Hardware Installation Guide

ACQ1014-16-BNC

16 channel, 80MSPS/channel DAQ appliance

Applies to REVB unit (s/n SYS_CE4010210 up)

1 Overview

Drawing 1: ACQ1014-16-BNC Photograph

ACQ1014-16-BNC is a 1U, 19” rack-mount DAQ appliance, providing

16 channels x 80MSPS input clock rate, 14 bit simultaneous analog inputs on the front panel via BNC connectors.

The front panel also includes trigger TRG and clock CLK/TRG2 BNC inputs. The unit may be operated as follows:

- 16 channels, internal CLK, internal TRG.
- 16 channels, internal CLK, front panel TRG
- 16 channels, front panel CLK (subrate), front panel TRG.
- 16 channels, slave CLK and TRG from rear panel SYNC input.

1.1 Expansion over multiple boxes.

- On ACQ1014-revB, this is extended to four boxes for 64 simultaneous channels.
- To make larger systems, an additional clock expander “CLK-TRG-STAR” provides additional fanout

1.2 Clock Options

- Internal clock, 10..80MHz
- User clock on front panel FPCLK, 1..20MHz. *
- Multibox clock from SYNC bus, 1..20MHz *

* NB: ADC clock range 10..80MHz, must use internal clock multiplier.

1.3 Trigger Options

- Internal SOFT TRG, synchronized over 16 channels.
- User front panel TRG, synchronized over 16 channels.
- Multibox TRG from SYNC bus.

1.4 Throughput vs Sample Rate

Unit supports 80MHz clock rate, aggregate to local DRAM is 2x800MB/s aggregate rate.

Operating limits:

- 16 channels 80MSPS direct to DRAM. POST TRIGGER ONLY
- 16 channels 50SMSP direct to DRAM, PRE/POST supported.
- ADC includes LP FIR filter options, typical sample rate / bandwidth tradeoffs as shown:

#CH	*ISR MSPS*	*DEC*	*OSR MSPS*	*DATA MBPS*	*SHOT S*	*Comment*
16	80	1	80	2560	0.5	Analog BW limit 40MHz (2V pp) 15MHz (5V pp)
16	80	2	40	1280	1.0	FIR LP Filter, BW=20MHz
8	80	1	80	1600	1.0	
16	80	8	10	320	4.0	FIR LP Filter, BW=5MHz or less

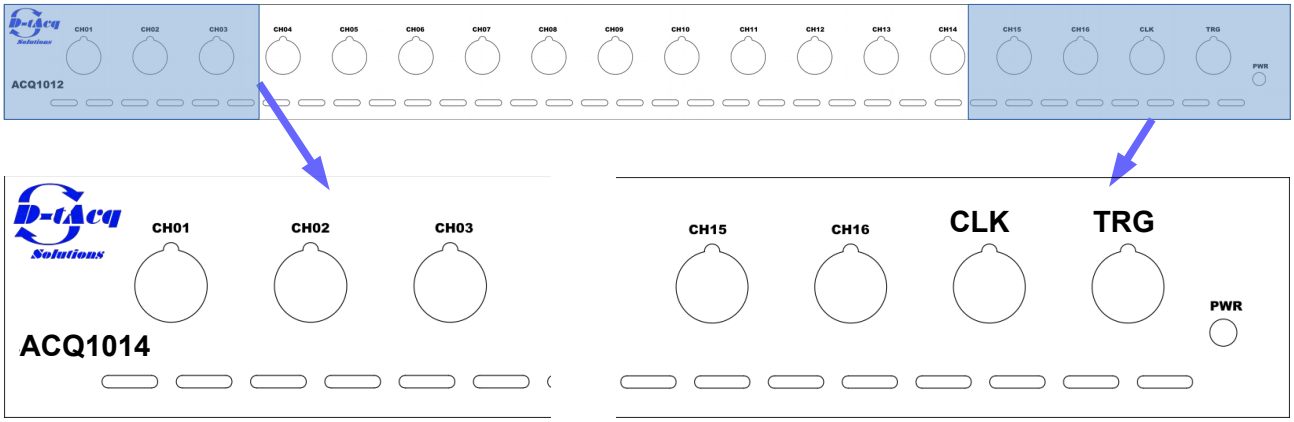
- ISR is Input Sample Rate (Sample Clock),
- DEC is filter decimation factor
- OSR is Output Sample Rate (Sample rate to memory), after decimation.
- SHOT is maximum capture duration in seconds.

2 Variants

ACQ1014 is available in the following configurations.

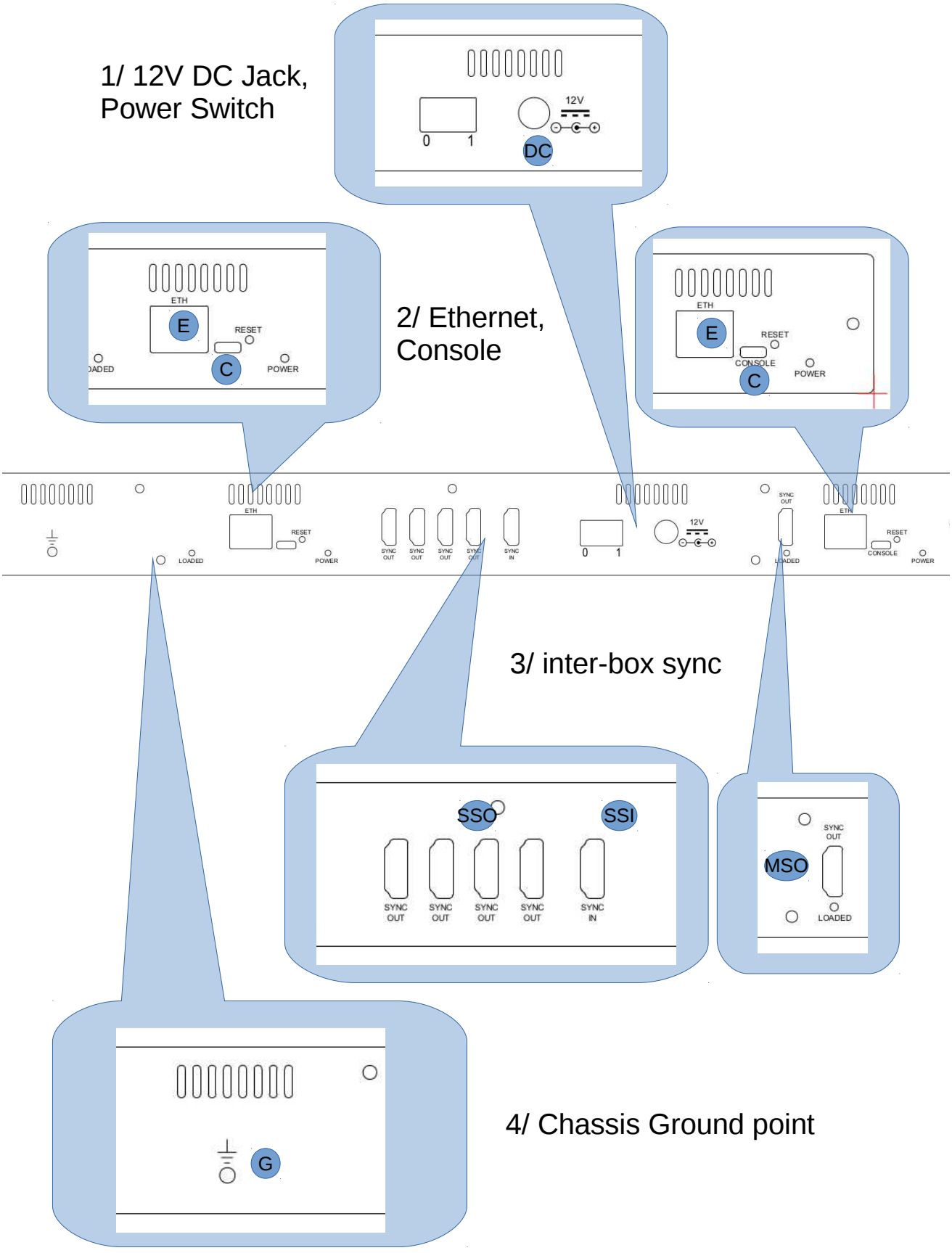
Product Name	*Description*
ACQ1014-16-BNC	16 channels, 80MSPS/channel, BNC front panel

