MicroTCA.4 based Single Cavity Regulation

including Piezo Controls

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on behalf of MSK Group
Outline

> Introduction
> Hardware
> Firmware
> Software
> Results
Introduction

> DESY employ since Feb. 2015
> Member of MTCA.4 hardware R&D team leded by M. Fenner

If You have Your MTCA.4 hardware questions, problems please contact:
mtca-support@desy.de or michael.fenner@desy.de konrad.przygoda@desy.de
MTCA.4 Electronics: RTM
4 Channel Piezo Driver

> Double width MTCA.4, Mid-Size Rear-Transition Module (RTM), Class D1.0, D1.1, D1.2 compatible

> Features:

- Supports 4-channel Piezo Drivers and Piezo Sensors
- Remotely switchable actuator and sensor functionality
- Remotely switchable driving input source (ext./int.)
- 4x DAC 18-bit up to 0.5 MSPS
- 16x ADC 18-bit up to 100 kSPS
- Unipolar: 0..+100 V and bipolar: ±100 V piezo power supplies (ext./int.)
- Interlock signal support
MTCA.4 Electronics: RTM
8 Channel Down-Converter 1 channel Vector-Modulator

> Double width MTCA.4, Mid-Size Rear-Transition Module (RTM), Class A1.0, A1.1, A1.2 compatible

> Features:

- 8 down-conversion input channels (AC) with programmable attn.
- LO input for analog down-conversion 1.3 GHz
- 2 analog general purpose inputs (DC)
- 1 up-conversion output channel (AC) with programmable attn.
- REF input for analog up-conversion 1.3 GHz
- ADC clock input (AC) up to 125 MHz
- Interlock signal support
MTCA.4 Electronics: AMC
Fast Digitizer

> Double width MTCA.4, Mid-Size Advanced Mezzanine Card (AMC), Class A1.0, A1.1 compatible

> Features:

  - 10x Analog Inputs: ADC 125 MSPS
  - 2x Analog Outputs: DAC 125 MSPS
  - RTM linked to Virtex 6 FPGA
  - RTM hotplug support
  - PCIe 4x served by Virtex 6 FPGA
  - 6 MGTs (4xLLL + 2x SFP) => up to 10 Gbps

SIS8300L2
Struck Innovative Systems
with DESY collaboration
MTCA.4 Electronics: AMC Dual FMC Carrier Board

> Double width MTCA.4, Mid-Size Advanced Mezzanine Card (AMC), Class D1.0 compatible

> Features:

- 1x HPC and LPC FMC linked to Spartan 6 150 FPGA
- RTM linked to Spartan 6 150 FPGA
- RTM hotplug support
- PCIe 1x => Spartan 6 45 FPGA
- 1x MGT => up to 3 Gbps AMC backplane connection on ports 12-15
- Interlock signal support

DAMC-FMC20 licensed by Eicsys
FMC Extensions

- DFMC-SFP4: 4x SFP up to 10 Gbps
- DFMC-AD16: 16x analog inputs up to 100 kSPS
- DFMC-MD22: 2x step motor drivers
- DFMC-UNIO: 48x general purpose I/Os, external clock input
Single Cavity RF and Detuning Controller

> Control Theory Point of View
Single Cavity RF Controller

> MTCA.4 Point of View
Single Cavity Detuning Controller

> MTCA.4 Point of View
Cavity RF and Detuning Controller (Simulation)

> RF/Piezo Feedbacks off

for ii=1:Ncav
if NOISE && dw_m(ii).ena
    det(ii) = det(ii) + 2*pi*dw_m(ii).ampl*sin(2*pi*dw_m(ii).freq*n*DT);
end
end

for ii=1:Ncav
    Vcav(n,ii)=(Vcav(n-1,ii)+DT*w0*rho*Ifwd*exp(1i*phig)).../(1+DT*(w12+1i*det(ii)));
end

> RF/Piezo Feedbacks on
Single Cavity RF and Detuning Controller (Software)

```plaintext
rf_c = mtca4u('SISL_6')
pzt_c = mtca4u('FMC20_5')

rf_ctl_init(rf_c)
piezo_ctl_init(pzt_c)

rf_ctl_ff(rf_c, val)
piezo_ctl_ff(pzt_c, val)

rf_ctl_sp(rf_c, val)
piezo_ctl_sp(pzt_c, val)

rf_ctl_fb(rc_c, val)
piezo_ctl_fb(pzt_c, val)

[a b] = read_dma_daq({rf_c; pzt_c}, no_chan, no_samp, addr)
```
Cavity Signals Readout (RF feedforward)
Single Cavity RF and Detuning Controller (First Results)

- RF Feedback off (Feedforward only; SP=1MV)
- Piezo Feedback off (Cavity detuned by 15 degrees)
Single Cavity RF and Detuning Controller (First Results)

> RF Feedback off (Feedforward only; SP=1 MV)
> Piezo Feedback on (Cavity tuned to 1.3 GHz resonance frequency)
Future Plans

- Demonstrate full performance of single cavity RF feedback
- Demonstrate full performance of single cavity detuning feedback
- Demonstrate full performance of single cavity both feedbacks
- Out-of-loop measurements
- DOOCS server and operator panels evaluation
- Share our experience with other labs, i.e. HZB, HZD
Thank You for Attention