Direct-Sampling Coarse Bunch Arrival Time Monitor in the Free Electron Laser FLASH based on the Fast Digitizer Implemented in the FMC VITA 57.1 Standard

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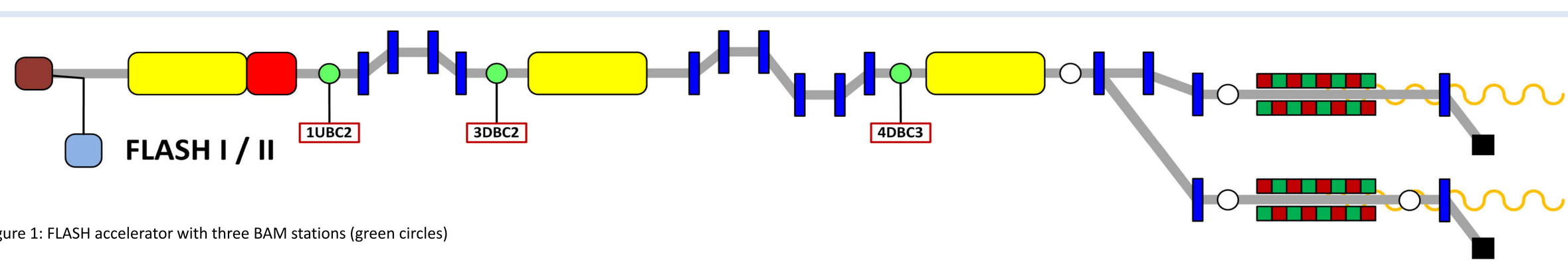


Figure 1: FLASH accelerator with three BAM stations (green circles)

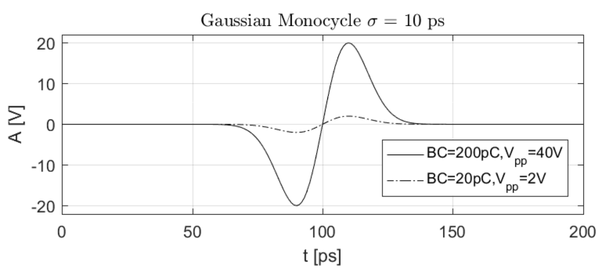


Figure 2: Gaussian Monocycles for different bunch charges

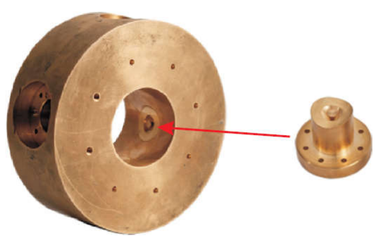


Figure 3: beam pick up

FLASH – First prototype

- first prototype installed in FLASH at 1UBC2 BAM station before first bunch compressor
- beam pick up produces a high frequency pulse when the electron bunch passes by
- pulse can be approximated with a gaussian monocycle which has highest power density between 20 GHz and 40 GHz
- amplitude depends on the bunch charge and can reach up to 20 V peak to peak

Analog Front-end

- bandpass filtering of the signal
- reduces bandwidth to 2.383 GHz
- attenuation of high input voltages
- amplification of low input voltages to drive full scale range of the ADC

