

CS1133 V_{SAT} Probe



Summary

The CS1133 V_{SAT} probe is used to measure the saturation voltage of a switching transistor. It uses a 30mA high compliance current source to measure the transistor forward voltage while the voltage across the device is less than the clip level. The clip level can be set to 3 ranges; approximately 15V, 1.5V and 150mV. Above the clip level the V_{SAT} probe is disconnected from the Unit Under Test (UUT). It is expected that the UUT will have a good deal more than 30mA flowing through it so this small additional current will not significantly change the saturation voltage. The CS1110 is designed to work into a 50 ohm load. The CS1133 is rated for operation over the input voltage range of 0V to +3.3kV. It can also withstand negative overshoot on the UUT down to -100V for short term transients.

The CS1133 is powered by +5V sourced by the CS448 LINK PORT (pin 1) via an 8 pin Mini Din Connector. It also includes two controls to select clip level; IN1 (pin 8) & IN2 (pin 5). The power and control signals are isolated via a low capacitance isolated power supply and optical isolators housed in a separate unit. The isolation withstand voltage is 1kVAC CAT III or 2kVDC. In addition the active portion of the CS1133 is shielded to ensure it can be used to measure the high side transistor while they are switching.

Connections

The CS1133 is made up of two units; the Probe Head which had the measuring electronics and the Power & Control Isolator. The Probe Head connects to the Isolator with a 150mm long Type-C USB cable.



WARNING The Power/Control connectors on the Probe Head & Isolator do not use standard USB pin-out or signals. DO NOT connect these to a standard USB cable or computer, phone, etc.

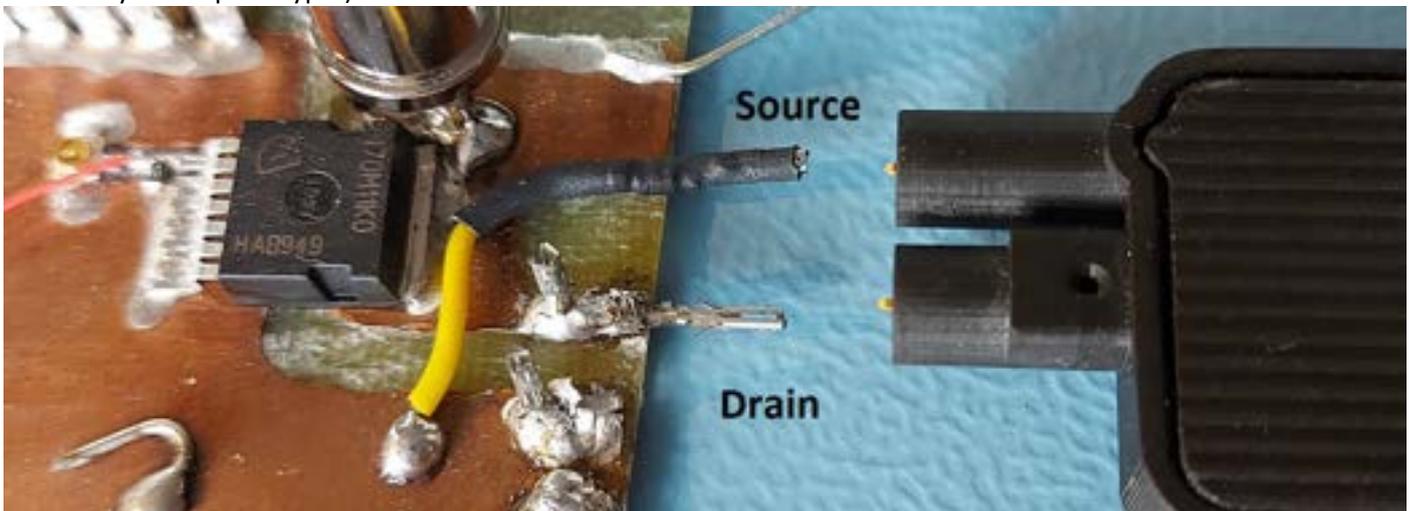
To connect the Probe Head slide the protective sheath towards the input pins and then screw on the SMA coax and plug in the power/control cable



Connect the other end of the power/control cable to the Isolator. Connect the 8 pin Mini Din cable to the CS448 LINK PORT and the 50ohm terminated coax to a CS448 channel input.

