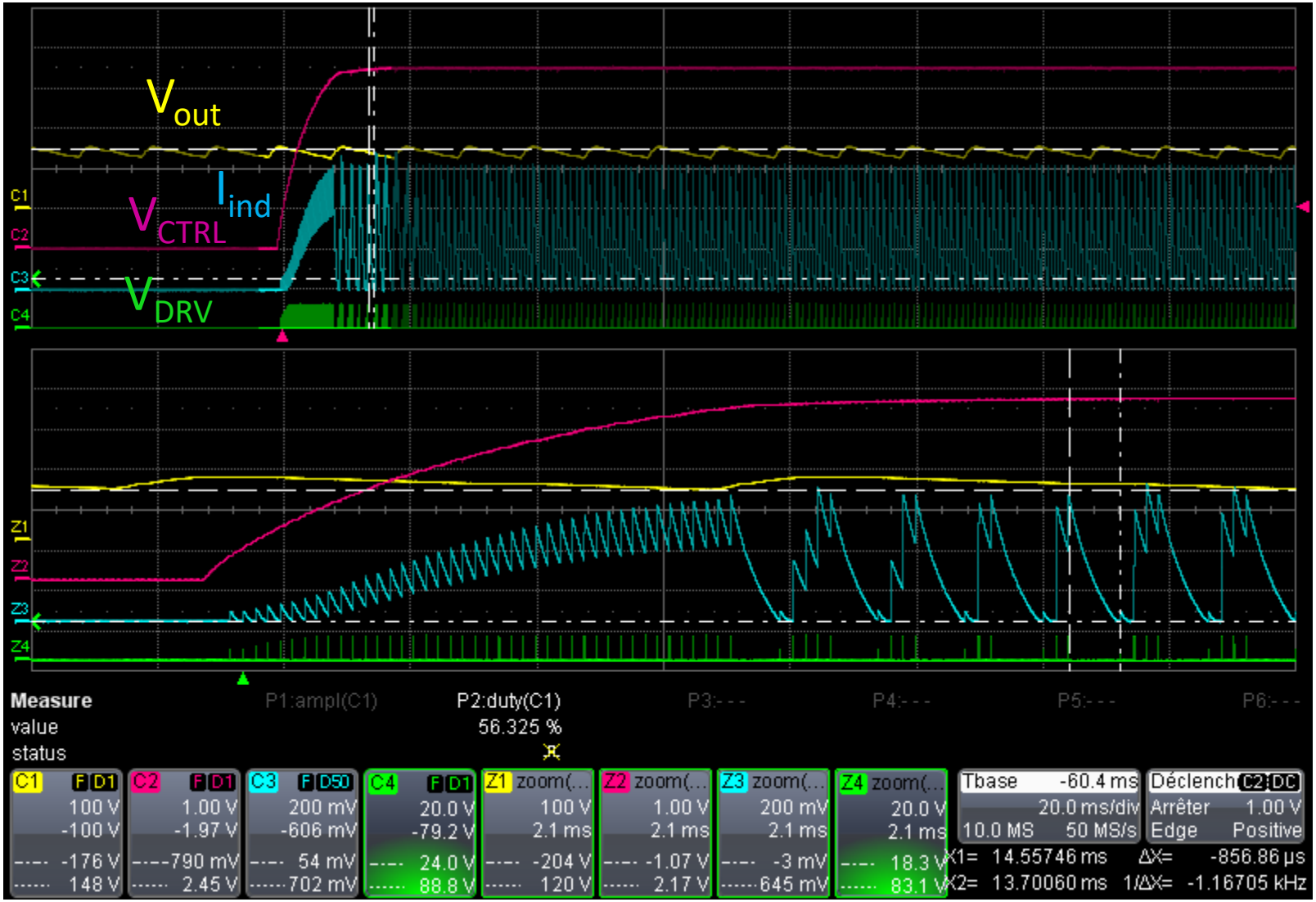
Bypass Diode SHORT Test

Bypass Diode Short Test

A simple manual switch like the one used to do the pin to pin shorting and pin opening is used to short (and un-short) the bypass diode D2 (see slide#3).
The short is either applied before starting the PFC application or from steady state.

V_{mains}=110V_{rms}, F_{mains}=60Hz, I_{load}=400mA

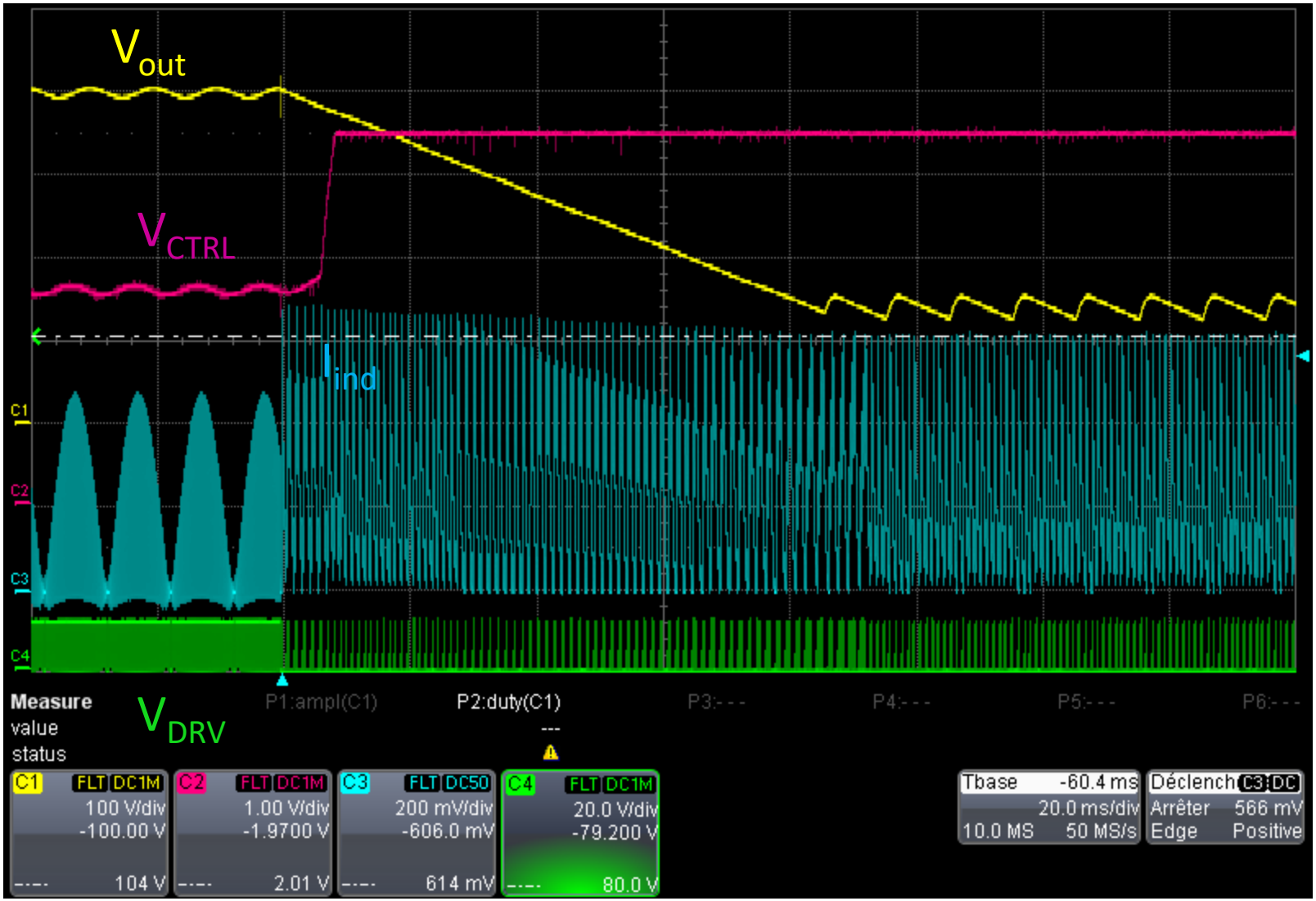
Bypass diode shorted & NTC shorted before startup



Inductor current is limited to OCP level by OVS system

V_{mains}=110V_{rms}, F_{mains}=60Hz, I_{load}=400mA

Bypass diode shorted during steady state



Bypass Diode Short Test Result

Bypass Diode Short	Application Behaviour	Smoke or Flame ?
D2 (see slide #3)	When bypass diode is shorted, the inductor current does not discharge during off-time, resulting in CCM conduction and rapid increase of the inductor current. An internal protection system, internal to the controller, disables the DRV signal during 800us when OCP is triggered and no demagnetization has been detected during the previous cycle or if OVS signal is triggered (50% higher threshold than OCP)	NO

Protections Triggering

Short Test	Stops Switching	Open GND Detection	CSZCD Open detection	VCTRL Static OVP	VCTRL dis	VCC,off	UVP	OCP plus No ZCD	CS short	OVP	OVS	OVP2
Bypass Diode	NO							YES				

Bypass Diode Short Test Result Summary:
Test passed

Shorted device	Result
Bypass Diode	✓

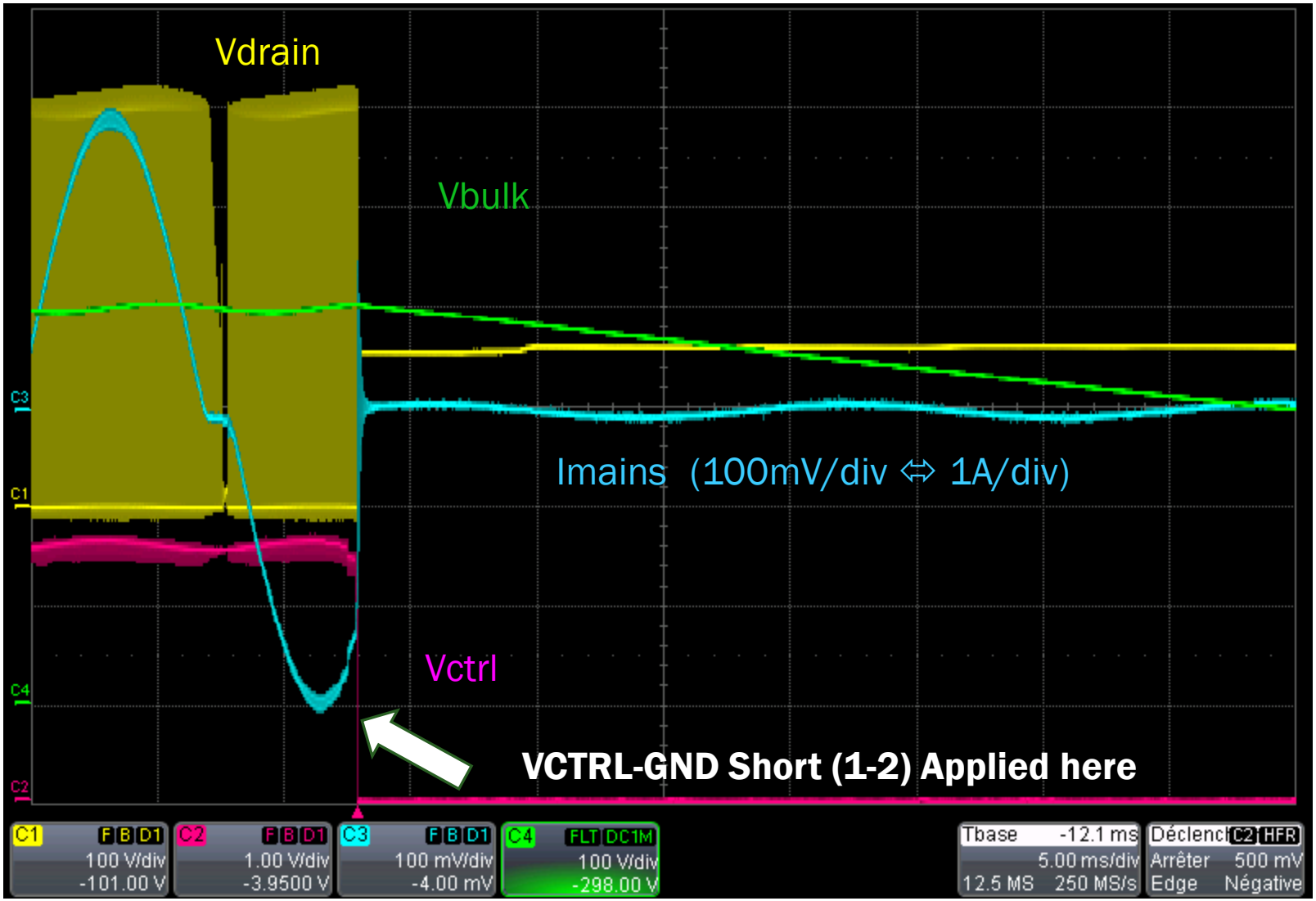
CONCLUSION & DISCLAIMER

- **All pin to pin possible short test , Open pin tests and Bypass Diode test passed OK** and for each test and the controller was able to re-start and regulate Vbulk when the short was removed.
- The short and open tests have been done from a steady state starting point, for a given Vmains and load current and with an external Vcc supply voltage set to 15V (20V for Open tests) with a 50mA clamp current
- These test conditions do not guaranty that other way of performing the test on another application board does not lead to short-test failure. It is the responsability of the customer to perform these short-test tests on his application board to guaranty that there will be no safety problems.

ANNEX

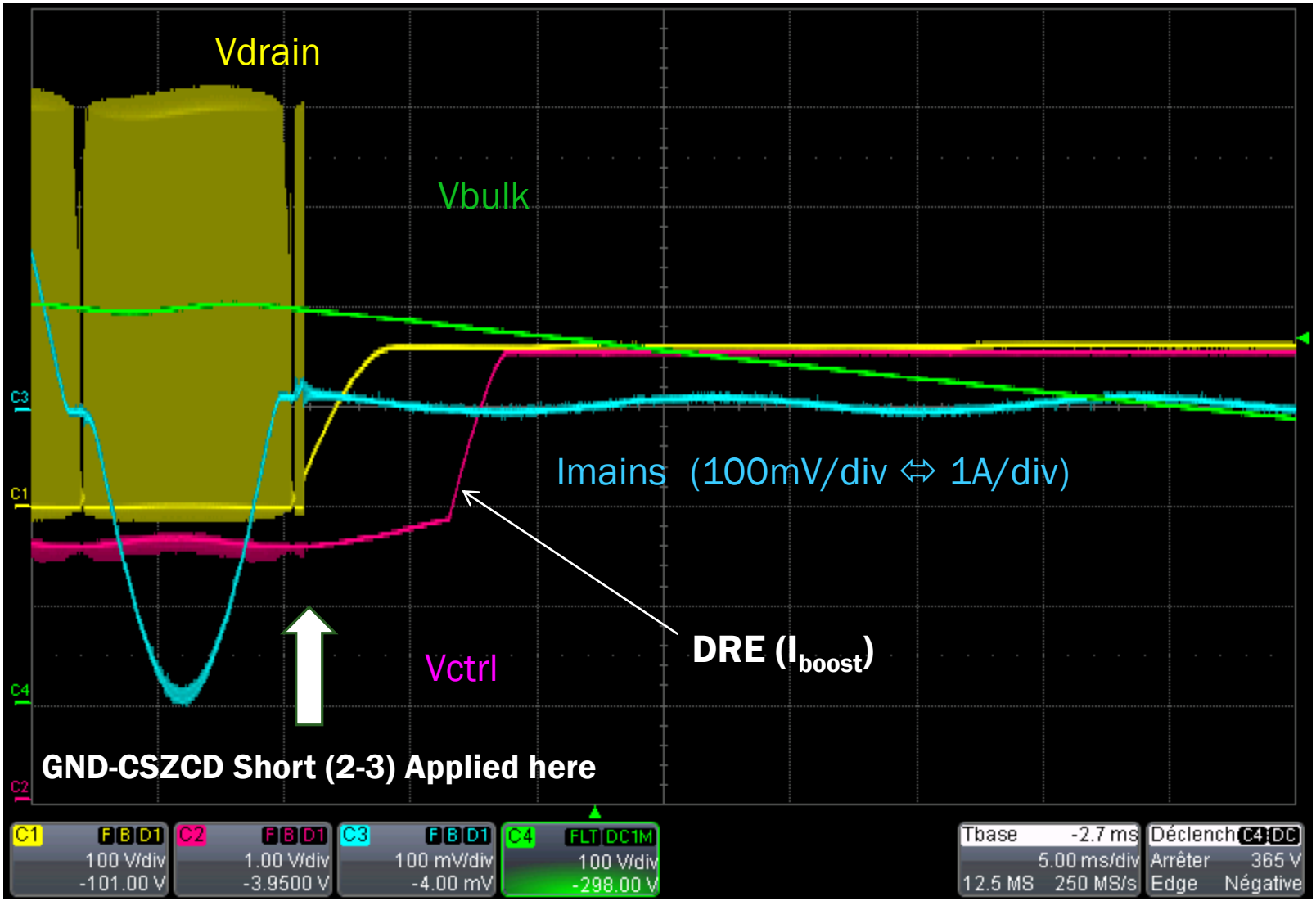
SCOPE SCREEN SHOTS FOR EACH PERFORMED TEST

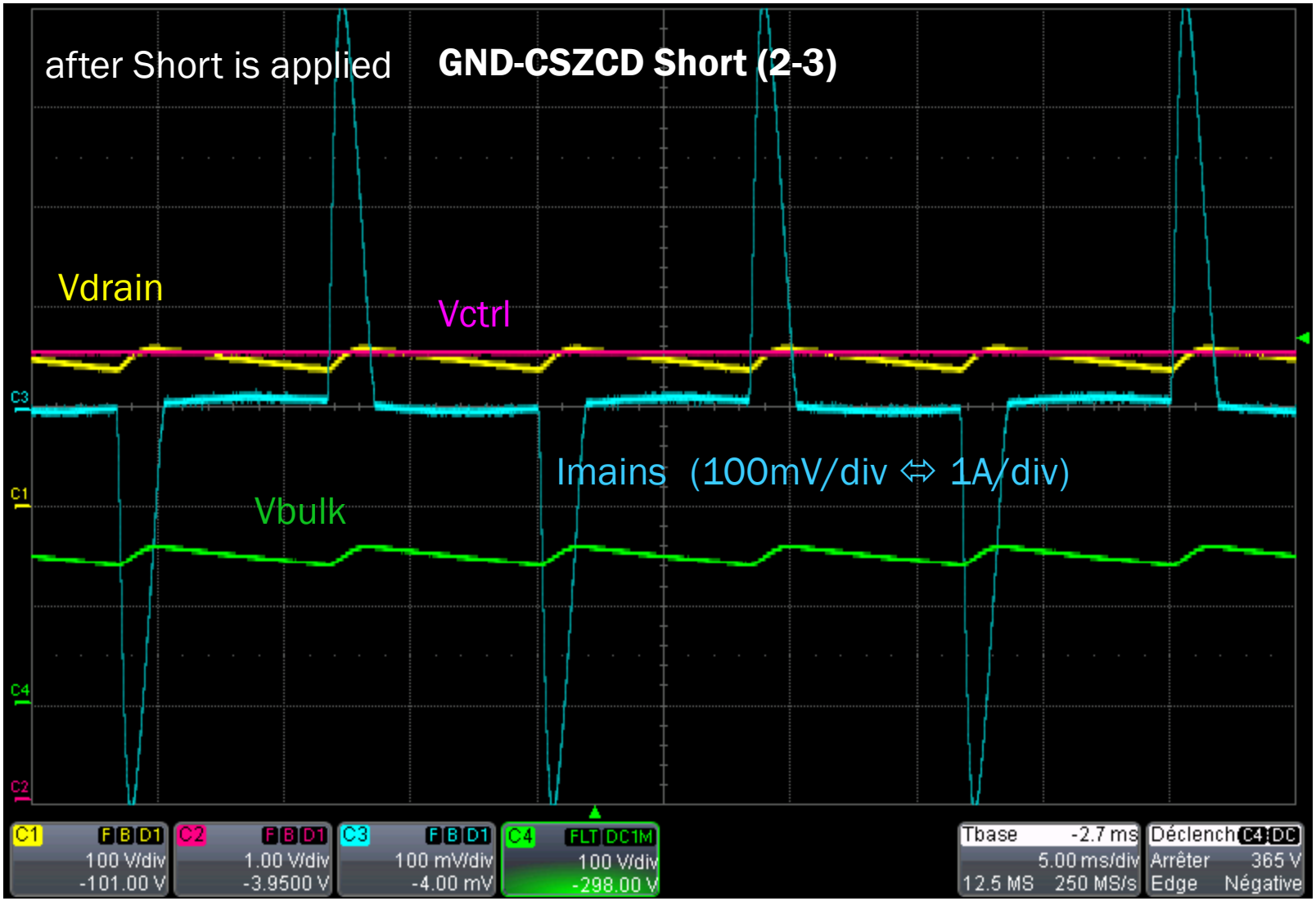
VCTRL-GND Short (1-2)


Vdrain
Vbulk
Imains (100mV/div ⇔ 1A/div)
Vctrl
VCTRL-GND Short (1-2) Applied here
C3
C1
C4
C2
C1 F B D1 100 V/div -101.00 V
C2 F B D1 1.00 V/div -3.9500 V
C3 F B D1 100 mV/div -4.00 mV
C4 FLT DC1M 100 V/div -298.00 V
Tbase -12.1 ms 5.00 ms/div 12.5 MS 250 MS/s
Déclenc C2 HFR Arrêter 500 mV Edge Négative

GND-CSZCD Short (2-3)

