Visit to FDI Technology,
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Travel Report

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Abstract
The design and manufacture of the pulse amplifier required for the 3 MeV test stand chopper has been attributed to FID gmbh which is a branch of FID Technology of Saint Petersburg. This visit has been made to monitor the status of the supply.
INTRODUCTION

Last February the order of four pulse amplifiers was placed with the following delivery schedule:

- 1st unit: 29 June 2006
- Remaining units: 28 November 2006

Different difficulties pushed the delivery of the first unit ahead but measurements provided in May and October showed considerable progress and email exchanges suggested that the evolutions would have led to the achievement of the specified parameters. The visit was thus planned for a general verification of the amplifier status in view of the delivery of the first unit at the beginning of next year.

DEVELOPMENT STATUS

The amplifier seen and measured in St. Petersburg (see figures below) is based on a three terminal FID device. Current flow through the device is a replica of the control current but with improved transient characteristics. The improvement is possible because the control charge must equal the extracted charge and therefore, adjusting the control and output currents amplitude the transition time ($\tau_{in}$, $\tau_{out}$) can be reduced:

$$Q_{in} = I_{in} \tau_{in} = Q_{out} = I_{out} \tau_{out}$$

The amplifier generates a control pulse with a rising and falling front of ~3-4 ns and gets at the output a copy of it with improved voltage amplitude and front characteristics. The driving pulse is generated with some IXYS 420 gate drivers that drive a first FID to get a ~200 V driving pulse. This in turn drives the output stage. Presently, two to four 200 V control signal amplifiers, driven one after the other in order to increase the repetition frequency to 45 MHz, are used to control the final device.

This complex configuration brings along general pulse synchronization and pulse distortion problems that presently are not sufficiently well handled. Moreover, the IXYS 420 gate driver’s output signals are coupled to the downstream circuitry using small ferrite loaded transformers that saturate already after few tens of $\mu$s. This effect has been indicated as the reason for the short burst duration presently achieved by the prototype and the engineer in charge expressly said that there is not a power dissipation concern in the output device. The measurements done during the visit have shown that most of the specifications can be achieved but not during the whole burst (already much shorter that required) so that finally nearly no specification is fully achieved:

- The voltage amplitude of 700 V has been seen but they prefer working at 600 V.
- The maximum pulse length of 1 $\mu$s gives no problem but the minimum is 12 ns instead of 8 ns.
- The minimum off time pulse is better than specified: 10 ns instead of 14 ns.
- The maximum repetition frequency is around 30 MHz instead of 45 MHz.
- The minimum burst length is 10 $\mu$s instead of 1 ms.
Here below, two consecutive output pulses are shown for two different pulse lengths. The prototype under test uses only two driving channels and the output pulses can distinctly be linked to one or the other as even and odd pulses always present similar imperfections. In pulse #26 the falling edge is very close to the specifications but the following pulse #27 does definitely not.

30 ns pulse #26 and #27: the falling front is definitely different

Making the pulse longer (100 ns instead of 30 ns) changes the falling edge response and introduces even more remarkable differences between two following pulses.

100 ns pulse n.10 and n.11: both fronts are different
IXYS420  Driver FID  Output Stage FID  Output cable

Main card

Power supply and box
CONCLUSION

The present prototype does not prove that the specified performance can be achieved because basically none of the specifications is entirely fulfilled but at the same time we can clearly see that the target is not too far away. The use of IXYS gate drivers brings along considerable timing problems while the ability of FID devices to deal with high average power is not proven because only short bursts have been seen.

These considerations have been somehow anticipated by the company that has already developed a home made driver stage. It is based on their own technology of generating precise and fast short pulses. In this way they go back to a technique that they already know and, according to them, should completely correct the timing problems. The driver will be used with a different power device that can be triggered in the two conducting states by short pulses. Details about this device seem to be confidential. Generating positive or negative pulses is not considered by the company a possible source of problems because they can manufacture their devices from P or N material without altering the overall performance. They aim to provide a final generator composed of one power device and one driver. To do this the existing driver that only works to 20 MHz has to be improved and the new version is now under test. The possibility also exists of combining two drivers to achieve
the repetition frequency. Considering the accumulated delays and our needs, a common agreement has been found on the following schedule:

1. The prototype based on the home made driver will be assembled and measured within two weeks, and before Christmas a detailed set of oscilloscope shots proving the achievement of the specifications will be provided by email.
2. Both polarities shall be tested.
3. The delivery of the first unit is confirmed for end of February.