Connection to UUT

The CS1133 has two 0.64mm square input pins which enable close connection to the UUT. This minimises the loop area to keep the input inductance low and achieve a fast response. To connect the CS1133 to the UUT solder some 0.64mm square sockets with short wires to the Drain & Source (or Collector & Emitter). In the example shown here the CS1133 is connected to the Drain and Source of a TO263-7 1.7kV SiC MOSFET (IMBF170R1K0M1). (Please excuse the crudity of the prototype!)



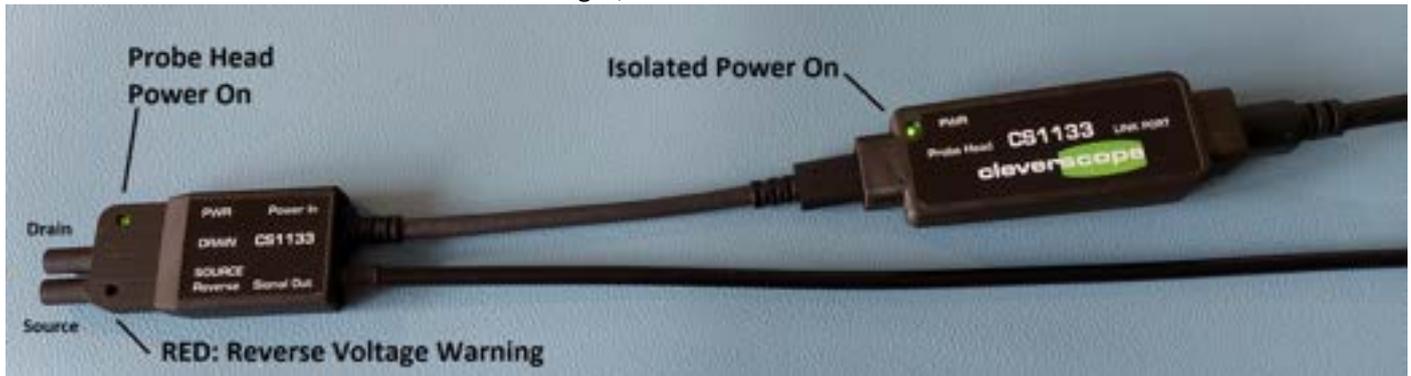
WARNING Ensure that the CS1133 is connected with the correct polarity to the Drain & Source (or Collector & Emitter) of the UUT. Reverse connection will damage the CS1133.

Here some 0.64mm square sockets have also been used to simultaneously measure V_{DS} with a x200 probe



