

WEPAK018

LLRF CONTROL UNIT FOR SuperKEKB INJECTOR LINAC

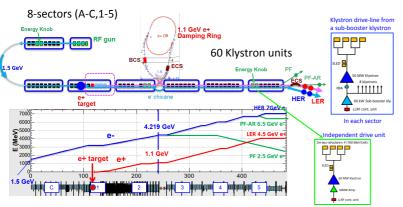
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Introduction

SuperKEKB Injector LINAC provides the beams to four storage rings: SuperKEKB HER/LER, PF, and PF-AR. RF phase is switched at 50-Hz for the each mode by the *event system*.

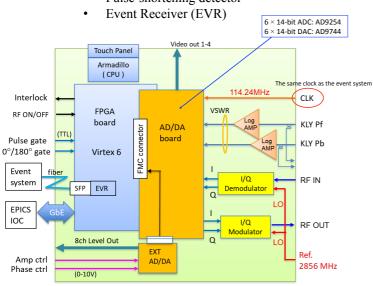


Layout and beam energy patterns of KEK injector linac.

LLRF Control Unit

Functions • RF pulse modulator

- RF monitor
- VSWR meter
- Pulse-shortening detector



Block diagram of the LLRF control unit

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The second secon	<u>F</u> ile <u>H</u>	elp							
	Interlock	Main	Output	RF	VSWR Meter	Trend	System	2018/04/2	
	RF On	Output							
	REMOTE	Amplitud		88.0	Phase[0.4		
	TRIG.	RF On/Off		On	-	p Time[se	-		
100 " HAL HAL HALL HELL HELL & BALL HALL A AND A	BE In	0/180deg Control M	Delay[usec]	0.00 Analog	-	ieg Edge(u Address:	usec]: 0.10	-	
		CONT IN A		Disable		ADDRESS:	Enable		
<u>a</u> a	Min		Level[dBm]:	0.60		ut Limit(df	<u> </u>		
	Max	Monitor							
	VSWR	Outp		Level k Ava	kW Pei	Phas ak Aw			
	CLK	1 7.11							
	EVR	2 -40. Pf	00 -40. MW	00 0.00 Pb	0.0 MW				
		/wg 39.0	Pea	k Avg	Pei 0.1	ak Ave	a Peak		
	SITCP	1 38.8			0.1				
	EXT1	2 40.2	2 40.	6 0.01	0.0	2 1.0	3 📀 1.04		
	EXT2	3							
		VIDEO P	f v V	IDEO LV	L - V	IDEO O	UT - VIDE	OUT	

Front/rear panel of LLRF control unit

Main panel

Frequency 2856 MHz **RF** output level +10 dBm (100%) 0.3% rms and max < ±0.5% Linearity of amp. RF pulse rise time < 35 ns (0 - 90%) $0 - 400^{\circ}$ Phase setting-range 0.3° rms and max < $\pm 0.5^{\circ}$ Linearity of phase 1.001 270 0.9 Error=0.02% rms Error=0.04 deg rms 1.0008 0.7 180 1.0006 Pha 0.5 1.0004 90 0.3 (deg) <mark>یہ</mark> 1.0002 Phase (deg) 0.1 0 -0.1 U 0.9998 -90 -0.3 0.9996 -0.5 0.9994 -0.7 0 9992 -0.9 -270 0.999 0 180 270 n 180 270 360 Phase (deg) Phase (deg)

Amplitude and phase error of RF output

The nonlinearity of the I/Q modulator is corrected by using the I/Q calibration table stored in the compact flash memory on the FPGA board.

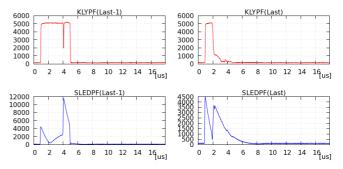
VSWR Meter

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Interlock	Main Output RF VSWR Meter Trend System	2018/04/17 17:03:50
RF On	VSWR Meter Setup	1
REMOTE	Limits Pf High Level Mode:	
TRIG.	Gate1 Gate2 Gate3	
RF In	Pf: 50.0MW 50.0MW 50.0MW Pb: 1.4MW 1.4MW 1.4MW	
Min	VSWR: X 1.40 X 1.40 1.40	
Max	Pf Low Level Mode: Gate1 Gate2 Gate3	
VSWR	Pf: 10.0MW 10.0MW 10.0MW	
CLK	Pb: 1.4MW 1.4MW 1.4MW VSWR: X 4.20 X 4.20 4.20	
EVR	Pf Low Threshold Level:	
SiTCP	10.0MW	
EXT1	Pf Pulse Width Deviation Max: 10.00usec Min: -10.00usec	
EXT2		Back
	VIDEO Pf - VIDEO LVL - VIDEO OUT - VIDE	O OUT -

The interlock level is switched in the high- or low-level mode for the threshold level

Pulse-shortening Detector

The pulse-shortening is detected by comparing the pulse gate width and the measured pulse width.



When the pulse-shortening occurs, the VSWR interlock may occurs because of the low or zero forward power. In the case of the pulse-shortening, we can choose whether to disable the VSWR interlock.

The information of the pulse-shortening events is stored in a log-file.

RF Pulse Modulator