3 Front Panel



Drawing 2: ACQ10014-16-BNC Front Panel : 18 BNC connectors in 1U

4 Rear Panel


1/ 12V DC Jack, Power Switch
12V
0 1
DC
ETH
E
RESET
C
POWER
2/ Ethernet, Console
CONSOLE
3/ inter-box sync
SSO
SSI
SYNC OUT
SYNC IN
MSO
LOADED
G
4/ Chassis Ground point

4.1 Rear Panel Ports

4.1.1 12V DCJack and Switch DC

Power to the entire box is provided by an external 12V regulated DC supply, of minimum output 10W depending on payload. The unit ships with a 45W 12V DC supply, sufficient for any payload combination.

The socket accepts a standard DC barrel connector, centre-positive, 2.5mm internal diameter, 5.5mm external diameter, with length a minimum of 10.5mm.

The power supply's input Earth should be connected to the output 0VD. Th

4.1.2 Console C

ACQ1001 uses an FTDI FT232 USB-Serial converter for console access via a Micro USB port. Connection is automatic on modern PC's, serial console settings are as follows.

Name	***Setting***
Baud Rate	115200
Data Bits	8, No Parity, 1 Stop, No flow control
Emulator	D-TACQ recommends c-kermit.

4.1.3 Ethernet

The gigabit Ethernet port accepts standard RJ45 connectors. Please be sure to connect BOTH ports. E

4.1.4 Reset

Use a pen or similar object to push the reset button if required.

4.1.5 LEDs

The rear panel provides extra LEDs for system information.

LED	***Description***	
LOADED	Green	Lights approximately 20s after power-up to indicate FPGA loaded. If unlit after this, check the validity of the SD card image or check the Console for error messages.
POWER	Green	Lit when digital power supplies are all valid.

4.1.6 Sync Bus

D-TACQ provides two Sync Bus connectors allowing multiple units to be chained together. The bus uses standard HDMI cables and has two ports – one input, one output. The pinouts and functionality are described as follows.

In a standalone system, NO HDMI sync cable is required. This is an enhancement from RevA.

Examples of use of the SYNC connectors are shown in #11

- Master Sync Out MSO
- Slave Sync In SSI
- Slave Sync Out SSO

Pin	***Name***	***Description***	
		Output	***Input***
1	Sync	Synchronisation Output	Synchronisation Input
4	Trigger	Trigger Output	Trigger Input
7	GPIO	General Purpose Output. May be switched to an input if desired. 11	General Purpose Input. May be switched to an output if desired.
10	Clock	Clock Output	Clock Input
15	SCL	I^2C Master Clock Output	I^2C Slave Clock Input
16	SDA	I^2C Master Data	I^2C Slave Data
19	Cable Detect	Allows master to detect the presence of a slave device.	Ground (0VD)
2, 3, 5, 6, 8, 9, 11, 12, 17	GND	Ground (0VD)	
13, 14, 18	NC	Not Connected	

Please be sure to connect the SYNC loopback cable.

4.1.7 Fans

Fan outlets help keep ACQ1014 cool, drawing air across the modules from front to back. Do not cover the fan outlets.

4.1.8 Chassis Grounding Point G

Connect chassis ground with a thick copper cable to local chassis ground. This is essential for the input transient suppression to be effective.

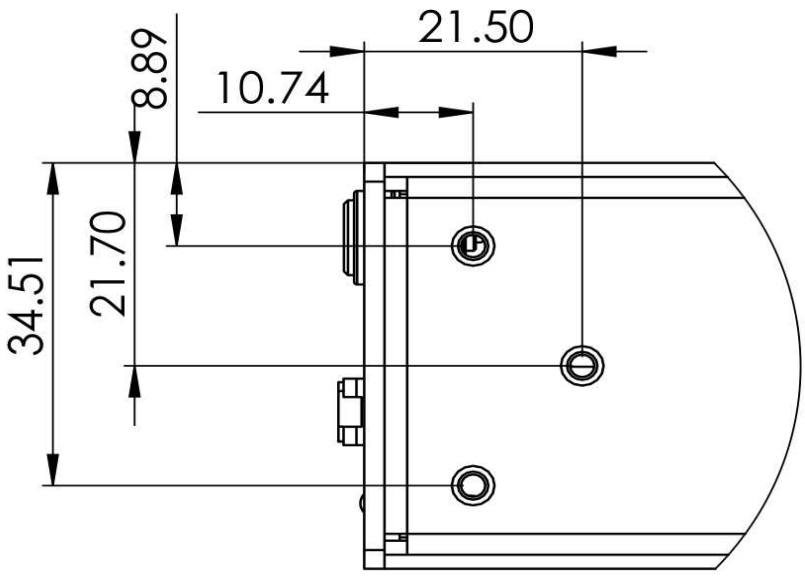
5 Analog Characteristics.

Parameter	*Value*	*Comment*
Channels	16	Simultaneous
Max SR	80MHz	Maximum rate to memory, 50MHz. Use 80MHz clock with /2 decimating filter to stream to DRAM at 40MSPS.
Resolution	14 bit	
Input Range	+/-2.5V	Single Ended
Impedance	100K/50R	Soft switched termination
Gain	0..12dB	
Filtering	FIR	24 tap filter in ADC. Additional filters available in FPGA.

6 Mounting Options

ACQ1014 is a standard 19” wide rack, with 3 point mounting points as shown.

The rack is supplied complete with mounting brackets.



Drawing 3: Mounting Points for Rack Case

7 Quickstart

1. Store the default root login credentials shipped with the box for future reference.
2. Mount chassis with clear airflow front to back
3. For setup, connect USB consoles (only needed if IP address not known)
4. Connect 2 x Ethernet RJ45 cables to a 1000T switch on the site Ethernet.
5. Connect DC12V and power of at wall jack.
6. If the consoles are connected, this will provide a commentary on the boot process (60s).
7. The units are set to acquire their ip-address using DHCP. Assuming that the user has access to the DHCP server, it's easy to arrange for the ACQ to get an ip-address and for the user to know what it is. Failing that, there is a fallback address: 192.168.0.serial-number.
8. To set a static ip-address, log in on the console and set as per 4GUG.
9. From a computer on the same subnet, check that you can see the embedded web pages at port 80, and that you can connect to the box using ssh.
10. To control the box using the D-TACQ GUI, install cs-studio, add our OPI project and connect. Press STREAM and view live data on trigger (external or, select soft trigger).
11. A production system may use the GUI, or it may be entirely scripted, or a mix of both. User's choice.

7.1 GUI Setup

cs-studio is based on the eclipse environment. This allows a flexible interface, with pre-defined opi screens dockable N,S,E,W.