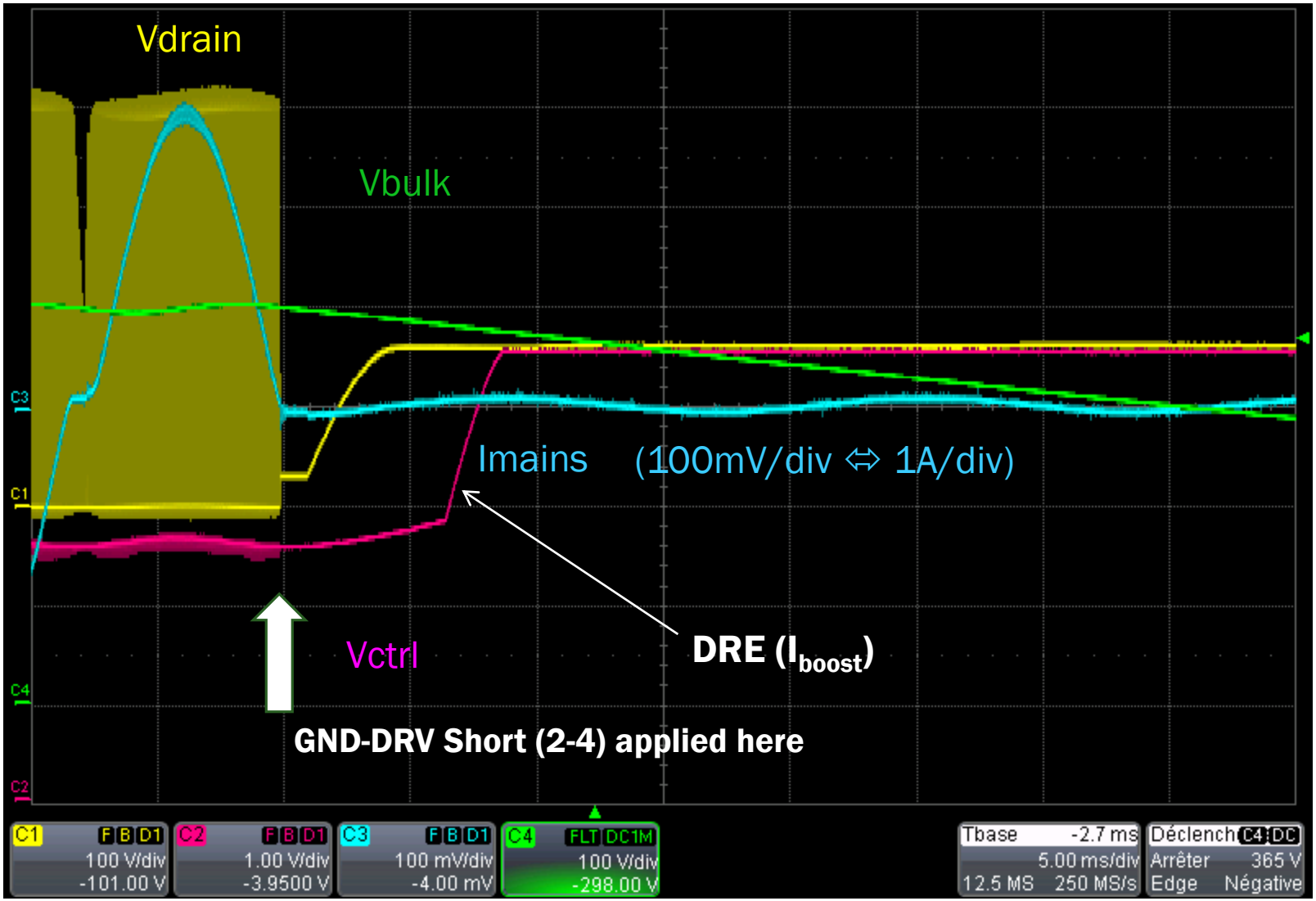
When Short is applied



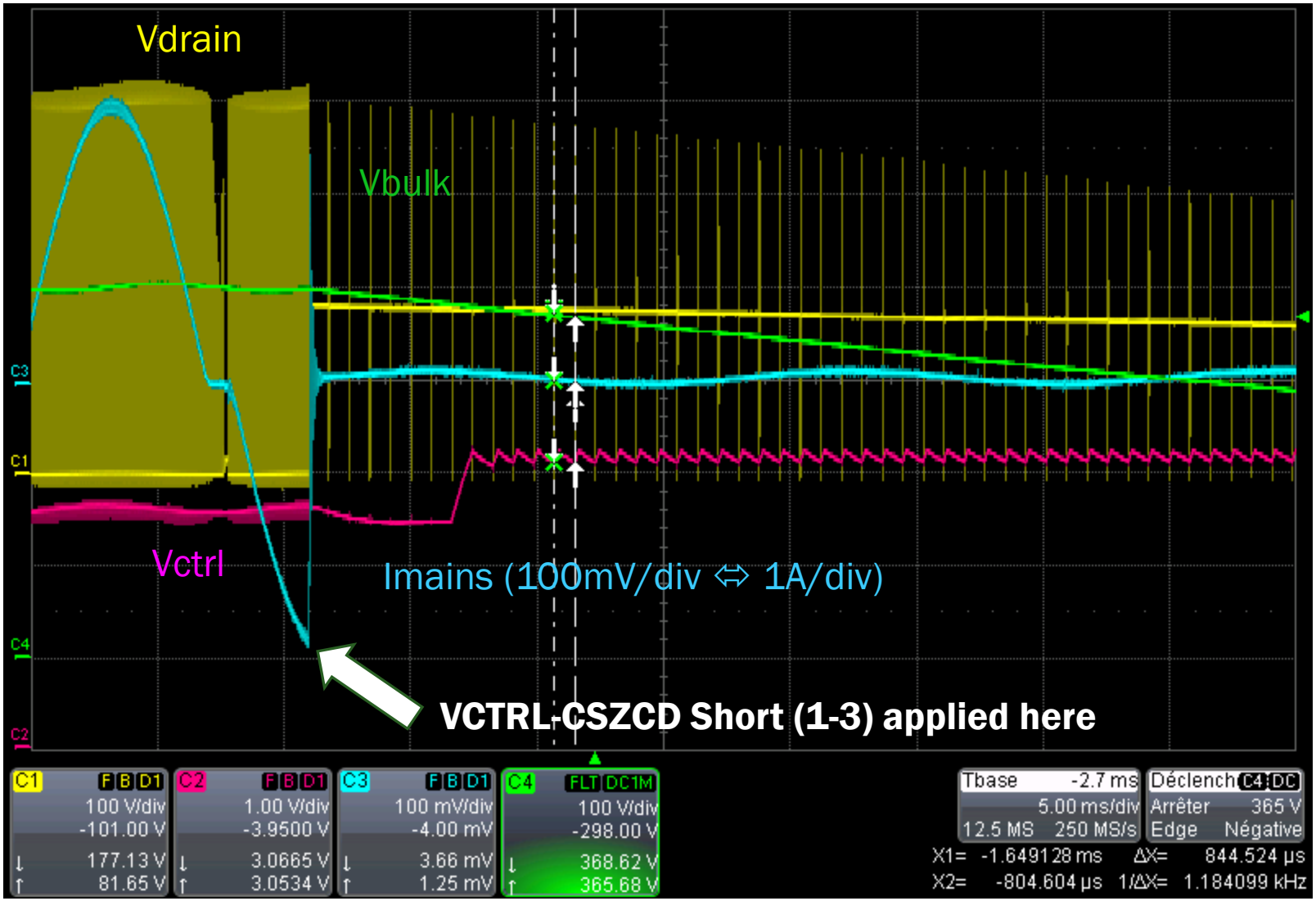

after Short is applied
GND-CSZCD Short (2-3)
Vdrain
Vctrl
Imains (100mV/div ⇔ 1A/div)
Vbulk
C3
C1
C4
C2
C1 F B D1 100 V/div -101.00 V
C2 F B D1 1.00 V/div -3.9500 V
C3 F B D1 100 mV/div -4.00 mV
C4 FLT DC1M 100 V/div -298.00 V
Tbase -2.7 ms
5.00 ms/div
12.5 MS 250 MS/s
Déclench C4 DC
Arrêter 365 V
Edge Négative

GND-DRV Short (2-4)

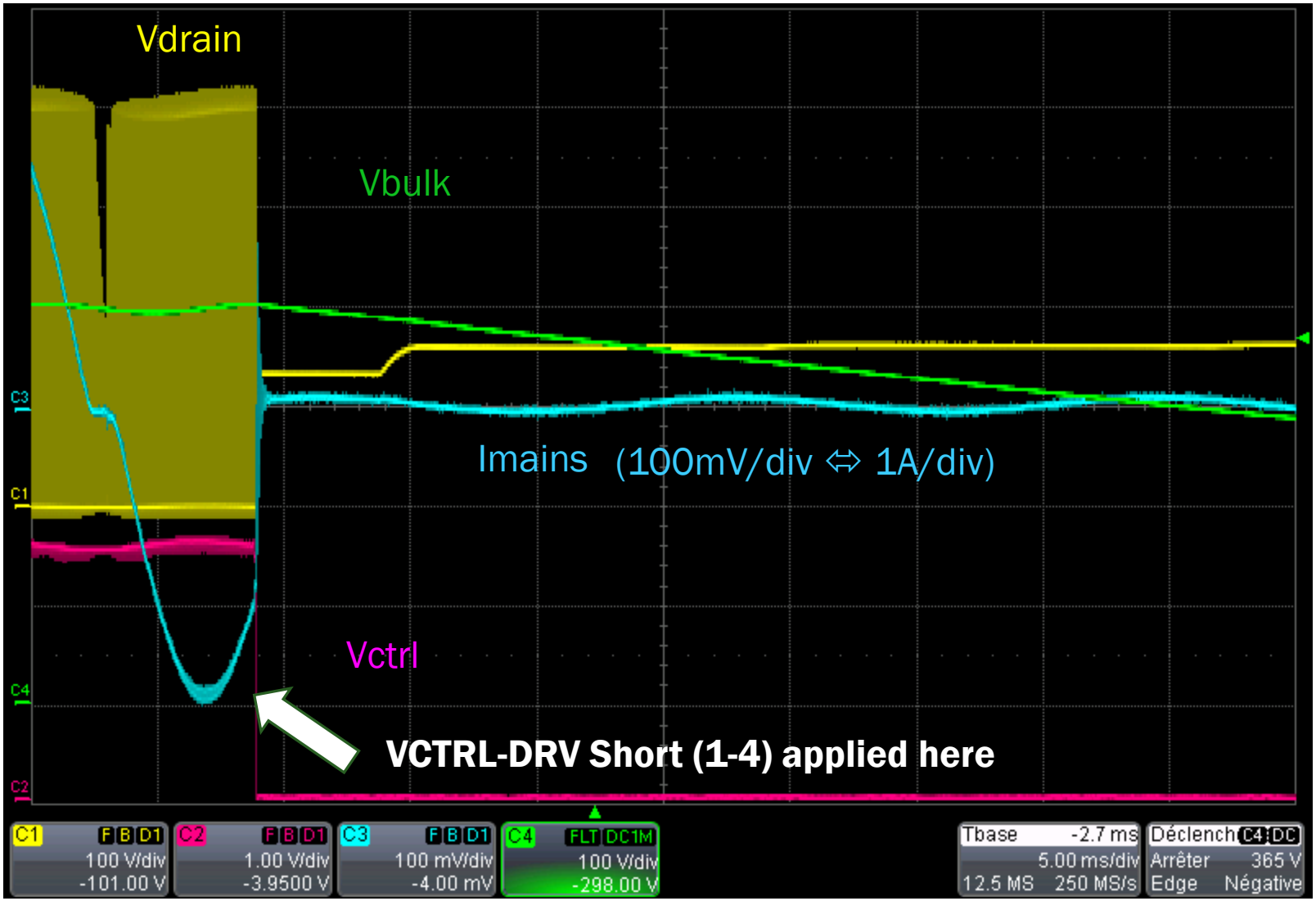
Vcc does not consume extra current



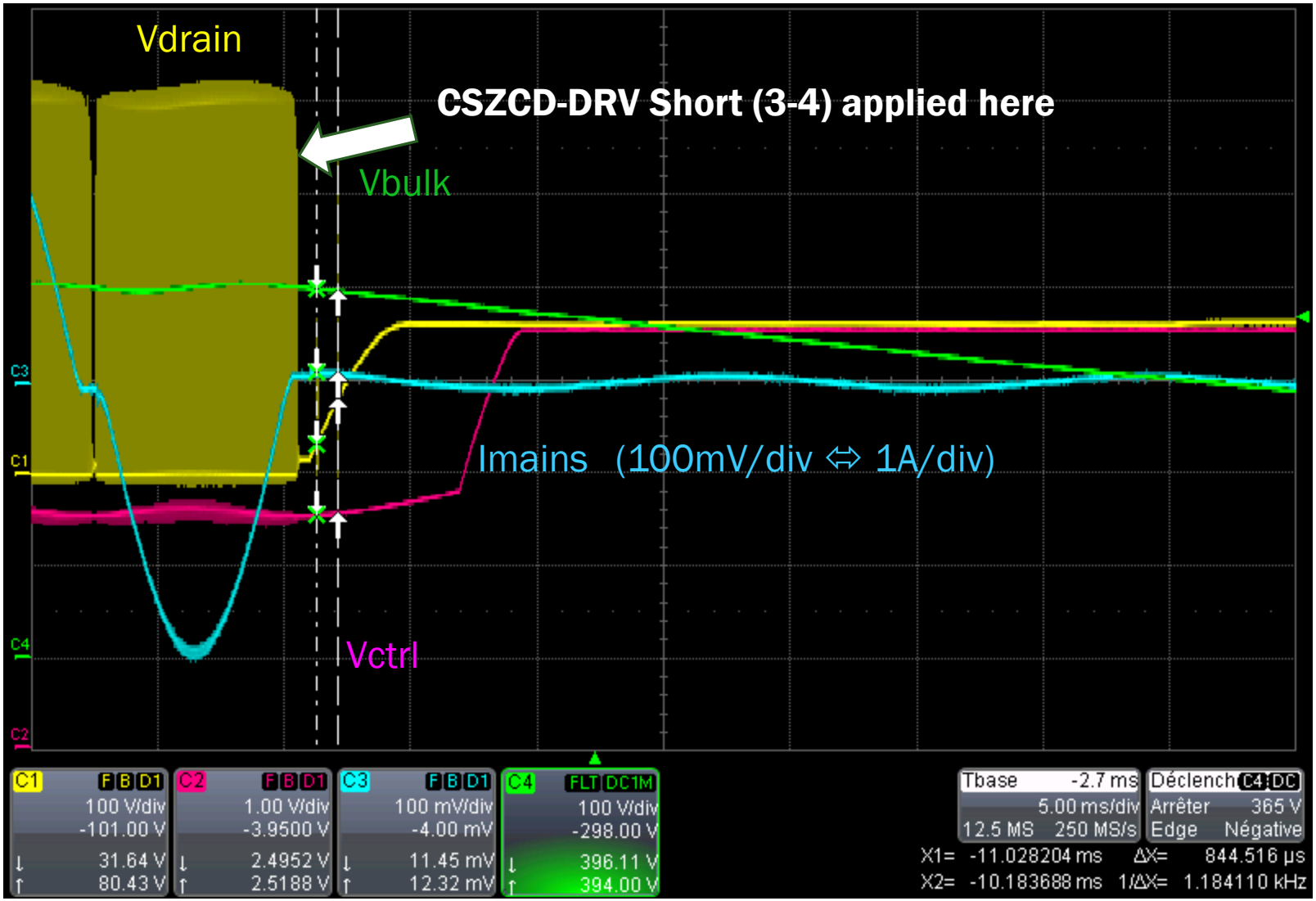
VCTRL-CSZCD Short (1-3)


Vdrain
Vbulk
Vctrl
Imains (100mV/div ⇔ 1A/div)
VCTRL-CSZCD Short (1-3) applied here
C1 F B D1
100 V/div
-101.00 V
177.13 V
81.65 V
C2 F B D1
1.00 V/div
-3.9500 V
3.0665 V
3.0534 V
C3 F B D1
100 mV/div
-4.00 mV
3.66 mV
1.25 mV
C4 FLT DC1M
100 V/div
-298.00 V
368.62 V
365.68 V
Tbase -2.7 ms
5.00 ms/div
12.5 MS 250 MS/s
Déclench C4 DC
Arrêter 365 V
Edge Négative
X1= -1.649128 ms ΔX= 844.524 µs
X2= -804.604 µs 1/ΔX= 1.184099 kHz

VCTRL-DRV Short (1-4)

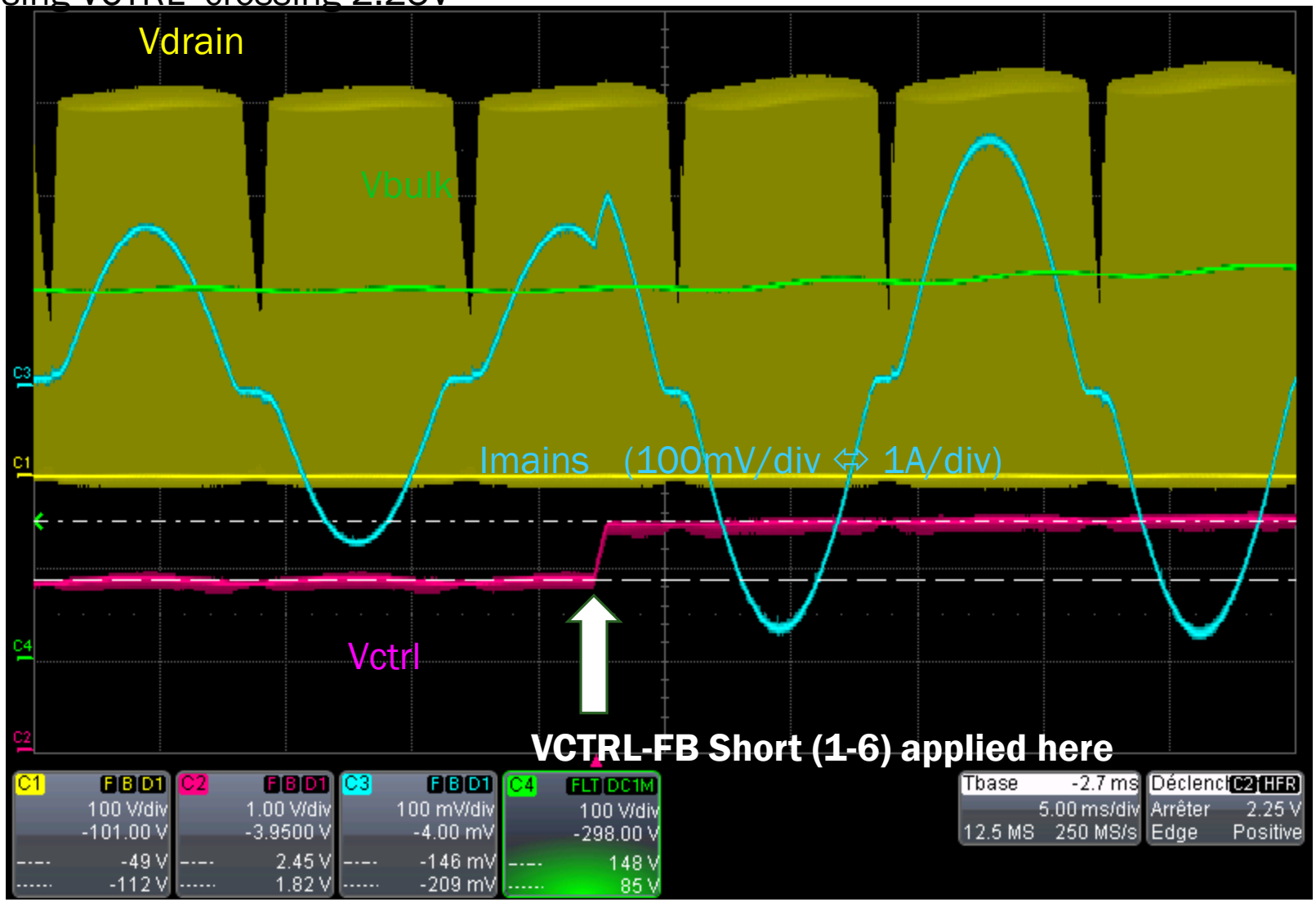

Vdrain
Vbulk
Imains (100mV/div ⇔ 1A/div)
Vctrl
VCTRL-DRV Short (1-4) applied here
C3
C1
C4
C2
C1 F B D1 100 V/div -101.00 V
C2 F B D1 1.00 V/div -3.9500 V
C3 F B D1 100 mV/div -4.00 mV
C4 FLT DC1M 100 V/div -298.00 V
Tbase -2.7 ms 5.00 ms/div 12.5 MS 250 MS/s
Déclench C4 DC Arrêter 365 V Edge Négative

CSZCD-DRV Short (3-4)

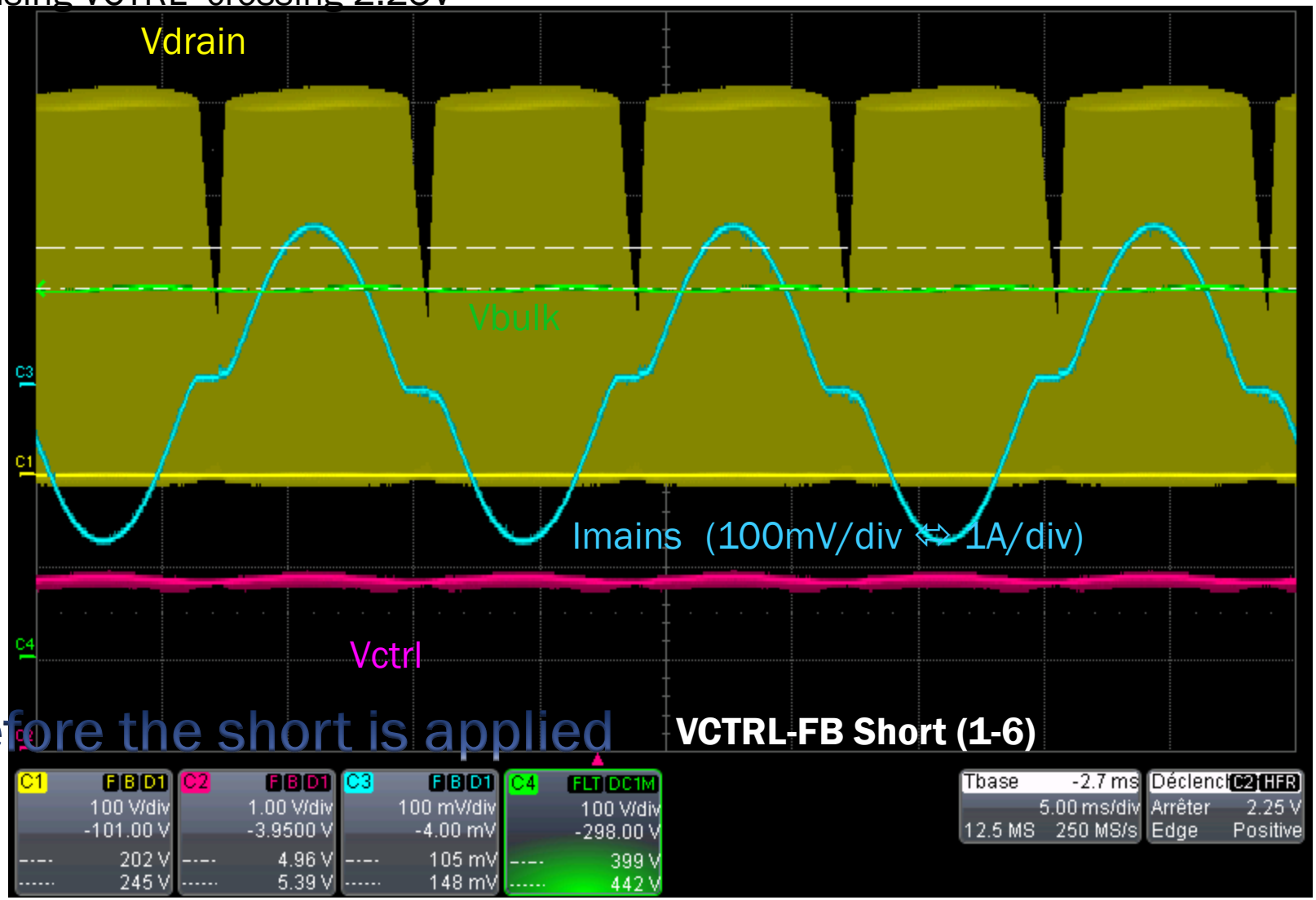

Vdrain
CSZCD-DRV Short (3-4) applied here
Vbulk
Imains (100mV/div ⇔ 1A/div)
Vctrl
C3
C1
C4
C2
C1 F B D1
100 V/div
-101.00 V
31.64 V
80.43 V
C2 F B D1
1.00 V/div
-3.9500 V
2.4952 V
2.5188 V
C3 F B D1
100 mV/div
-4.00 mV
11.45 mV
12.32 mV
C4 FLT DC1M
100 V/div
-298.00 V
396.11 V
394.00 V
Tbase -2.7 ms
5.00 ms/div
12.5 MS 250 MS/s
Déclench C4 DC
Arrêter 365 V
Edge Négative
X1= -11.028204 ms ΔX= 844.516 µs
X2= -10.183688 ms 1/ΔX= 1.184110 kHz

VCTRL-FB Short (1-6)

