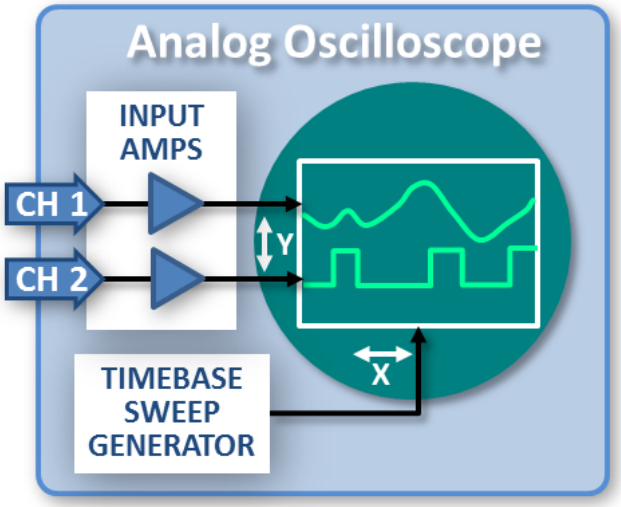
AGI DOC PACKAGE – Table Of Contents

An Analog Oscilloscope Overview

An oscilloscope accepts a voltage input from a device under test and displays that voltage as a dot on a display screen. A positive voltage into the scope drives the Y-axis of the trace, moving the 'dot' up on the screen, while a negative voltage input moves the 'dot' down. A second, independent voltage is applied to the X-axis of the oscilloscope. In this case, a positive voltage moves the dot to the right along the X-axis while a negative voltage moves the dot to the left.



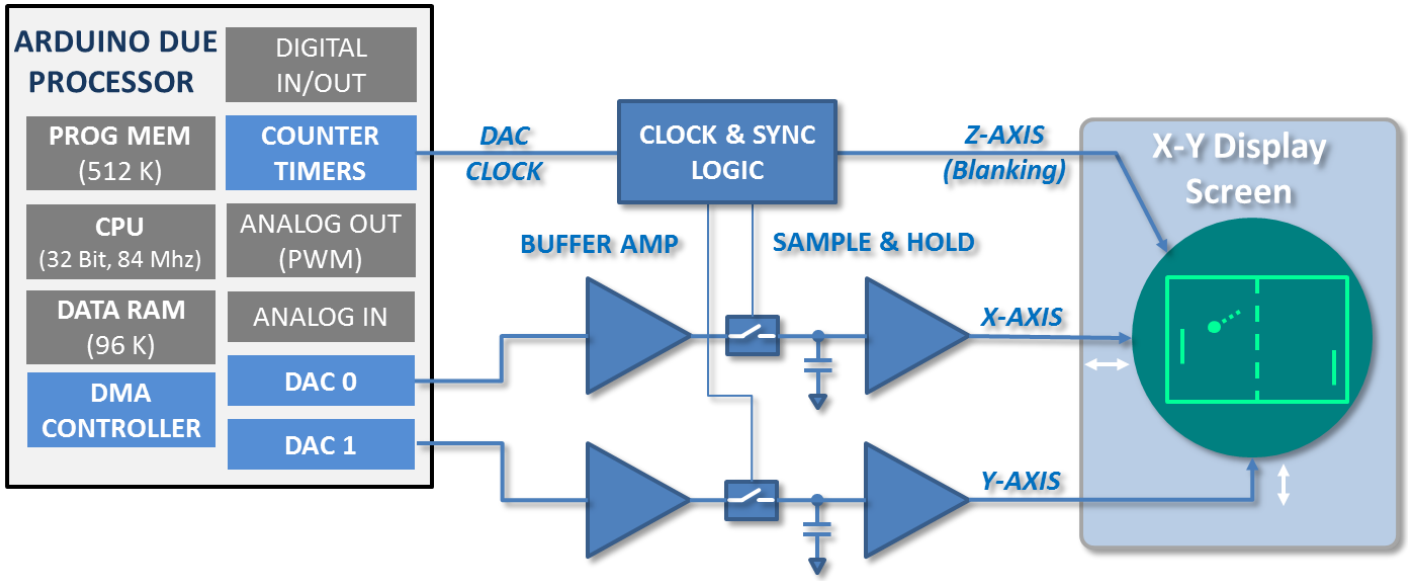
By applying the unknown test voltage into the Y-axis and a linear ramp waveform into the X-axis, the dot will graphically show how the unknown test voltage changes over time.

The linear ramp waveform driving the X-axis waveform is created inside the oscilloscope by an internal time base sweep generator circuit. Two (or four) channel oscilloscopes allow multiple signals to be simultaneously traced across the screen. With careful calibration of the time base and input amplifiers of the scope, precise amplitude and time measurements are made.

The earliest computer graphics and radar displays (circa: 1940-1970's) used CRTs driven in an X-Y fashion to show monochrome vector graphic displays.

This project side steps the internal Time Base seep generator of the oscilloscope and drives both the X & Y axis with a microprocessor. In this way we can show high resolution vector art graphic images on an oscilloscope screen.

AGI Block Diagram



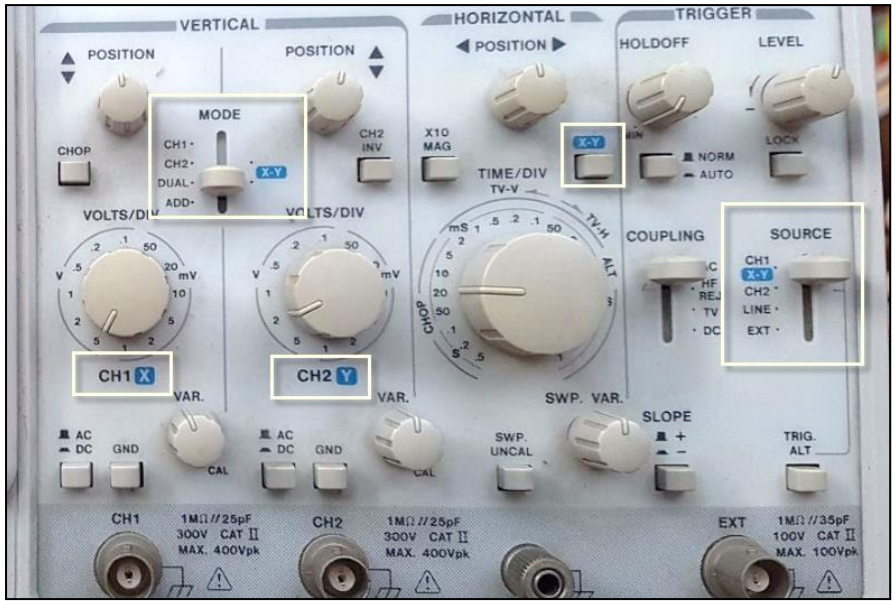
AGI Oscilloscope Requirements

Overall graphics quality is influenced by the quality and performance of the oscilloscope and CRT used. This project works well only with ANALOG Oscilloscopes; Digital scopes will only produce poor looking output.

There are many analog scopes manufactured by Tektronix, HP, Phillips, Leader, GW-Instek and others that will work well.
Look for these key features to find a suitable scope for this project:

- Screen size: Larger is better!
- Scope must support an X-Y Mode
- Scope must be run in DC Mode

Typical Scope Front Panel View showing XY Operation Controls



Typical Scope Rear Panel View showing Z-AXIS INPUT connector

Parts List – AGI Project

Item	Ref Designators	QTY	Description/Values/Notes	Manufacturer	Mfg PN	Alternate Sources	Additional Notes
1	AGI PCB Assembly	1	--	--	--	--	See build PCB Documentation beginning on page 6.
2	Arduino Due Processor Board	1	ARDUINO DUE (or compatible)	Arduino.org	See Web Site	Amazon, eBay, & others	
3	BNC to BNC Cables	2	BNC to BNC, 50Ohm Cable, 3-5Ft Length, AGI to Oscilloscope Interconnect	Various	Various	Amazon, eBay, & others	Shielded or Twisted Pair cabling is recommended; Final method & length of XYZ interconnection is BUILDER'S choice
4	+ 12VDC Power Supply	1	+12 VDC @ 2 Amp	Various	Various	Amazon, eBay, & others	Selection of Power Supply and method of interconnect to AGI PCB is BUILDER'S choice
5	Hookup Wire	AR	Wire for interconnection between AGI and Arduino Due	Various, As Required	Various	Amazon, eBay, & others	Method of interconnection is BUILDER'S choice
5	Misc Headers to facilitate interconnect	AR	Connectors headers for interconnect between AGI and Due	Various, As Required	Various	Amazon, eBay, & others	Method of' interconnection is BUILDERS choice
6	4-40 X 0.75 In Long Spacer (Spacer, Nuts, Screws AR)	4	Spacers used to mount DUE to TOP OF AGI PCB	Various	Various	Amazon, eBay, & others	Final mounting method is BUILDER'S choice
7	4-40 X 0.75 In Long Spacer (Spacer, Nuts, Screws AR)	4	Spacers used to mount AGI to a base or enclosure	Various	Various	Amazon, eBay, & others	Final mounting method is BUILDER'S choice
8	Project Enclosure	1	As Required, BUILDER'S choice	Various	Various	Amazon, eBay, & others	Final enclosure method is BUILDER's choice
9	Analog Oscilloscope with XYZ Drive Capability	1	Analog Oscilloscope is required as the final display device. Note: DIGITAL scopes will not work.	Various	Various	Amazon, eBay, & others	See OSCILLOSCOPE REQUIREMENTS page to qualify possible oscilloscope candidates.

