HVS1 Measurements of Input Currents on 2ch HV Control Card

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Measurements of input currents of the 2ch HV control card of the HVS1 TESLA high voltage power supply are described in this report. The maximum transient currents at start-up and switch-off states need to be known due to adequate protection fuse design for additional safety of HVS1 against accidental TRACO dc/dc converter's break down. The maximum measured switch-on current into each of three electronics parts of the 2ch HV control card is 47mA during 250ms, and then the steady state current decreases to 20mA. The protection fuses of these three blocks can be 100mA or 125mA.

Devices Used

• TESLA HVS1 high voltage power supply with 6 x 2ch HV cards, Fig.1. (a).
• 2ch HV control card under test, Fig.1 (b)

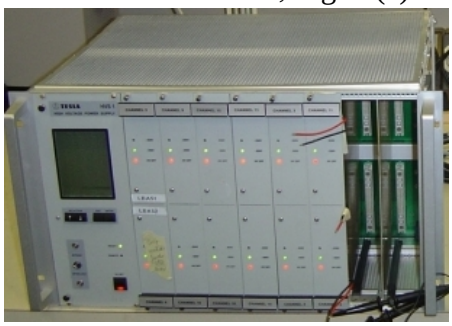


Figure 1. **(a)** **(b)**

• 4ch Digital Oscilloscope LeCroy PSLT344, 500MHz, 500MS/s
• Differential passive probe 100MHz LeCroy DXC100A
• Differential operational amplifier LeCroy DA1855A, see Fig.2.

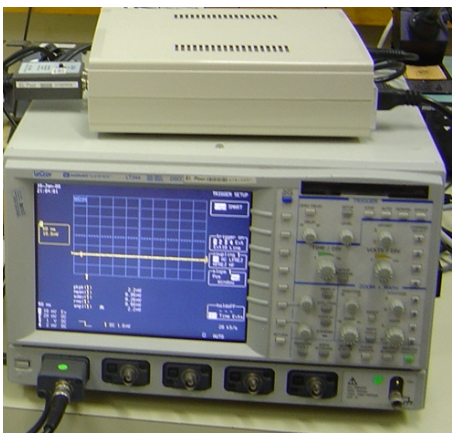
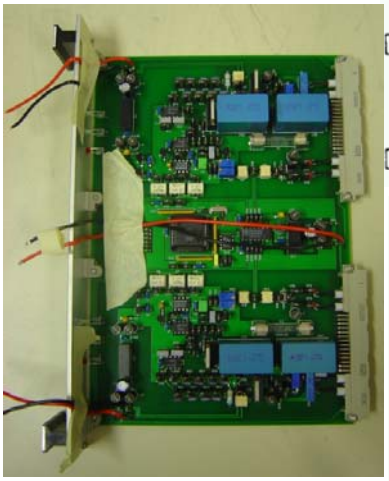


Figure 2.

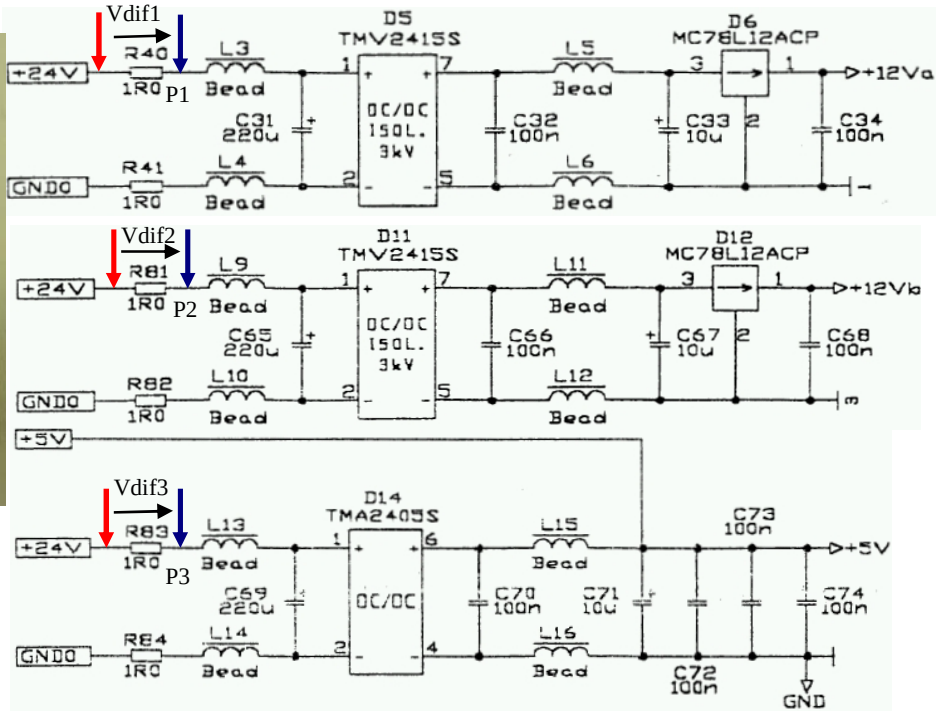
• Hand held digital multimeter TENMA 72-7930

