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ENTRANCE

softGlue

Run-time programmable digital electronics

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May, 2015

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Argonne National Laboratory



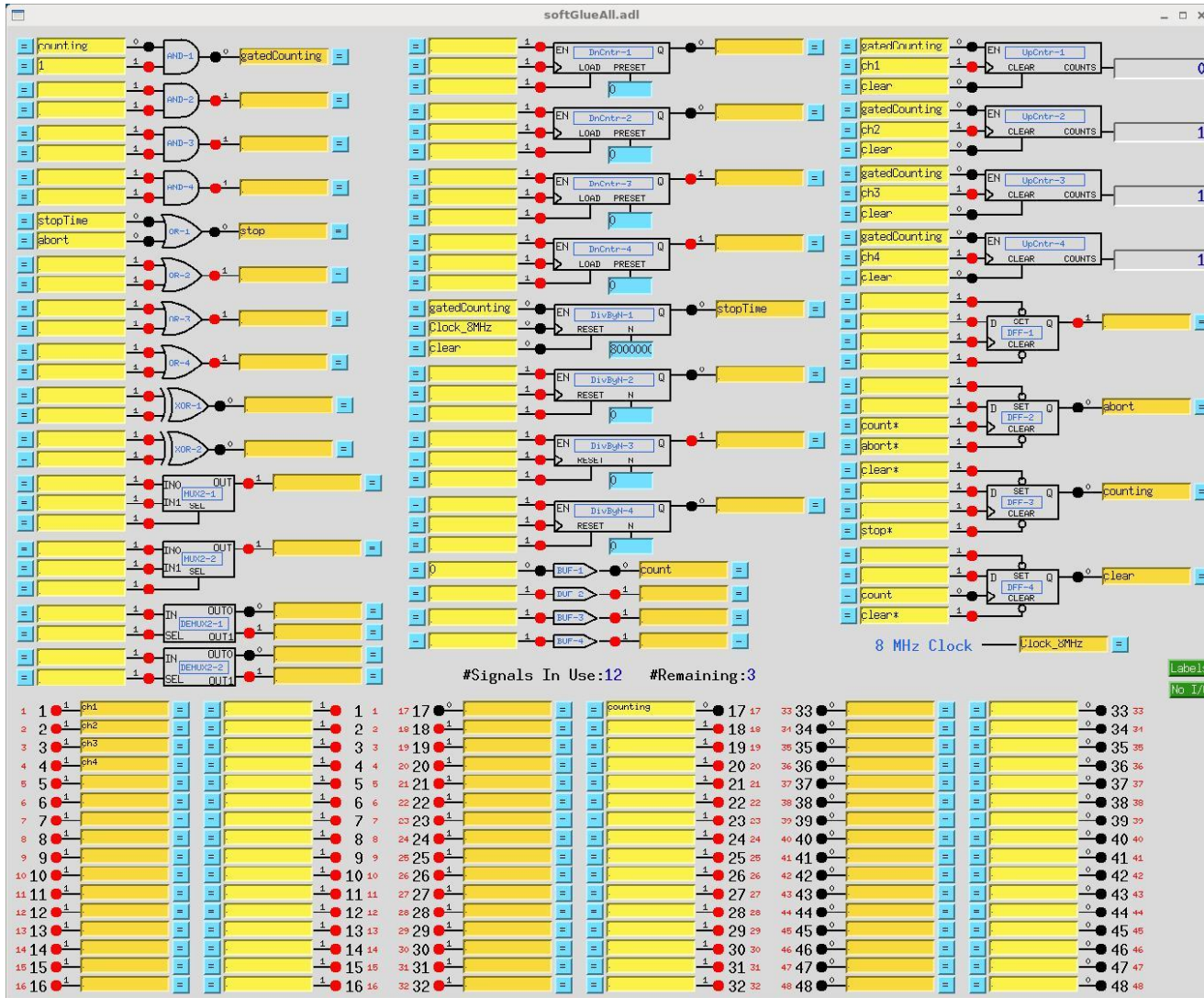
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Overview