- Project: contains the OPI (Operator Interface) screens, use as read-only code
- Workspace: contains site specific setup, including choice of UUT and OPI layout.
- UUT: Unit Under Test, the ACQ digitizer appliance(s)

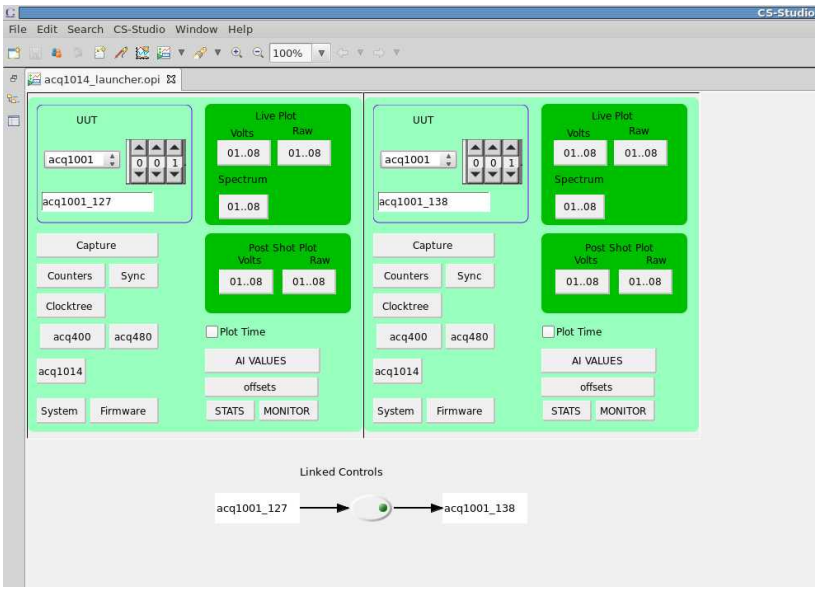
On a site with one UUT, there will be One Project, One Workspace, One UUT

On a site with many UUT's, there's still only one Project, but it may be convenient to run multiple GUI's, each with its own Workspace, UUT and settings.

Ideally, D-TACQ will supply both the Project and a pre-configured Workspace with a suitable layout. The layouts below assume this. If the workspace is not available, it's easy enough for a user to configure his own layout by launching OPI's from the “launcher”, then dragging and docking to get the desired layout. This is very quick with practise. Please see “Starting the UI from Scratch”.

7.2 Initial View, Launcher Only

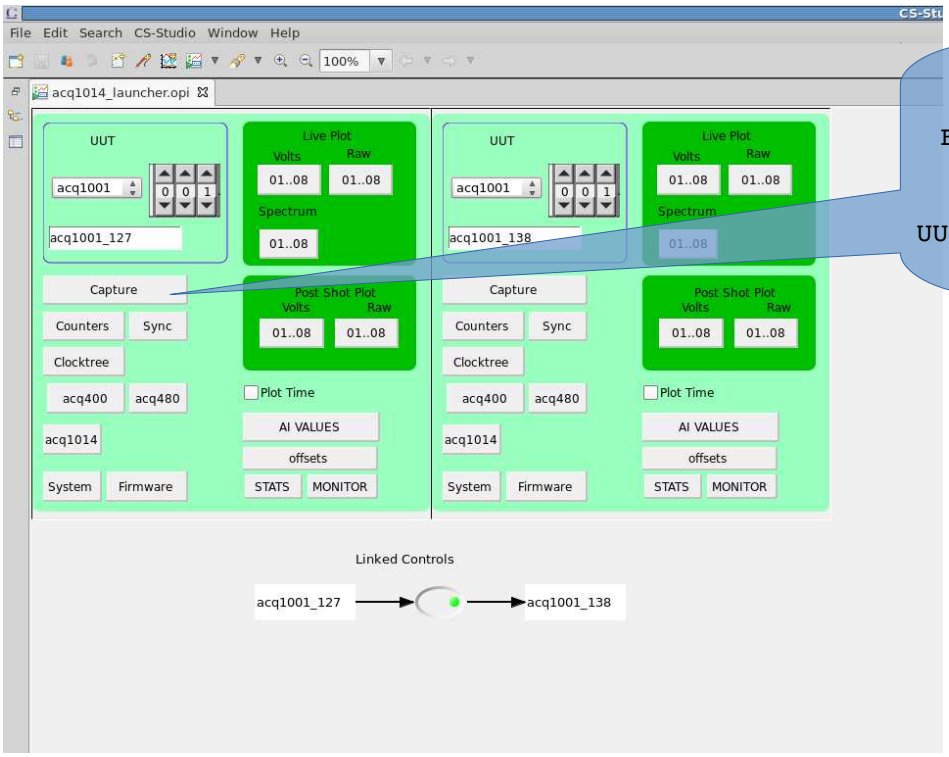
- ACQ1014 Launcher is provided for use with ACQ1014, two UUT's
- It's pre-programmed with UUTLEFT and UUTRIGHT, ID's for left and right digitizers.



7.2.1 Linked controls are recommended.

Press the “Linked Controls” button.

Linked controls means that setting a control on UUTLEFT is mirrored to UUTRIGHT. This saves time and avoids errors. However, if it's required to make different settings, uncheck to break the link.



(1)
Each button launches a pair of Operator Interfaces OPI
Click/Drag to keep a UUTLEFT/UUTRIGHT configuration

7.2.2 Launch OPI's as required

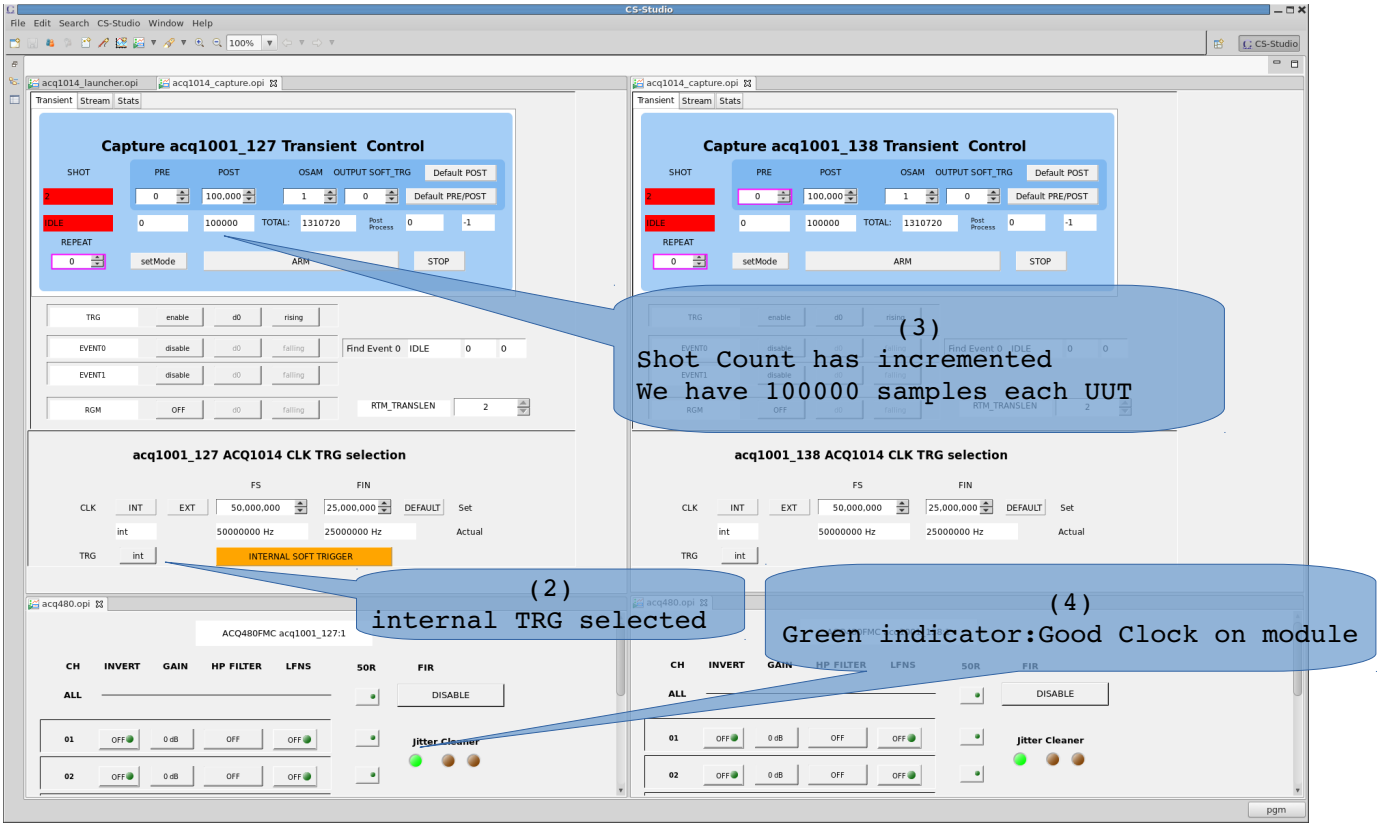
Pressing a single OPI launch button, will launch two OPI screens, one for UUTLEFT and one for UUTRIGHT. The screens appear in a tabbed manner, drag to split Left and Right on screen.