Measurement Setup

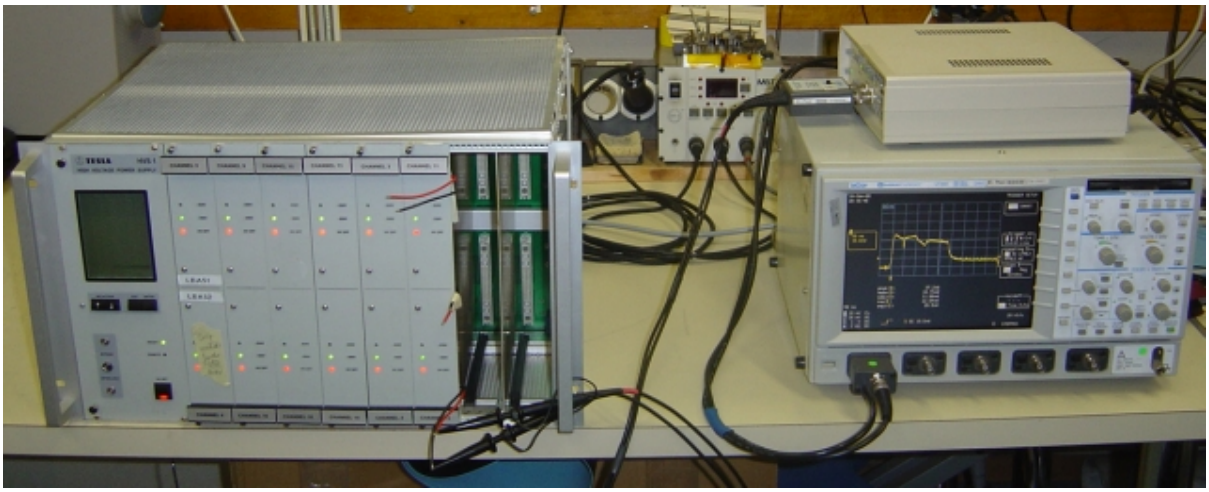
The input currents and on-off transients from 24V PS are measured via 1R resistors on 2ch HV control card (R40, R81, R83, see schemes on Fig.3.b) by the differential passive probe LeCroy DXC100A, differential amplifier LeCroy DA1855A, and visualized by LeCroy oscilloscope PSLT344. Voltage drop in mV on 1R resistors is proportional to flowing current in mA.



(a)



(b)

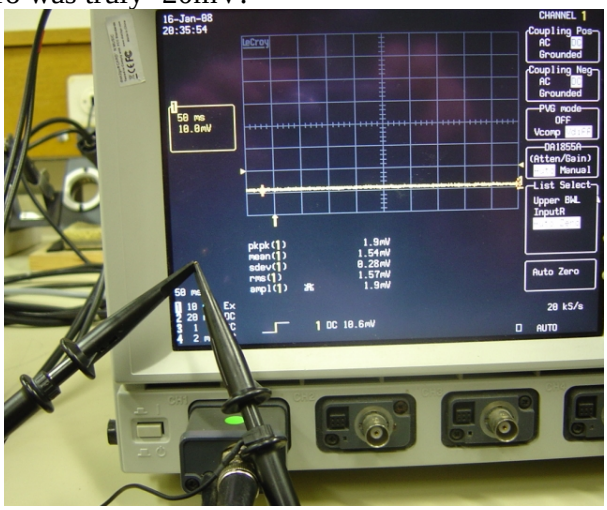


(c)

Figure 3. Modified 2ch HV control card (a), input currents to the card are measured as a voltage drop on 1R resistors R40 (Vdif1), R81 (Vdif2), and R83 (Vdif3), respectively (b), using a differential scope probe, operational amplifier, and visualized by LeCroy oscilloscope (c).