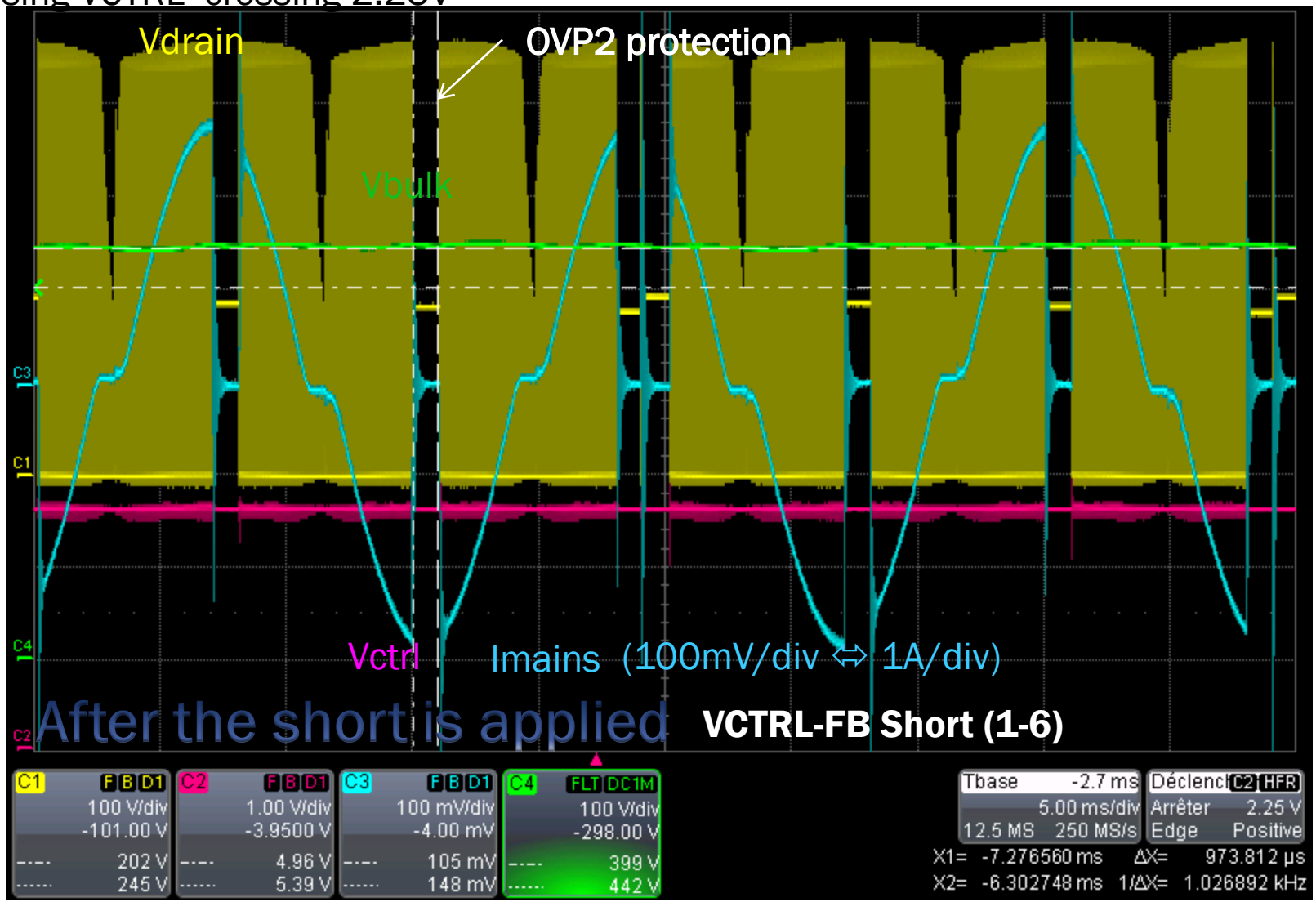
The short cause VCTRL=2.5V which is too close to initial VCTRL.
Iload is decreased (0.4A => 0.22A) to have a starting VCTRL =1.8V lower han 2.5V and tr
Rising VCTRL crossing 2.25V



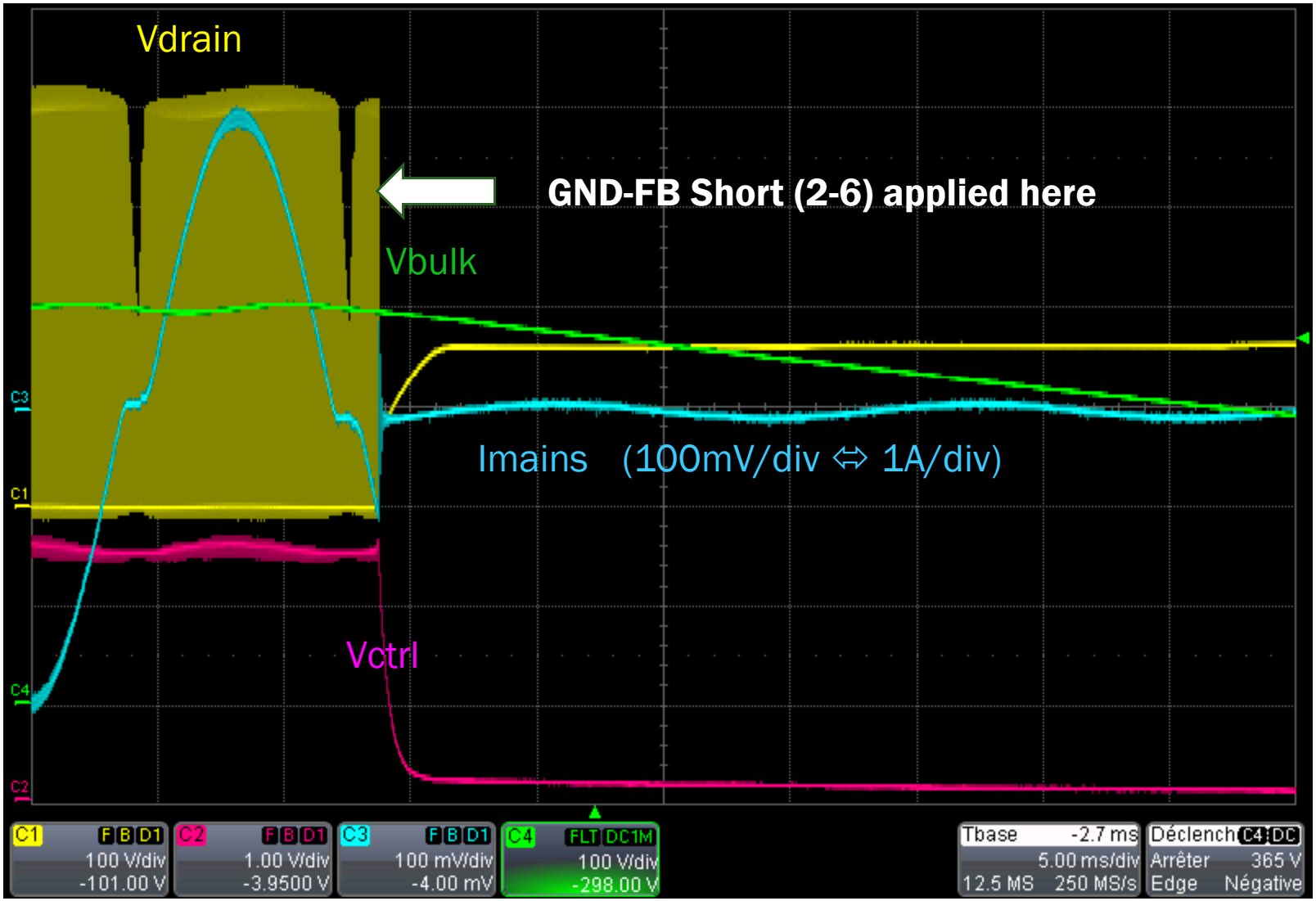
The short cause VCTRL=2.5V which is too close to initial VCTRL.
Iload is decreased (0.4A => 0.22A) to have a starting VCTRL =1.8V lower han 2.5V and tr
Rising VCTRL crossing 2.25V



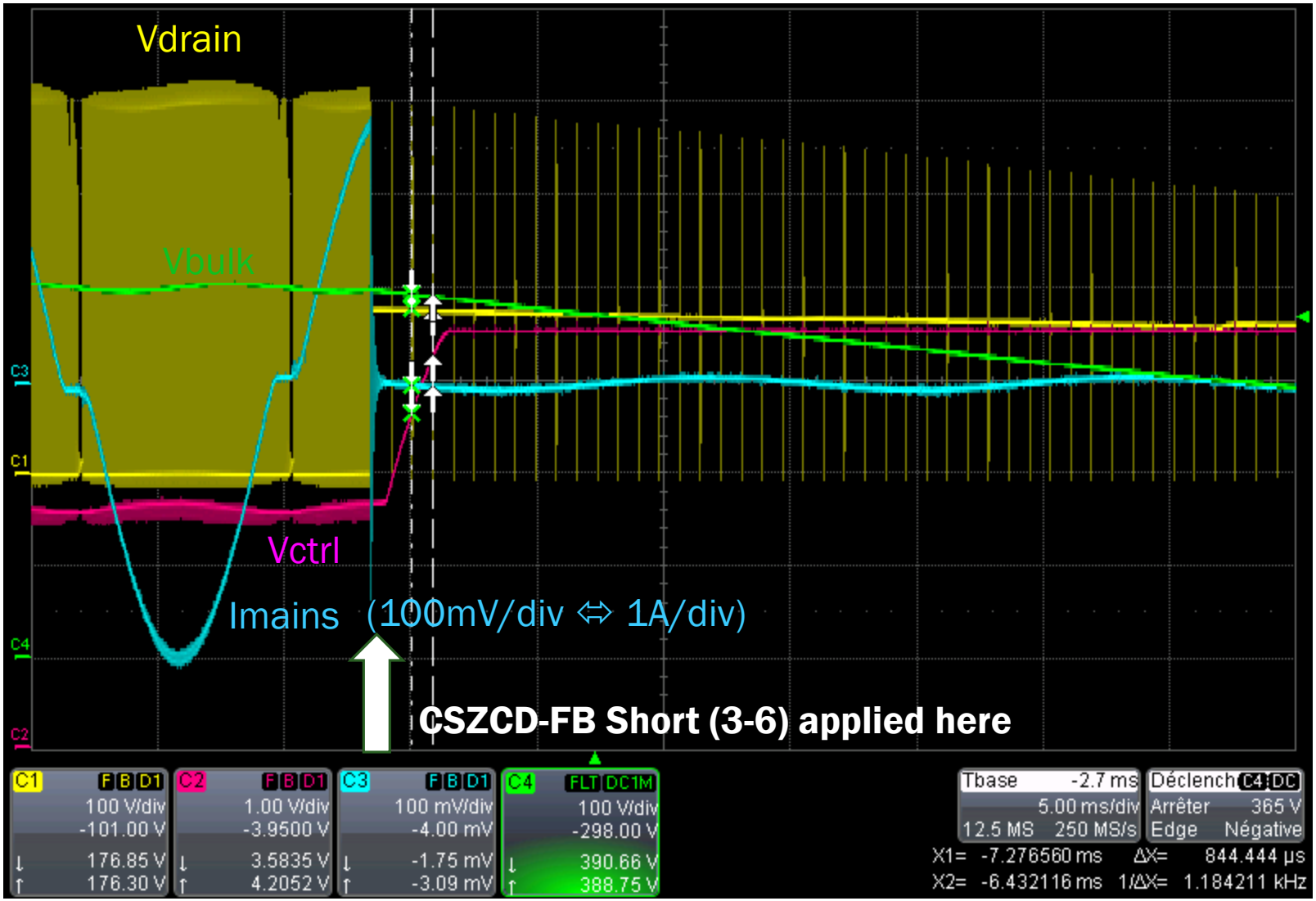
The short cause VCTRL=2.5V which is too close to initial VCTRL.
Iload is decreased (0.4A => 0.22A) to have a starting VCTRL =1.8V lower han 2.5V and tr
Rising VCTRL crossing 2.25V



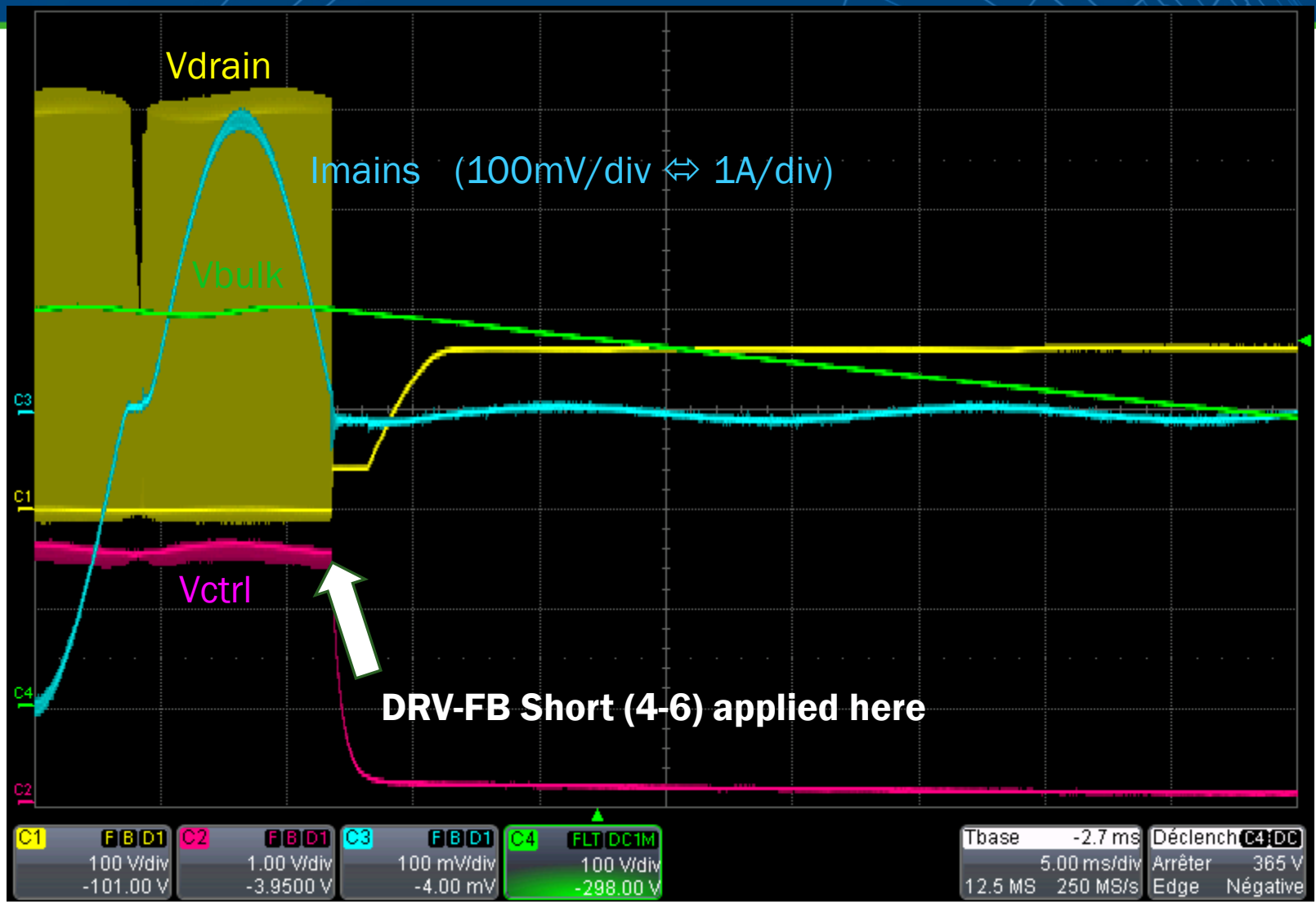
GND-FB Short (2-6)


Vdrain
GND-FB Short (2-6) applied here
Vbulk
Imains (100mV/div ⇔ 1A/div)
Vctrl
C3
C1
C4
C2
C1 F B D1 100 V/div -101.00 V
C2 F B D1 1.00 V/div -3.9500 V
C3 F B D1 100 mV/div -4.00 mV
C4 FLT DC1M 100 V/div -298.00 V
Tbase -2.7 ms 5.00 ms/div 12.5 MS 250 MS/s
Déclench C4 DC Arrêter 365 V Edge Négative

CSZCD-FB Short (3-6)

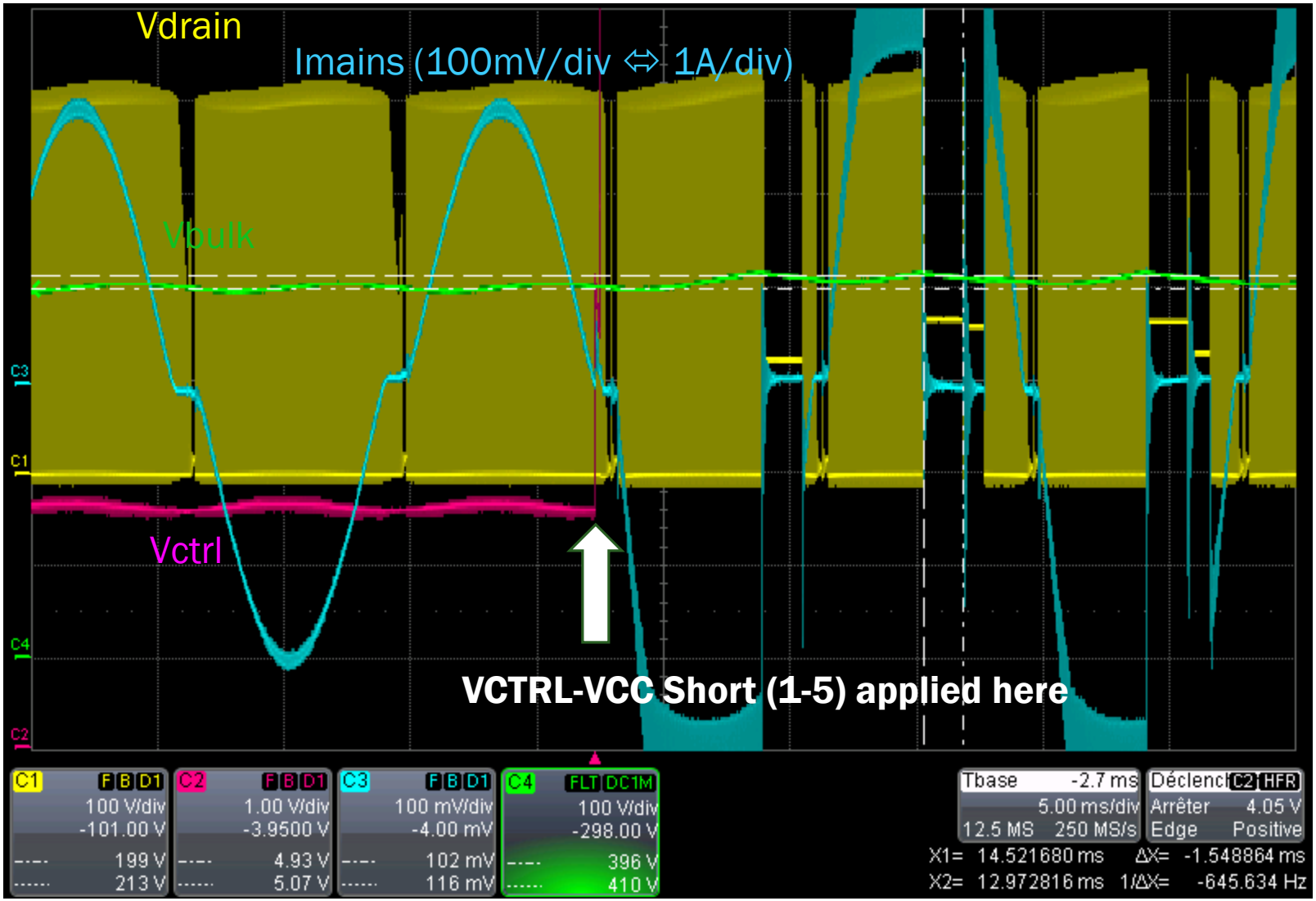

Vdrain
Vbulk
Vctrl
Imains (100mV/div ⇔ 1A/div)
CSZCD-FB Short (3-6) applied here
C1 F B D1
100 V/div
-101.00 V
176.85 V
176.30 V
C2 F B D1
1.00 V/div
-3.9500 V
3.5835 V
4.2052 V
C3 F B D1
100 mV/div
-4.00 mV
-1.75 mV
-3.09 mV
C4 FLT DC1M
100 V/div
-298.00 V
390.66 V
388.75 V
Tbase -2.7 ms
5.00 ms/div
12.5 MS 250 MS/s
Déclench C4 DC
Arrêter 365 V
Edge Négative
X1= -7.276560 ms ΔX= 844.444 µs
X2= -6.432116 ms 1/ΔX= 1.184211 kHz

DRV-FB Short (4-6)

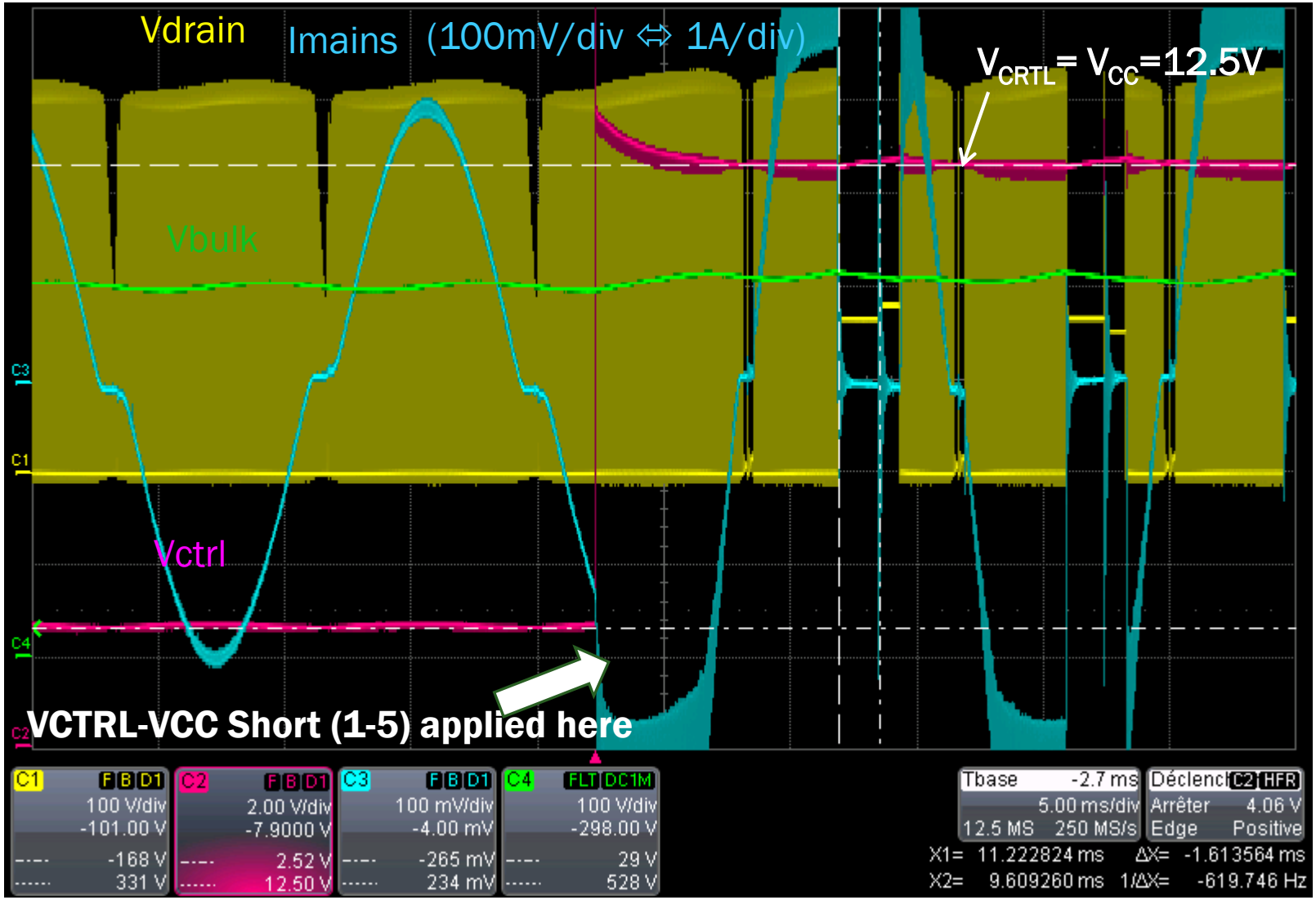

Vdrain
Imains (100mV/div ⇔ 1A/div)
Vbulk
Vctrl
DRV-FB Short (4-6) applied here
C1 F B D1 100 V/div -101.00 V
C2 F B D1 1.00 V/div -3.9500 V
C3 F B D1 100 mV/div -4.00 mV
C4 FLT DC1M 100 V/div -298.00 V
Tbase -2.7 ms 5.00 ms/div 12.5 MS 250 MS/s
Déclench C4 DC Arrêter 365 V Edge Négative