Parts List – AGI PCB ASSEMBLY

NOTE: Use PCB or hand-wire using Prototype Perf-Board for assembly. Use of IC sockets for all 8-pin and 14-pin devices is recommended.

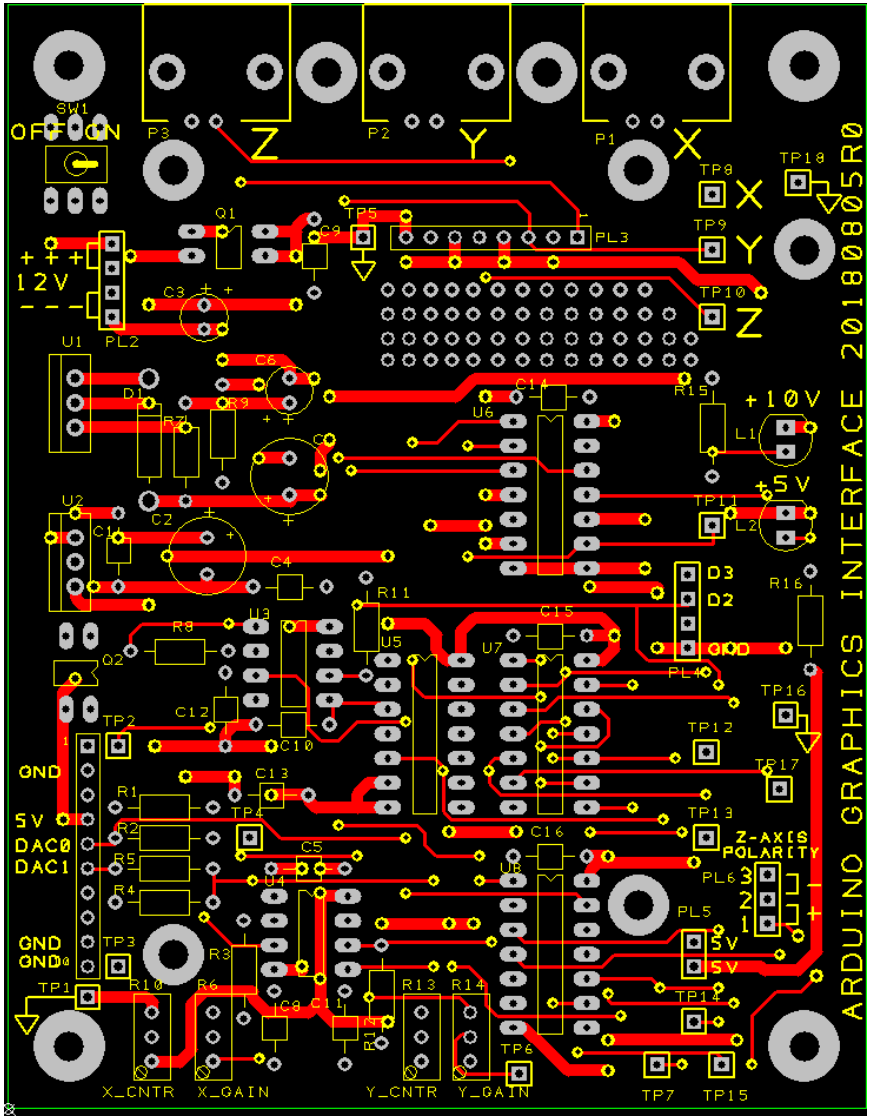
Item	Ref Designators	QTY	Value/Notes	Manufacturer	Mfg PN	Digikey (DK) PN	Description & Add'l Data
1	C10,C12	2	470pf	KEMET	C410C471J1G5TA7200	DK: 399-4473-1-ND	CAP CER 470PF 100V C0G/NP0 AXIAL
2	C11,C13,C14,C15,C16,C4,C5,C8,C9	9	.1uf	Taiyo Yuden	UP050F104Z-A-BZ	DK: 587-5501-1-ND	CAP CER 0.1UF 50V AXIAL
3	C2,C7	2	330uf	Panasonic	ECA-1EHG331	DK: P5542-ND	CAP ALUM 330UF 20% 25V RADIAL
4	C3,C6	2	47uf	Panasonic	EEU-FC1H470	DK: P10321-ND	CAP ALUM 47UF 20% 50V RADIAL
5	D1	1	1N4004	Micro Com	1N4004-TP	DK: 1N4004-TPMSCT-ND	DIODE GEN PURP 400V 1A DO41
6	L1,L2	2	LED 3MM GRN	Broadcom Limited	HLMP-1503-C0002	DK: 516-3190-2-ND	LED GRN DIFF 3MM ROUND T/H
7	P1,P2,P3	3	Can use Chassis Mount BNC	TE Connectivity AMP Connectors	1-1634612-0	DK: A97555-ND	CONN BNC JACK R/A 50 OHM PCB
8	PL1	1	Alt: Jumper Wire	Samtec	MALE: TSW-110-07-T-S FEMALE: SSA-110-S-T	MALE DK: SAM1035-10-ND FEMALE DK: SAM1035-10-ND	10 PIN .025" SQ. MALE OR FEMALE TERM
9	PL2	1	Alt: Jumper Wire	Samtec	HTSW-101-07-T-S	DK: SAM11363-ND	4 PIN .025" SQ. MALE TERM
10	PL3	1	Alt: Jumper Wire	Samtec	MALE: TSW-108-07-T-S FEMALE: SSA-108-S-T	MALE DK: SAM1035-08-ND FEMALE: SAM1122-08-ND	8 PIN .025" SQ. MALE OR FEMALE TERM
11	PL4	1	Alt: Jumper Wire	Samtec	MALE: HTSW-101-07-T-S	MALE DK: SAM11363-ND	4 PIN .025" SQ. MALE OR FEMALE TERM
12	PL5	1	Alt: Jumper Wire	Samtec	MALE: TSW-102-24-T-S FEMALE: SSA-102-S-T	MALE DK: SAM12303-ND FEMALE DK: SAM1122-02-ND	2 PIN .025" SQ. MALE OR FEMALE TERM
13	PL6	1	Alt: Jumper Wire	Samtec	TSW-103-15-T-S	DK: SAM9525-ND	3 PIN .025" SQ. MALE TERM
14	Q1,Q2	2	IRFD9120	Vishay, Siliconix	IRFD9120PBF	DK: IRFD9120PBF-ND	MOSFET P-CH 100V 1A 4-DIP
15	R1,R11,R4,R8	4	4.7K	Yageo	CFR-25JB-52-4K7	DK: 4.7KQBK-ND	RES 4.7K OHM 1/4W 5% AXIAL
16	R10,R13	2	10K	Bourns, Inc	PV36W103C01B00	DK: 490-2875-ND	TRIMMER 10K OHM 0.5W TH
17	R12,R2,R3,R5	4	10K	Yageo	MFR-25FBF52-10K	DK: 10.0KXBK-ND	RES 10K OHM 1/4W 1% AXIAL
18	R14,R6	2	100K	Bourns, Inc	PV36W104C01B00	DK: 490-2876-ND	TRIMMER 100K OHM 0.5W TH
19	R15,R16	2	1K	Yageo	MFR-25FBF52-1K	DK: 1.00KXBK-ND	RES 1K OHM 1/4W 1% AXIAL
20	R7	1	240	Yageo	CFR-25JB-52-240R	DK: 240QBK-ND	RES 240 OHM 1/4W 5% AXIAL
21	R9	1	1.5K	Yageo	MFR-25FBF52-1K5	DK: 1.50KXBK-ND	RES 1.5K OHM 1/4W 1% AXIAL
22	SW1	1	1 A @ 20 VDC	BUILDER CHOICE	BUILDER CHOICE	BUILDER CHOICE	PWR SWITCH for remote mount as desired. Substitute jumper wire if not needed (See Build Doc for details)
23	TP1,TP10,TP11, TP12,TP13,TP14, TP15,TP16,TP17, TP18,TP2,TP3,TP4, TP5,TP6,TP7,TP8, TP9	18	OPTIONAL	Samtec	HTSW-101-07-T-S	DK: SAM11363-ND	1 PIN .025" SQ. MALE TERM OR HAND-FORM TEST POINT FROM INSULATED, SOLID-CORE WIRE. PHYSICAL TEST POINTS ARE NOT REQUIRED AND MAY BE OMITTED IF DESIRED .
24	U1	1	LM317	Fairchild/ON Semi	LM317AHVT	DK: LM317AHVT-ND	IC REG LINEAR ADJ 1A TO220-3 [Heat Sink Required!]
25	U2	1	LM7805	Fairchild/ON Semi	LM7805ACT	DK: LM7805ACT-ND	IC REG LDO 5V 1A TO220-3 [Heat Sink Required!]
26	U3,U4	2	CA3240	Intersil	CA3240EZ	DK: CA3240EZ-ND	IC OPAMP GP 4.5MHZ 8DIP (USE 8-PIN SOCKET)
27	U5	1	CD4066	Texas Inst.	CD4066BE	DK: 296-2061-5-ND	QUAD BILATERAL SWITCH 14-DIP (USE 14-PIN SOCKET)
28	U6	1	CD1013BE	Texas Inst.	CD4013BE	DK: 296-2033-5-ND	IC D-TYPE POS TRG DUAL 14DIP (USE 14-PIN SOCKET)
29	U7	1	74HC00	Tex Instr.	74HC00E	DK: 296-12769-5-ND	IC GATE NAND 4CH 2-INP 14-DIP (USE 14-PIN SOCKET)
30	U8	1	74LS14	Tex Instr.	SN74LS14N	DK: 296-1643-5-ND	IC HEX SCHMITT-TRIG INV 14-DIP (USE 14-PIN SOCKET)