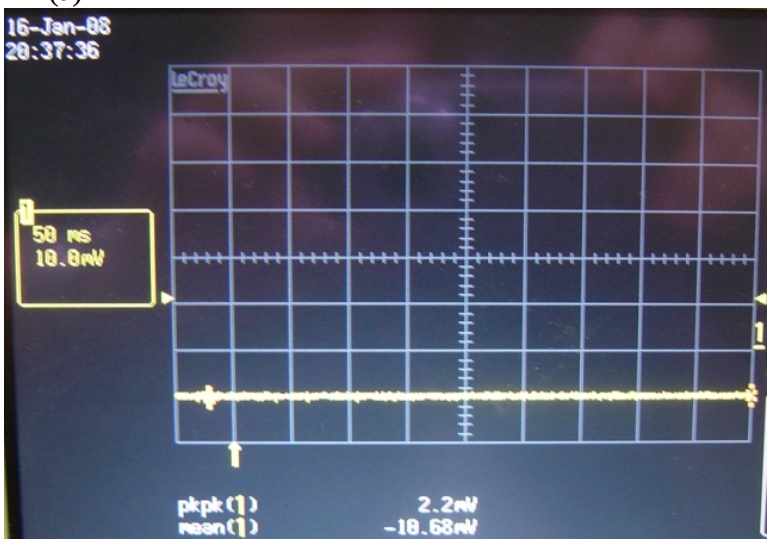
The passive probe and the differential amplifier were calibrated and auto zeroed before each measurements. However, an offset of -10mV was still present in the measured range of 10mV/div scale when the passive probe was connected to a working channel 1R resistor. More demonstration can be showed on figure 4.

At first, resistor values were measured; their resistances were 1-1.1ohms. When both positive and negative passive differential probes were connected together on air, minimum offset was present ~1.5mV on scope, see Fig.4.a. When both probes were shortened to one side of measured voltage drop (points P1, P2, P3, see Fig.3.b, and Fig.4.b) on HVS1 unit that was switched off, the scope also presented zero offset. After that HVS1 was switched on, and a non-zero voltage offset of -10.6mV appeared, see Fig.4.c.
The offset was later verified by a hand held multimeter; the voltage drop was ~20mV on all three R40, R81, and R83 resistors contrary to differential voltage scope measurements that displayed about 10.6mV less. The real and true voltage difference was observed only when HVS1 unit was switched off and the voltage (and thus corresponding current) transient recorded; the difference from quiescent value to zero was truly -20mV.



Initial dif. probe offset 1.5mV.

(a)



(b) **(c)**

Figure 4. Auto reset of passive differential probes (a), detail of connection of both differential probes to point P3 on HV control card (b), non-cancelled probe offset of -10.6mV when HVS1 was switched on (c).

Thus in the following HVS1 2ch control card measurements during switch-on state, real voltage drops across 1R resistors are to be about 10mV higher than displayed on scope screen. During switch-off state the voltage drop is right displayed.

Measurement Results

All three input currents and on-off current transients from 24V distributed voltage level were measured. When ON transient is measured, 10mV more has to be added due to observed differential offset as explained in previous section.