VCTRL-VCC Short (1-5)

17mA drown from Vcc=15V

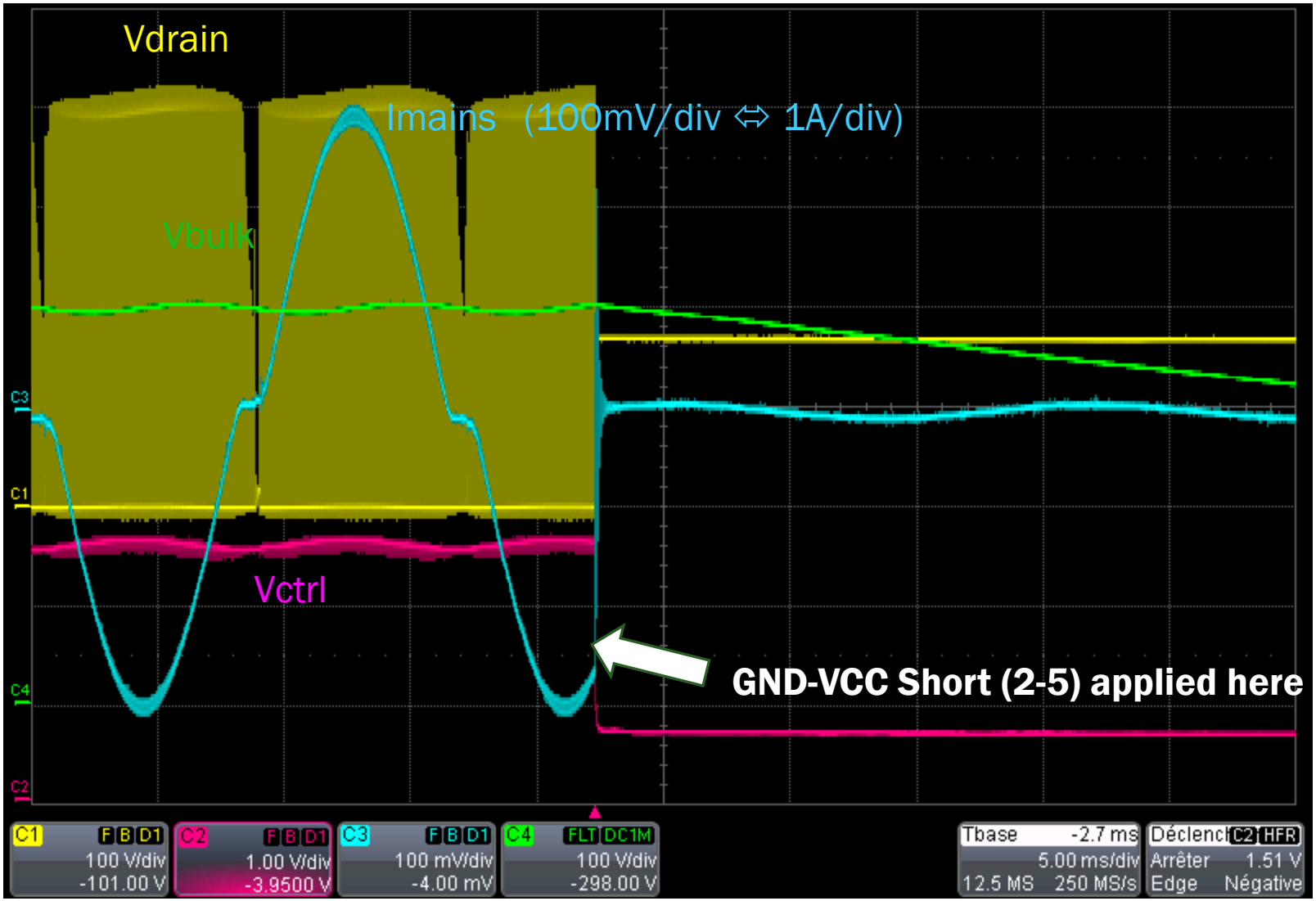


17mA drown from Vcc=15V

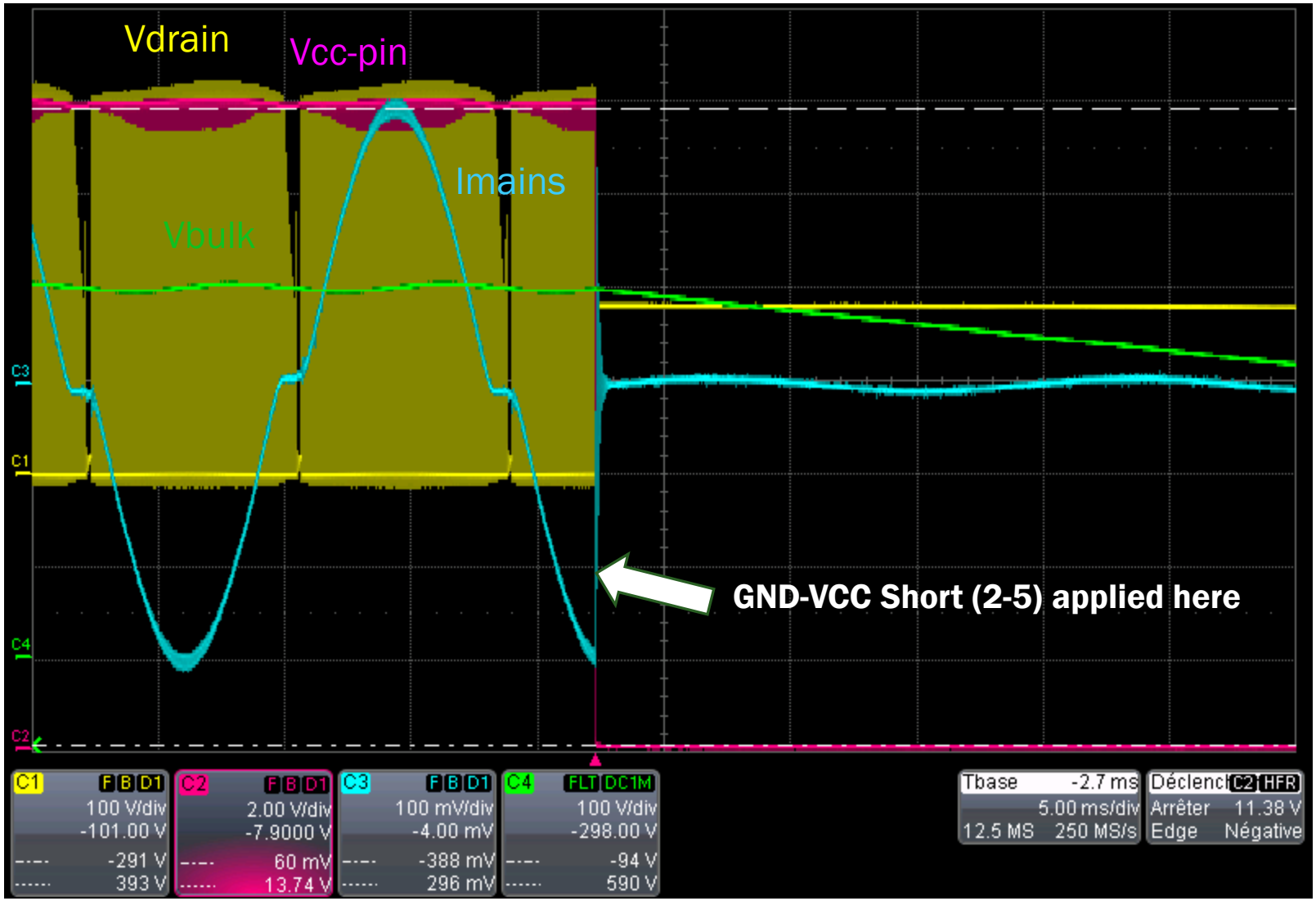


GND-VCC Short (2-5)

50mA drawn from VCC supply (I_{clamp}=50mA)

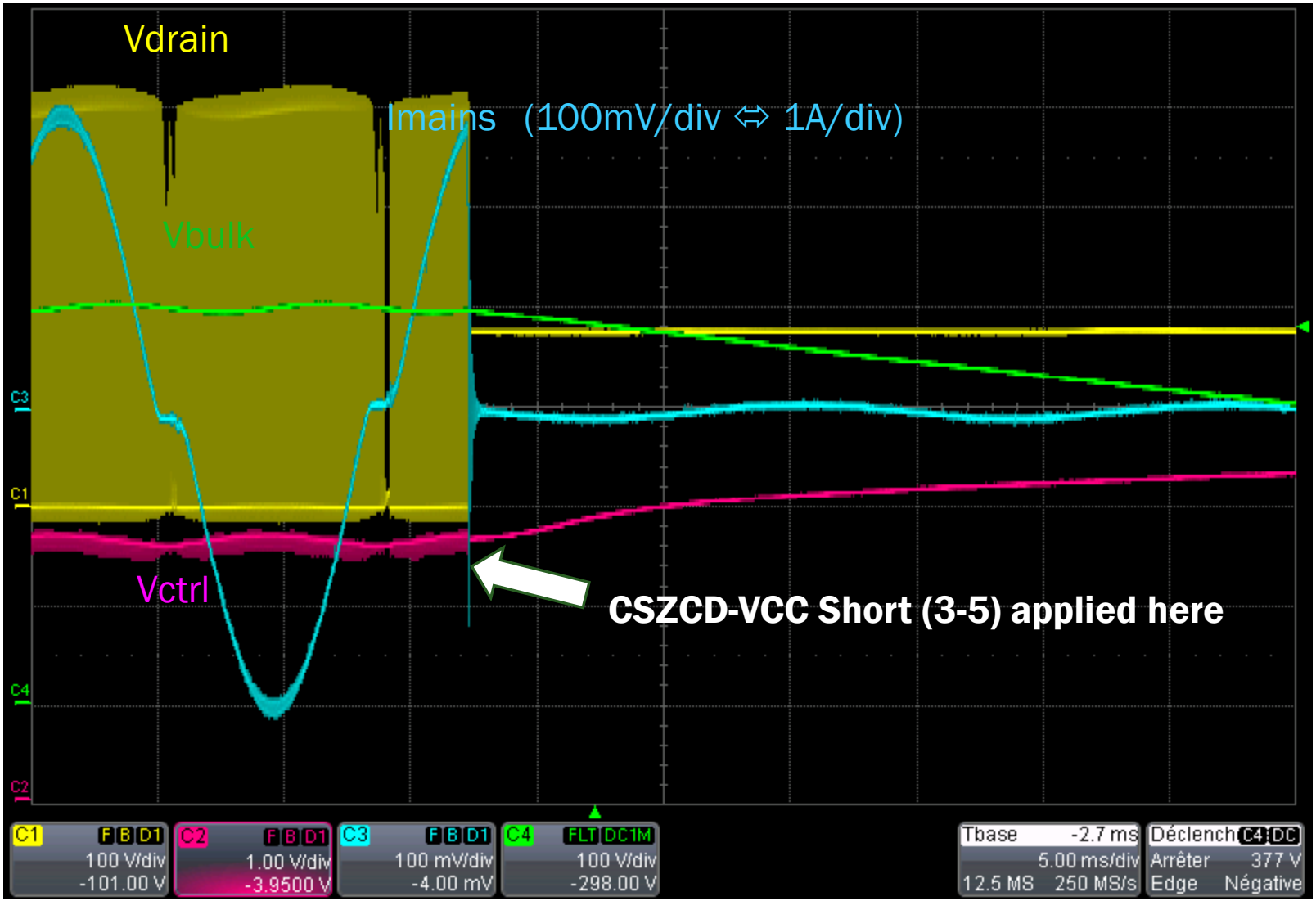


50mA drawn from VCC supply (Iclamp=50mA) VCC supply drops to 5.69V

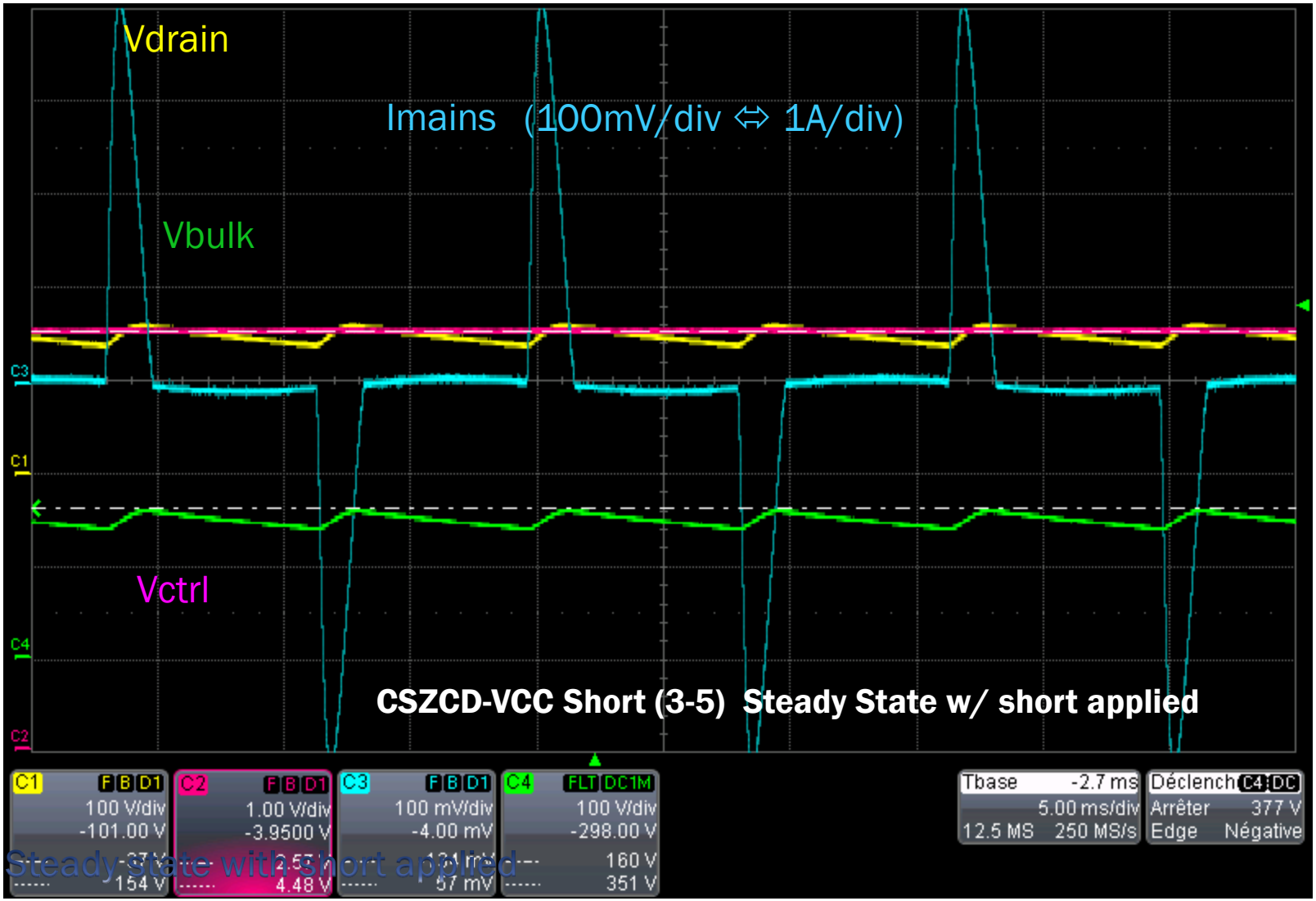


CSZCD-VCC Short (3-5)