- **SoftGlue enables beamline users and staff to construct simple digital electronic circuits, and connect those circuits to field wiring, by writing to EPICS process variables (PVs).**
- **SoftGlue also provides safe (throttled) user control over how hardware interrupts are generated by field I/O signals, and dispatched to cause EPICS processing.**
- **SoftGlue circuits can be autosaved and restored, saved as text files, emailed to another user, and managed by *configMenu*.**
- **SoftGlue does this by loading an IndustryPack FPGA-based digital I/O module with a predefined collection of circuit elements (logic gates, counters, flip-flops, etc.), whose inputs and outputs are connected to switches controlled by EPICS PVs.**

MEDM display



configMenu.adl

configMenu: SG

NAME: gatedScaler
DESC: four channel scaler
STATUS: Success

config Name

Load	accelDeceIGate	Save
Load	clear	Save
Load	encoderTest	Save
Load	fourPulses	Save
Load	gatedScaler	Save
Load	pulseFromEdge	Save
Load	shutterDetTrig	Save
Load	pulse_stretcher	Save
Load	twoRandTest	Save
Load		Save

Page: 0

Done Less More

xxBusyR

Done Busy

OUTPUT LINK

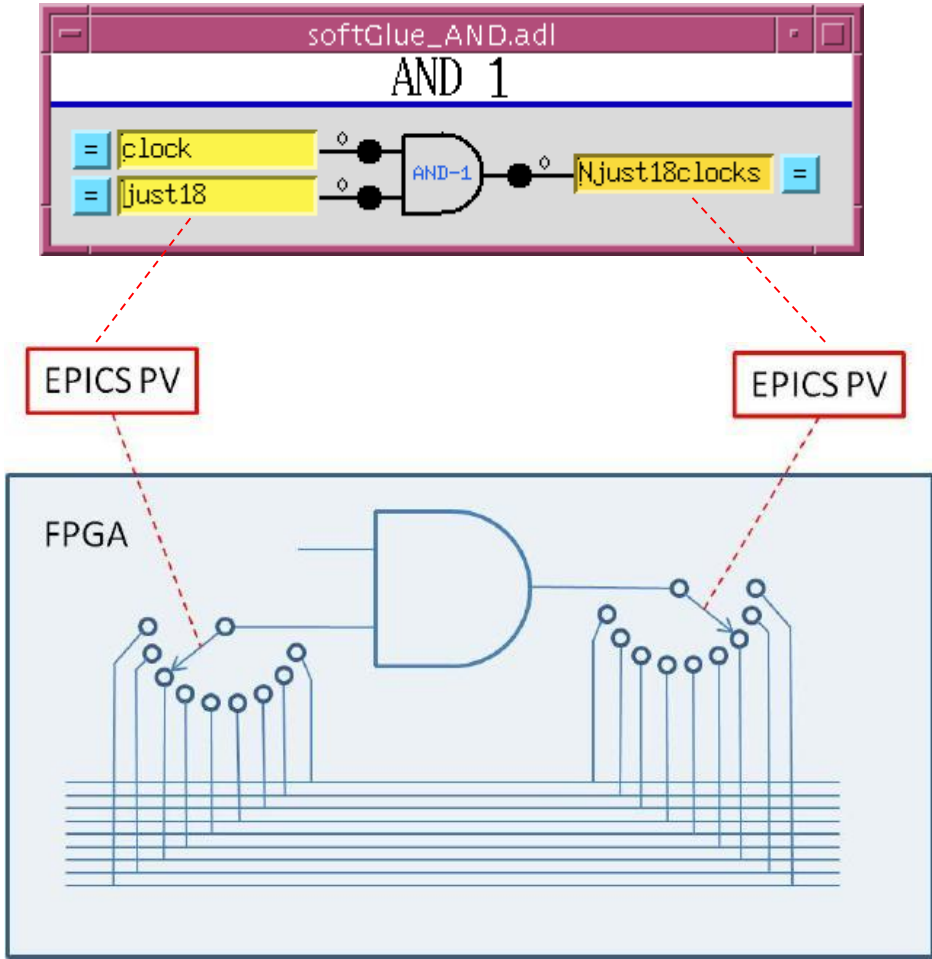
yyy:softGlue:BUFFER-1

FWD LINK

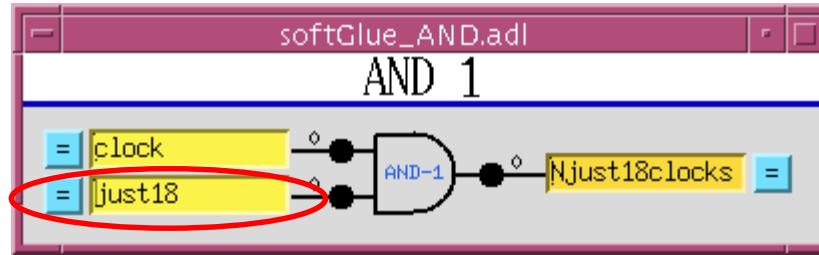
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How it works, conceptually



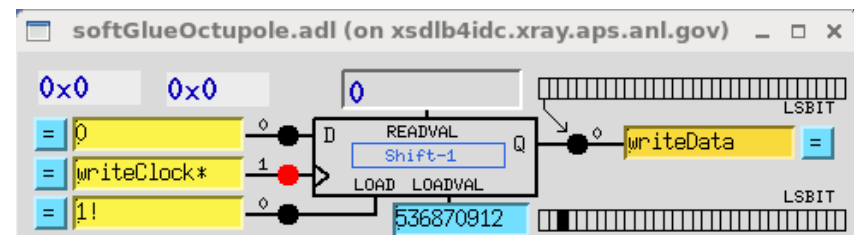
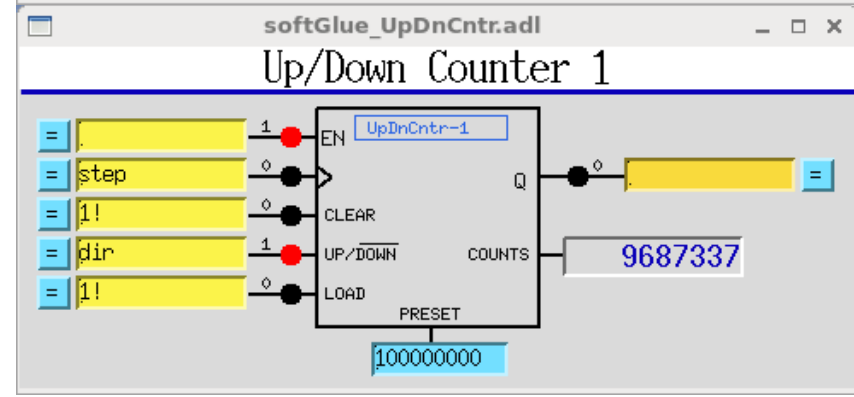
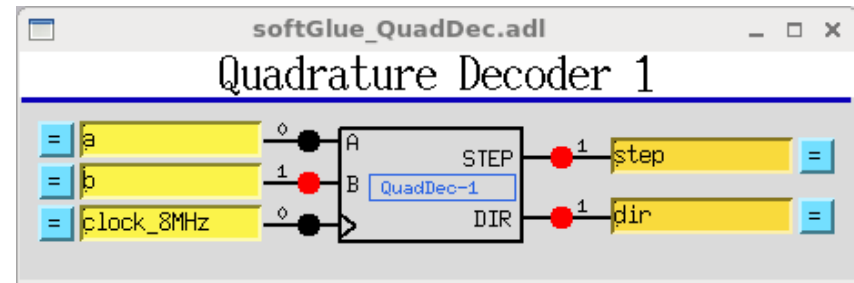
Circuit-element inputs



option	example	result	comment
empty		1	
number	1	1	
	0	0	
	1!	Positive-going pulse	~6 μ s
	0!	Negative-going pulse	~6 μ s
	0.499	0	
name	mySignal	Connected to all other inputs and output named "mySignal"	