Figure 4: coarse BAM analog front-end

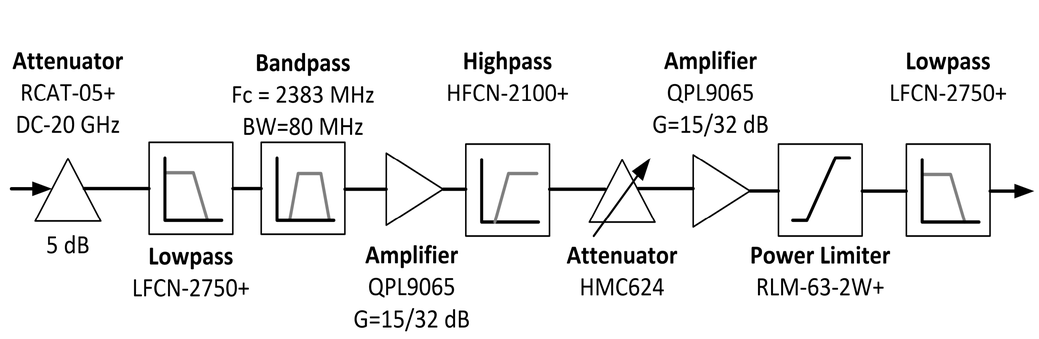


Figure 5: coarse BAM analog signal processing

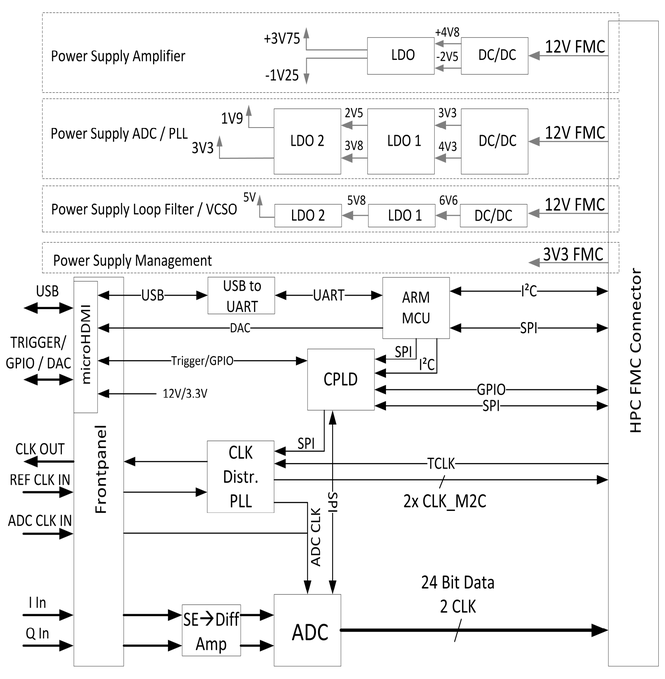


Figure 6: schematic overview DFMC-DS500

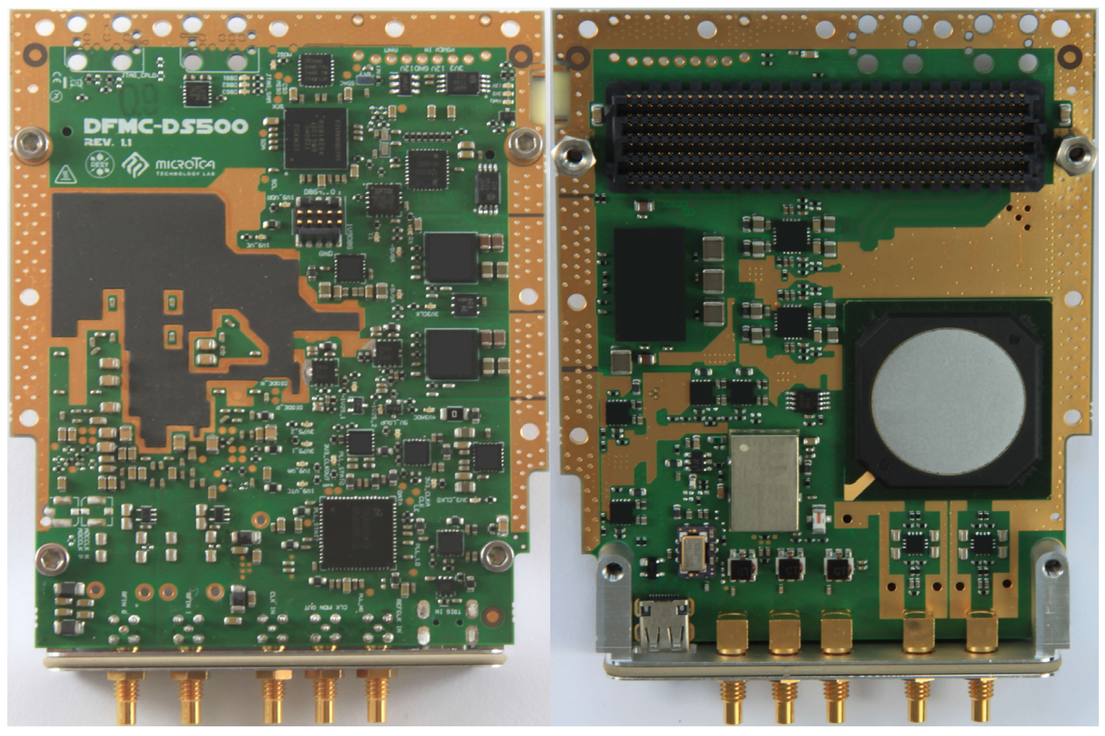


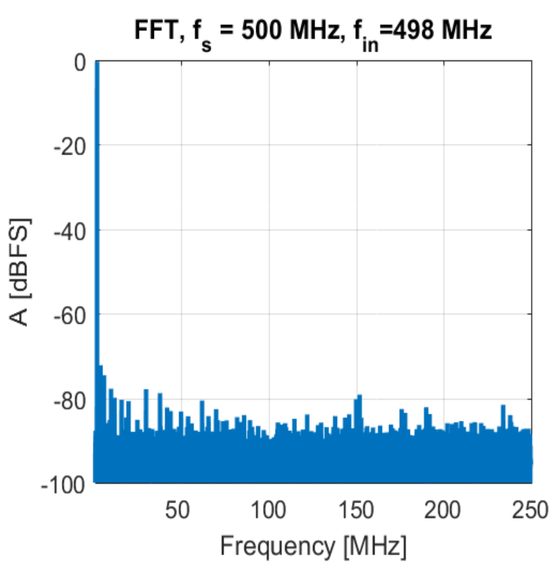
Figure 7: DFMC-DS500 board, left: bottom view, right: top view

DFMC-DS500 Direct Sampling Digitizer

- 12-bit dual channel ADC 500 MS/s
- 1 GS/s in dual edge sampling mode
- -3 dB bandwidth 2.7 GHz (non-DES)
- singel-ended to differential converting highly linear amplifier
- large signal bandwidth of 4.8 GHz
- low jitter (120 fs) PLL for clocking