Start with the CAPTURE screen:

- press CAPTURE, drag the UUTRIGHT opi to dock at the right hand side.
- select SITE=1 and press ACQ480, dock to lower edge of the screen.

Example: Run a Transient: Before

Example: Run a Transient: After

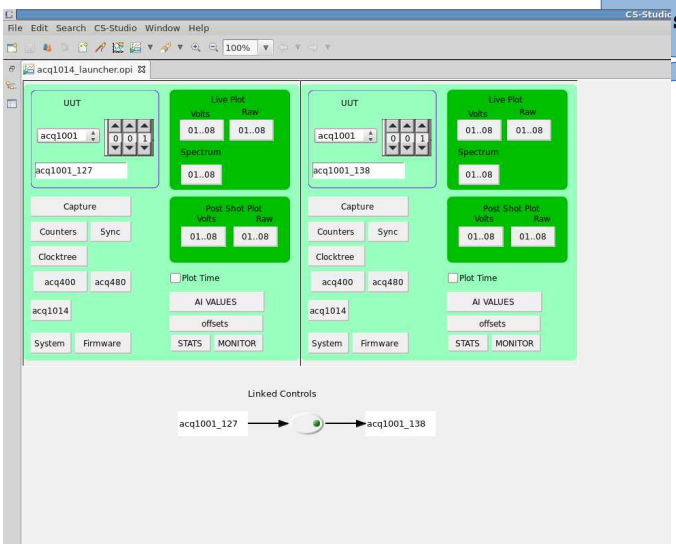


7.3 Quickstart GUI : Transient Capture

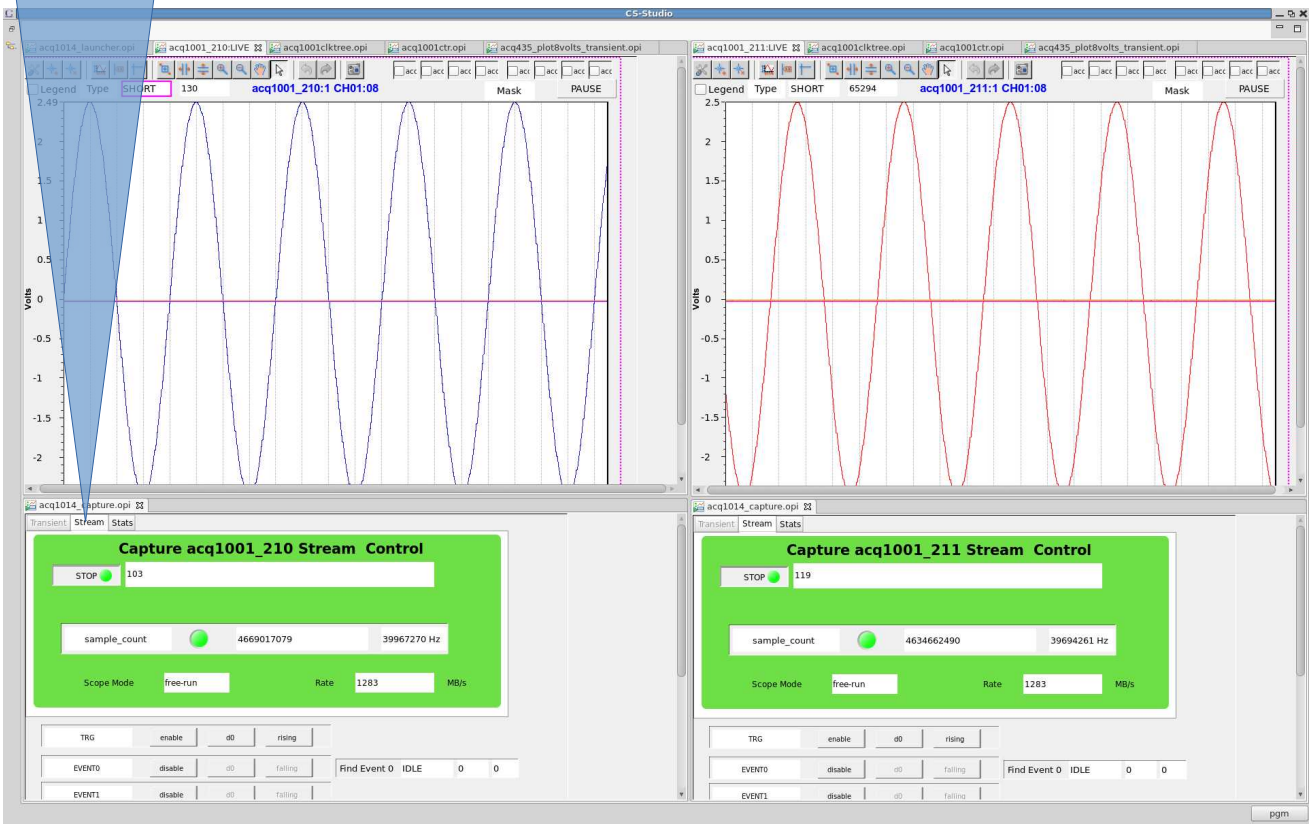
7.4 Quickstart Streaming Plot

Unsynchronized snapshot plot.

(1)
ss LIVEPLOT VOLTS ..