Additional circuit elements

- **Quadrature decoder**
read encoder
- **Up/Dn Counter**
count output signals from quadrature decoder
- **Shift register**
bit stream I/O
- **Other circuit elements are possible. See Kurt Goetze.**



Example applications

- With no user programming, softGlue is a digital I/O module.
- Trigger a detector after every N steps of a motor.
- Trigger a detector after every N[i] steps of an encoder.
- Gate a detector off during a motor's accel/decel time.
- Trigger a detector 23.7 ms after a shutter.
- Conditionally execute an EPICS record on the rising edge of an external signal.
- Implement an extraordinarily smart oscilloscope trigger.
- Cause an EPICS database to wait for 0.7 ms.
- Count encoder pulses.
- Convert encoder pulses to up/down pulses, for use with a multichannel scaler.
- Send/receive a bit stream from external hardware.
- Latch the value of an external signal.

Documented example circuits

- https://subversion.xray.aps.anl.gov/admin_bcdaext/softGlue_examples
 - [Programmable pulse train](#)
 - [Gated scaler](#)
 - [Pulse burst](#)
 - [Delay generator](#)
 - [Motor accel/decel pulse gate](#)
 - [Debouncer](#)
 - [TTL Pulse Stretcher and Delay](#)

Field I/O

- Connected just as are circuit elements
- Interrupt can drive EPICS record on falling edge, rising edge, etc.

softGlueFieldIO_Intxx.adl

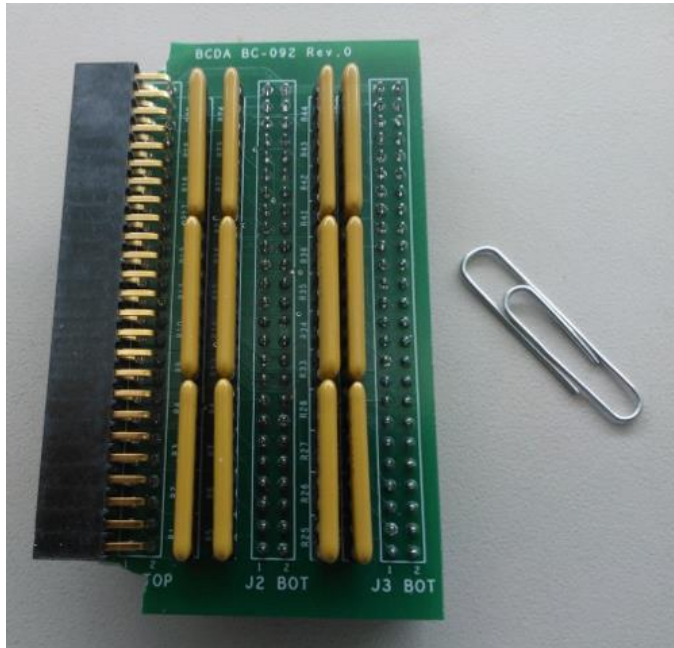
Field Input Bit		Interrupt-driven record		Field Output Bit	
		INTERRUPT ENABLE	ON INTERRUPT, WRITE SIGNAL VALUE VIA THIS LINK		
1	1	=	None	=	1
2	2	=	None	=	2
3	3	=	None	=	3
4	4	=	None	=	4
5	5	=	None	=	5
6	6	=	None	=	6
7	7	=	None	=	7
8	8	=	None	=	8
9	9	=	None	=	9
10	10	=	None	=	10
11	11	=	None	=	11
12	12	=	None	=	12
13	13	=	None	=	13
14	14	=	None	=	14
15	15	=	None	=	15
16	16	=	Both	=	16