Bare Printed Circuit Board – Rev 0

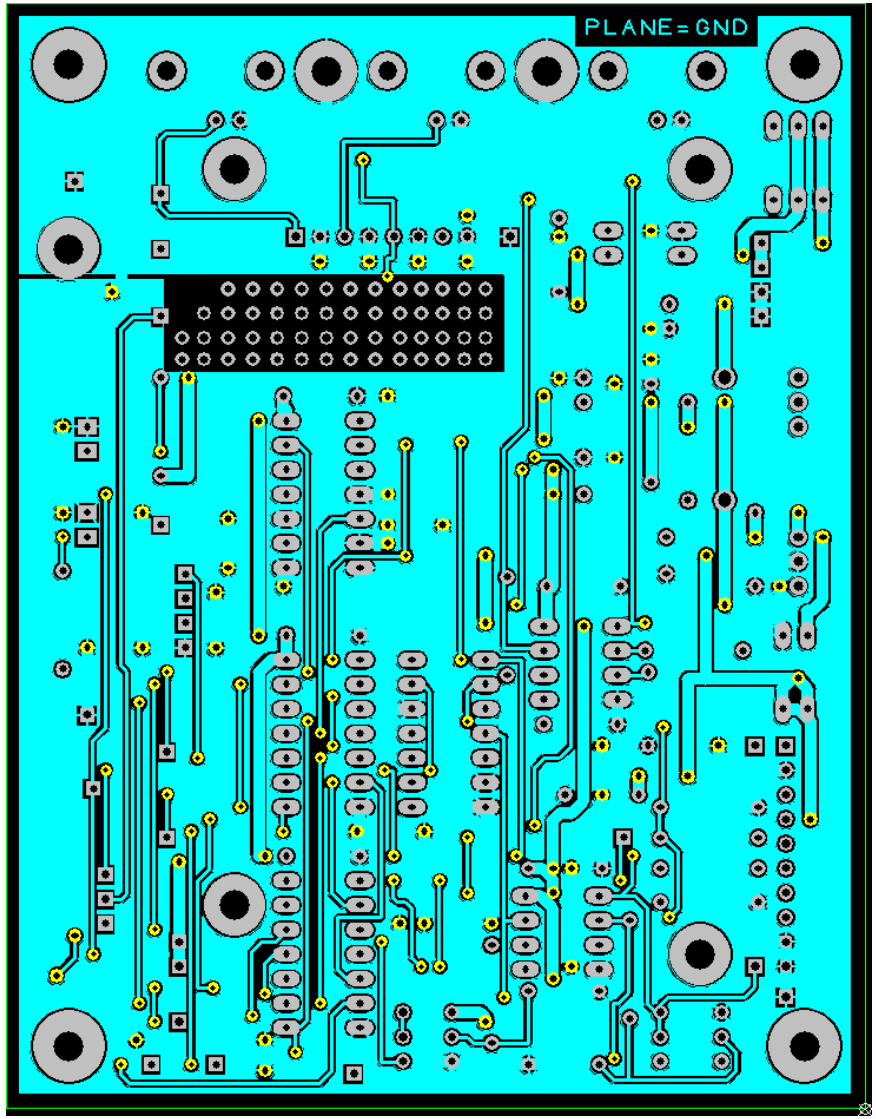
NOTE: See next 2 pages for required REWORK when using this revision!

TOP SIDE VIEW

Board Revision Level Mark



BOTTOM SIDE VIEW



THIS DOCUMENT CONTAINS PROJECT SPECIFIC DOCUMENTATION	First Made For AGI: Arduino Graphics Interface Last updated: 20180104 EWA	Filename 20180805R1 BUILD DOC.pptx	Revision 2 Printed 1/4/2018 16:09	Page 7	**AMC** Brookfield, WI USA
Made by: E. Andrews Date: 8-17-2017					

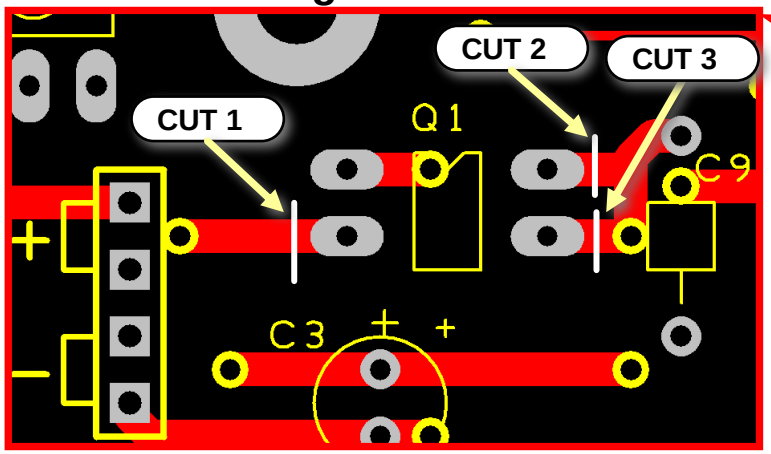
REV 0 PCB TOP-SIDE REWORK INSTRUCTIONS

(Only perform this rework when using REV 0 PCBs!)

This rework required for Rev 0 Boards (R0) PC ONLY!

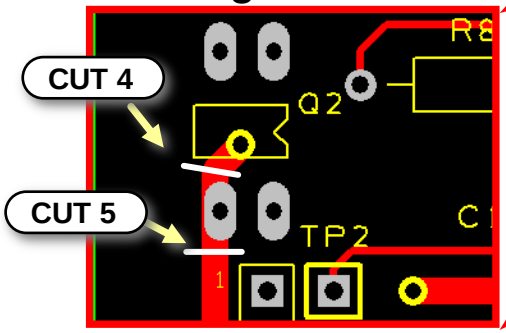
1. Cut traces in 3 spots (CUT 1,2,3) on TOP of PCB as shown in **Figure A** below.

Figure A.

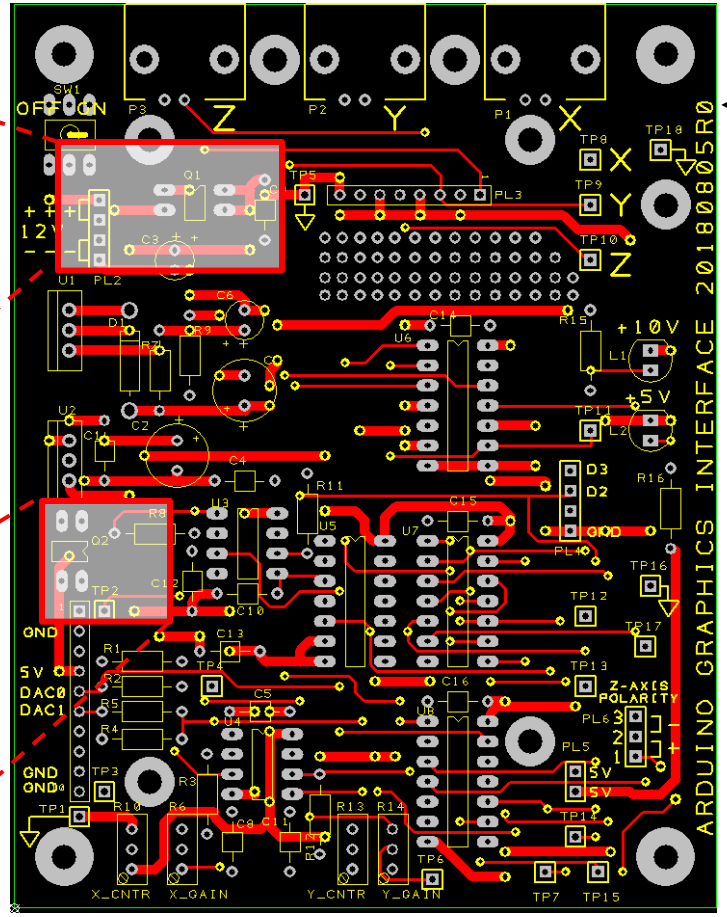


2. Cut traces in 2 spots (CUT 4,5) on TOP of PCB as shown in **Figure B** below.

Figure B.



