Fermilab 3.9 GHz RF Signal Processing for LCLS-II Cryomodule Test Stand E. Cullerton, B. Chase, Fermilab, Batavia, IL, USA L. Doolittle, LBNL, Berkeley, CA, USA

Introduction

The LCLS-II 3.9 GHz cryomodule will be tested at Fermilab's Cryomodule Test Stand (CMTS) facility. Presented is the RF hardware for frequency conversion and distribution of RF signals for processing by the LLRF FPGA control system. All the RF signals are generated from a single low noise RF synthesizer running at 1.3 GHz. The RF hardware is powered from a single 6V power source and is housed in 19" rack mount chassis'. Presented are chassis' that generate 1.32 GHz signals for FPGA clocks and up conversion, 3.9 GHz reference signals, and 3.92 GHz local oscillator signals. A description of the RF hardware for up and down conversion from 3.9 GHz to IF frequencies is also presented.

1.3 GHz, 1.32 GHz, 3.9 GHz, and 3.92 GHz Signal Generation

Using a low noise Agilent synthesizer, a 1.3 GHz signal is used to generate all the RF signals and clocks required by the LLRF systems. A 19" rack mount chassis generates 20 MHz and 1.32 GHz RF signals from the 1.3 GHz signal is used for FPGA clocks, up conversion, and is sent to a second chassis to generate 3.92 GHz signals used for down conversion. There are also 1.3 GHz reference signals and 3.9 GHz reference signals required by the LLRF systems at the CMTS test facility. All output signals have >80 dB spurious signal suppression.







3.9 GHz to 20 MHz Down Conversion Hardware

- 6 channels of down conversion.
- RF input volts to IF output volts has a linearity of less than +/- 1.0 % up to 8 dBm RF input.
- RF to IF conversion loss ~2.4 dB, typical.
- Adjacent channel to channel isolation > 100 dB.
- Integrated 1/f noise from 0.02 Hz to 20 Hz at the IF output is 0.15 fs.
- Output noise at the IF Output is -157.5 dBc/sqrt(Hz).
- Amplitude and phase temperature stability are approximately 0.2%/deg C and 0.2deg/deg C.
- RF input has an input return loss better than -15 dB.
- LO Input has an input return loss better than -19 dB.
- IF Output return loss better than -18 dB.

60 MHz to 3.9 GHz Up Conversion Hardware

• 2 channels of up conversion.

- IF to RF conversion gain is approximately 11 dB (Individual channel conversion may slightly vary).
- LO Input has an input return loss >14 dB @ 1320 MHz.
- IF Input has an input return loss > 18 dB @ 60 MHz.
- RF output has an output return loss >11 dB @ 3.9 GHz.
- RF output RF switch has 49 dB isolation.
- Power supply is 6 Volts, 1.1 Amps.
- RF monitor has >33 dB isolation to the RF output.
- RF monitor is ~15 dB from the RF output.
- LO monitor is ~6.9 dB from the LO input.
- IF monitor is ~ 10.9 dB from IF input.
- Channel to Channel isolation > 63 dB.
- Phase noise @ 10kHz offset = -131.8 dBc/sqrt(Hz).
- Phase noise @ 100kHz offset = -140.8 dBc/sqrt(Hz).

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