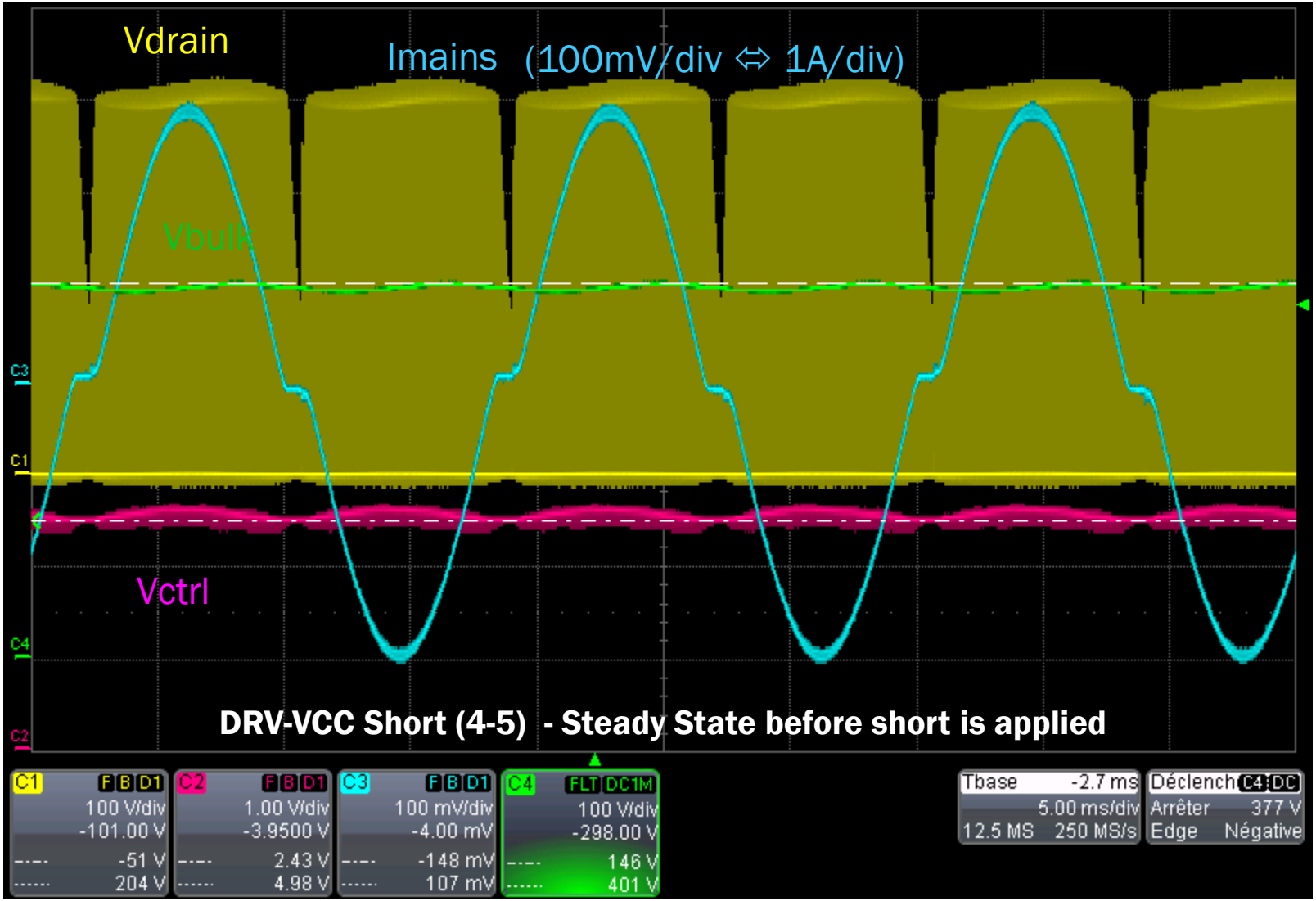
15mA drawn from VCC



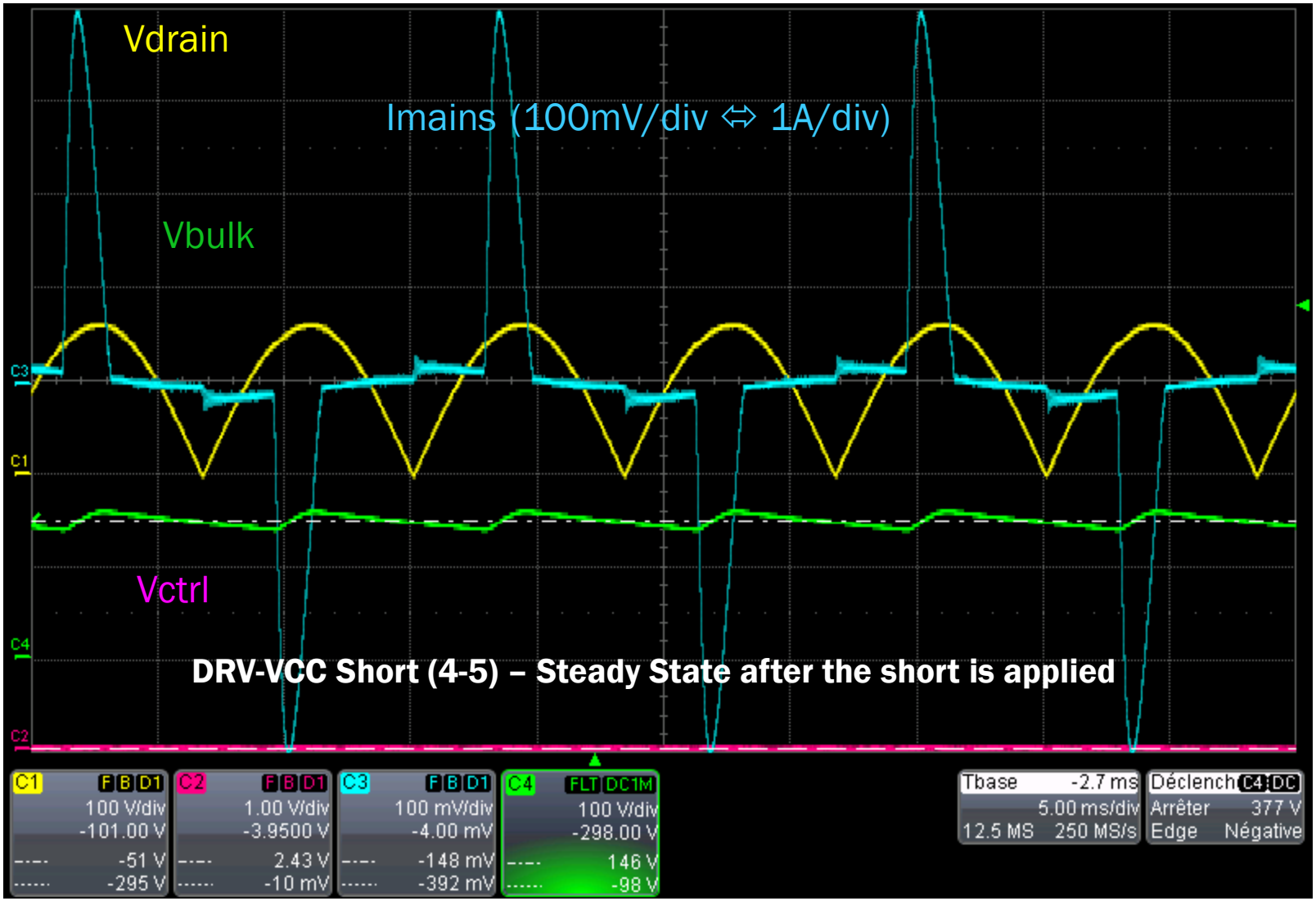
15mA drawn from VCC



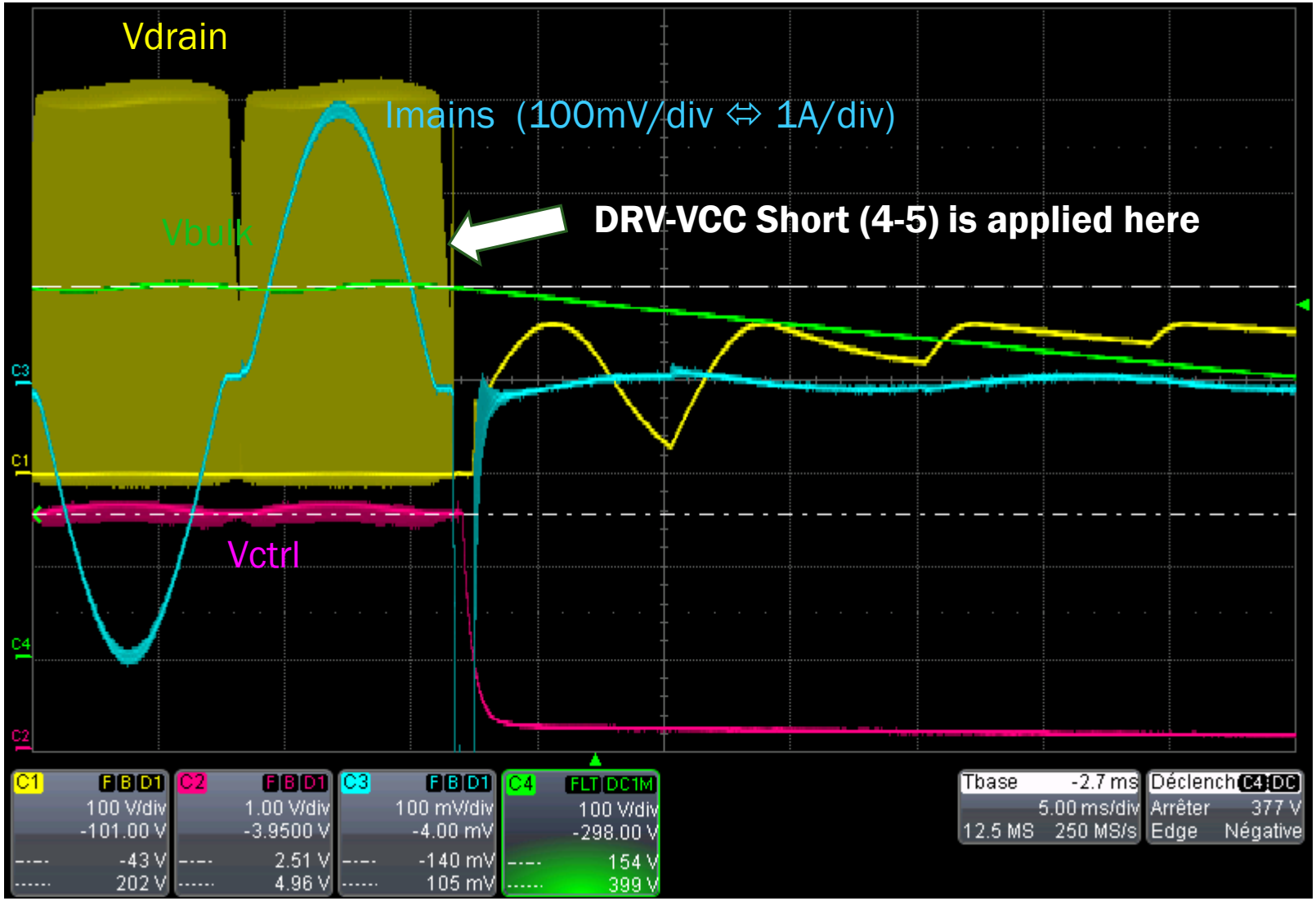
DRV-VCC Short (4-5)


Vdrain
Imains (100mV/div ⇔ 1A/div)
Vbulk
Vctrl
C3
C1
C4
C2
DRV-VCC Short (4-5) - Steady State before short is applied
C1 F B D1
100 V/div
-101.00 V
-51 V
204 V
C2 F B D1
1.00 V/div
-3.9500 V
2.43 V
4.98 V
C3 F B D1
100 mV/div
-4.00 mV
-148 mV
107 mV
C4 FLT DC1M
100 V/div
-298.00 V
146 V
401 V
Tbase -2.7 ms
5.00 ms/div
12.5 MS 250 MS/s
Déclench C4 DC
Arrêter 377 V
Edge Négative

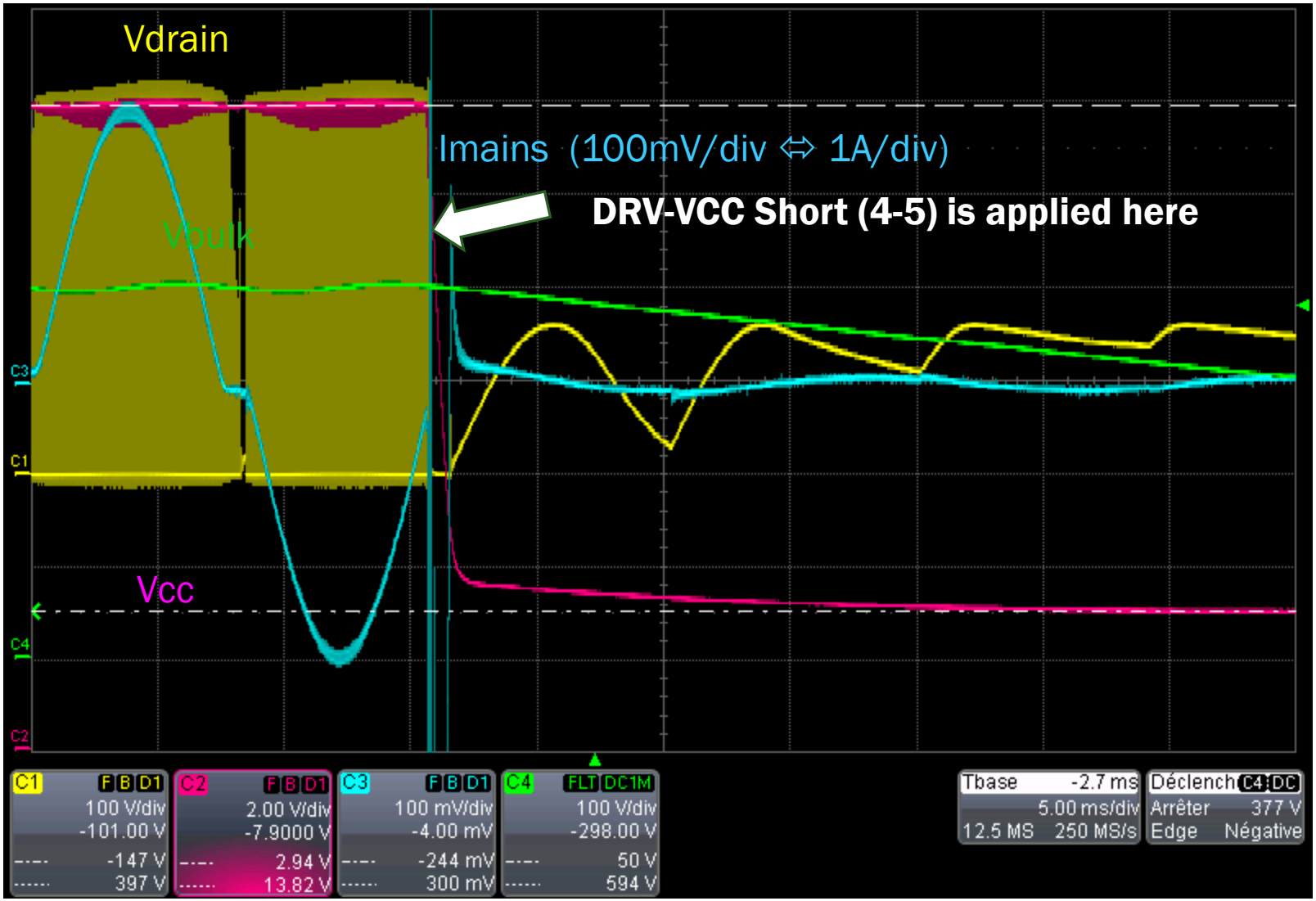
49mA drawn from Vcc external supply which drops from 15V to 9.13V



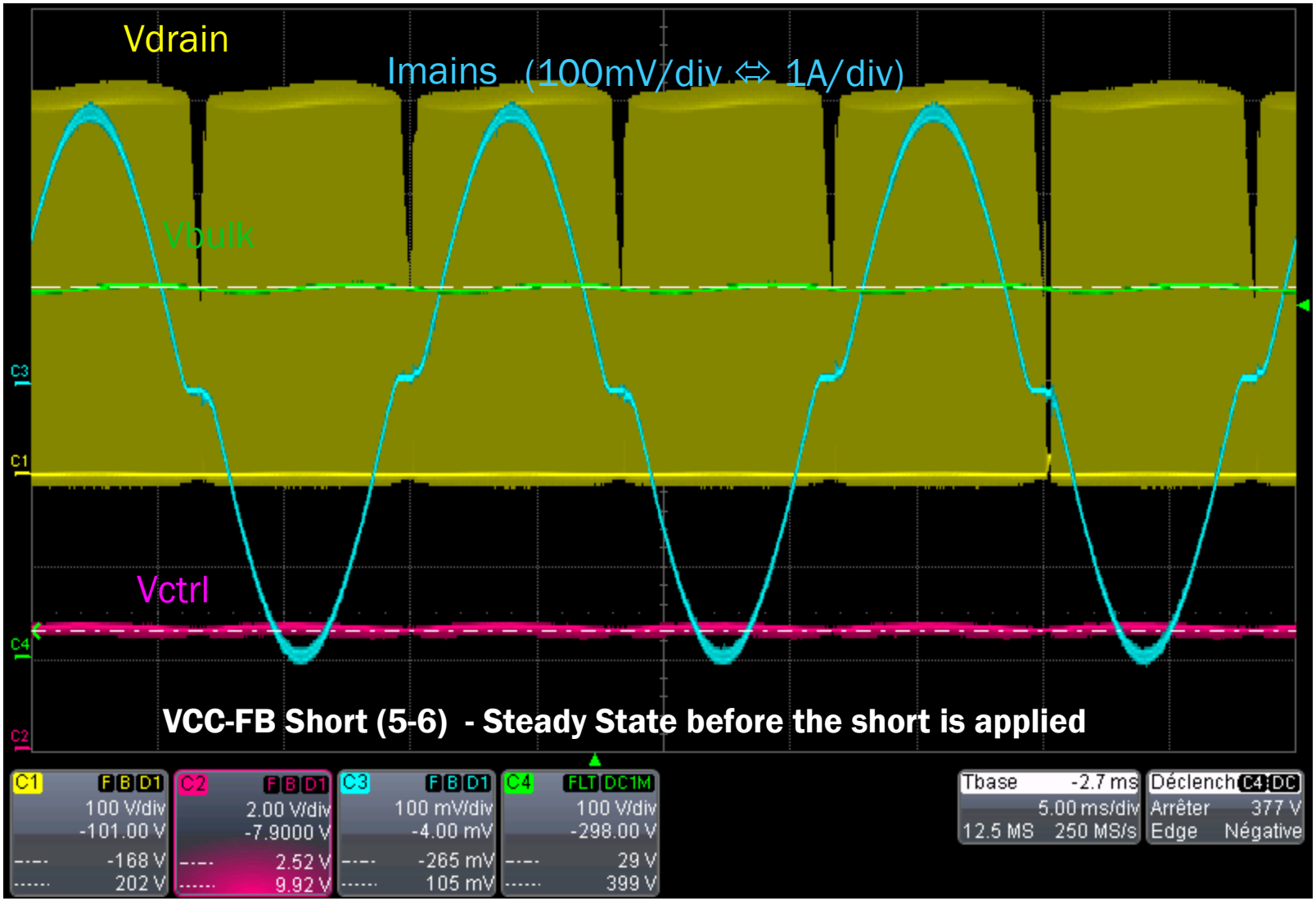
49mA drawn from Vcc external supply which drops from 15V to 9.13V



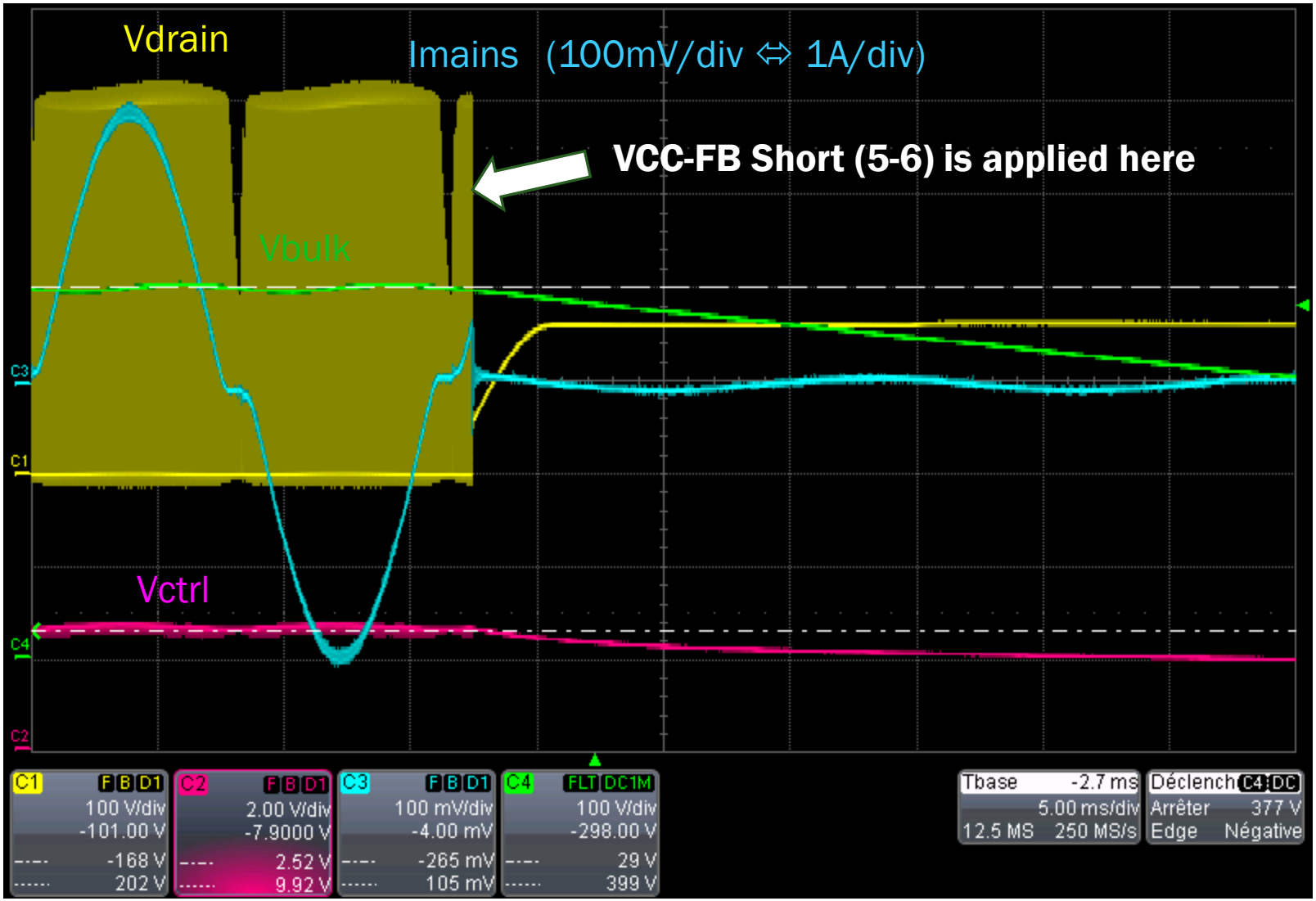
49mA drawn from Vcc external supply which drops from 15V to 9.13V



VCC-FB Short (5-6)

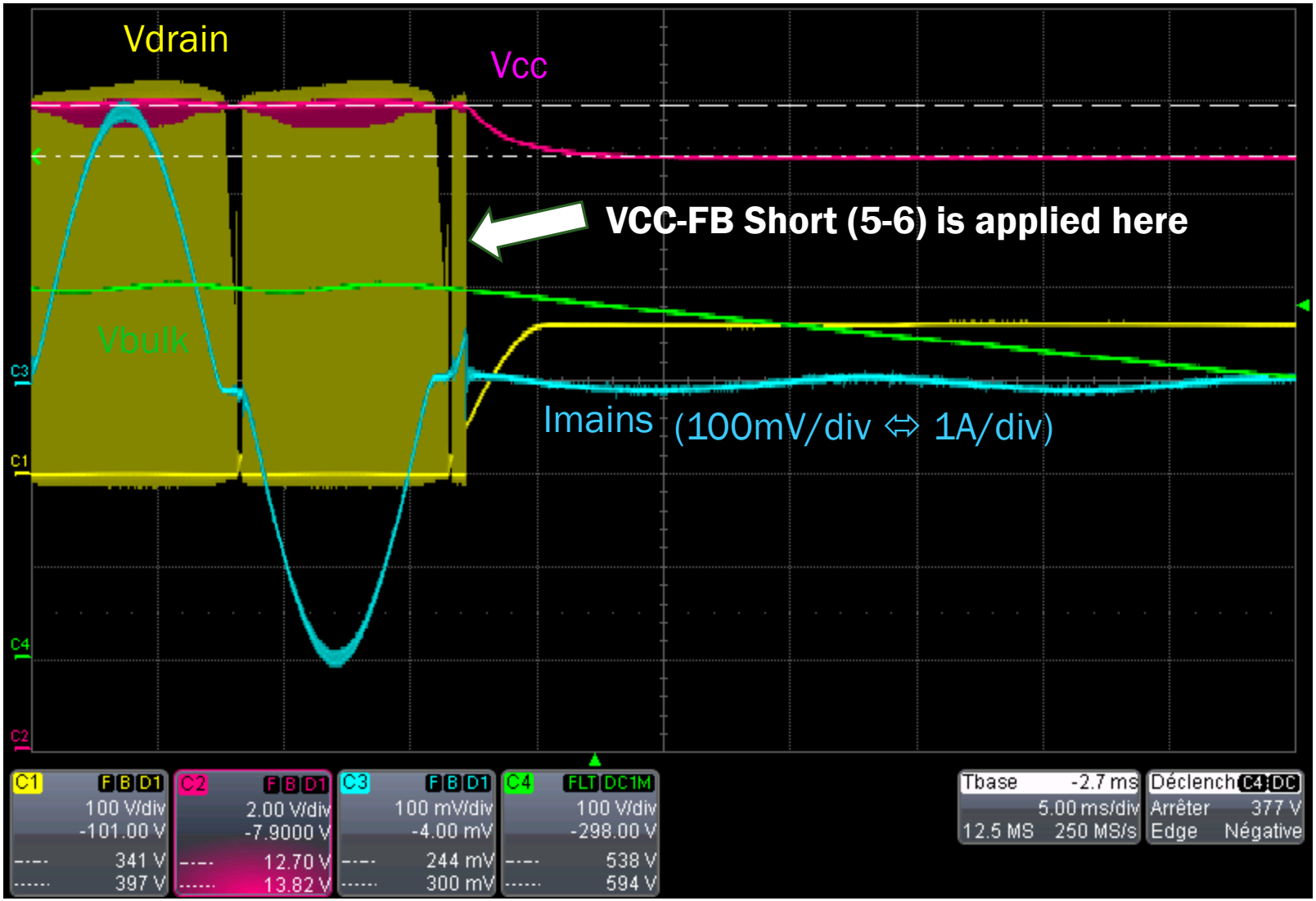

Vdrain
Imains (100mV/div ⇔ 1A/div)
Vbulk
Vctrl
C3
C1
C4
C2
VCC-FB Short (5-6) - Steady State before the short is applied
C1 F B D1
100 V/div
-101.00 V
-168 V
202 V
C2 F B D1
2.00 V/div
-7.9000 V
2.52 V
9.92 V
C3 F B D1
100 mV/div
-4.00 mV
-265 mV
105 mV
C4 FLT DC1M
100 V/div
-298.00 V
29 V
399 V
Tbase -2.7 ms
5.00 ms/div
12.5 MS 250 MS/s
Déclench C4 DC
Arrêter 377 V
Edge Négative