TOP SIDE VIEW



REV 0 PCB BOTTOM-SIDE REWORK INSTRUCTIONS

(Only perform this rework when using REV 0 PCBs!)

BOTTOM SIDE VIEW

See TOP SIDE LABELING to determine PCB revision level!

1. Add 2 Jumper Wires (JUMP 1,2) on BOTTOM as shown in **Figure A** below.
2. Cut traces in 4 spots (CUT 1,2,3,4) on BOTTOM as shown in **Figure B** below.
3. Add 3 Jumper Wires (JUMP 3,4,5) on BOTTOM as shown in **Figure C** below.

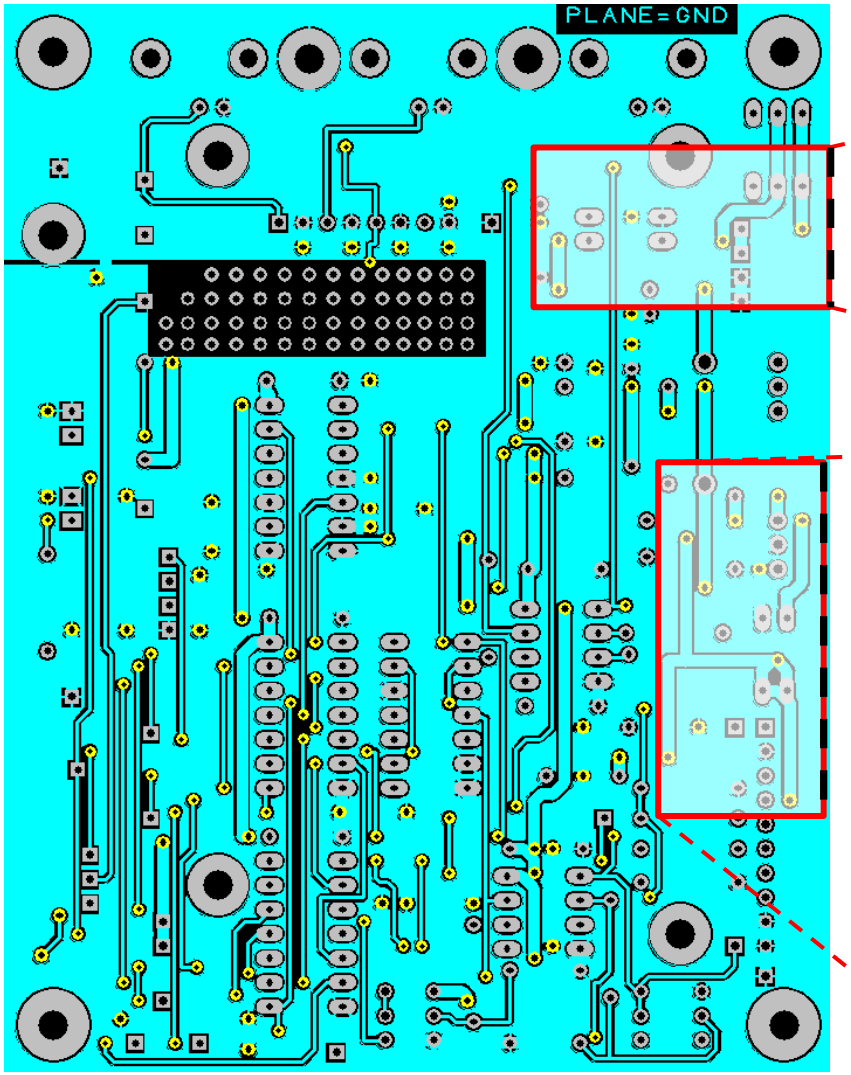


Figure A.

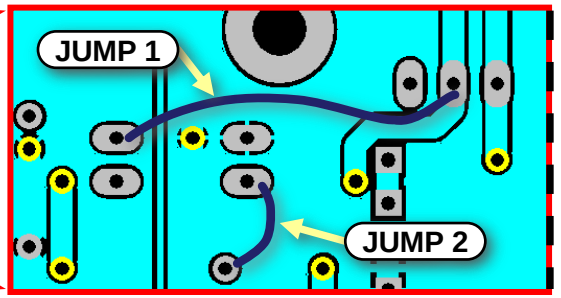


Figure B.

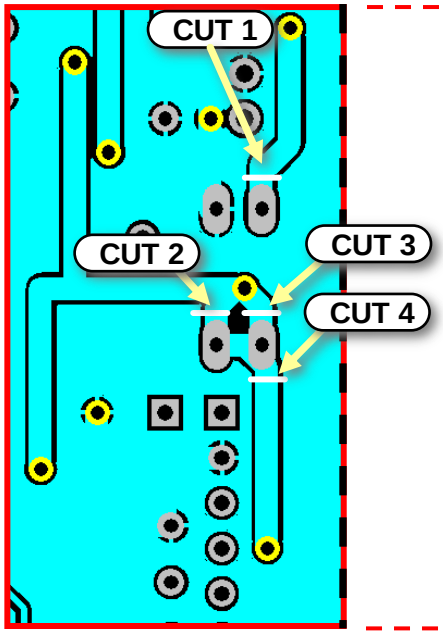
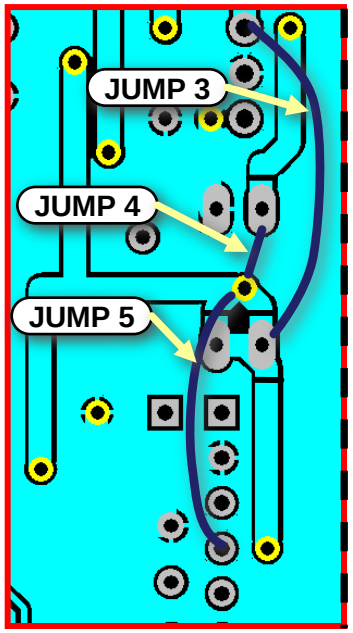


Figure C.