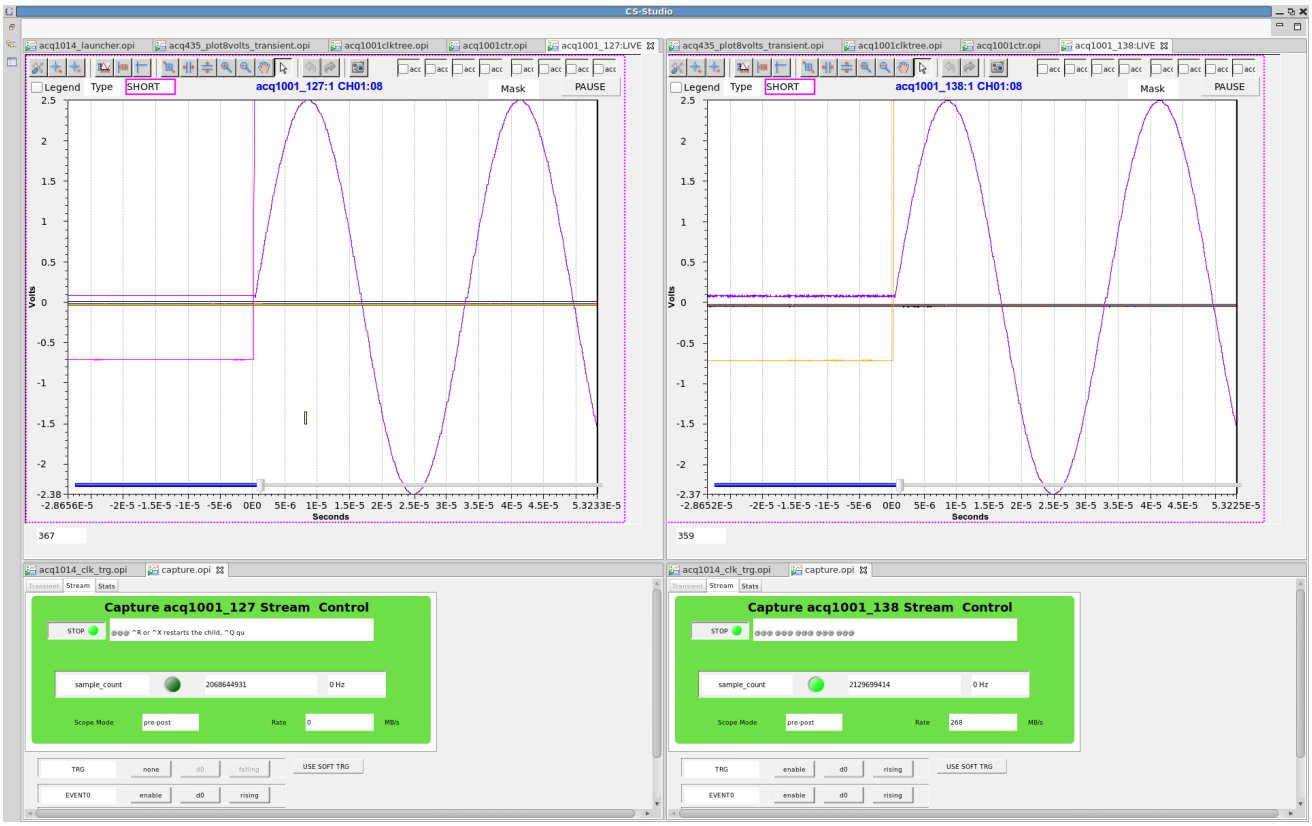
(2)
Select STREAM tab .., press START



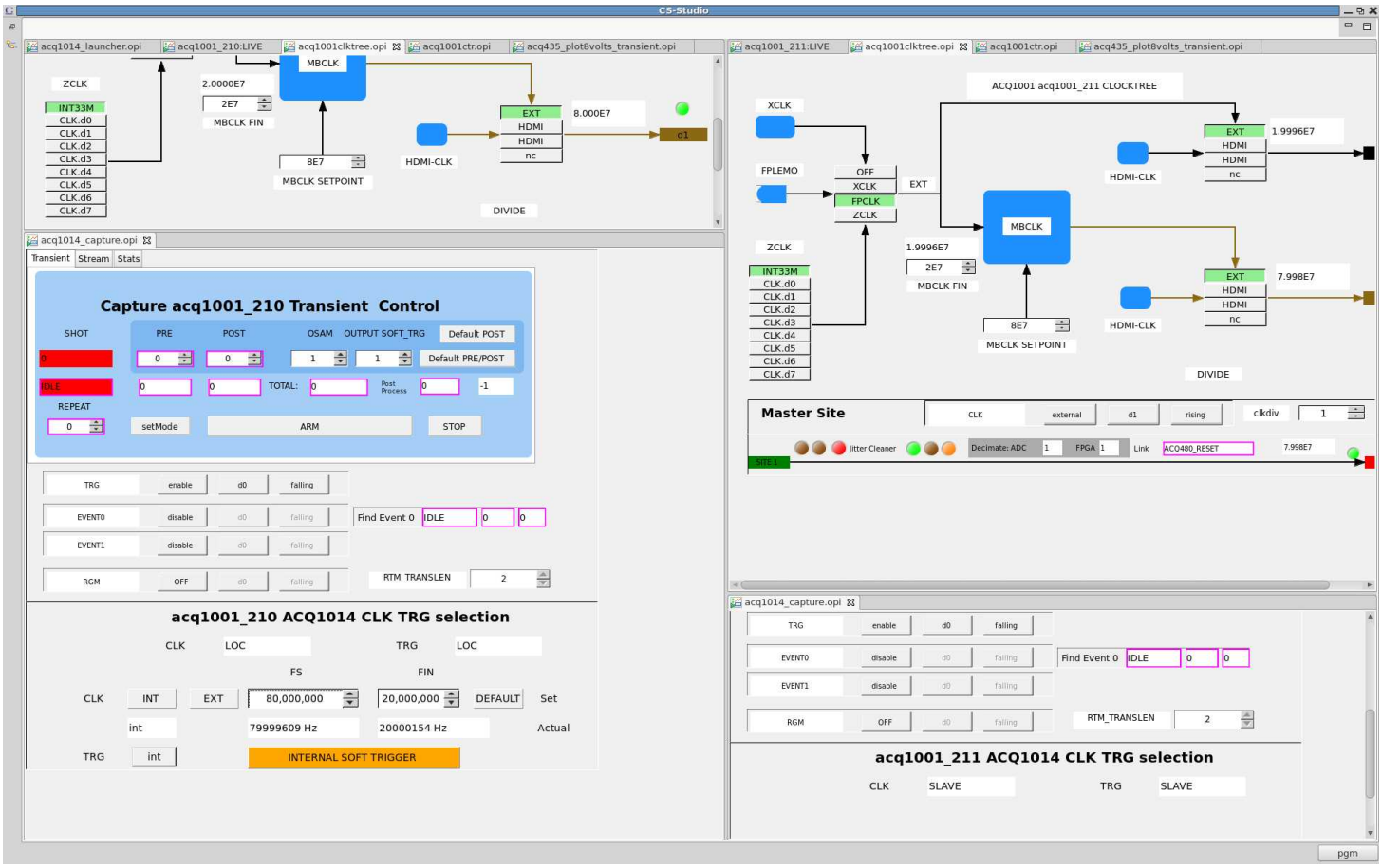
7.5 Quickstart GUI Streaming Capture (Live Scope)

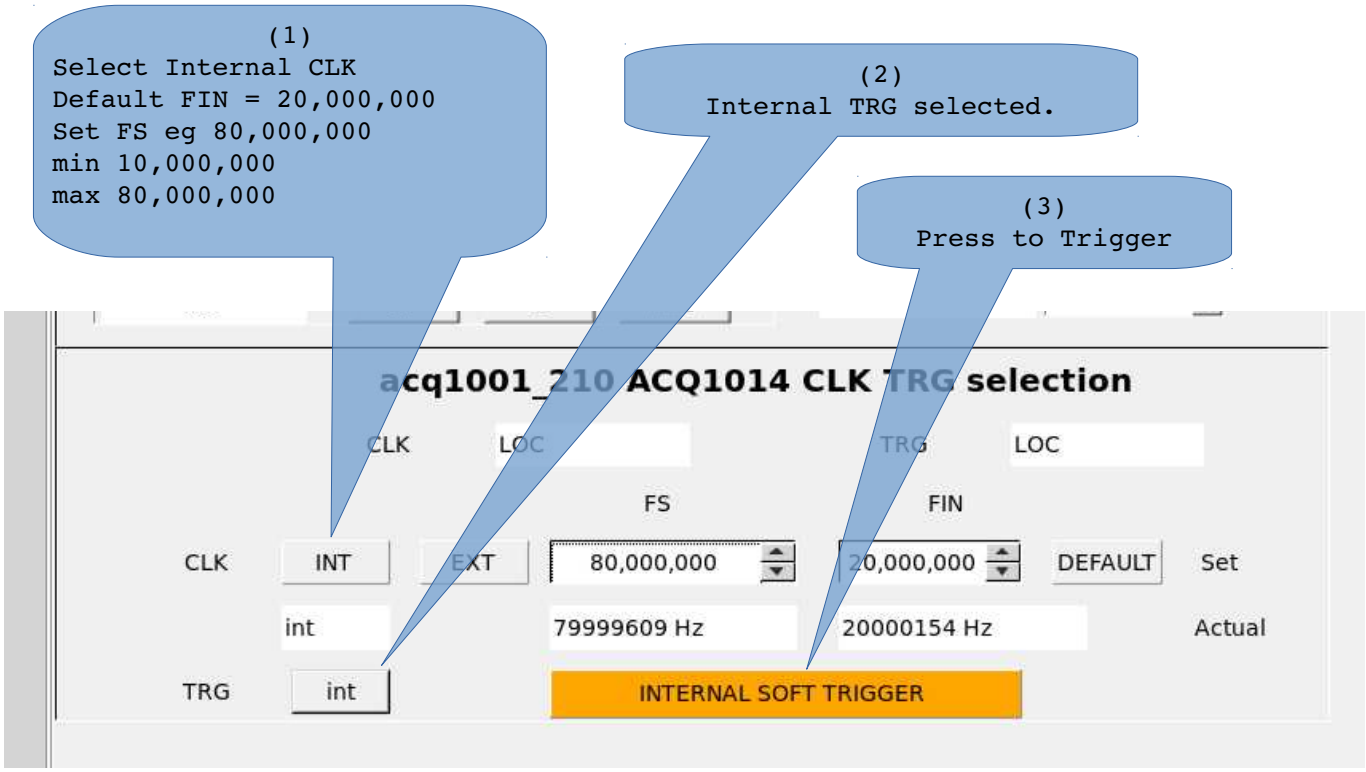
AVAILABLE 1D ONLY (50MSPS MAX)

