4/8-Pack Low Level RF
Cost Estimates for the NLC 4-Pack
LLRF Monitor Hardware

Andrew Young
Specifications

4-Pack: 4 Klystrons to be monitored.

- Signal counts:
  - 4-Pack will have ~37 monitor points
  - 8-Pack will have ~100 monitor points
- Waveform Diagnostics (100MS/s) on select group of signals to measure breakdown,
- Monitor ports for Spectrum Analyzers,
- Single Pulse diagnostics using “Gated ADC”,
- Peak Detected signals sampled at 100MS/s.
NLC LLRF
RF Generator Block Diagram
Digital Option

Timing Generator
Racal 3162B Dual 500Ms/s Waveform synthesizer
(From main drive line)

10 MHz Phase Reference

Trigger Request

476 MHz Phase Reference

10,829 MHz Phase Reference

119 MHz I.F. 1

595 MHz I.F. 2

11,424 MHz RF AMPS TWT's

VXI Based System
Baseband Vector Modulation Analog Option

11.424GHz +/-30 MHz

HP 83731B

4-way Splitter

Dual I/Q modulator and amp

Ia Qa Ib Qb

I/Q waveform generator and driver

TWT1

TWT2

Monitor point 1
Monitor point 2

Pulse train 1 (coax)

Ribbon cable

Voltage levels from existing DAC’s
(VMIVME-4100)

32

Ia Qa Ib Qb

I/Q waveform generator and driver

TWT3

TWT4

Monitor point 3
Monitor point 4

Pulse train 2 (coax)

HW timing signals

Monitor point 3
Monitor point 4
I/Q waveform generator and driver

74VHC4053
DP4T 80 ohm 40ns (typ)

NC7SB3157
SPDT
7ohm 5.7ns

CLC449
1.1GHz
6ns settling to 0.1% typ

Each half

Ia

Qa

To test points

Monitor point buffers

2/4 CLC115
700MHz BW

To other half

Switch control logic, autoreset and level shifting

Pulse train

MC10E1651
1ns delay

Enable

Enable

2

2
NLC LLRF
RF Monitor Block Diagram Rev2

RF Chassis Located by a Group of 8 Components

12 way Splitter

8 way Splitter

LO
10.948 GHz
Distribution for Monitoring
(kly,SLEDII/DLDS, ACCEL Structures, etc
~100 RF signals)

IQ Module
Diodes

High Speed Digitizer

Joerger Digitizer

Joerger Digitizer

IF Signal
RF Signal
NLC LLRF

4-Pack RF Monitor Block Diagram

LO 10.948 GHz

Distribution for Monitoring (kly, etc ~40 RF signals)

RF Chassis Located by a Group of 8 Components
NLC LLRF
IQ Module Block Diagram

- LO 476 MHz
- 8 way Splitter
- 8-way Splitter
- 2-port Coupler
- 8 to 1 MUX
- GADC Joerger Digitizer
- 30 MHz LPF
- RMS/Peak Power
- Power Out
- Mux Control
- High Speed Scope
- GADC Joerger Digitizer
- Inputs=9
- Outputs=24
NLC LLRF Timing System

2 STB’s
18 Ch. PDU’s
## VME Crate Layout 4-Pack

### RF Monitor VME Crate #1 Layout

<table>
<thead>
<tr>
<th></th>
<th>CPU</th>
<th>IF PLL</th>
<th>RF PLL</th>
<th>Joerger</th>
<th>Joerger</th>
<th>Joerger</th>
<th>IQA</th>
<th>IQA</th>
<th>IQA</th>
<th>IQA</th>
<th>MUX</th>
<th>MUX</th>
<th>Joerger</th>
<th>Joerger</th>
<th>GADC</th>
<th>GADC</th>
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</thead>
</table>

### IQA Front Panel

- Power Trip
- Power Trip
- Power Trip
- Power Trip
- Power Trip
- Power Trip
- Power Trip
- Power Trip
- Power Trip
### RF Monitor VME Crate #1 Layout

<table>
<thead>
<tr>
<th>CPU</th>
<th>VMIC</th>
<th>VMIC</th>
<th>Joerger</th>
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</thead>
</table>

### RF Monitor VME Crate #2 Layout

| CPU | MUX1 | MUX2 | MUX3 | Blank 5 | VME Scope | IQA | IQA | IQA | IQA | IQA | IQA | IQA | IQA | IQA | IQA | IQA | IQA |
|-----|------|------|------|---------|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

4-Pack NLC LLRF
RF Generator Costs
(analog additional)

- Hardware
  - Splitters $1.6K
  - IQ Mixers $1.6K
  - Amplifiers 20dbm X-band $2.5K
  - Couplers $2K
  - VME Crate $5K
  - VME CPU $5K
  - Filters $1.5K
  - HP Generator $30K
  - Cap/Opamps/Switches/ECL Logic $2K
  - VMIC $18K

- Total $70.2K
NLC LLRF

RF Monitor Costs

- Hardware
  - Splitters (need 12) $1600
  - Down Converter Mixers (need 100) $400
  - IQ Mixers (need 100) $500
  - Amplifier 10W 11.424GHz $7500
  - Cable Plant $125K
  - Diodes (need 100) $500
  - Couplers $2K
  - VME Digitizers (10MHz/100MHz) $4500
  - High Speed digitizers $24K
  - MUX $12K
  - VME Crate $5K
  - VME CPU $5K
- Total $600K
# 4-Pack LLRF Monitor

## Hardware Cost

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Qty</th>
<th>Price</th>
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<tbody>
<tr>
<td>Splitters</td>
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<td>Mixers</td>
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<td><strong>TOTAL</strong></td>
<td><strong>201000</strong></td>
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Cost Estimates for Hardware

- LLRF Detection (100 signals) $600K
- LLRF Modulation scheme $170K
- 4-Pack Analog Option Additional $201K*
- 3 LLRF EMI/RFI Racks (Mario Ortega Cost Est.)
- Total $770K

* Not included in Total
Man-Power Costs

- Hardware (Engineering) $125K
  - Timing Distribution Module (IF FREE)
  - IQ Modulator Elias Andrikopoulos
  - IQA Modules Andrew Young
  - Sample/Hold Modules (Engineer)
- Software (Code Development) $82K
- Software (Test/Database) $110K
- Technician $112K
  - (Boni Cordova-Grimaldi, Greg Dalit, Bob Noriega, Hunter Technologies, Jennifer Russell, Young Kim)
- System integration $110K
- Total $564K
- GRAND TOTAL $1.34M