16mA drawn from Vcc=15V

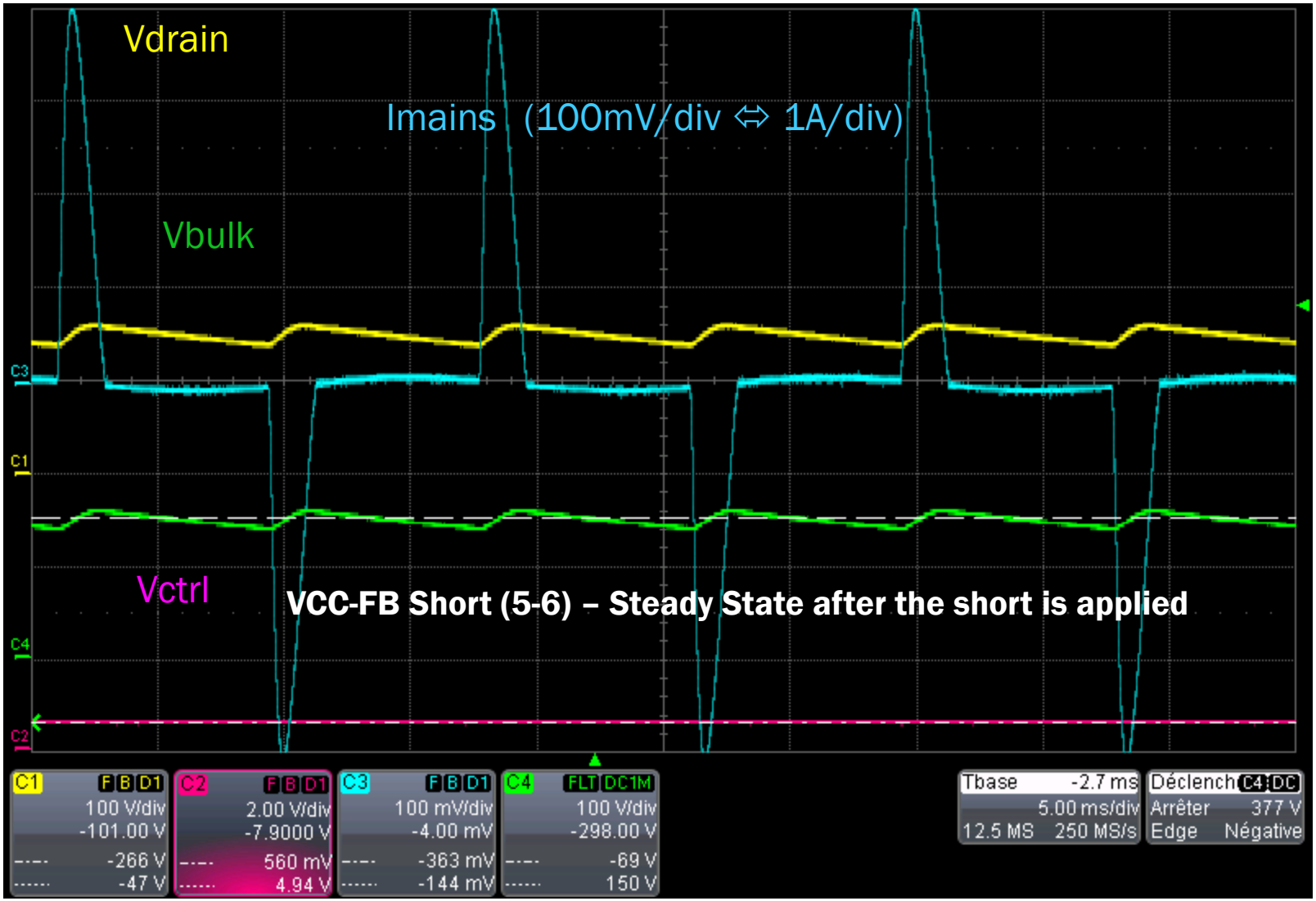


Before&After the short

16mA drawn from Vcc=15V

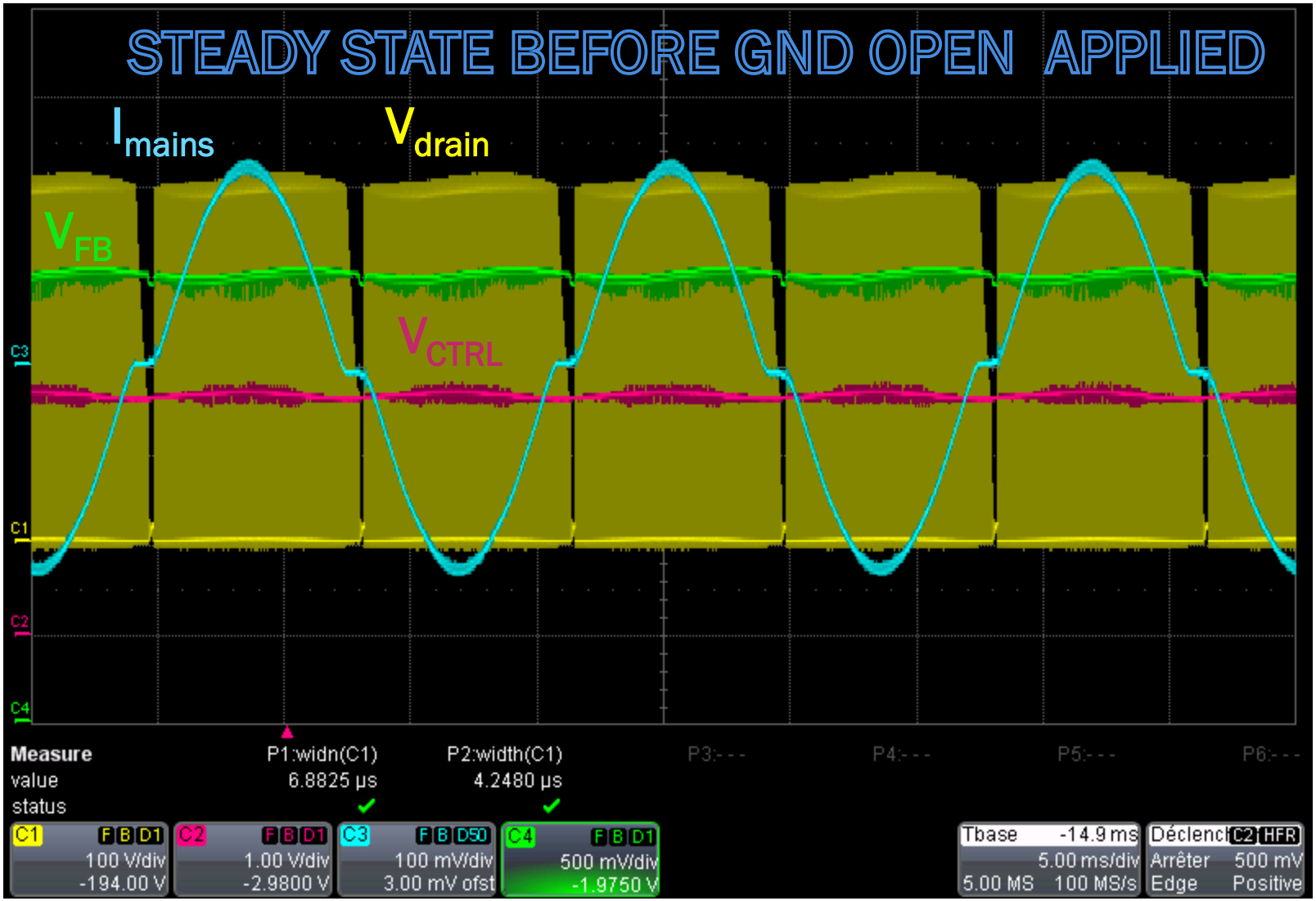


16mA drawn from Vcc=15V

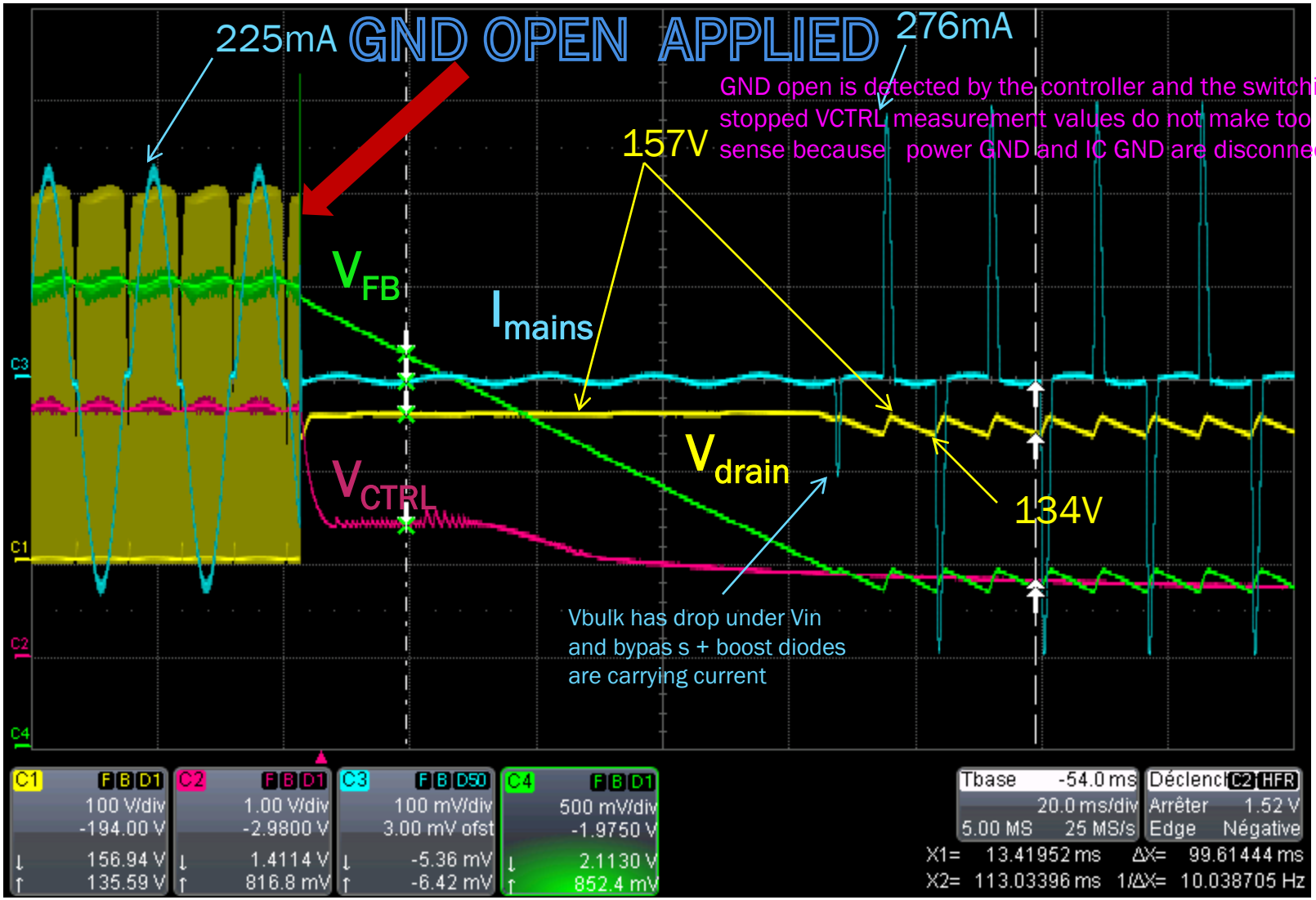


GND (2) Open

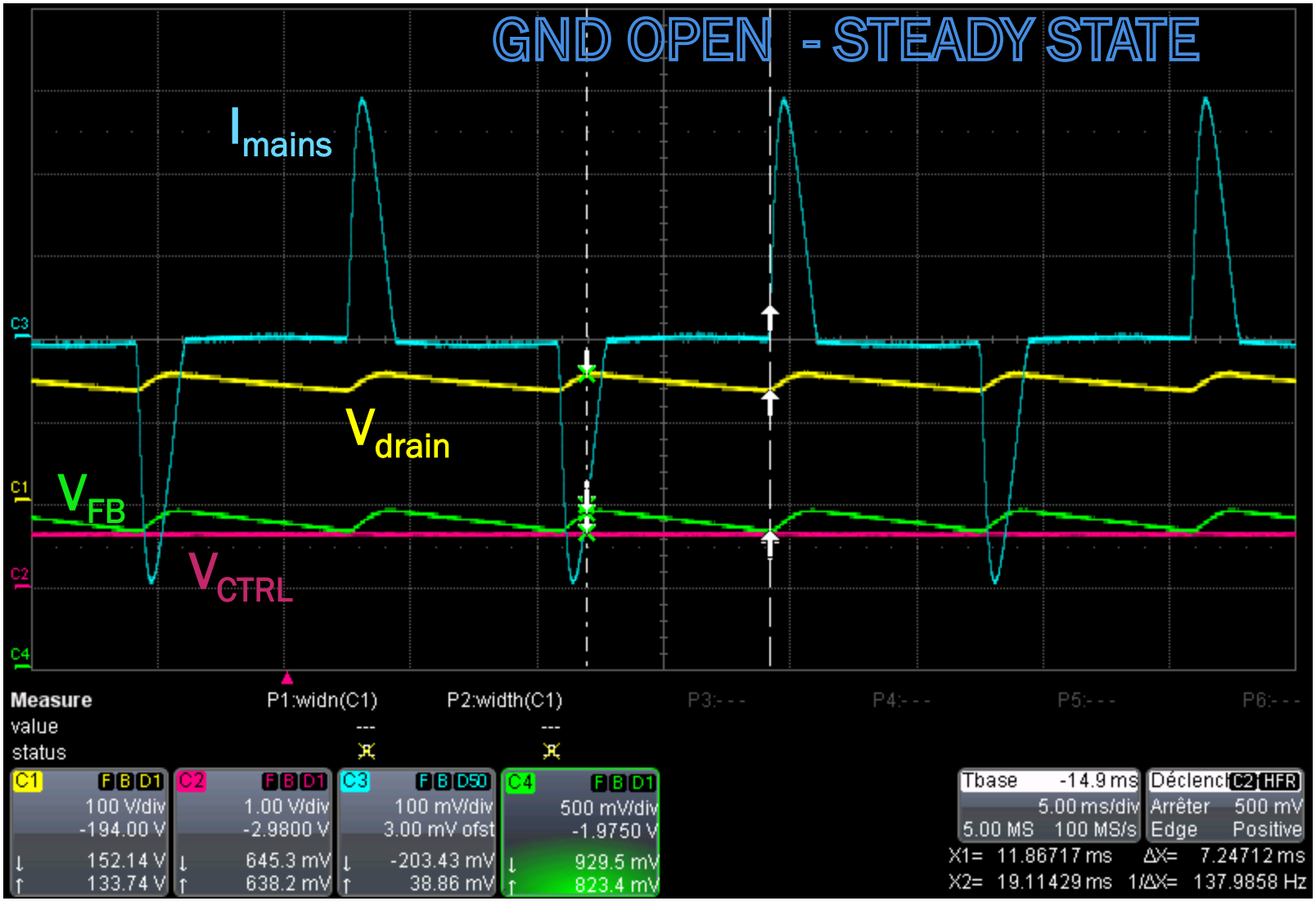
GND Normally Connected , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



GND Open from steady state, Vcc=20V Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



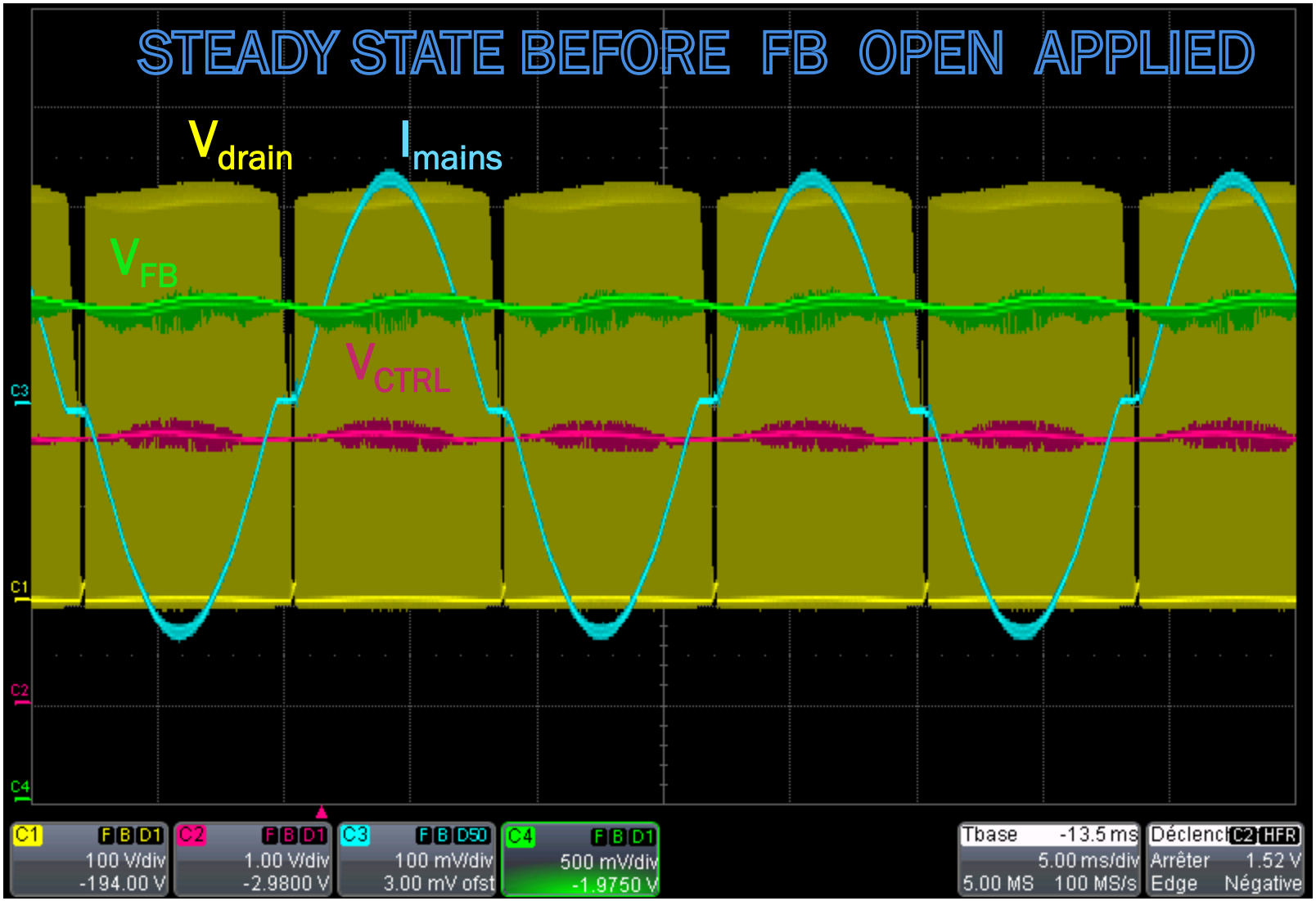
GND Open Before Startup , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 143V



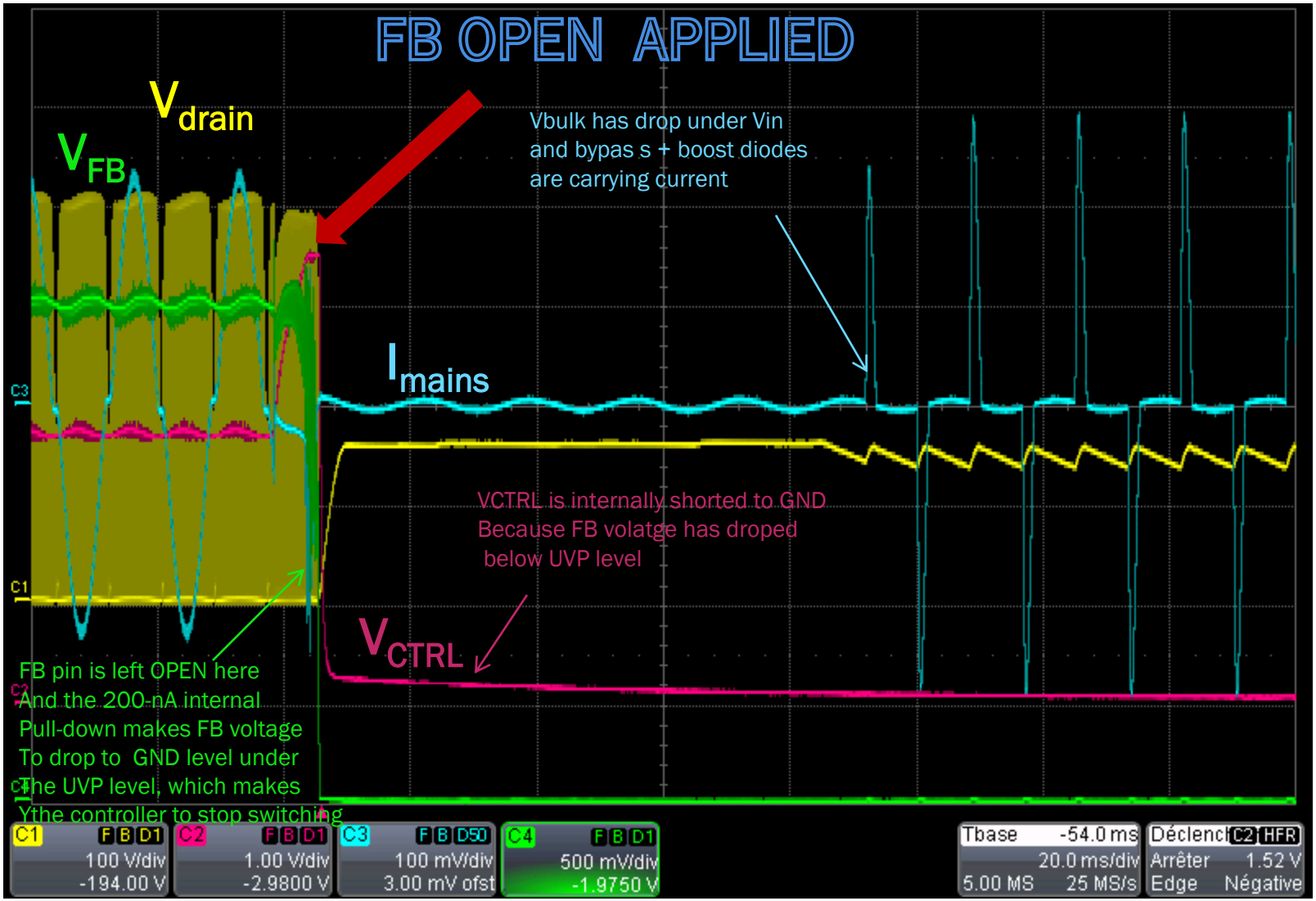
No switching, VCTRL rises up to about 640mV ??