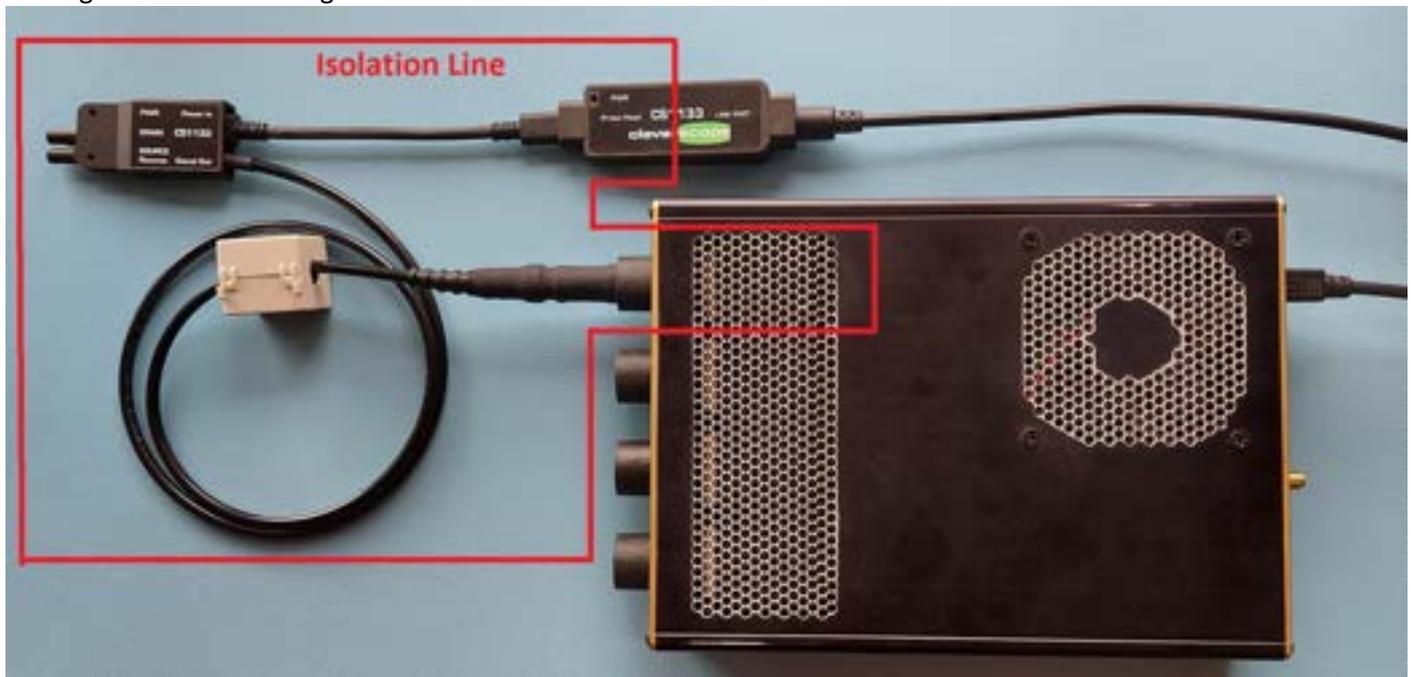
Indicators

The CS1133 has 3 indicator LEDs. One on the Isolator module to show isolated power is on. One on the Probe Head to show the power is on, and a red warning to show that the input voltage is reverse. Note the CS1133 can only withstand short duration transient reverse voltages, max -100V.



System Isolation

When used with the input channel isolation of the CS448 the CS1133 can be used to measure V_{SAT} of a high side or floating transistor. This diagram shows where the isolation occurs



All items within the isolation line (Channel A, Probe Head, Coax cable and output of Isolator) have a common reference connection which will be connected to the UUT Source (or Emitter). If the Source is a high side transistor in a half bridge this whole isolation island will move with the switching edges of the half bridge. A common mode choke (as supplied with the CS448) may be required on the coax cable to suppress common mode induced spikes and ringing.



WARNING All items within the isolation line above will be at the same potential as the UUT Source. DO NOT touch.

Ranges

There are 3 ranges

- 15V is useful for de-saturation measurements where the transistor V_{SAT} voltage increases during overload conditions.
- 1V5 range would be used for normal V_{SAT} measurements of an IGBT or MOSFET
- 150mV range is useful for very low RDS-ON transistors where the saturation voltage is below approx 100mV.

Range selection is via the input signals IN1 & IN2 on the LINK PORT and controlled by the CS448 application.