- Enable Event0, using input trigger signal, select Rising|Falling
- Press START, display shows a repeating update, synchonized with the trigger.
- A delay cursor allows continuously variable delay
- Event Rising|Falling may be changed in-shot

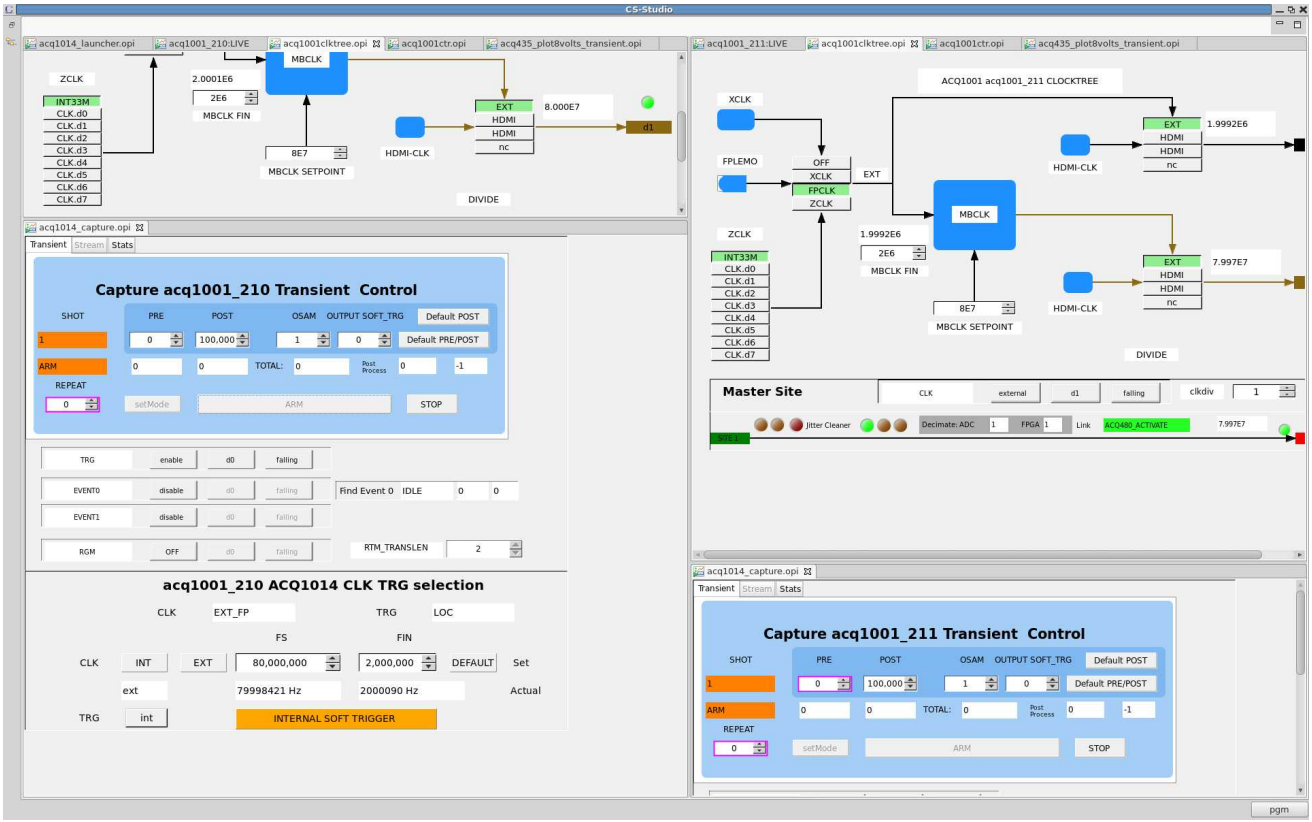


7.6 Select Internal Clock





7.7 External Clock



(1)
Select External CLK
Set FIN = 2,000,000 recommended
min 1,000,000 (FS=40,000,000 max)
max 10,000000
Set FS eg 80,000,000
min 10,000,000
max 80,000,000

8 Scripted Control

Anything that can be controlled from the UI can be controlled from a script, either local or remote.

8.1 ACQ1014 Unique commands

It's important to note that ACQ1014 is really 2 x ACQ1001 units, ie two discrete embedded systems, however, they can be configured to work in synchonization. The commands below are intended to be run identically on each unit.

Scriptable (boot time commands)	
acq1014+acq480.init SAMPLE-RATE	boot time initialization
The commands below are presented on port 4220 for ease of remote control.	
acq1014_is_master	outputs 1 if master sync loopback cable is connected to this unit.
acq1014_select_clk_src {int|ext} {SR} [CR]	configure clocking: int: internal (Rear Panel) clock ext: external (Front Panel) clock (SOLO box only – all SLAVE boxes are clocked from Rear Panel, and hence use the int clock) SR: Sample Rate in Hz CR: [external] clock rate in Hz if known.
acq1014_select_trg_src {int|ext|ext2}	configure triggers Master Box: int:soft trigger ext: Front Panel trigger ext2: Front Panel trigger, TRG2 if slave 8 channels Slave Box : must be int.

9 Remote scripting control with python

https://github.com/petermilne/acq400_hapi

https://github.com/petermilne/acq400_hapi_tests

- acq1014_configure_transient.py
- acq1014_caploop.py

10 Offload Transient Data

10.1 Host-Pull from Transient Data Service

Post-shot channelized data is available from sockets 53001..53008 / TCP.

Simply connect to the socket and read until done.

10.1.1 Minimal scripted Linux Host-Pull example

```
#!/bin/bash
# host-pull fetch channels [8] to files CH0x

UUT=${1:-acq1001_127}
CMAX=${2:-8}

for ch in $(seq $CMAX); do
        nc -i 1 $UUT 5300$ch > $(printf "CH%02d" $ch) &
done

for ch in $(seq $CMAX); do
        wait
done
```

Above script fetches data to 8 binary files-per-channel. Takes 9s for 25MSamples.

Minimum time is limited by the 1s idle time out on the general purpose NC. A customized client would avoid this.

Easy to plot the data using kst2. Needs this format file.

```
[pgm@hoy4 ACQ1014_TEST]$ cat format
CH01  RAW   s     1
CH02  RAW   s     1
CH03  RAW   s     1
CH04  RAW   s     1
CH05  RAW   s     1
CH06  RAW   s     1
CH07  RAW   s     1
CH08  RAW   s     1
```

10.2 Target-Push

- EPICS waveform records .. good to maybe 100k Points
- MDSplus Thin Client mdsPutCh – push to MDSplus tree with calibration and time.
- FTP Client - push raw data to remote FTP server
- Samba Client. - push raw data to remote Windows file share.

10.2.1 Target-Push direct to MDSplus

Automated post shot upload.