CH1 input current via R40

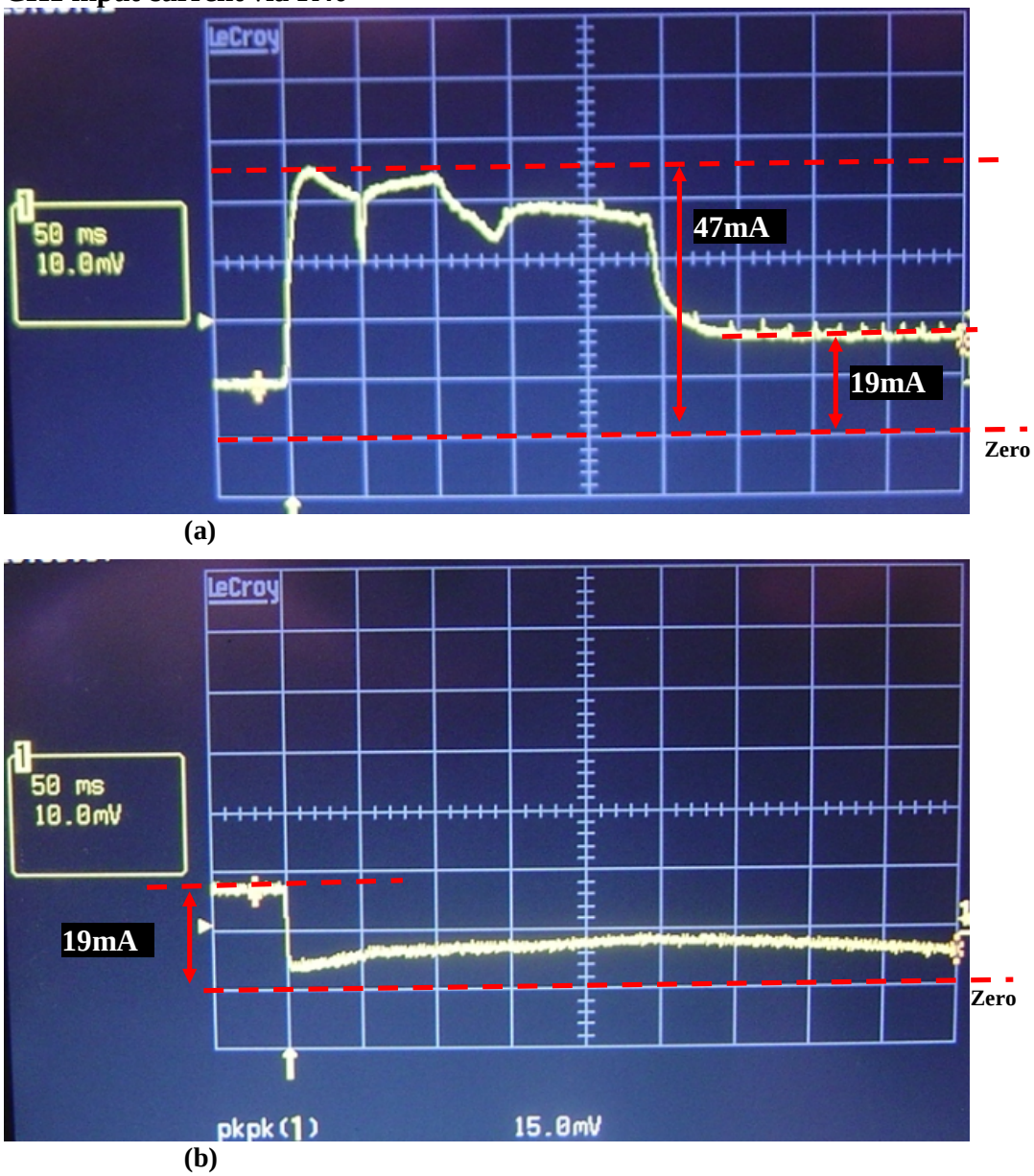
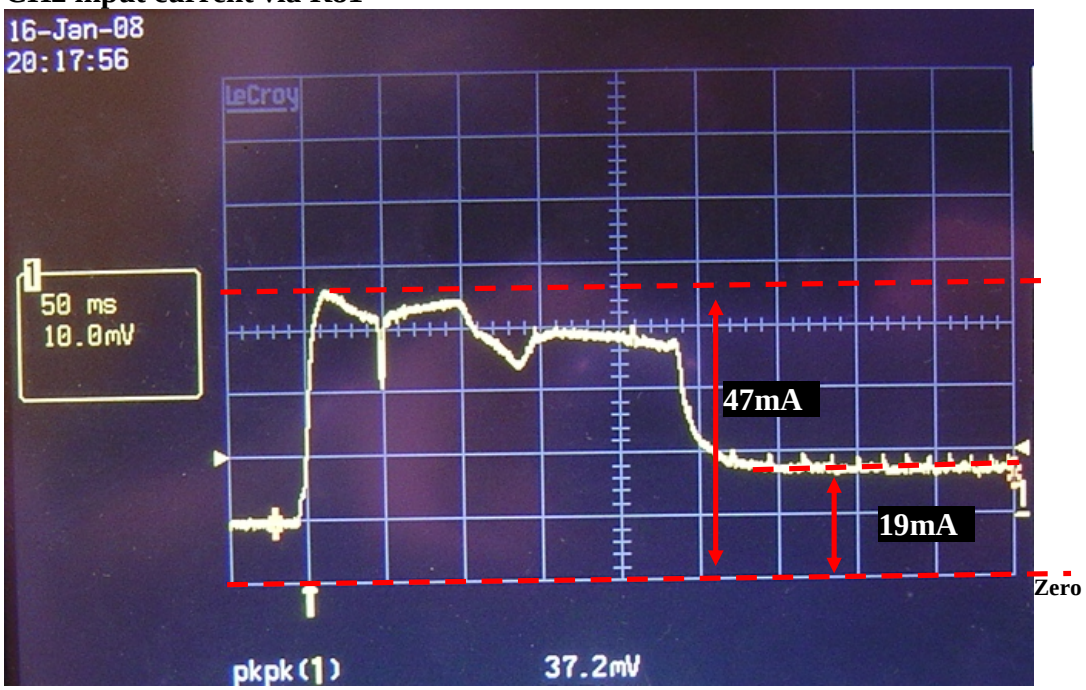