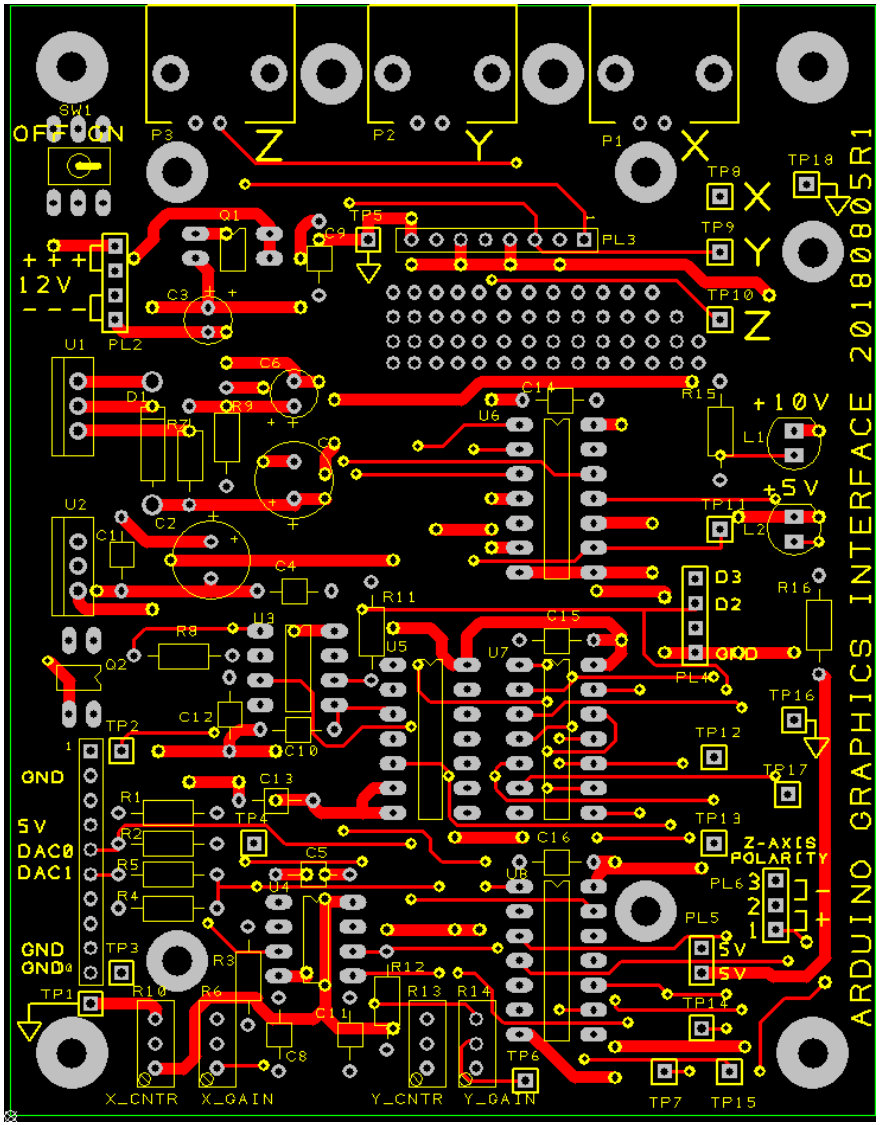
Bare Printed Circuit Board – Rev 1

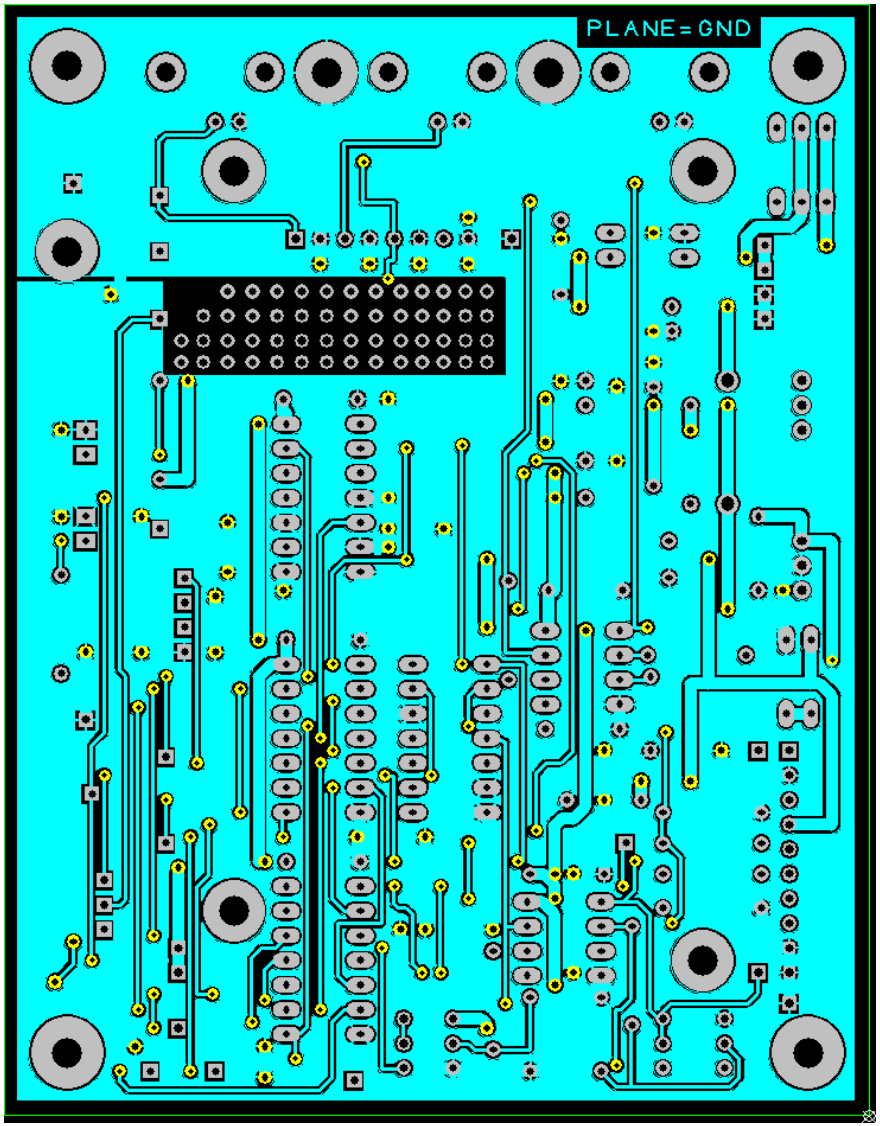
(NO Cut/JUMP rework should be required when using REV 1 PCB artwork)

TOP SIDE VIEW

Board Revision Level Mark

BOTTOM SIDE VIEW





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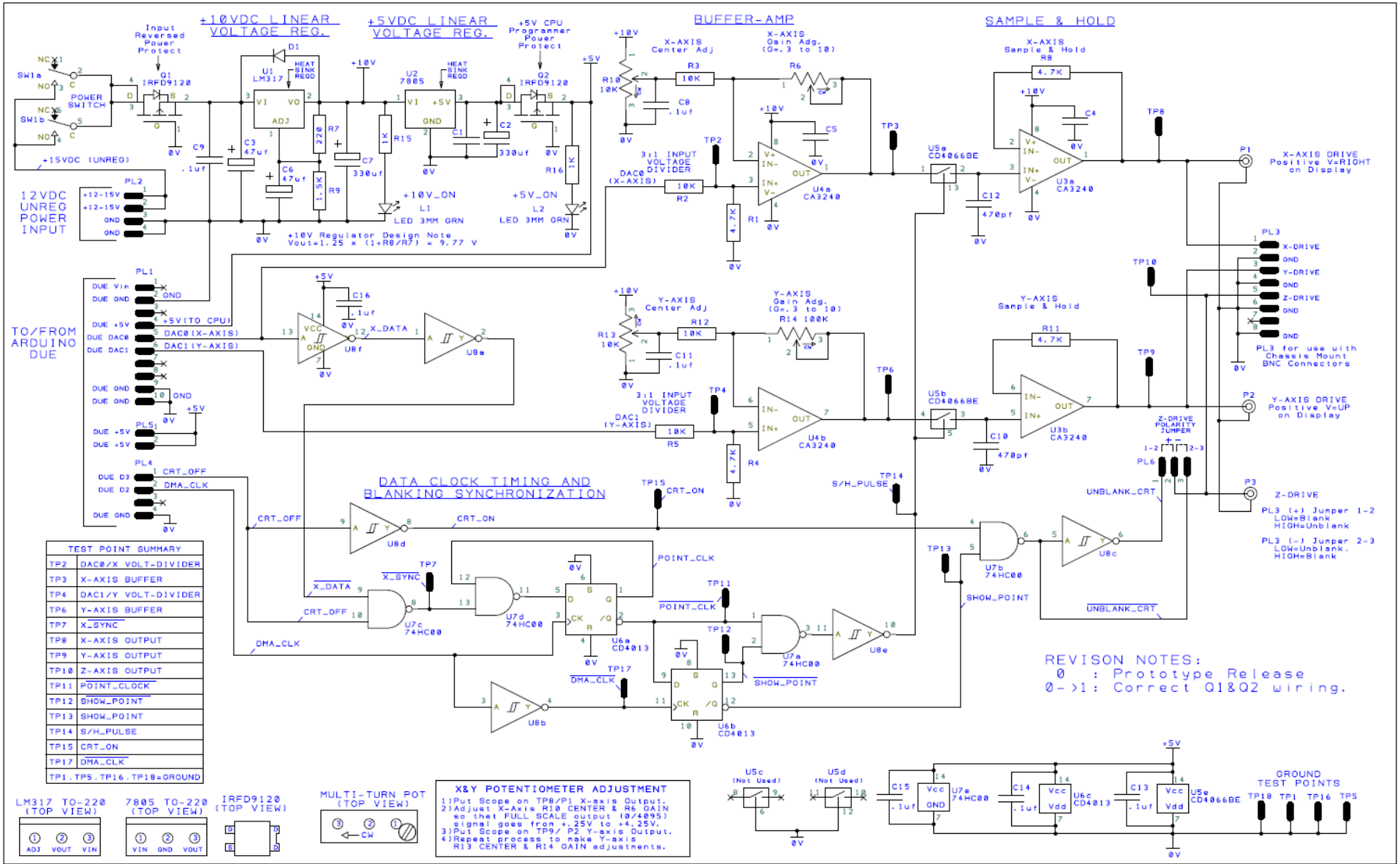