- Create canonical MDSplus tree.
- Enable package 70-mdsshell
- Upload scripts:

```
cat /mnt/local/mdsshell.sh
MDSHOST=mds-server-hostname

cat /mnt/local/postshot
#!/bin/sh


[ -e /mnt/local/sysconfig/mdsshell.sh ] && source
/mnt/local/sysconfig/mdsshell.sh

if [ "x$MDSHOST" = "x" ]; then
      logger -t postshot MDSHOST not defined
      exit 1
fi


HN=$(hostname)
sn=${HN#*_}
model=${HN#acq*}
typ=${model:0:1}
TN=a${typ}${sn}

mdsConnect $MDSHOST
mdsOpen $TN
mdsPutCh -b 1 --field AI.CH%02d --expr %calsig :
mdsClose
mdsValue setEvent\(\'${TN}_99\',42ub\)
mdsDisconnect
```

11 Clock and Sync Options

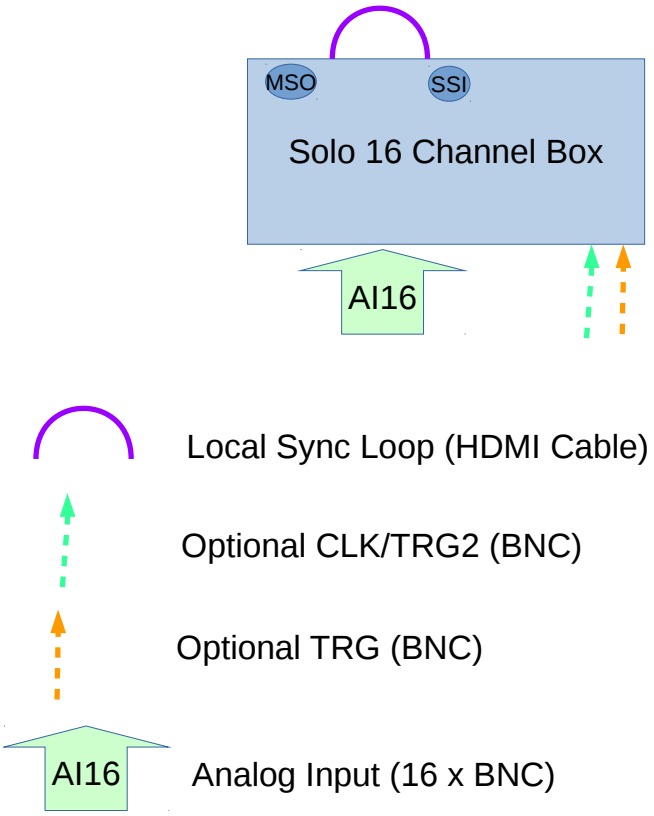
11.1 Single box:

Always connect the clock loopback from MSO to SSI.

Optionally connect your external clock to the front panel CLK input.

Optionally connect the primary trigger TRG

For 2 x 8 channel operation, connect the secondary trigger TRG2.

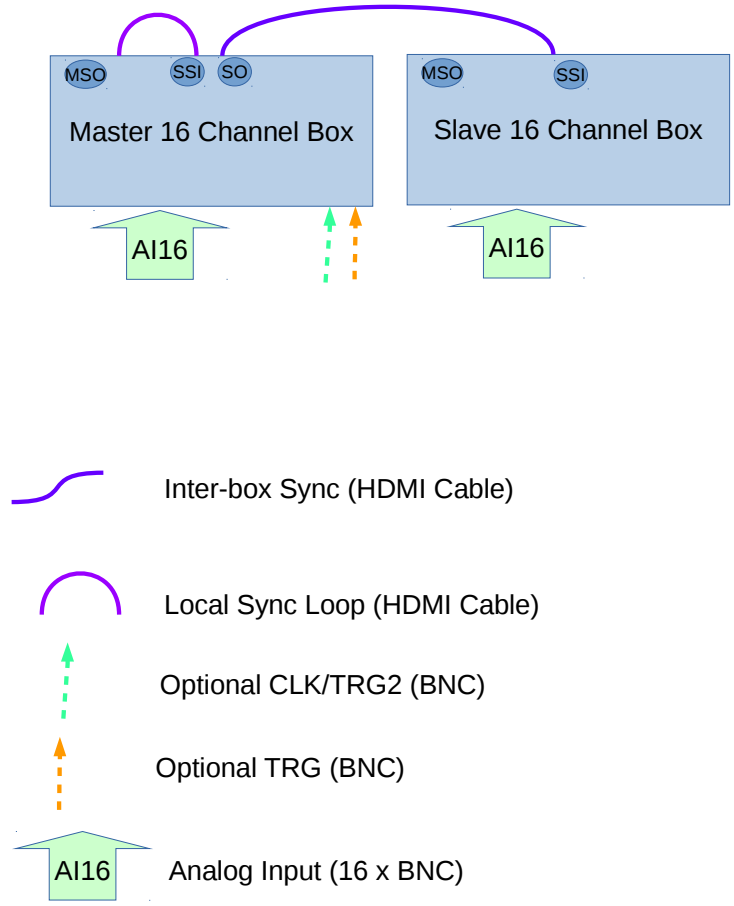


Drawing 4: : Single Box sync, plan view

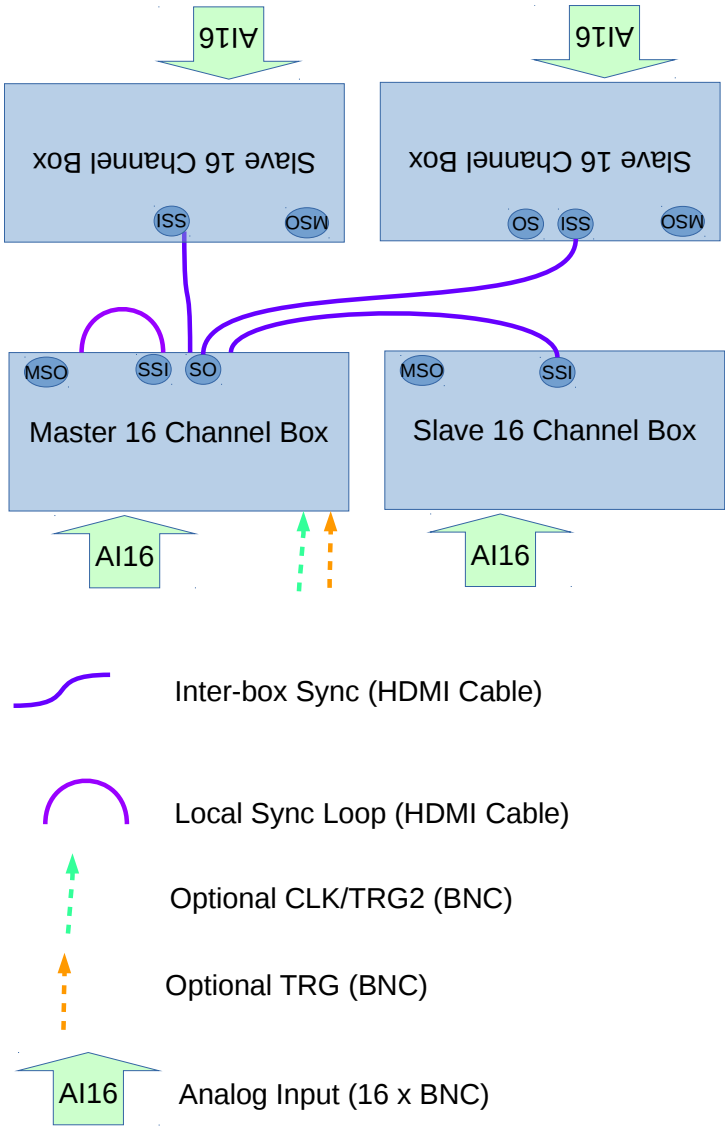
11.2 Multiple box:

Designate one box as the master, and connect as above.

