LCLS-II LLRF Naming Conventions

Created by Garth Brown, last modified by Sonya Hoobler just a moment ago

Names are broken down into the standard parts, **DeviceType** : **Area** : **Position** : **Attribute**

Device Type

Name	Description
ACCL	Used for everything in the RF system that is part of the general physics and operations interface at the cavity level
GUN	Used for everything in the gun

Area, Subset of Accelerator With RF Devices

See https://slacspace.slac.stanford.edu/sites/lcls/lcls-2/wd/dsg/Forms/AllItems.aspx, Naming Convention section 6.1.2.2

Area	Physical Location
GUNB	LCLS-II Gun
L0B	LCLS-II L0 Accelerator Region
L1B	LCLS-II L1 Accelerator Region
BC1B	LCLS-II Bunch Compressor 1
L2B	LCLS-II L2 Accelerator Region
BC2B	LCLS-II Bunch Compressor 2
L3B	LCLS-II L3 Accelerator Region
SYS2	Full LCLS-II Accelerator scope, e.g. global phase offset

Position

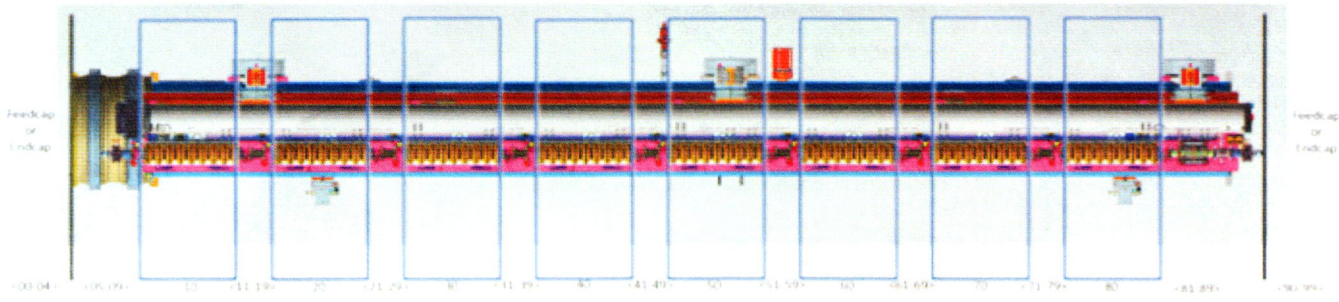
See https://slacspace.slac.stanford.edu/sites/lcls/lcls-2/wd/dsg/Forms/AllItems.aspx, Naming Convention section 6.1.2.3.2

The position of the gun is 100. The position of the buncher is 455.

The position of cavities is 4 numbers where the first two indicate the cryomodule and the second two the cavity. For example, 0430 is cryomodule 4, cavity 3.

Cryo Module #	Description
01-35	CM01-CM35, 1.3GHz cavity
H1	3.9GHz Cryomodule 1, located in L1B and follows CM03
H2	3.9GHz Cryomodule 2, located in L1B and follows H1

Numbering of cavities within a cryomodule:



Attribute

Attributes that comprise the physics interface. Scalar unless otherwise specified