TEST POINT SUMMARY	
TP2	DAC0/X VOLT-DIVIDER
TP3	X-AXIS BUFFER
TP4	DAC1/Y VOLT-DIVIDER
TP6	Y-AXIS BUFFER
TP7	X_SYNC
TP8	X-AXIS OUTPUT
TP9	Y-AXIS OUTPUT
TP10	Z-AXIS OUTPUT
TP11	POINT_CLOCK
TP12	SHOW_POINT
TP13	SHOW_POINT
TP14	S/H_PULSE
TP15	CRT_ON
TP17	DMA_CLK
TP1.TP5.TP16.TP18=GROUND	

E	D	C	Rev 1 102417	Rev 0 080817	Drawn EWA 5-16-2017	Check EWA 8-8-2017	Projection Do Not Scale
Drn	Drn	Drn	Drn EWA 102417	Project AGI GRAPHICS INTER'FC		Client N&V Article	
Chk	Chk	Chk	Chk EWA 102417	Title 20180805R0 (SCHEMATIC)		Filename X-Y Graphics Intfc(Rev_1).sch	

AGI:ARDUINO-DUE GRAPHICS INTERFACE

E. ANDREWS
AMC Consulting Brookfield, WI 53045

Drawing No.: X-Y Graphics Intfc(Rev_1).sch
X-Y Graphics Intfc(Rev_1).pcb

Sheet: 1 of 1

Load Parts: .1uf Capacitor, 1N4004 Diode

TOP SIDE VIEW

BEFORE YOU BEGIN ASSEMBLY

Use and OHM METER to verify the following:

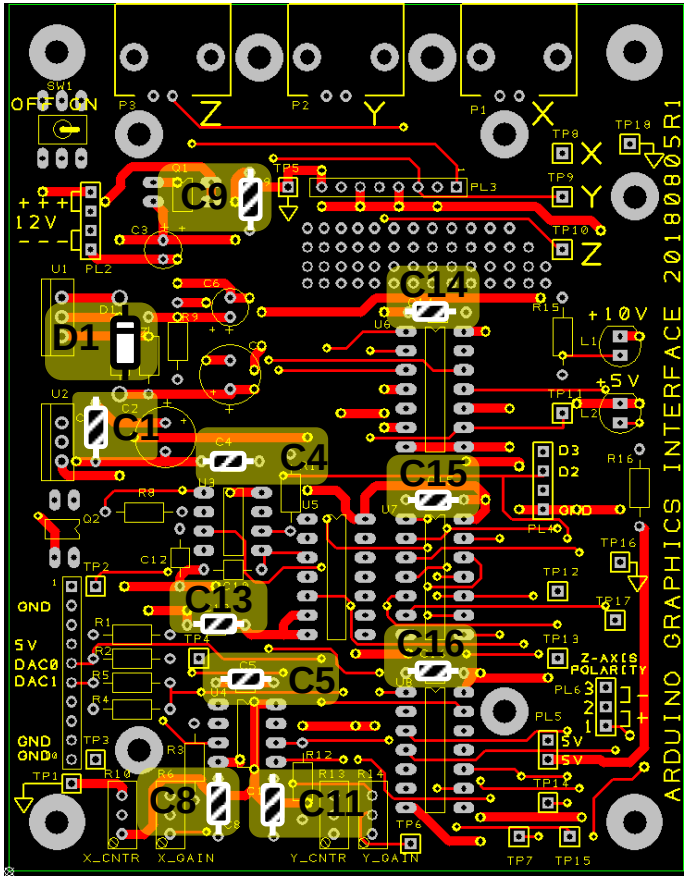
1. Perform any PCB rework steps as required and defined on preceding pages of this document.
2. +5V bus is NOT SHORTED TO GROUND.
3. +10V bus is NOT SHORTED TO GROUND.
4. +5V bus is NOT SHORTED to +10V bus.
5. +12 V input is NOT SHORTED TO +10V.

Ref Name	Qty	Value
C1	1	.1uf
C11	1	.1uf
C13	1	.1uf
C14	1	.1uf
C15	1	.1uf
C16	1	.1uf
C4	1	.1uf
C5	1	.1uf
C8	1	.1uf
C9	1	.1uf

10

D1	1	1N4004

←Observe Polarity!



Load Parts: 470pf, 47uf, 330uf Capacitor

Ref Name	Qty	Value
C10	1	470pf
C12	1	470pf

2

C3	1	47uf
C6	1	47uf

2

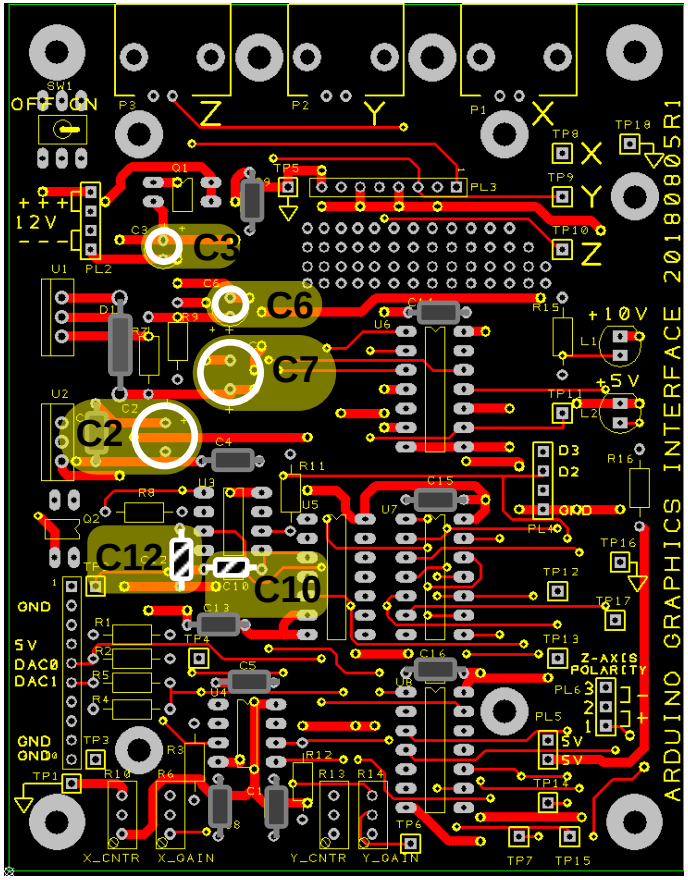
←Observe Polarity!

C2	1	330uf
C7	1	330uf

2

←Observe Polarity!

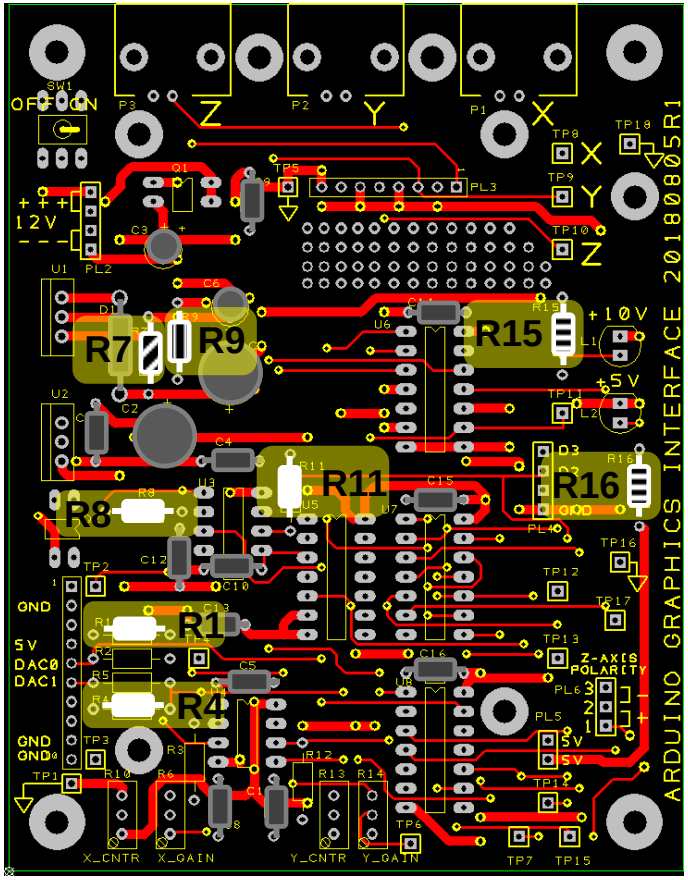
TOP SIDE VIEW



Load Parts: Resistors

Ref Name	Qty	Value
R7	1	240
R9	1	1.5K
R15	1	1K (2)
R16	1	1K
R1	1	4.7K
R11	1	4.7K (4)
R4	1	4.7K
R8	1	4.7K

TOP SIDE VIEW



Load Parts: 10K Res., Q1-Q2, U1-2, L1-2

Ref Name	Qty	Value
R12	1	10K
R2	1	10K
R3	1	10K
R5	1	10K

(4)

Q1	1	IRFD9120
Q2	1	IRFD9120

(2) ←Note device orientation!

U1	1	LM317

←Note device orientation!

