BPM ELECTRONICS UPGRADE FOR THE FERMILAB H- LINAC BASED UPON CUSTOM DOWNCONVERTER ELECTRONICS * E. McCrory, N. Eddy, F. G. Garcia, S. Hansen, T. Kiper, M. Sliczniak Fermi National Accelerator Laboratory, Batavia, IL 60510, USA

Abstract

As part of the Fermilab Proton Improvement Plan, the readout electronics for the beam position monitors (BPMs) in the Fermilab H⁻ Linac have been upgraded. The new custom electronics provide a low cost solution to process the 2nd harmonic of the 805 MHz RF. A single four-channel NIM-bin module is used to readout each fourplate stripline BPM pickup. Each module is locked to the external 805 MHz machine reference from the low level RF. A number of measurements at each BPM are provided, including average horizontal and vertical position, average intensity, and average relative phase for variable pulse lengths up to 50 µsec. The system is being exploited in a number of ways with new operations applications.

BPM Electronics Modules



Specifications

- Position resolution: 0.1 mm,
- Long-term stability: 0.25 mm,
- Phase resolution of 0.2°. This has been achieved.



Hardware Overview

- 67 identical modules in Linac/Booster
- 15 NIM crates
- Modules synced to Linac 805MHz RF
 - Selects 2nd harmonic for analysis
- Obtain I and Q for each plate
- IF = 3.125 MHz
 - IF digitized at 50 MHz (805 MHz/16)
- Processed by Altera Cyclone FPGA
 - 64MB DDR RAM

Microcontroller in the modules:

- Configuration & control :
 - ARM Cortex-M3 μp
 - 80 MHz
- Master and up to five slaves
- Slaves talk with Master via LVDS serial data link
- 1kB Flash for configuration parameters
- Command and control for the expert via
 - Telnet connection
 - USB connection (locally)

LNBP05 V L:BPRG02: 29A8	L:BPRG03: A1A8	L:BPRG04: A1A8	L:BPRG11: A1A8	L:BPRG12: A1A8	L:BPRG13: A1A8	Application	Summary
LNBP06	L:BPRG22: A1A8	L:BPRG23: A1A8	L:BPRG31: A1A8	L:BPRG32: A1A8		Linac BPM Simple Display	Show summary data from the
LNBP07	L:BPRG41: A1A8	L:BPRG42: A1A8	L:BPRG43: A1A8	L:BPRG44: A1A8	L:BPRG33: A1A8		BPMs during normal operations
LNBP09	L:BPRG64: A1A8	L:BPRG71: A1A8	L:BPRG72: A1A8	L'BPRG73: A1A8	L:BPRG74: A1A8	Linac BPM Expert	Display and control of the
MTABP7	L:BPRGE3: E7A8	L:BPRGE2: E7A8	L:BPRGE1: E7A8	 _			registers flesh mennemy and
MTABP8	B:BPRG02: A1A8	B:BPRGLM: A1A8	B:BPRG03: A1A8	B:BPRG04: A1A8	B:BPRG05: A1A8		registers, hash memory and
MTABP9 B:BPRG06: 29A8 MTABP10 B:BPRG10: 29A8 D:BPRG10: 29A8 MTABP10	B:BPRG07: A1A8	B:BPRG08: A1A8	B:BPRG09: A1A8	B-BBB (10) 2128			calibration of the BPMs, one
MTABPIO	B:BPRG11: A1A8	B:BPRG12: A1A8	B:BPRG17: A1A8	B:BPRGI3: AIA8			BPM at a time.
MTABP12	B:BPRGLD: A1A8	B:BPRGS1: A1A8	B:BPRGLU: A1A8	B:BPRG24: A1A8		Linac BPM Expert Overview	Shows the value of one register
							for each RPM in the entire
	Gloabal setting va	llue for register 1 (CSR	0: 0x Send				
					- DMQ 🌒		system. An expert-only
BPM Readings RMS Values of the readings	0.0000 # 0.0000 #	Last beam seen: Thu 12 Sep ?	2:42:38 Reset All Charts	Kviews HR BB BB	More J 28		application.
L:BPH20T L:BPH3IN L:BPH30T	L:BPH4IN L:BPH5IN	L : BPH50T L : D02BPI	I L:DO3BPH	2.5	Marine 41	Linac BPM Multiplex WF	Control the setup of the
2.2967 # 2.1901 # -0.3801 # 1.0690 # 0.9044 # 2.6561 #	-4.2628 # 1.6260 # 2.5970 # -0.0364 #	1.6338 # 0.537 2.0578 # 0.473		1.5		Control	multiplexed waveforms and
16.9217 # 15.4533 # 16.9917 #	20.2517 # 16.7600 #	15.2167 # 14.84	# 14.9067 #	0.5			show these waveforms. An
-16.9420 # -102.8210 # -106.0181 # L:D04BPH L:D11BPH L:D12BPH	-84.1168 # -96.5094 # L:D13BPH L:D21BPH	5.2899 # 59.809 L:D22BPH L:D23BPI	6 # <u>-94.2737</u> # 1 L:D31BPH	0 12:42:20 12:42:30 12:4	12:40 12:42:50 12:43:00 12:43:10 12:43:20		onorations application
-1.3944 # -0.8817 # 0.5028 # -1.6815 # 0.2587 # -2.0734 #	-0.6016 # 1.7812 # -3.1522 # 1.8077 #	0.4552 -0.267 3.7[0] # 0.70	4 # -0.1174 #				
14.9267 # 15.8967 # 16.9417 #	13.6133 # 15.3167 #	15.6950 # 16.383	3 # 15.0183 #			Linac BPIVI Sync DAQ	Control and display of the
139.2847 # -76.2671 # 86.3361 # L:D32BPH L:D34BPH L:D41BPH	162.0758 # 45.3241 # L:D42BPH L:D43BPH	44.0826 # 128.737 L:D44BPH L:D33BP	8 # 148.1561 # 1 L:D51BPH				Synchronous DAQ Waveforms
-0.3235 # 0.4046 # 2.2004 # -0.3865 #	-0.1309 # 0.4150 #	0.0000 # 0.016	9 # -1.5306 #				throughout the system.
16.3250 # 15.1350 # 16.0283 #	16.2783 # 16.0900 #	# 15.078	3 # 16.8400 #			Linac BPM All Readings	Show the readings and the RMS
28.1909 # 166.3330 # -100.7007 # L:D52BPH L:D53BPH L:D54BPH -1054BPH <	-168.3051 # -126.7438 # L:D61BPH L:D62BPH	# 12.387 L:D63BPH L:D64BP	1 # -73.9050 # L:D71BPH				deviations of the scalar values
-0.2734 # 0.5557 # 1.4831 #		-1.7263 # -0.576	0 # -2.1095 #				produced by all the DDM a Are
			-(3-()				produced by all the BPIVIS. An
							operations application.

Data from every BPM at 15Hz:

- Five scalar, floating-point readings
 - Horizontal and vertical positions \bullet
 - Beam phase and beam current
 - Pulse length
- Decimated data vectors of the beam positions (H) and V) within the Linac beam pulse.
- Open-Access Client Front End at 1Hz
- Status & control
 - Registers, flash memory, calibration \bullet
- Large data sets
 - 50MHz traces

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