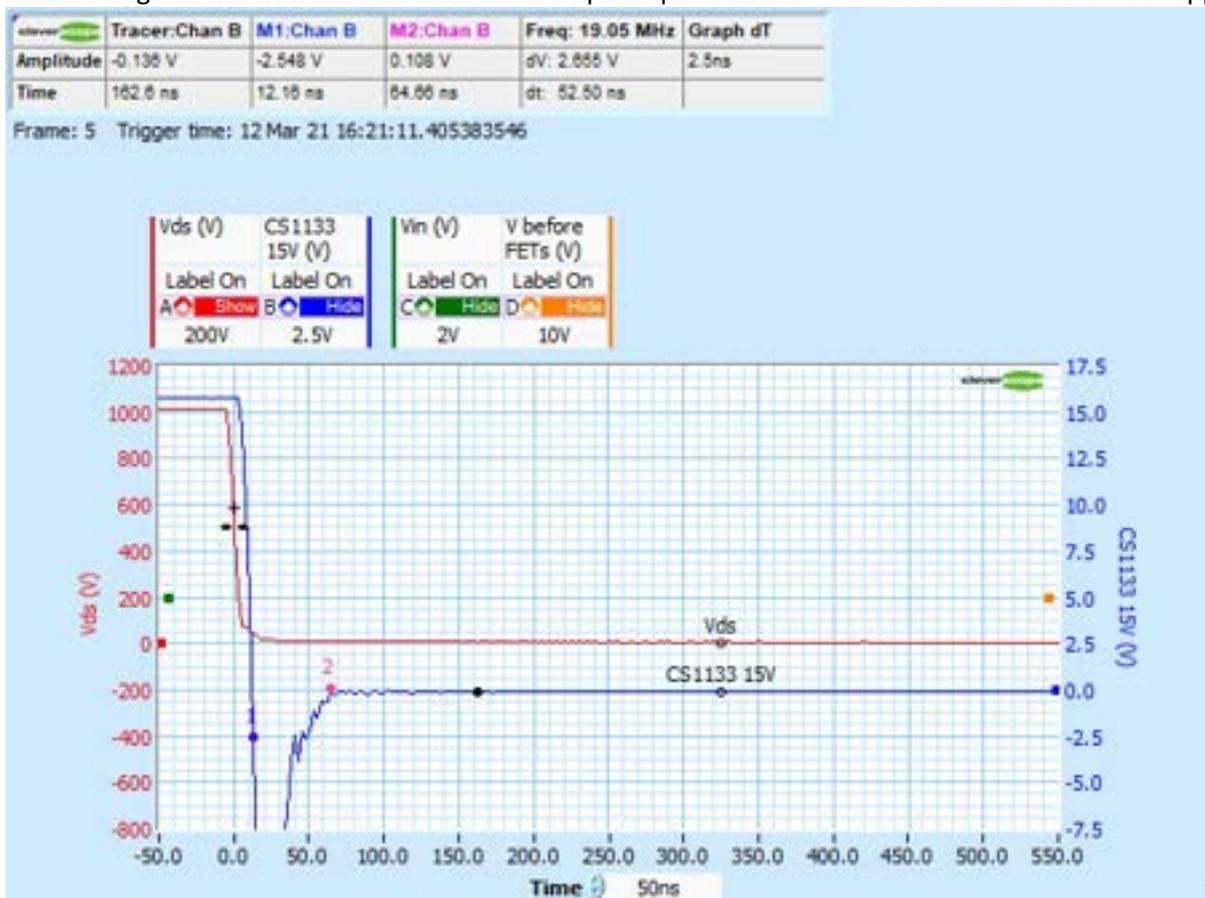
Specifications

| Parameter | Value (typical) | Comment |
|-----------------------------|--|--|
| Supply Voltage | 5V | From CS448 LINK PORT |
| Supply Current | 300mA | UUT Input open |
| Supply Current | 380mA | UUT Input shorted |
| Current source output | 30mA | |
| Input Voltage Range | 0-3300V | Do Not connect reverse |
| Max Negative Overshoot | -100V | Duration < 1ms, max 10% duty cycle |
| Isolation Working Voltage | 1kVAC CAT III or 2kVDC | |
| Clip Levels: | | |
| 15V range | 15V ± 1V | Set CS448 input to x20 & IN1,2=0,0 |
| 1V5 range | 1.5V ± 100mV | Set CS448 input to x2 & IN1,2=0,1 |
| 150mV range | 150mV ± 50mV | Set CS448 input to x2 & IN1,2=1,1 |
| Gain accuracy | < ± 1% | |
| Rise and Fall Times | <10ns | |
| Recovery after falling edge | 50ns on 15V range 100ns on 1V5 range | Approx. Depends on edge. With 1000V 10ns falling edge |
| Probe Head Size | 70x30x12mm | |
| Isolator Size | 94x30x20mm | |
| Supplied with | SMA-BNC cable with 50ohm termination, 1m LINK PORT cable, Mini DIN8, 1m Probe Head – Isolator cable, 150mm (USB-C) 0.64mm square sockets, 10pcs | |