U2	1	LM7805

←Note device orientation!

Note:

1) **WARNING: Heat Sink Tab on U1 LM317 = +9.0 VDC.**
2) **WARNING: Heat Sink Tab on U2 LM7805 = GND.**

DO NOT MOUNT U1 Heat Sink to GROUND. DO NOT mount U1 & U2 to a COMMON Heat sink unless insulating washers & hardware are used to electrically insulate tabs from one another and heat sink base metal!

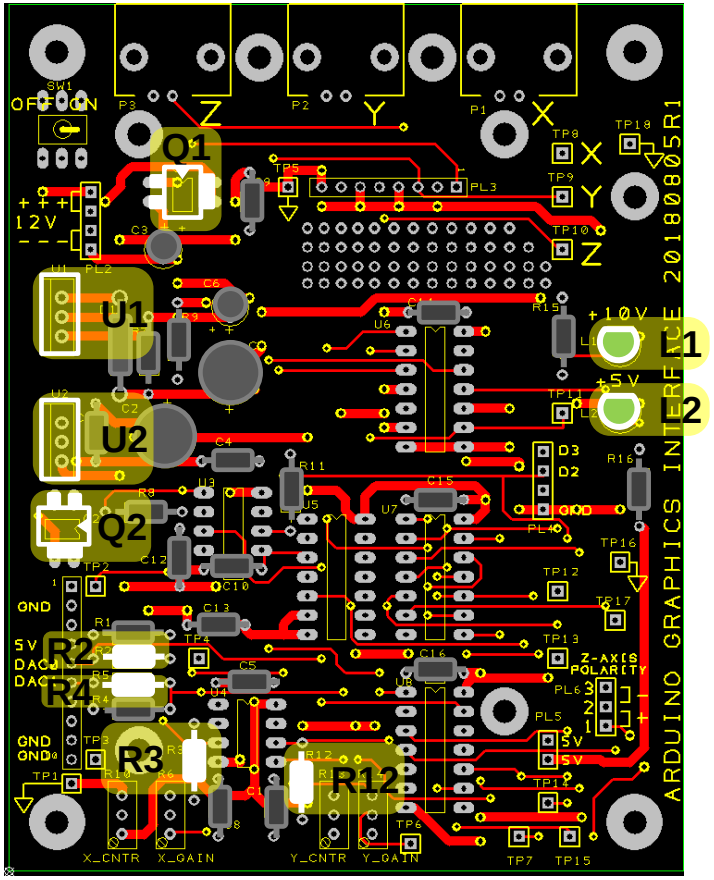
3) To ensure proper spacing & placement, Mount **U1** and **U2** devices to heatsink(s) **BEFORE** installing and attaching to PCB!

Ref Name	Qty	Value
L1	1	LED 3MM GRN
L2	1	LED 3MM GRN

(2) ←Note device orientation!

Note: Builders Choice - Any color LED may be used.

TOP SIDE VIEW

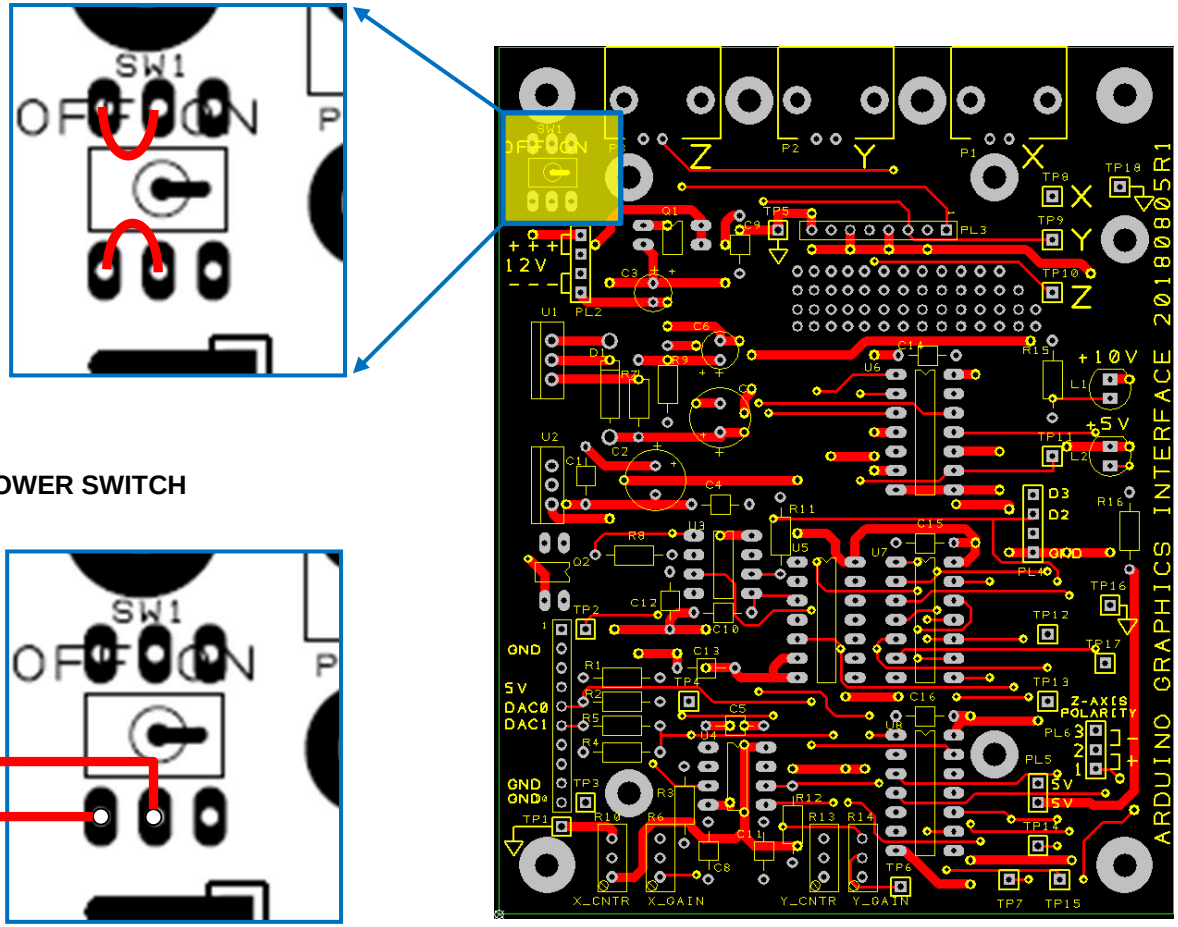


Power Switch Wiring

TOP SIDE VIEW

OPTION 1: NO EXTERNAL POWER SWITCH

If no external power switch is desired, install jumper wires as shown.



OPTION 2: OFF BOARD POWER SWITCH

Load Parts: Potentiometers & Test Points

Ref Name	Qty	Value		
R10	1	10K	10 Turn Potentiometer	←Note device orientation!
R13	1	10K		
R14	1	100K	10 Turn Potentiometer	←Note device orientation!
R6	1	100K		