CONNECTOR # POLL TIME (MS) 1000 Less

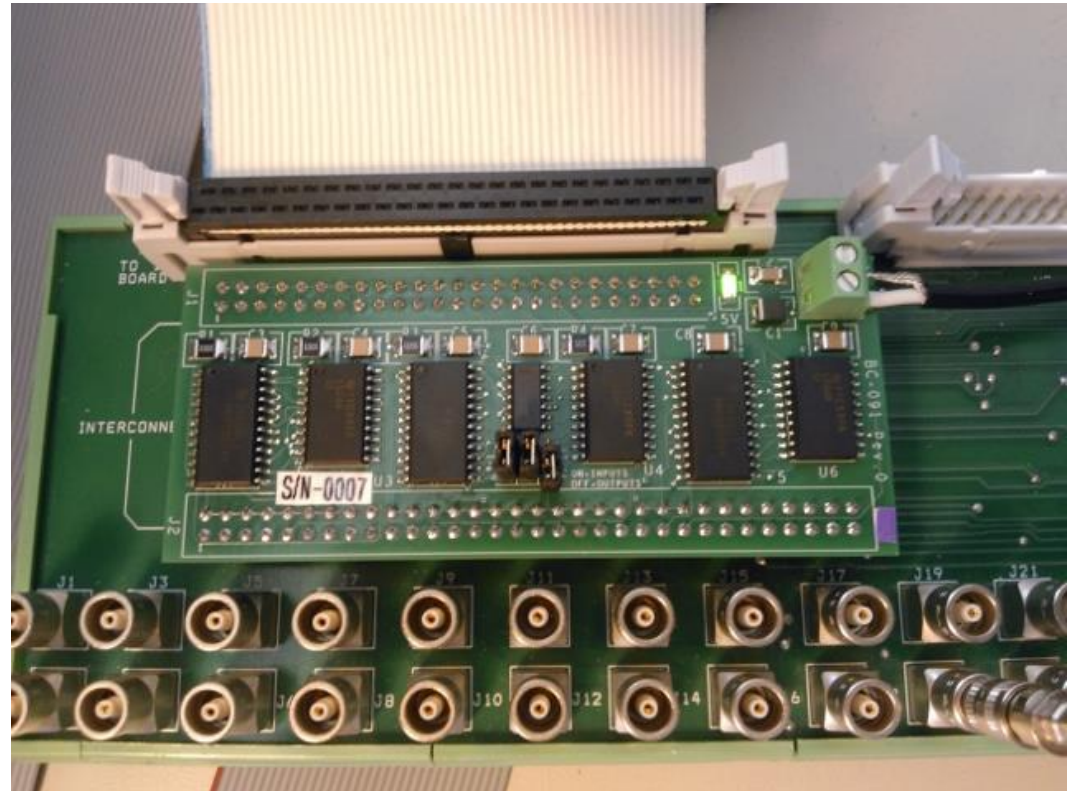
Field I/O cable termination

- **A:** 100-Ohm series termination to ribbon cables
- **B:** 50-Ohm line driver for RG58/RG174 coaxial cables

A



B



since last softGlue talk (Kurt Goetze)

- Support for IP_EP20x (RS-422, Ivds)
- Field I/O cable termination strategy
- Shift registers, quadrature decoders, up/down counters
- Divide-By-N's RESET signal now works
- Displays for caQtDM and CSS-BOY
- configMenu support for saving and restoring circuits
 - requires auto save R5-1
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- caputRecorder macro to move/copy a component from one softGlue instance to another

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softGlue: credits

- **Eric Norum – IndustryPack Bridge**
 - interfaces FPGA components to IP/VME bus
- **Marty Smith –EPICS driver, FPGA content for field I/O**
- **Kurt Goetze – FPGA content for softGlue, custom hardware**
- **Tim Mooney – softGlue driver, EPICS application**