R/W	Name	Description
R	GACT	Measured gradient from cavity probe (MV/m)
R	GMAX	Maximum allowable gradient (MV/m) - readback only
R/W	ADES	Operation amplitude setpoint (MV)
R	AACT	Measured amplitude from cavity probe (MV)
R/W	AMAX	Maximum allowable amplitude (MV)
R/W	PDES	Operation phase setpoint (degrees, where 0 is on-crest)
R	PACT	Measured phase from cavity probe (degrees)
R/W	SEL_POFF	SEL phase offset setpoint (not used in SELA mode)
R/W	PREF	a.k.a.gold, phase offset used by LLRF to convert measured phase to one relative to on-crest operation, adjusted by beam phasing (degrees)
?	DFDES	Cavity detuning setpoint (Hz) - is this needed?
R	DFACT	Detune seen by the resonance system (Hz)
R/W	RFMODECTRL	RF mode control (SEL, SELA, SELAP)
R	RFMODE	Readback of current RF mode
R/W	RFCTRL	Cavity on/off control. Off = LLRF drive set to 0. (SSA control will be different.)
R	RFSTATE	Readback of cavity RF on/off state
R	AWF	Waveform of cavity probe amplitude, which is used to calculate AACT (MV)
R	PWF	Waveform of cavity probe phase, which is used to calculate PACT (degrees)
R	FWD	Forward signal from SSA to cavity - amplitude
R	FWDPWR	Forward signal from SSA to cavity - power
R	REV	Reverse signal from cavity - amplitude
R	REVPWR	Reverse signal from cavity - power
R/W	ALEM	LEM computed integrated RF amplitude (MV) per cavity and per cryomodule
R/W	PLEM	LEM computed phase (deg)
R/W	EGLEM	LEM computed energy gain (MeV)
R/W	CHLEM	LEM computed chirp (MeV)
R	FUDG	Beam-based scale factor applied to cavity probe amplitude readback. Nominal value of 1.
R	L	Cavity length
R	FREQ	Cavity frequency
R	IMPED	Shunt impedance
		In Progress/Tentative
	RFREADY	*Status of RF controls, (Ready, Not Ready) set to ready when control loops are closed and RF is continuous. Or will we ever run with pulsed RF?*
	STAT	*Status bits in software (define the bits)*
	HSTA	*Hardware status*
	DFDES	*Cavity detuning setpoint (Hz)*
	ERRWF	*Error waveforms corresponding to waveforms above, captured and put in a separate buffer when a fault is detected (degrees or MV)*
	PZWF	*Waveforms from tuner piezo motors, useful for finding microphonics. Units TBD.*
		Latching SRF Interlocks - In Progress/Tentative
R	QUENCH_FLT	
R	QUENCH_LTCH	Cavity quench fault, from interlock chassis. Current status, latched status, and reset command
W	QUENCH_RESET	
R	CPLRVAC_FLT	

R	CPLRVAC_LTCH	Coupler vacuum fault, from interlock chassis. Current status, latched status, and reset command
W	CPLRVAC_RESET	
R	BMLNVAC_FLT	
R	BMLNVAC_LTCH	Beamline vacuum fault, from interlock chassis. Current status, latched status, and reset command
W	BMLNVAC_RESET	
R	STEPTEMP_FLT	
R	STEPTEMP_LTCH	Stepper temperature fault, from interlock chassis. Current status, latched status, and reset command
W	STEPTEMP_RESET	
R	CPLRTEMP_FLT	
R	CPLRTEMP_LTCH	Coupler temperature fault, from interlock chassis. Current status, latched status, and reset command
W	CPLRTEMP_RESET	
W	INTLK_RESET_ALL	Reset all latched faults from interlock chassis

Non-Latching SRF Interlocks (These are per-cryomodule, not per-cavity) - In Progress/Tentative

R	HEPRES_FLT	Helium pressure fault, from cryo system PLC
R	HELEVEL_FLT	Helium level fault, from cryo system PLC
R	RFHEARTBEAT_FLT	Cryo receives RF heartbeat, from cryo system PLC
R	CRYOHEARTBEAT_FLT	Cryo PLC heartbeat fault. Generated by RF software when cryo data stops updating or updates too slowly

Interlock Thresholds - In Progress/Tentative

R/W	CPLRVAC_THRES_L	
R/W	CPLRVAC_THRES_H	
R/W	BMLNVAC_THRES_L	
R/W	BMLNVAC_THRES_H	
R/W	STEPTEMP_THRES_L	
R/W	STEPTEMP_THRES_H	
R/W	CPLRTEMP_THRES_L	
R/W	CPLRTEMP_THRES_H	

Cavity Ramp-Up and Calibration Output

R	QLOADED	Loaded Q
R	CAV_CONST	Cavity calibration constant (later will be merged with CAV:CAL_SCALE)
R	LDCOEF	Lorentz detuning
R	BCOEFM	State space B coefficient magnitude
R	BCOEFP	State space B coefficient phase
R	SSA:SLOPE	SSA slope
R	SSA:PED	SSA pedestal
R	SSA:MINX	SSA min X

Waveform Signals

The PVs below will be provided for each waveform signal. Each cavity has the following waveform signals:

Description	*PV name, <SIG> in following section*
Drive	DRV
Forward Power	FWD
Reflected Power	REV
Cavity Probe	CAV
Detune	DF
DAC (FPGA internal, input to DAC that drives SSA)	DAC