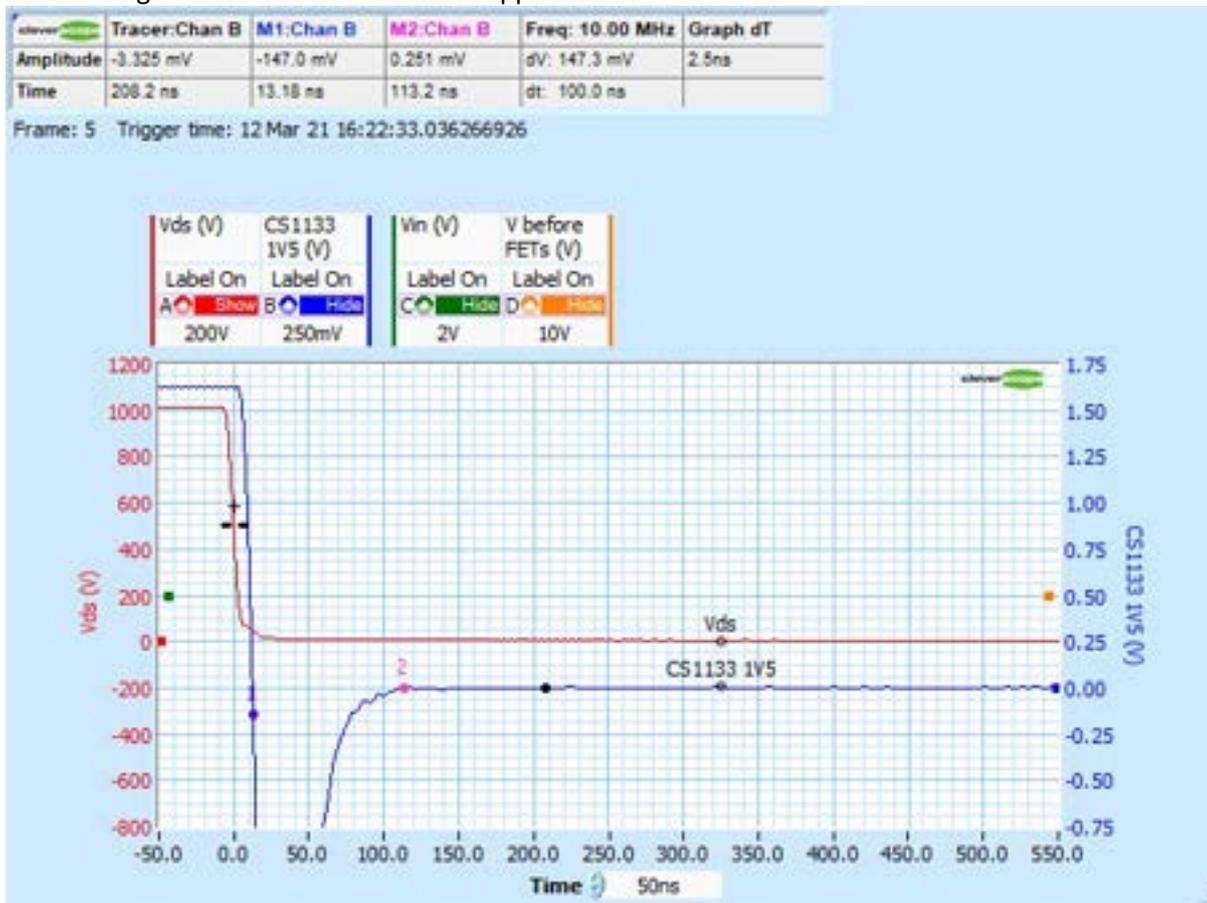
Measurements

The CS1133 is used to measure V_{DS} of a 1.7kV SiC MOSFET (IMBF170R1KOM1) with a 1M pullup to 1kV. Falling edge is approx 10ns, 100V/ns.