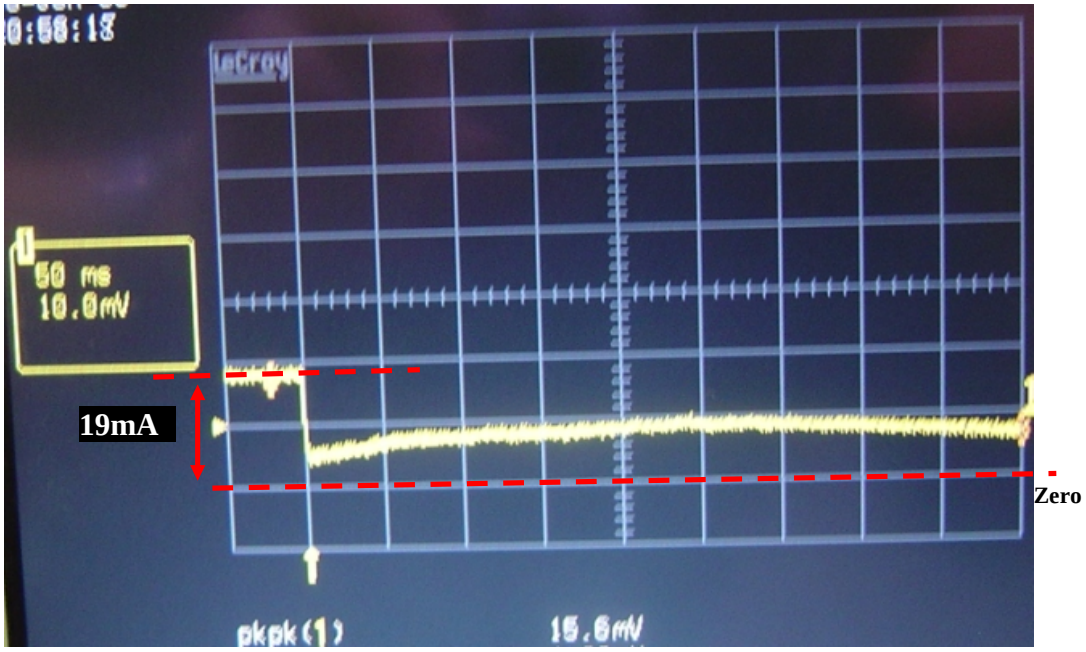
Figure 5. Switch-On and off current transients via R40 of CH1 HV control card.

The maximum current is measured to be 47mA, the steady state continuous current level is then 19mA (a). Switch off current fall from 19mA down to zero when HVS1 unit is switched off (b). Here voltage units on scope screen in mV correspond directly to flowing current in mA.

CH2 input current via R81



(a)