FB (6) Open

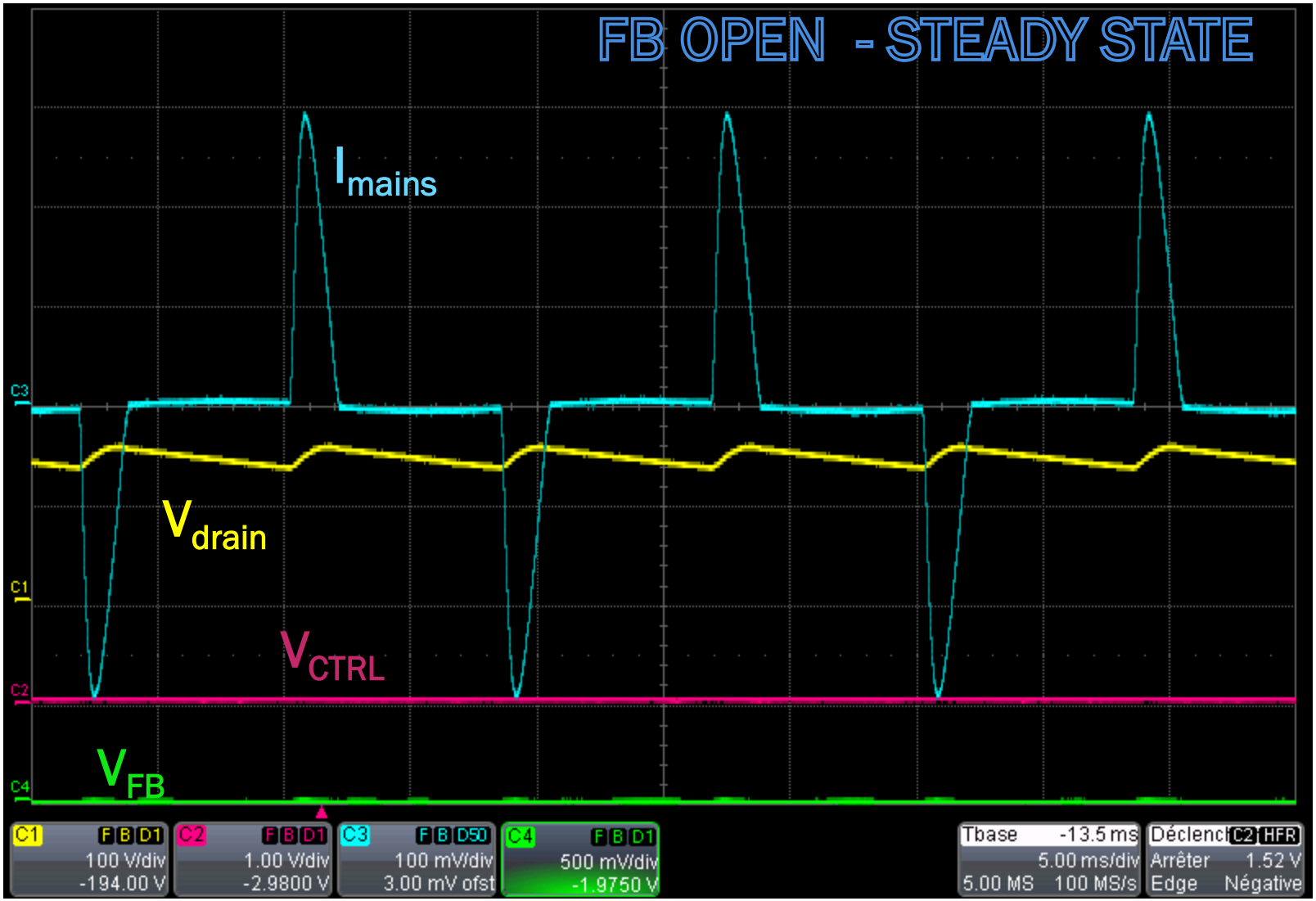
FB Normally Connected , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



FB Open from steady state, Vcc=20V Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



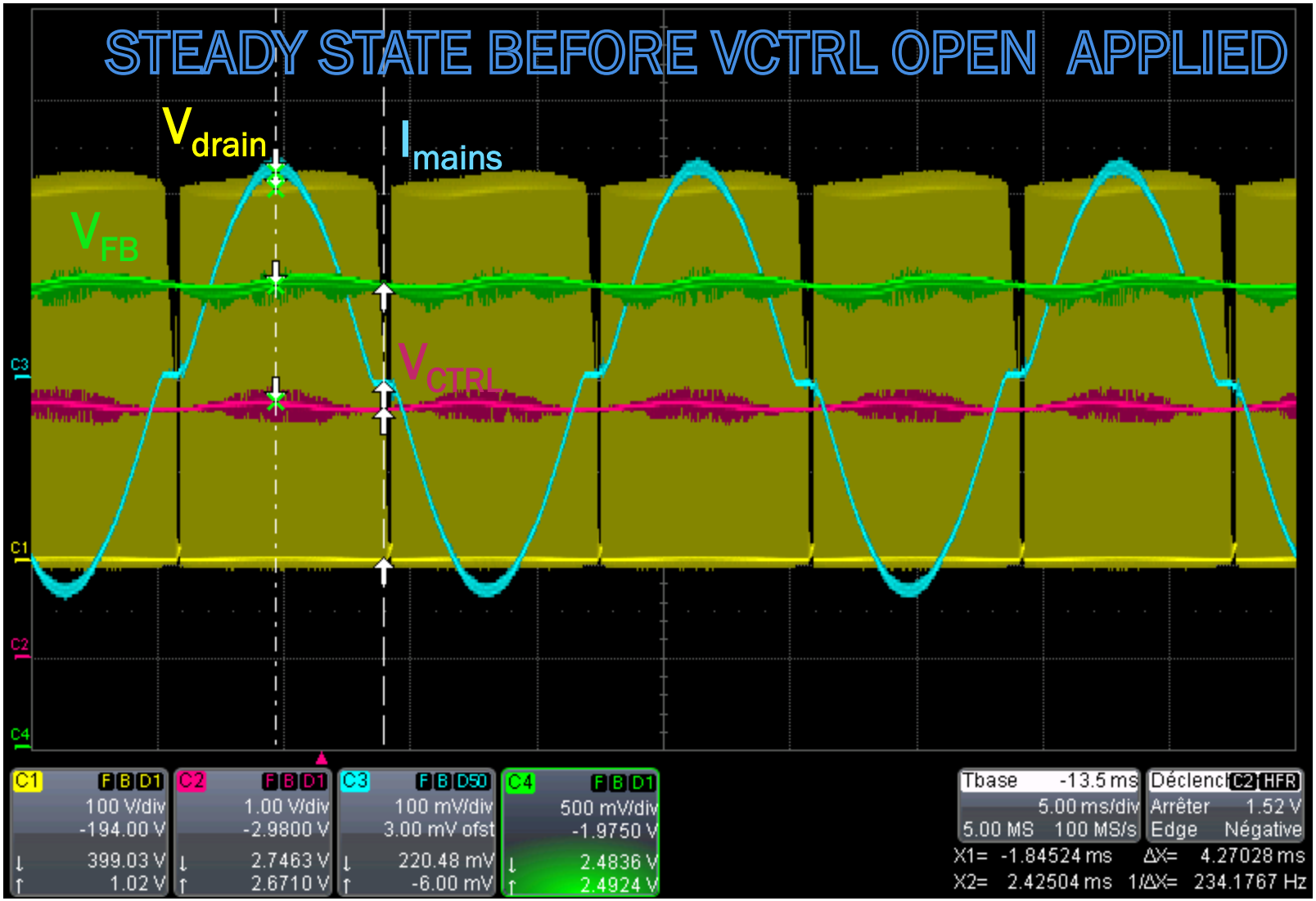
FB Open Before Startup , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 143V



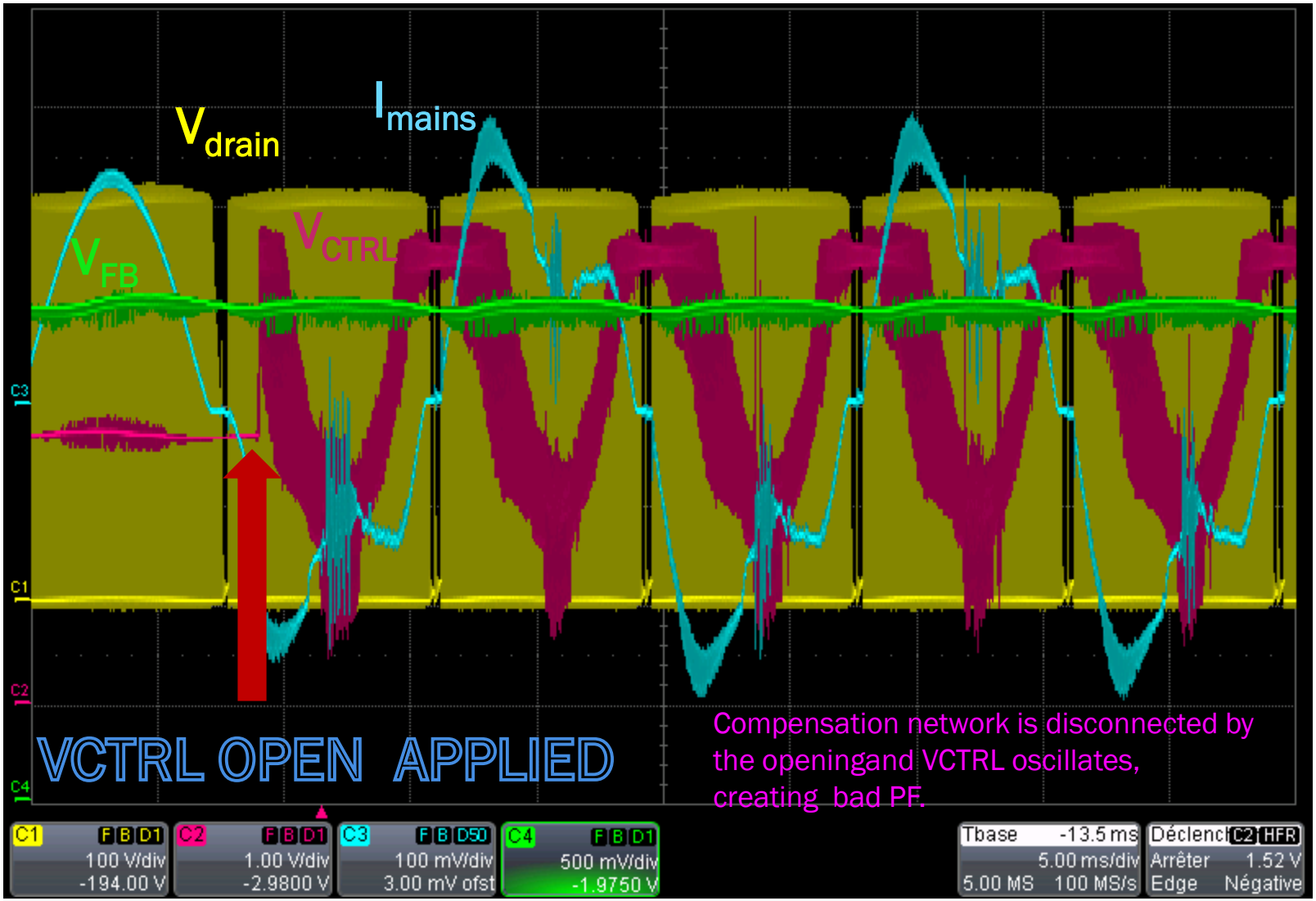
The controller does not start because the FB pin pull-down current source maintains FB pin volatge under the UVP level which has the consequence of maintaining the cont disabled

VCTRL (1) Open

VCRTL Normally Connected , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V

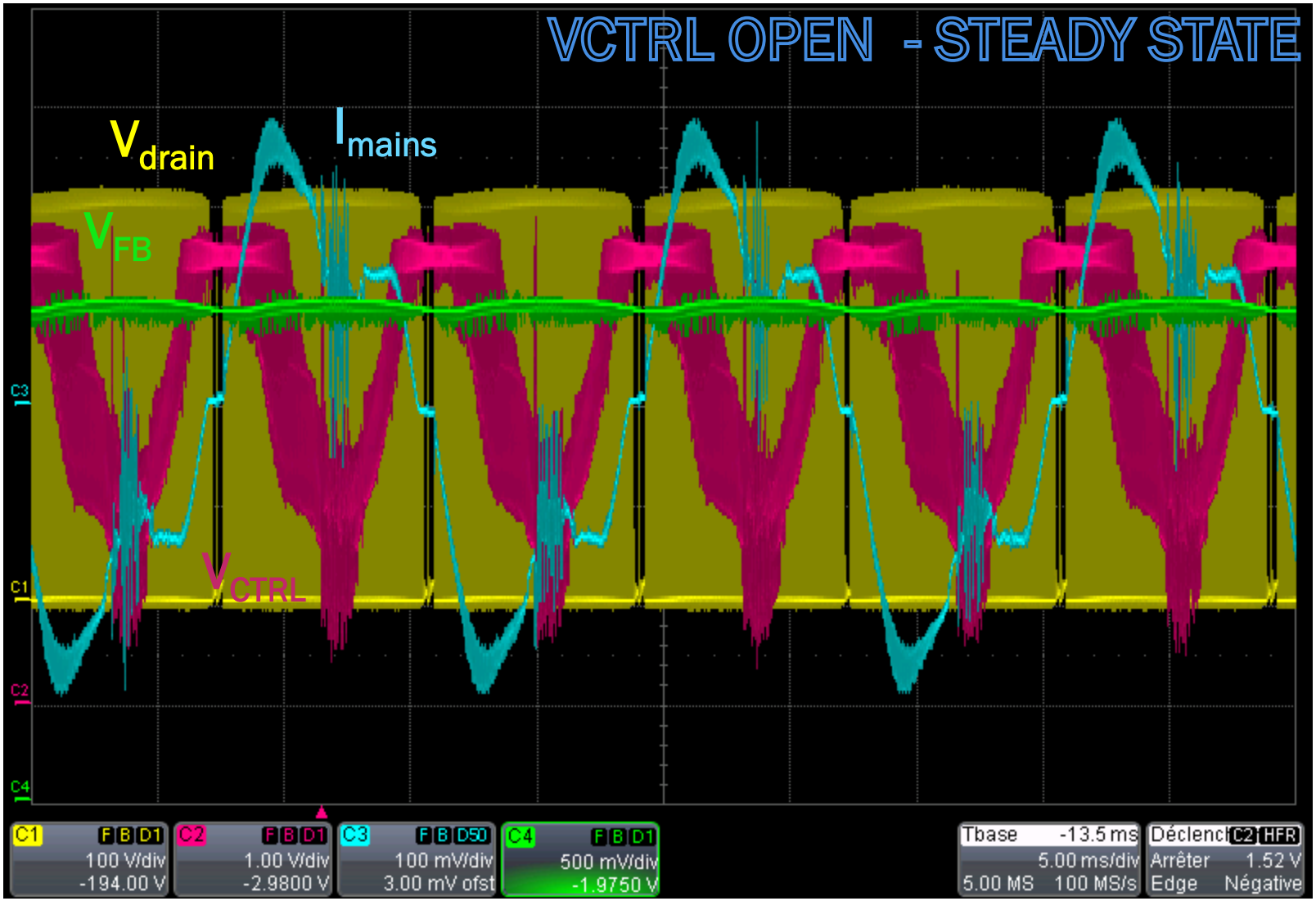


VCTRL Open from steady state, Vcc=20V
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



The controller does not stop switching and the FB voltage does not change too much
VCTRL pin voltage oscillates widely and PF is bad

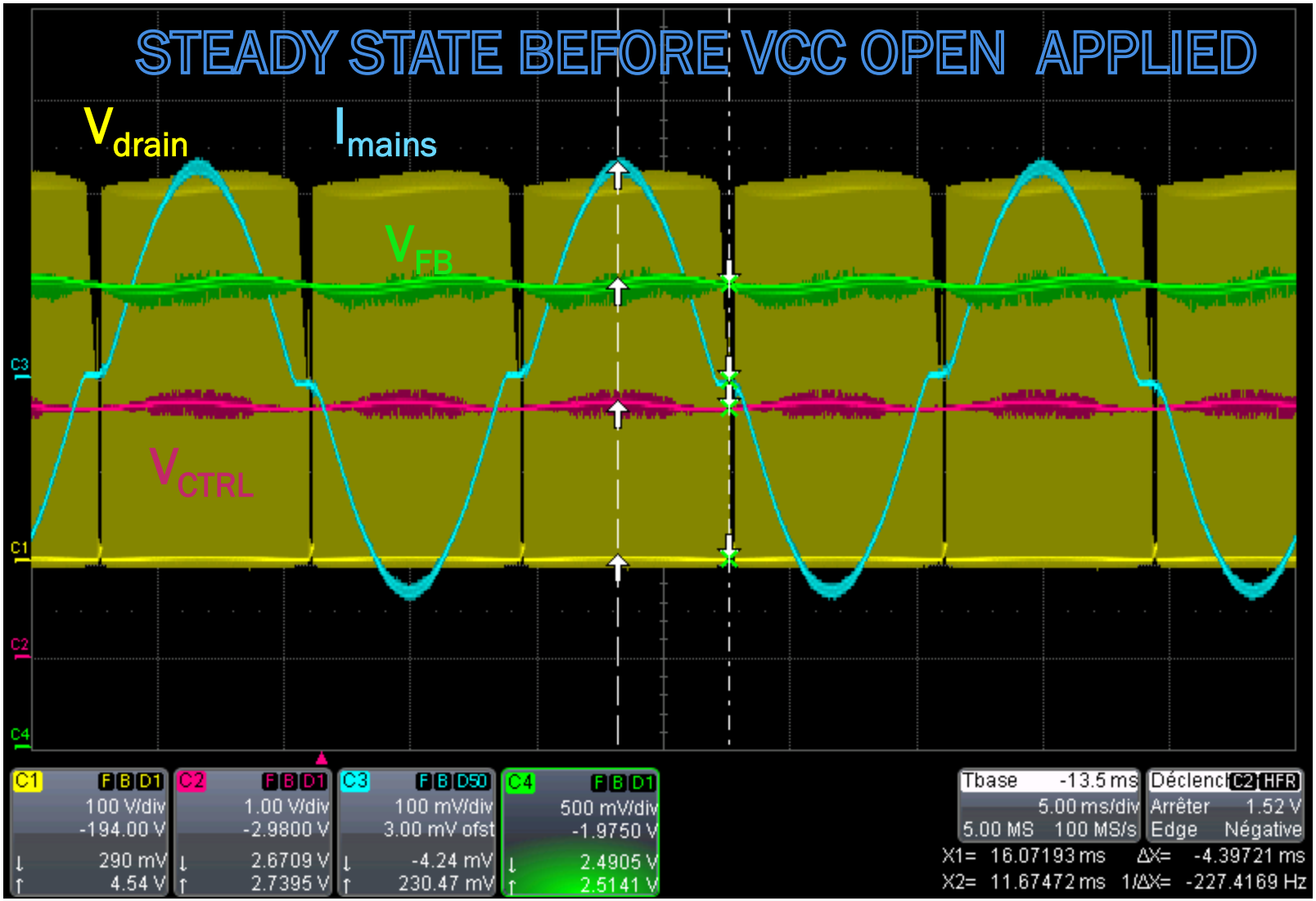
VCTRL Open Before Startup , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



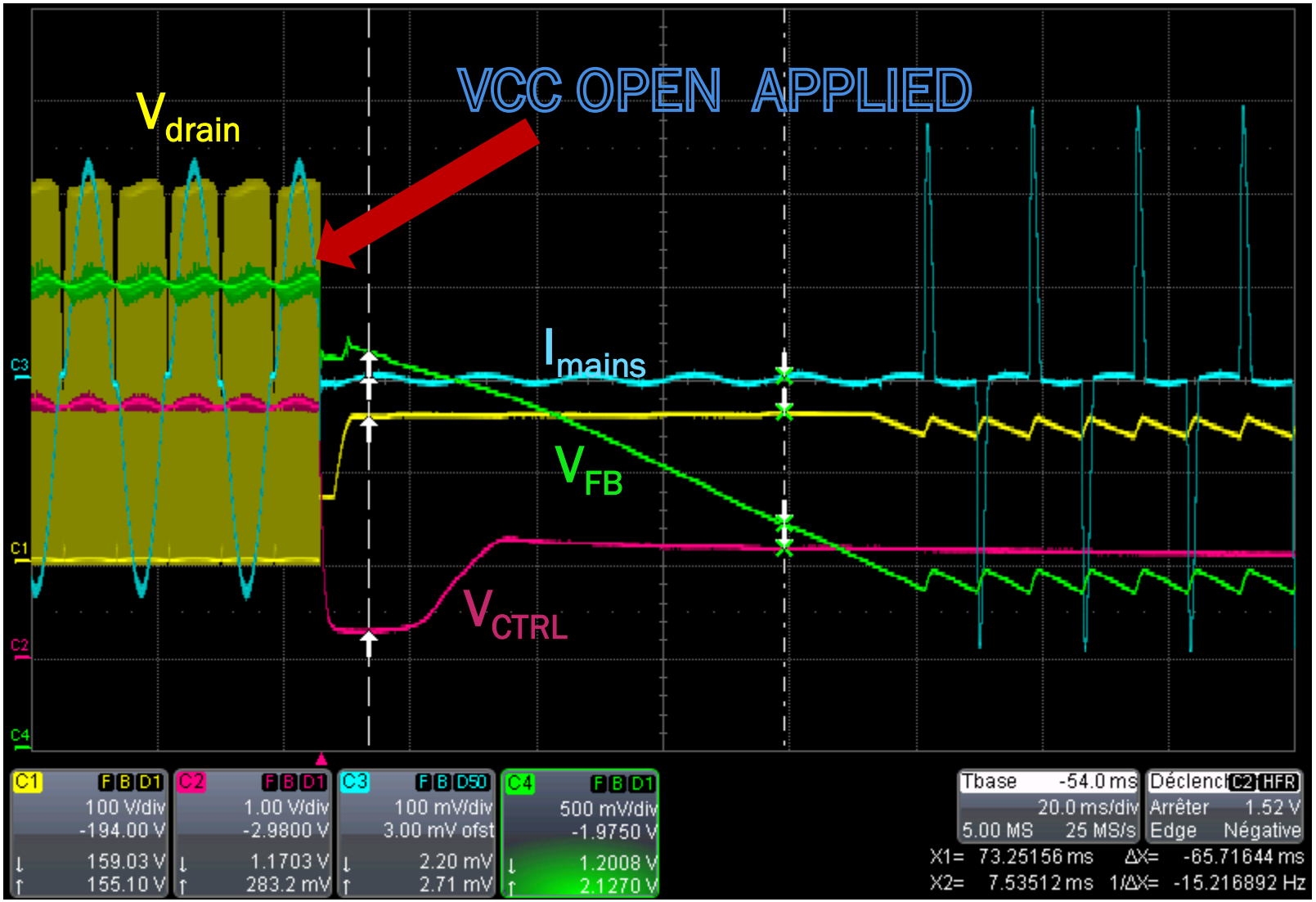
The controller does not stop switching and the FB voltage does not change too much
VCTRL pin voltage oscillates widely and PF is bad

VCC (5) Open

VCC Normally Connected , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V

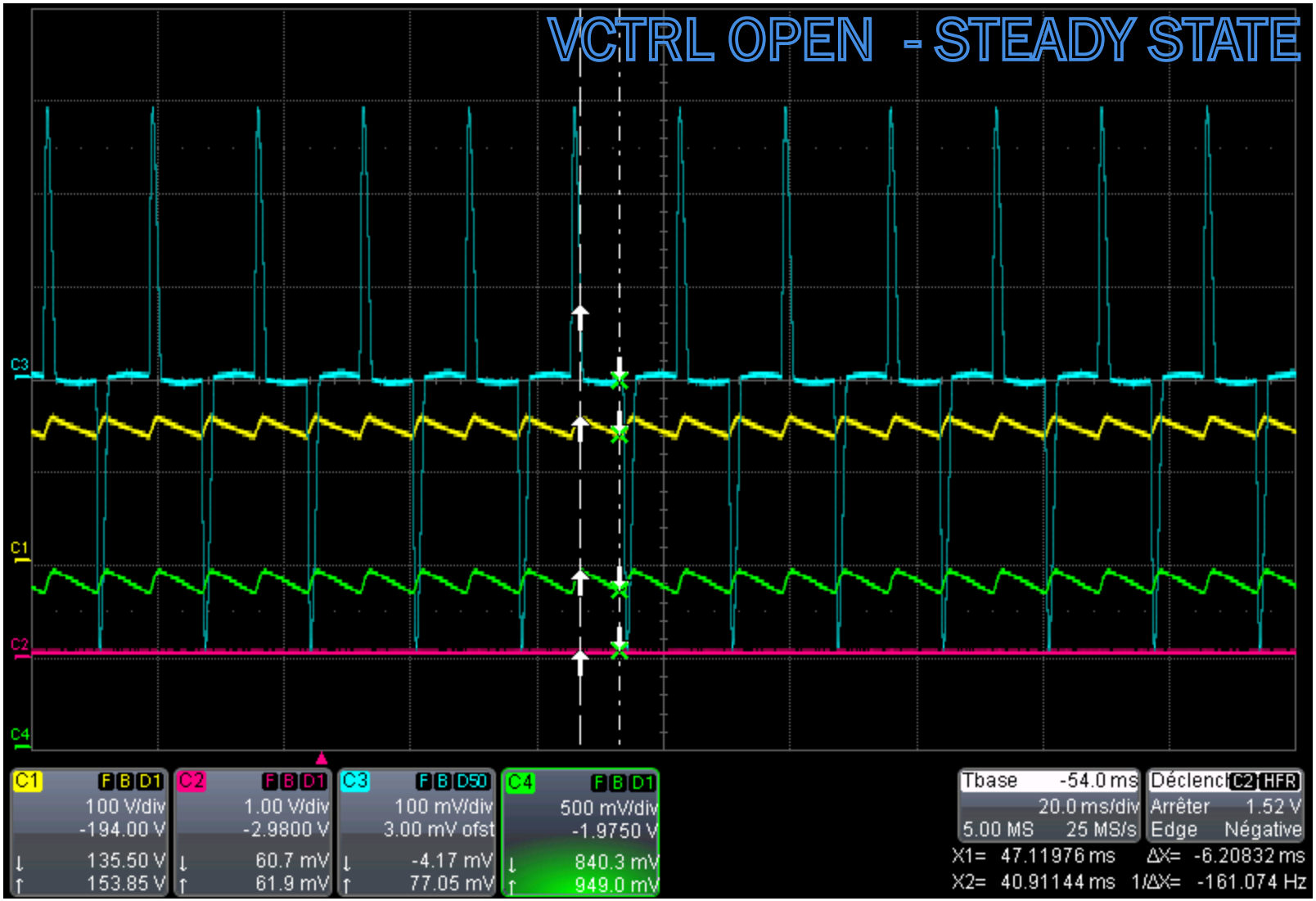


VCC Open from steady state, Vcc=20V
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