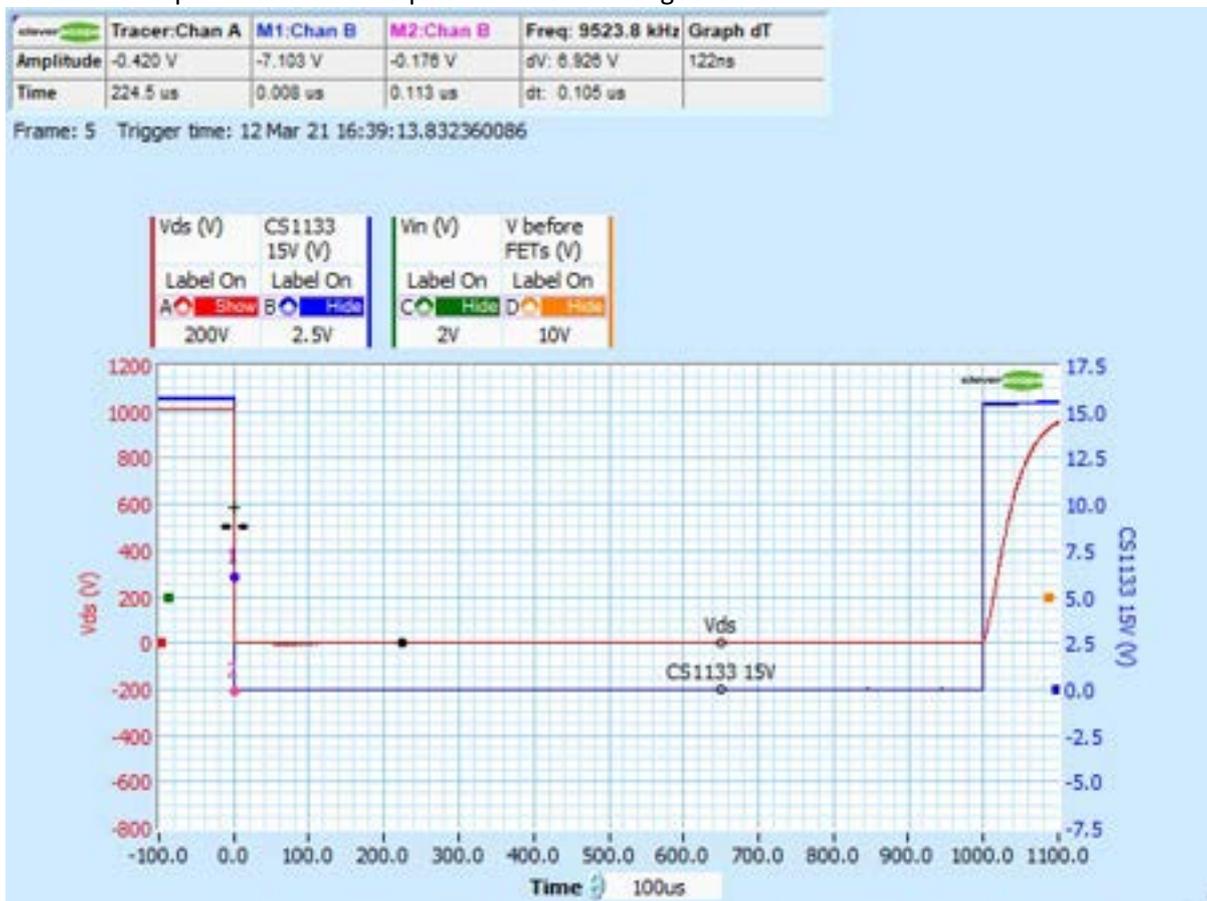
On 15V range there is an overshoot due to the input capacitance of the CS1133 which recovers in approx 50ns