Waveform	R	<SIG>:AWF	Signal amplitude waveform

Statistics	R	<SIG>:AMEAN	Mean of <SIG>:AF
	R	<SIG>:ASTD	Standard deviation of <SIG>:AWF
	R	<SIG>:AMIN	Minimum of <SIG>:AF
	R	<SIG>:AMAX	Maximum of <SIG>:AWF
Waveform	R	<SIG>:PWF	Signal phase waveform
Statistics	R	<SIG>:PMEAN	Mean of <SIG>:PWF
	R	<SIG>:PSTD	Standard deviation of <SIG>:PWF
	R	<SIG>:PMIN	Minimum of <SIG>:PWF
	R	<SIG>:PMAX	Maximum of <SIG>:PWF
Waveform	R	<SIG>:PWRWF	Signal power waveform
Statistics	R	<SIG>:PWRMEAN	Mean of <SIG>:PWRTRACE
	R	<SIG>:PWRSTD	Standard deviation of <SIG>:PWRWF
	R	<SIG>:PWRMIN	Minimum of <SIG>:PWRWF
	R	<SIG>:PWRMAX	Maximum of <SIG>:PWRWF
Waveform	R	<SIG>:ITWF	Signal I waveform
Waveform	R	<SIG>:QTWF	Signal Q waveform

Deployment and calibration attributes

By default, these should be write-protected during operation

Name		Description
		(from Chris Adolfsen. Garth wonders should this be a calibration attribute rather than physics interface?) Slow tuner start-up position prior to rf turn on - with the piezo voltages zeroed, the cavity would be tuned close to 1.3 GHz after the operating gradient is established - thus the initial detuning with rf off relative to 1.3 GHz is K*(operating gradient)^2
		(from Chris Adolfsen. Garth wonders should this be a calibration attribute rather than physics interface?) Slow tuner park position - this is the position the tuner would be set if one wants to detune the cavity so it does not interact with the beam.
Q0		Q_0 measurement from partner labs, delivered with the cryomodule
Qext		Qext measured in-situ (last measurement – used to calibrate cavity probe signal based on discharge power)
LFD		Lorentz Force Detuning K factor(Hz/(MV/m)^2) measured in-situ
		Calibration of the slow tuner (Hz/step) measured in-situ
		Calibration of the piezo tuners (Hz/volt) measured in-situ
		Signal calibration. The PVs below will be provided for FWD, REV, DRV signals.
Measured values		
<SIG>:CAL_ADC_10DBM	R/W	ADC counts at 10 dBm. EPICS software uses this to calculate RF power at full scale.
<SIG>:CAL_LOSS_CABLE	R/W	Measured cable losses used in signal calibration. Positive value in dB.
<SIG>:CAL_LOSS_CPLR	R/W	Measured coupler loss used in signal calibration. Positive value in dB.
<SIG>:CAL_LOSS_ATTEN	R/W	Fixed attenuator used in signal calibration. Positive value in dB.
<SIG>:CAL_LOSS_OTHER	R/W	Unattributed measured loss used in signal calibration. Positive value in dB.
EPICS-calculated values		
<SIG>:CAL_REF_PWR	R	RF power at ADC full scale. In dBm. Analogous PVs exist for reverse and drive (aka loopback) signals.
<SIG>:CAL_LOSS_TOTAL	R	Total (of cable, coupler, atten, other) loss used in signal calibration. Positive value in dB.
<SIG>:SCALE	R	Calibration scale factor to convert raw ADC counts to amplitude in sqrt(Watts). Calculated internally by RF software, based on system losses and ADC power at full scale.
		Signal calibration for Cavity Probe (CAV)
CAV:CAL_SCALE	R/W	Calibration scale factor to convert cavity probe raw ADC counts to amplitude in MV. Calculated by LLRF calibration sequence. See CAV:SCALE for more info.
CAV:SCALE	R	

	Calibration scale factor to convert cavity probe raw ADC counts to amplitude in MV. Is equal to product of CAV:CAL_SCALE and beam-based FUDG scale factor.
	Chassis and ADC scale factor, or polynomial coefficients. From lab measurements of chassis to convert ADC units to physics units
	PI(no D) loop parameters for amplitude and phase loops. Maybe PKp, PKi, GKp, GKi
	Open loop amplitude and phase DAC settings
	Control loop status (open, closed)

Other attributes for operations - In Progress/Tentative

Name	Description
V	Chassis power supply voltage
T	Chassis board temperature
DC	SSA enable/disable internal DC power
	SSA RF enable, how to distinguish from global RF enable?
PzVout	Output voltage to the piezo tuning motor
PzHz	Expected tuning change from PzVout

Expert attributes, not for use on operations screens

Name	Description
	Firmware MD5
	BMB7 board serial #
	Digitizer board serial #
	Chassis serial # and/or Depot number