VCTRL decreases very slowly because internal the part is disabled and pull-down is not effe

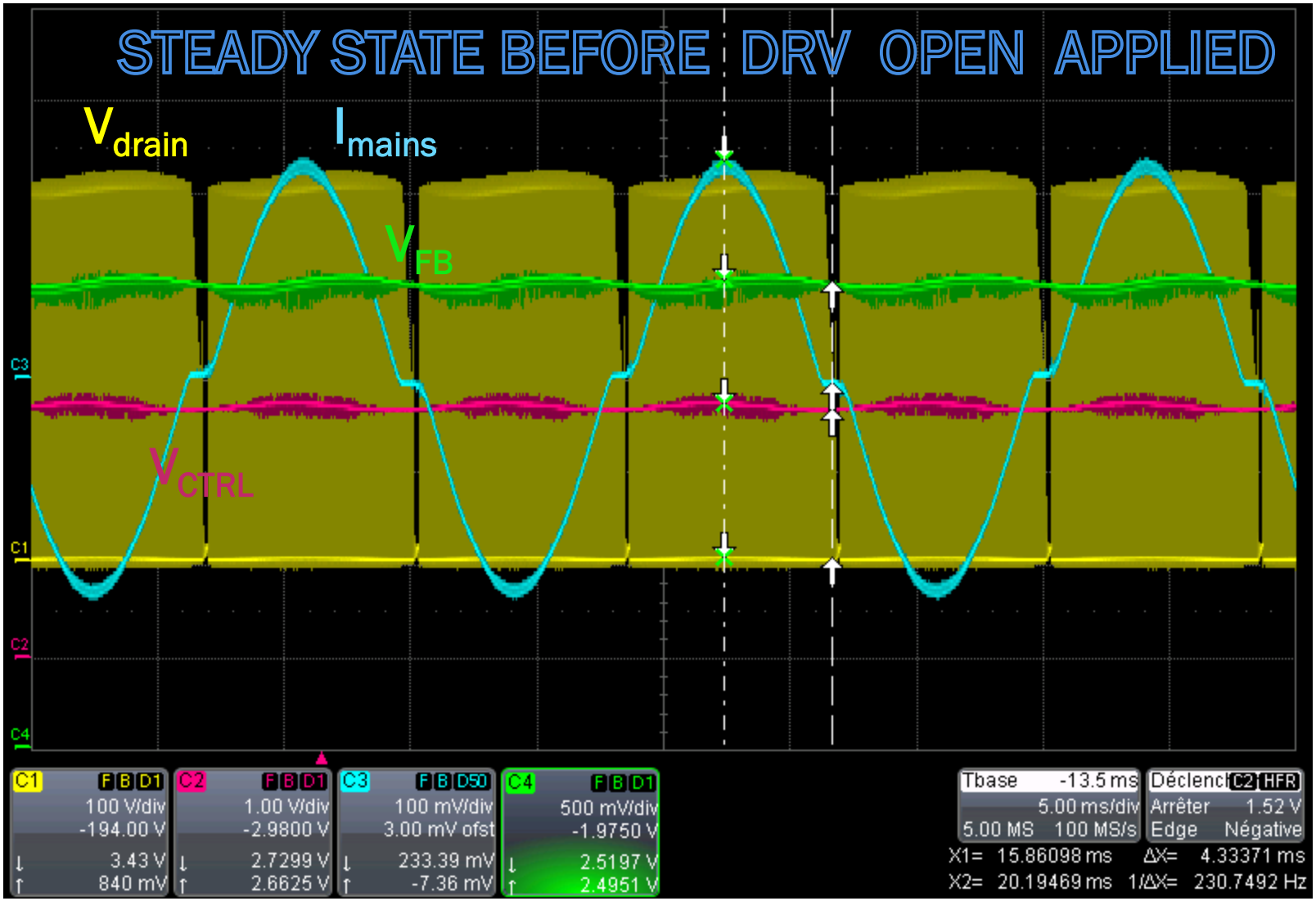
VCC Open Before Startup , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 143V



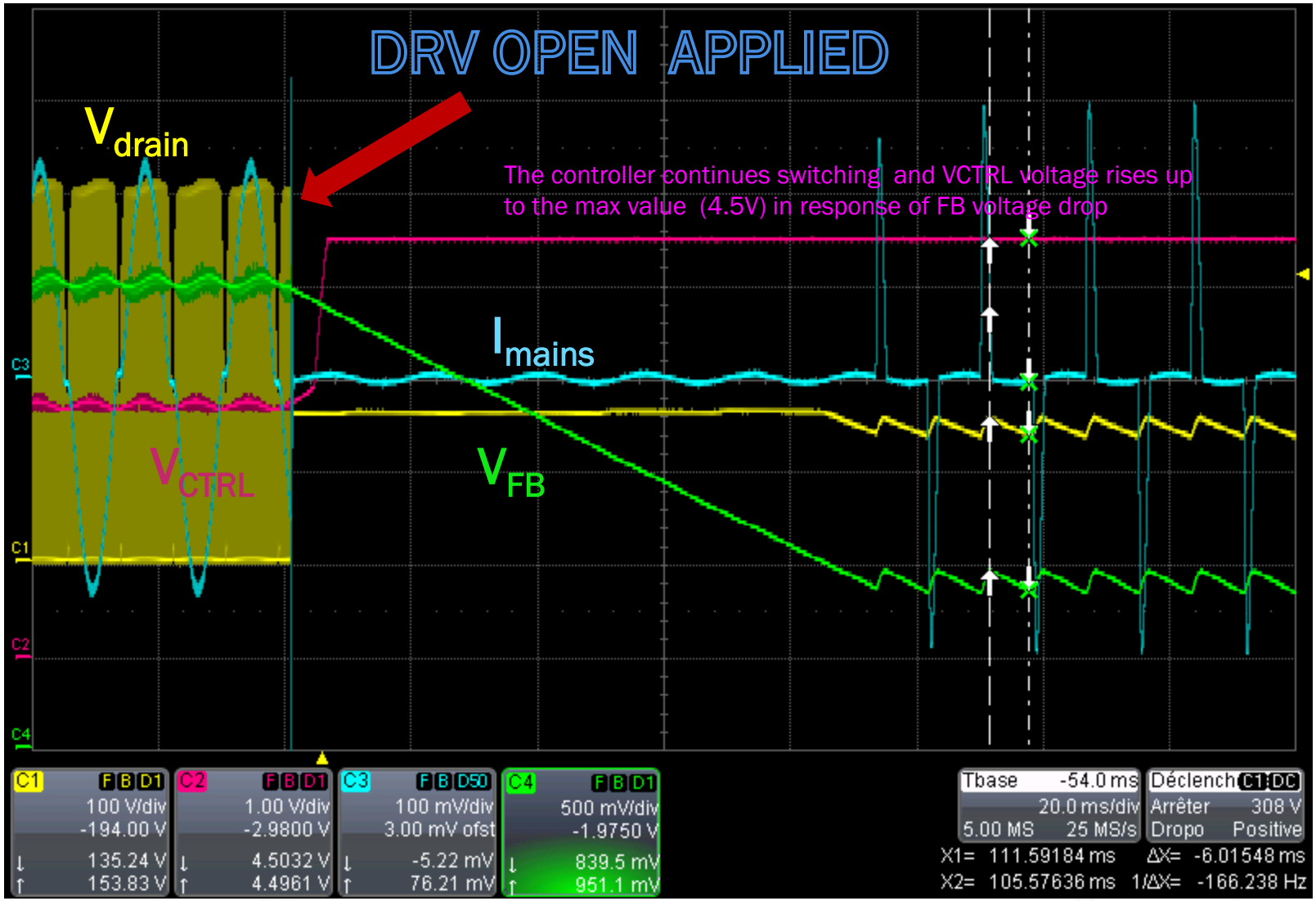
VCTRL gets fully discharged through the compensation resistor

DRV (4) Open

DRV Normally Connected , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V

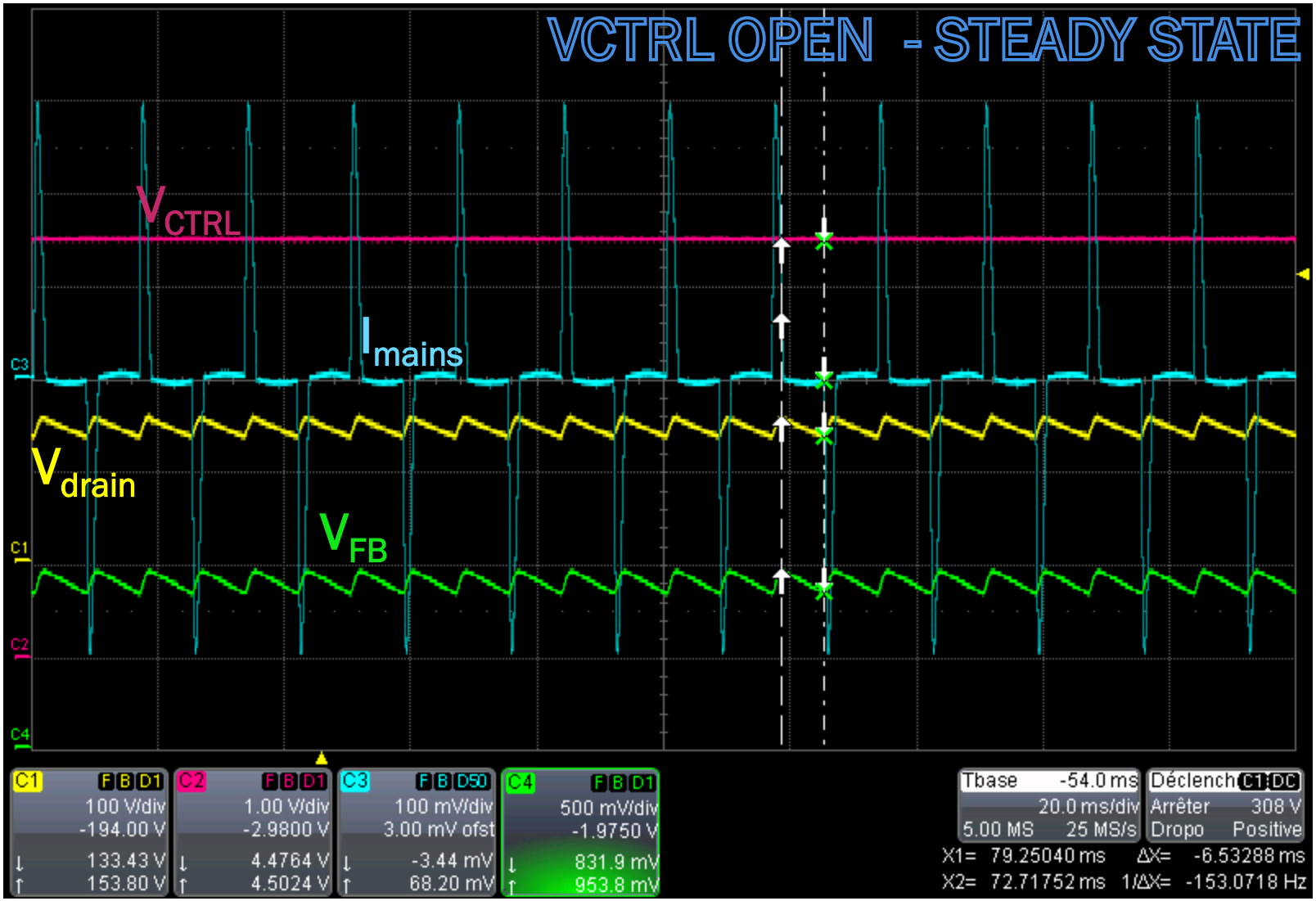


DRV Open from steady state, Vcc=20V
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



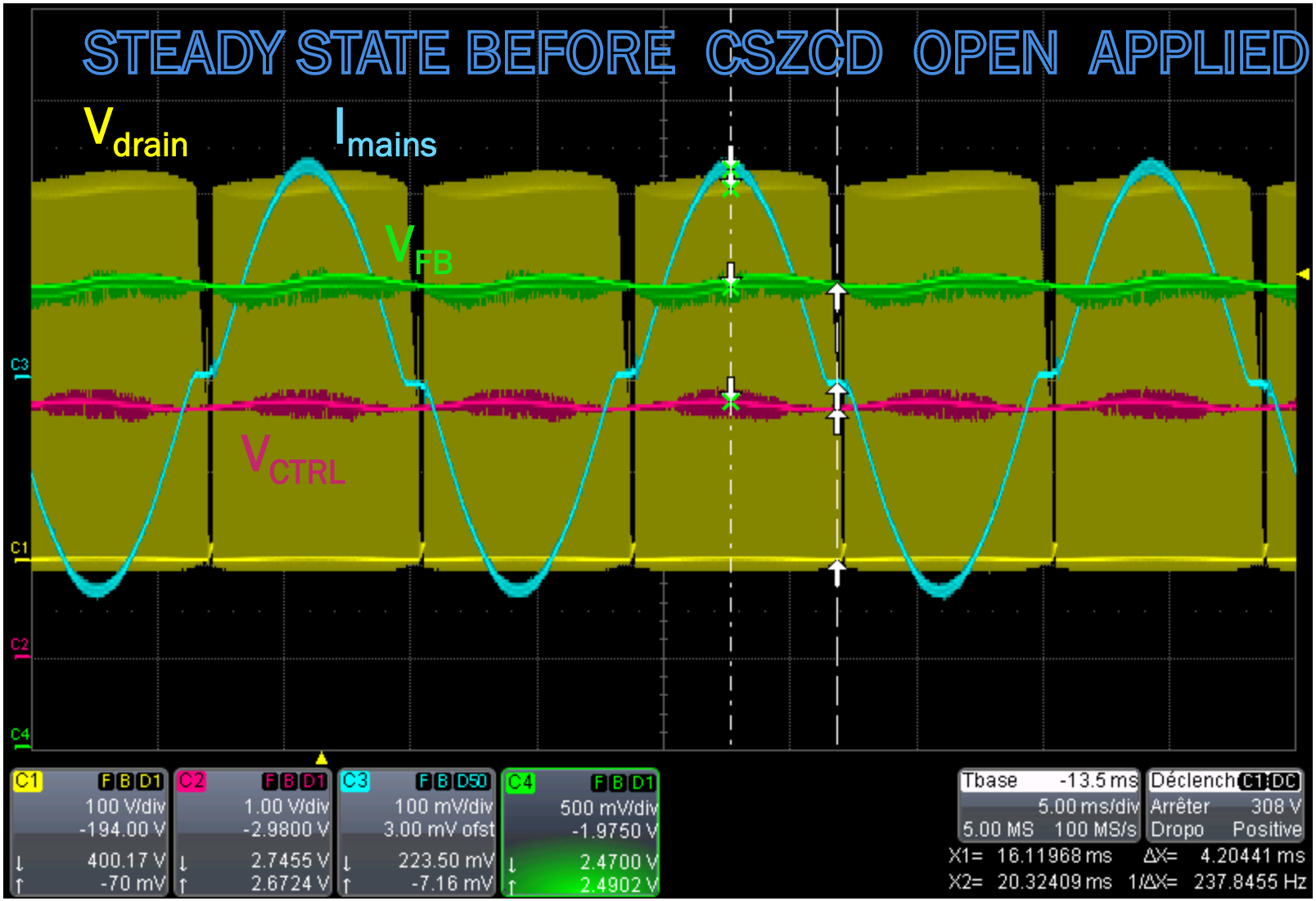
Power mosfet is no more connected to DRV pin and is kept off by the Gate to Source external resistor . No power is tranfered to Vbulk which gets discharged by the load current.

DRV Open Before Startup , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 143V

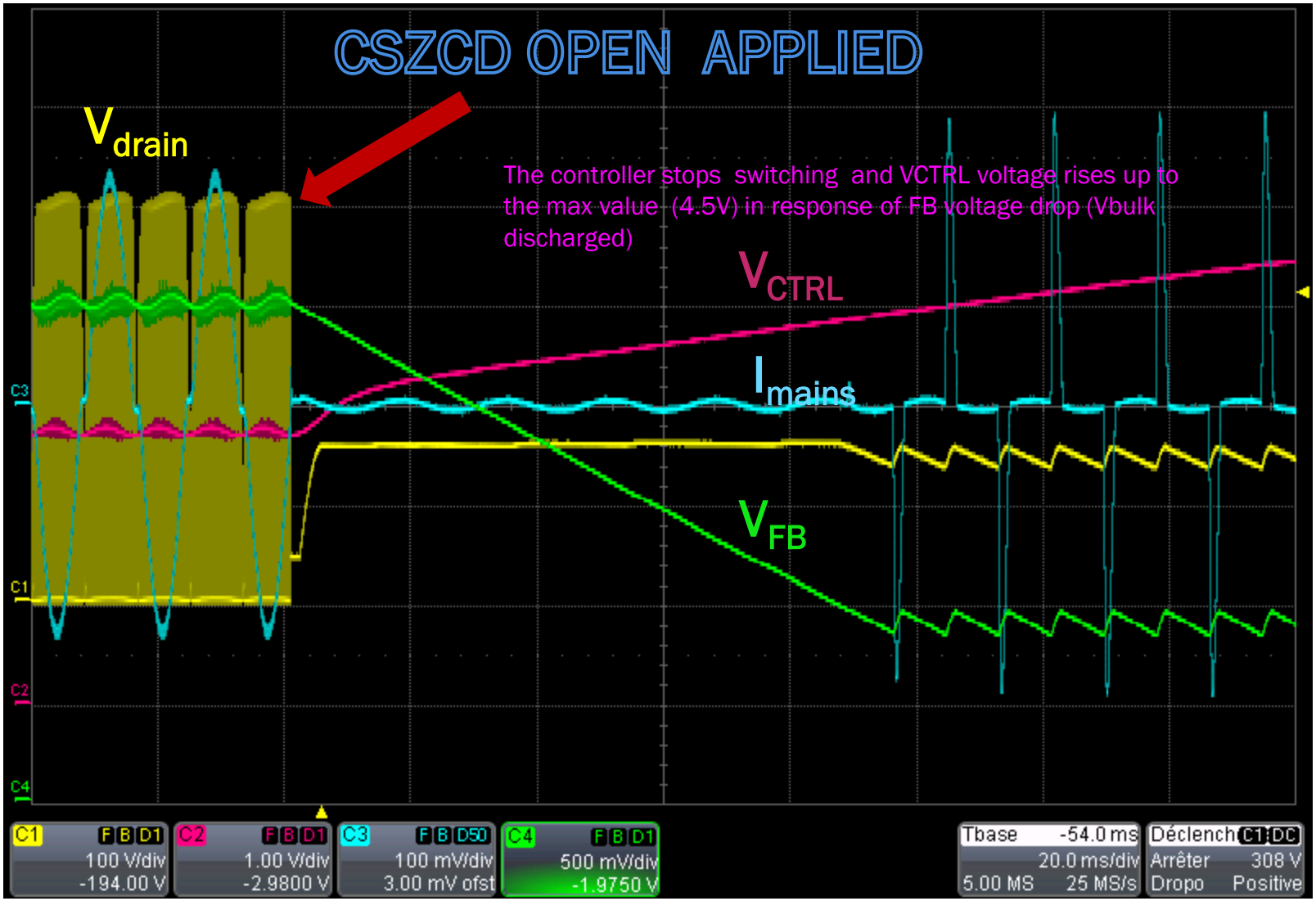


CSZCD (3) Open

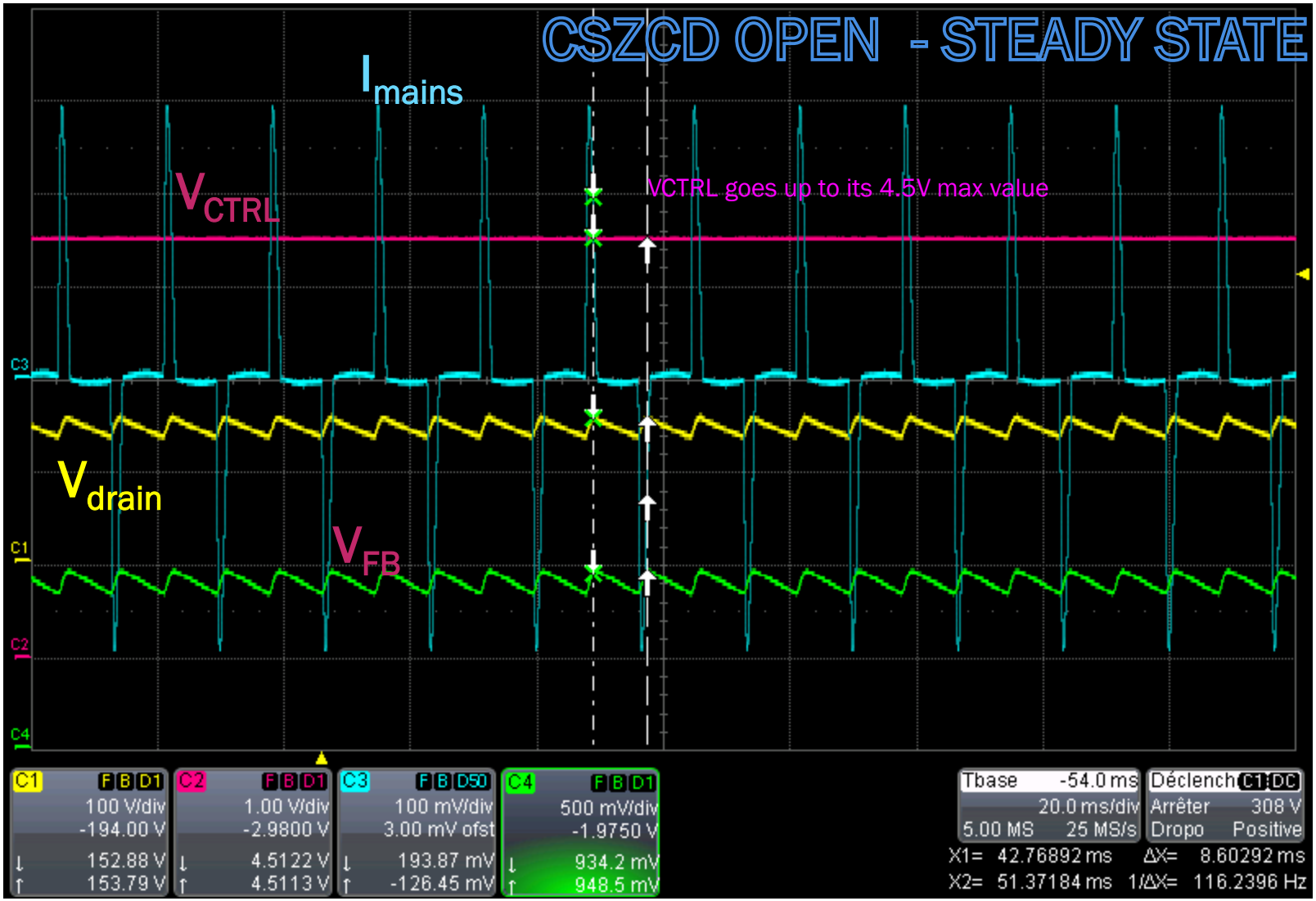
CSZCD Normally Connected , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



CSZCD Open from steady state, Vcc=20V Vmains=110 Vac ; Iload=400mA; Vbulk= 390V



CSZCD Open Before Startup , Vcc=20V is applied
Vmains=110 Vac ; Iload=400mA; Vbulk= 143V



END OF THE ANNEX