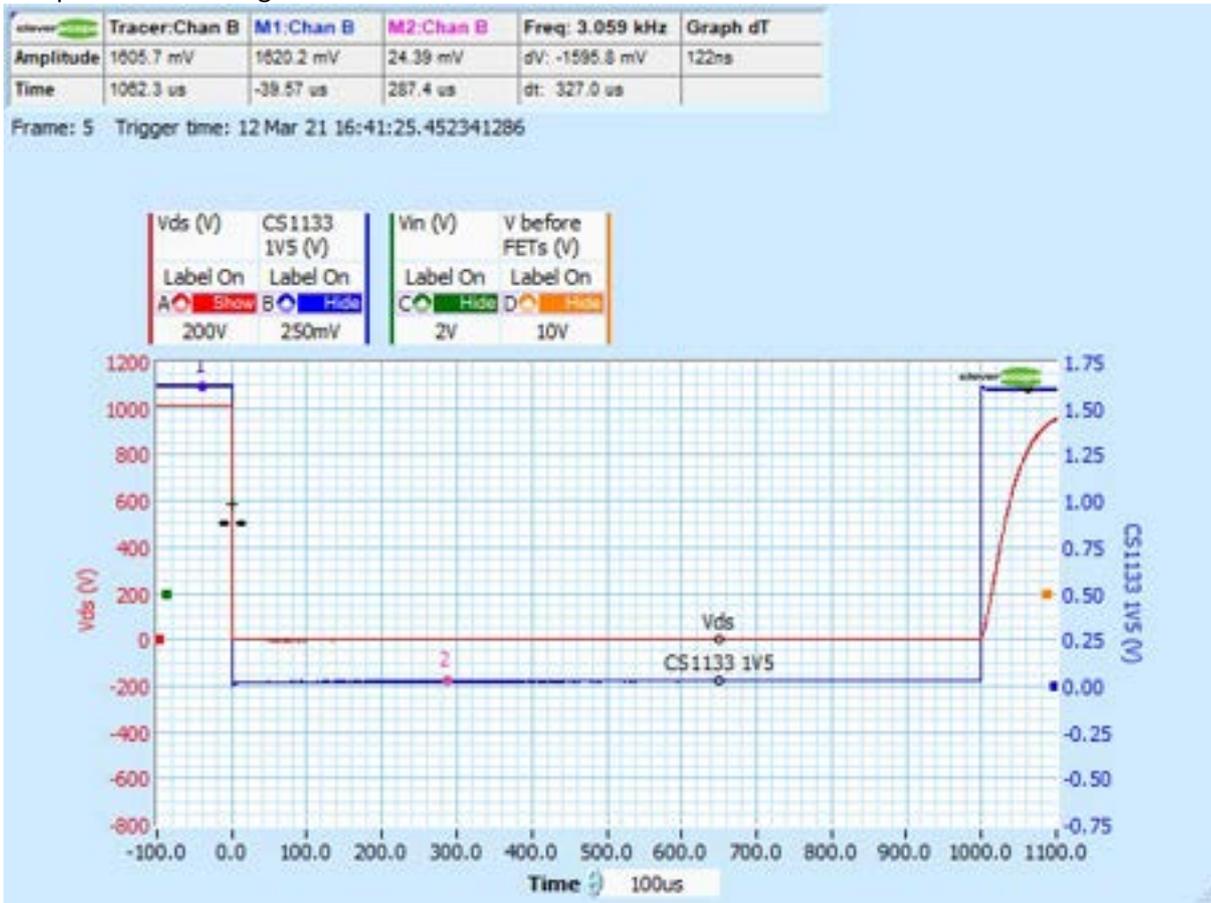
On 1V5 range the overshoot recovers in approx 100ns



Here is the response to a 1ms ON pulse for the 15V range.



1ms pulse on 1V5 range



1ms pulse on 150mV range. The 25mV offset is due to the CS1133 30mA current source and the approx 1ohm UUT MOSFET RDS-ON