On each slave box, connect an HDMI cable from SYNC OUT in the middle of the master box rear panel to SYNC IN on the slave box. Each slave box will experience a single gate delay or less than 10nsec delay; this is not visible in the sampling system.



Drawing 5: : Two Box sync, plan view

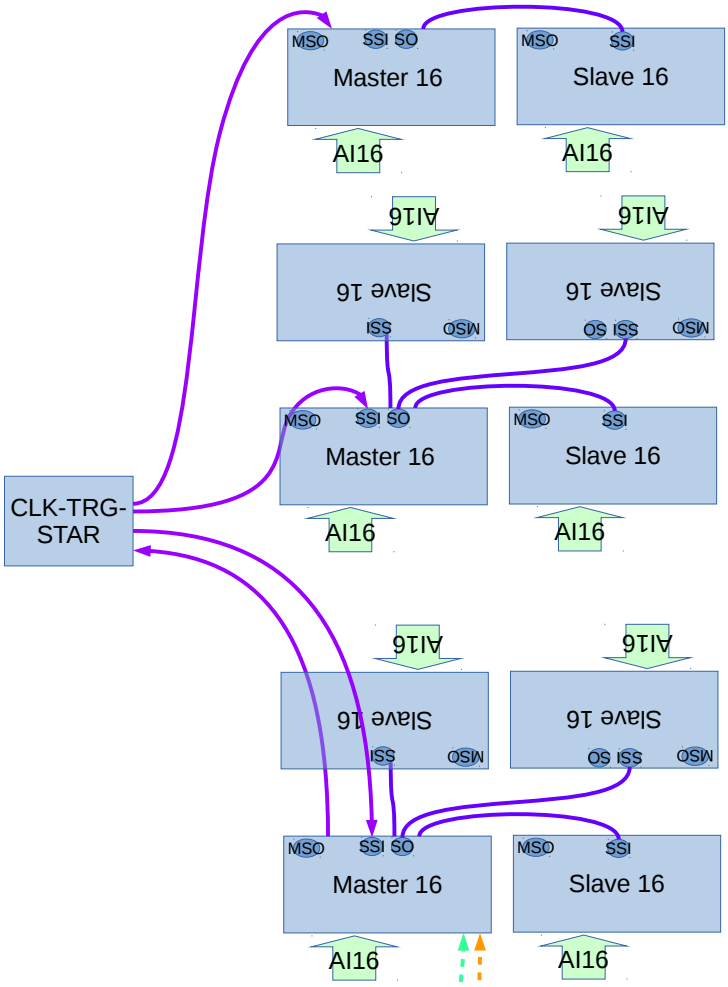


*Drawing 6: : Three/Four Box sync, plan view (*Rev B only)*

11.3 Unlimited fanout with CLK-TRG-STAR accessory.

While it's possible to daisy-chain additional slave boxes, we don't recommend this as the gate delays will add up. D-TACQ provides a clock distribution box for this purpose.

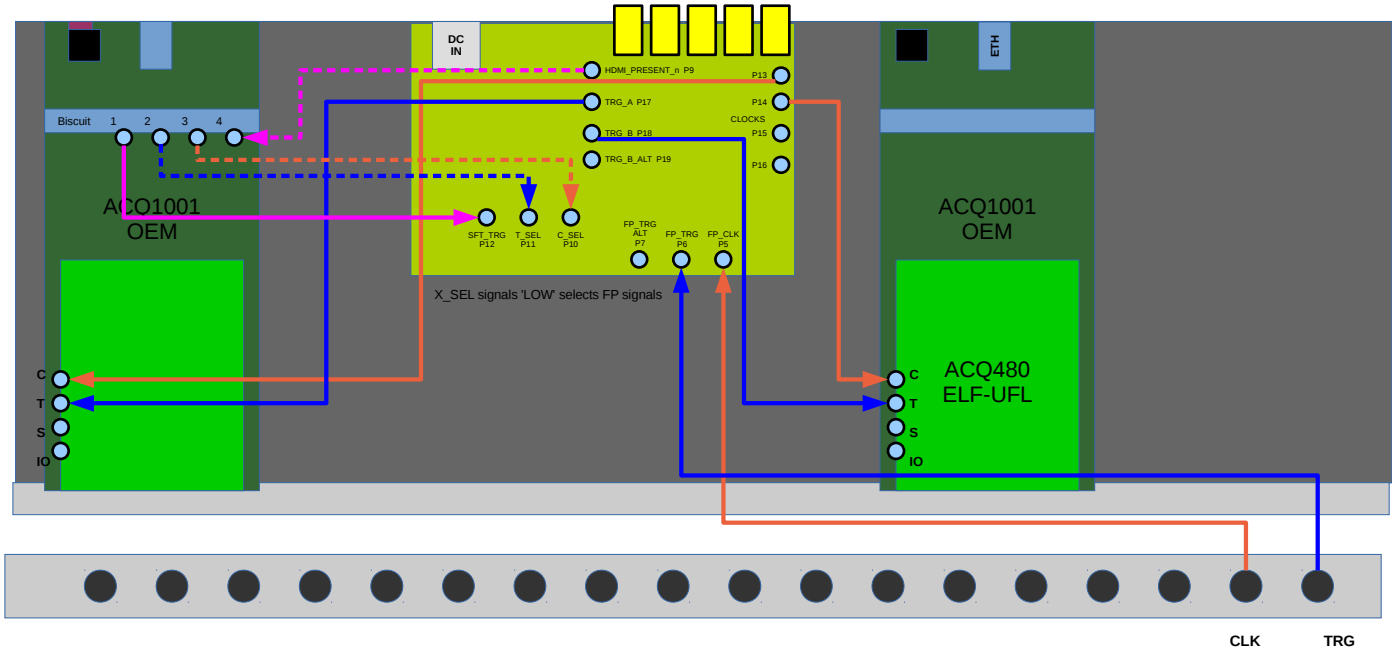
CLK-TRG-STAR provides 1:4 fan out from a master clock, allowing 4 x 64 channels sampling with maximum 1 gate delay variation.



Drawing 7: : Multiple box sync, using CLK-TRG-STAR

11.4 Internal Signal Routing.

NEW – ACQ1014



12 Appendix: starting the UI from scratch.

1. Download cs-studio binary eg from :

   https://ics-web.sns.ornl.gov/css/products.html

   https://ics-web.sns.ornl.gov/css/updates/apps/basic-epics-4.1.1-win32.win32.x86_64.zip

   https://ics-web.sns.ornl.gov/css/updates/apps/basic-epics-4.1.1-linux.gtk.x86_64.zip

   https://ics-web.sns.ornl.gov/css/updates/apps/basic-epics-4.1.1-macosx.cocoa.x86_64.zip

2. Download D-TACQ OPI set

   https://github.com/petermilne/ACQ400CSS/

   Store data at PROJECTS/ACQ400/OPI

3. Run cs-studio, create new workspace

   Press “Workbench”

   From Navigator:

   Right Click, New Project, General, Project, Next>

   Uncheck Use default location

   Browse to PROJECTS/ACQ400/OPI/ACQ400 [OK]

   Project Name : type ACQ400

   [FINISH]

4. Specifically for ACQ1014

   Edit | Preferences | CSS Applications | Display | BOY |

   Top OPI's : delete all, enter acq1014_launcher.opi

   [APPLY]

   Opi Runtime

   Macros ADD:

   UUTLEFT <uutleftname eg acq1001_112>

   UUTRIGHT <uutrightname eg acq1001_113>

   [APPLY] [OK]

   File | Restart cs-studio

   From Navigator, double click ACQ1014_launcher.opi. Check that UUT left and right names are correctly set.

13 Changelog

Date	*Rev*	*Section*	*Changes*
20161109	2	8.2,8.3	matched and independent central control