- external clock input for ADC or reference input to PLL
- digital interface at front panel

Conclusion and Outlook

- performance degradation of ADC by input amplifier is minimal
- coarse BAM system works in FLASH and can take samples
- implementation of algorithms to determine phase and arrival time
- implementation of automatical tuning of the electro-optical BAM system



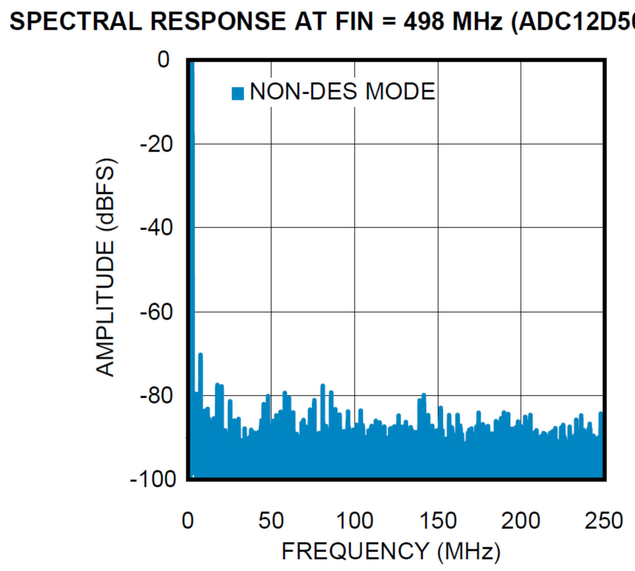


Figure 8: spectral response , left: DFMC-DS500, right: ADC12D500RF datasheet

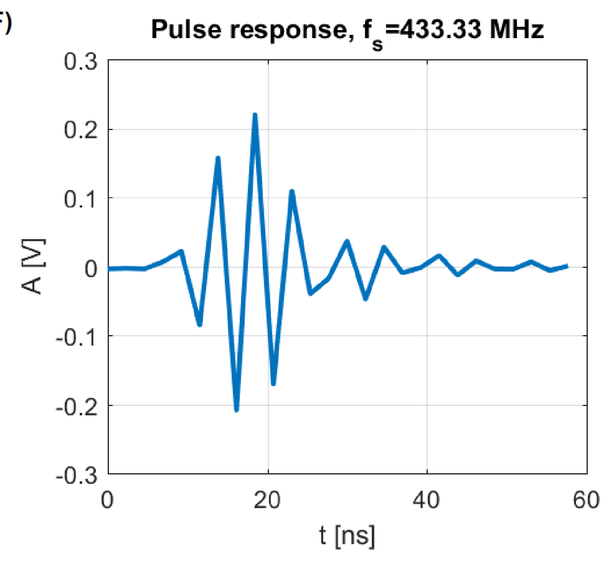


Figure 9: coarse BAM first sampled pulse response from AFE in FLASH

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