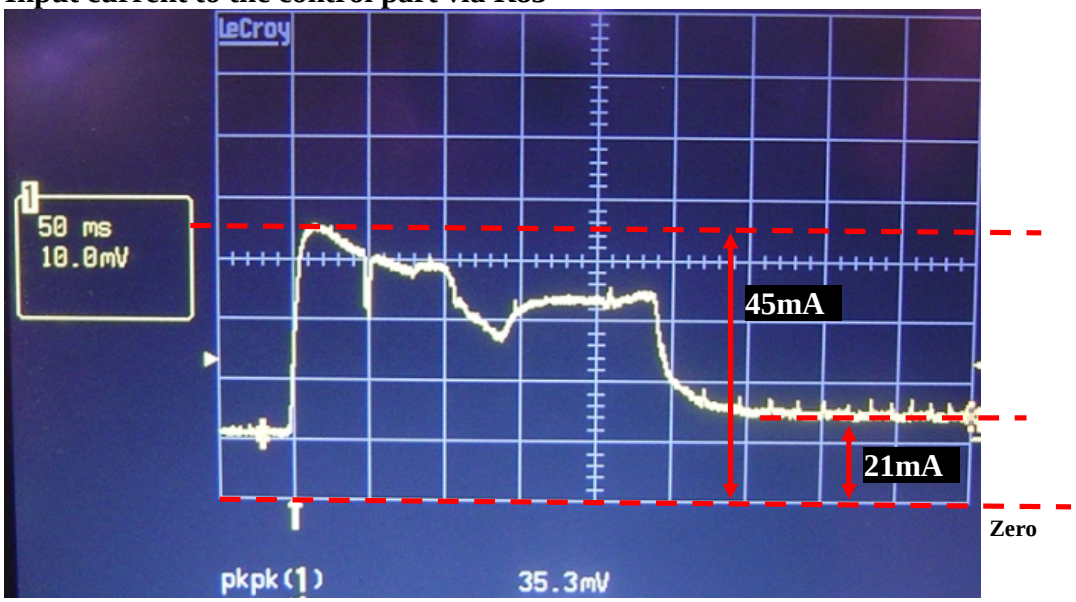


(b)

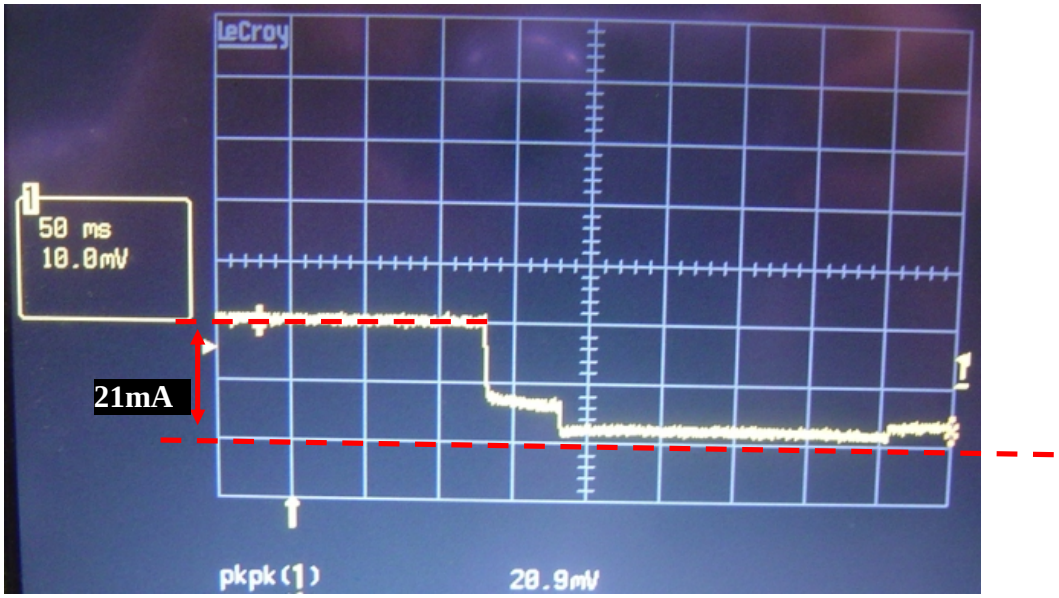
Figure 6. Switch On and off current transients via R81 of CH2 HV control card.

The maximum current is again measured to be 47mA, the steady state continuous current level is 19mA (a). Switch off current fall from 19mA down to zero (b).

Input current to the control part via R83



(a)



(b)

Figure 7. Switch On and off current transients via R83 of the HV control card.
The maximum switch-on current for this part is measured to be 45mA, and the steady state continuous current level is 21mA (a). Switch off current fall from 21mA down to zero (b).

Conclusions

The maximum input current for all three inputs and to the traco dc/dc converters measured on 2ch HV control card of the HVS1 power supply is 47mA loading 24V power supply during 250ms. All three electronic blocks (ch1 and ch2 power supply chains, controller power supply) present similar startup transients. When the HVS1 unit is switched off, the currents are going down without increase.

The protection fuses (replacing R40, R81, and R83) that will protect HVS1 crate against traco isolation damages on 2ch control card can be dimensioned to 100 or 125mA.

References

[1]"HVS1 power supply Operational Manual and schemes", TESLA Hloubetin, Prague, CZ, technical manual, 2001.