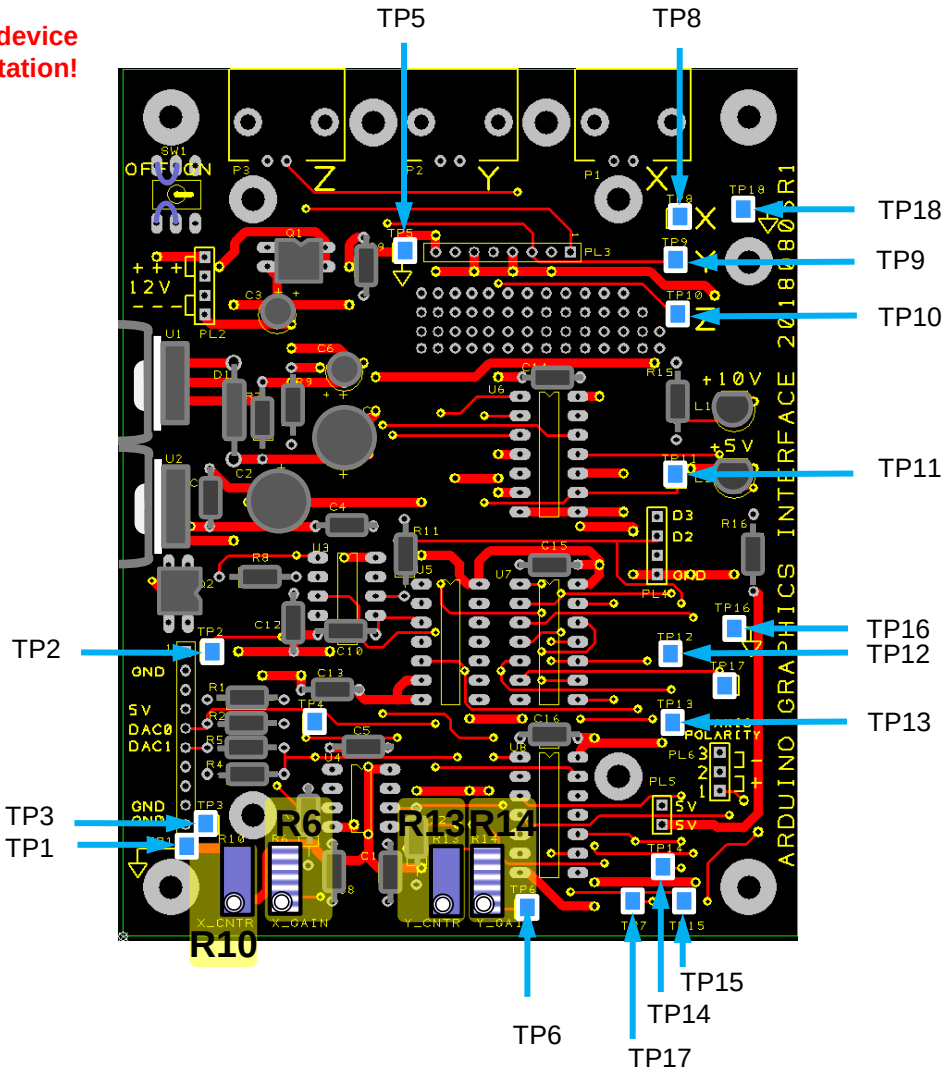
TP1	1	GROUND, OPTIONAL
TP10	1	OPTIONAL
TP11	1	OPTIONAL
TP12	1	OPTIONAL
TP13	1	OPTIONAL
TP14	1	OPTIONAL
TP15	1	OPTIONAL
TP16	1	GROUND, OPTIONAL
TP17	1	OPTIONAL
TP18	1	GROUND, OPTIONAL
TP2	1	OPTIONAL
TP3	1	OPTIONAL
TP4	1	OPTIONAL
TP5	1	GROUND, OPTIONAL
TP6	1	OPTIONAL
TP7	1	OPTIONAL
TP8	1	OPTIONAL
TP9	1	OPTIONAL

18

Note: Installation of Test Point (TP) pins is OPTIONAL. TP pins may be omitted and scope probes touched to TP hole as needed.

Alternately, TP pins may be made from snap apart male-headers or short pieces of insulated wire protruding up from board.

TOP SIDE VIEW



Load Parts: Headers,Connectors,IC Sockets

Ref Name	Qty	Value
P1	1	Can use Chassis Mnt BNC
P2	1	Can use Chassis Mnt BNC
P3	1	Can use Chassis Mnt BNC

ALTERNATE FOR P1-P3: If using Chassis-mount BNC connectors, construct a bracket for the BNC connecters to mount through. Then, mount the bracket to the PCB using holes provided and connector to PL3 or X-Y-Z connector pads appropriately.

PL1	1	10 PIN FEMALE HDR
PL2	1	4 PIN MALE HDR
PL4	1	4 PIN MALE HDR
PL5	1	2 PIN FEMALE HDR
PL6	1	3 PIN MALE HDR

PL3	1	8 PIN MALE - OPTIONAL

PL3 is optional and is only used when using off-board chassis-mounted BNC connectors.

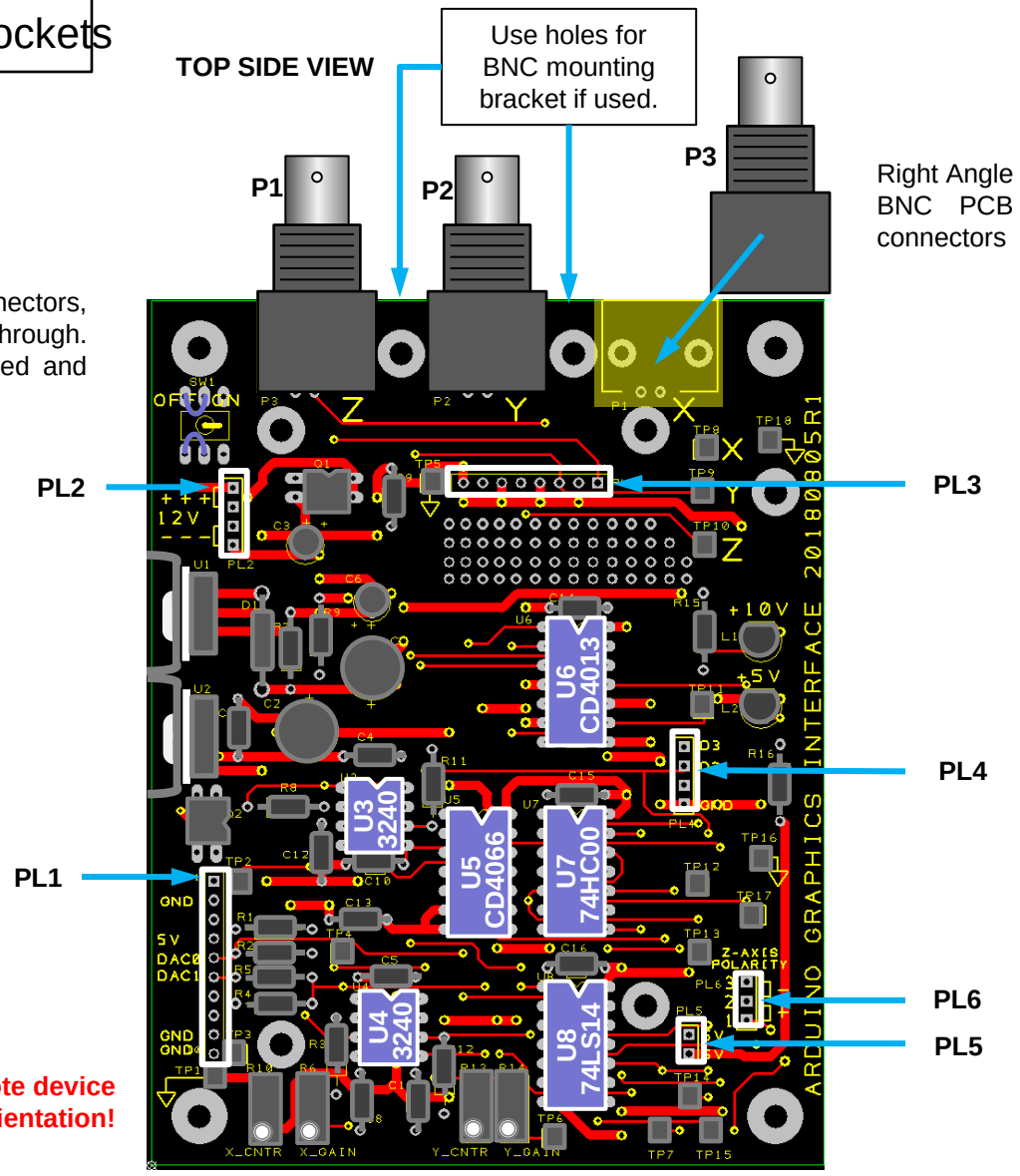
IC SOCKETS *(IC sockets is Highly Recommended!)*
Install 8-Pin Sockets for U3 & U4.
Install 14-Pin sockets for U5,U6,U7, and U8.

U3	1	CA3240	2	Install 8 Pin Socket
U4	1	CA3240		

←Note device orientation!

U5	1	CD4066	4	Install 14 Pin Socket
U6	1	C4013BE		
U7	1	74HC00		
U8	1	74LS14		

←Note device orientation!



Power Supply Checks & IC Installation

VERIFY POWER SUPPLY

CAUTION: BEFORE CONNECTING TO ARDUINO DUE OR INSTALLING U3-U8, CHECK POWER SUPPLY VOLTAGES! DO NOT PROCEED IF VOLTAGES ARE INCORRECT!

1. With AGI board DISCONNECTED FROM Arduino DUE, apply power +12V to AGI BOARD via PL2.
   a) OBSERVE < 25 MA draw from +12 VDC supply.
   b) OBSERVE LED L1 & L2 are illuminated.

2. With a voltmeter, CONFIRM ANALOG VOLTS REG:
   a) 9.0VDC ± 0.15 VDC is present at PIN 8 of U3 & U4.

3. With a voltmeter, CONFIRM DIGITAL VOLT REG:
   a) 5.0VDC ± 0.15 VDC present at PIN 14 of U5, U6, U7, U8.

4. With a voltmeter, CONFIRM:
   a) +5V power is present at both pins of PL5.
   b) PL1_DAC0 and PL1_DAC1 pins = 0.0 VDC.

5. If all voltage checks are correct, remove power from AGI & install U3-U8 per table below.

INSTALL ICs INTO SOCKETS

Ref Name	Qty	Value	
U3	1	CA3240	Install IC into 8 Pin Socket
U4	1	CA3240	

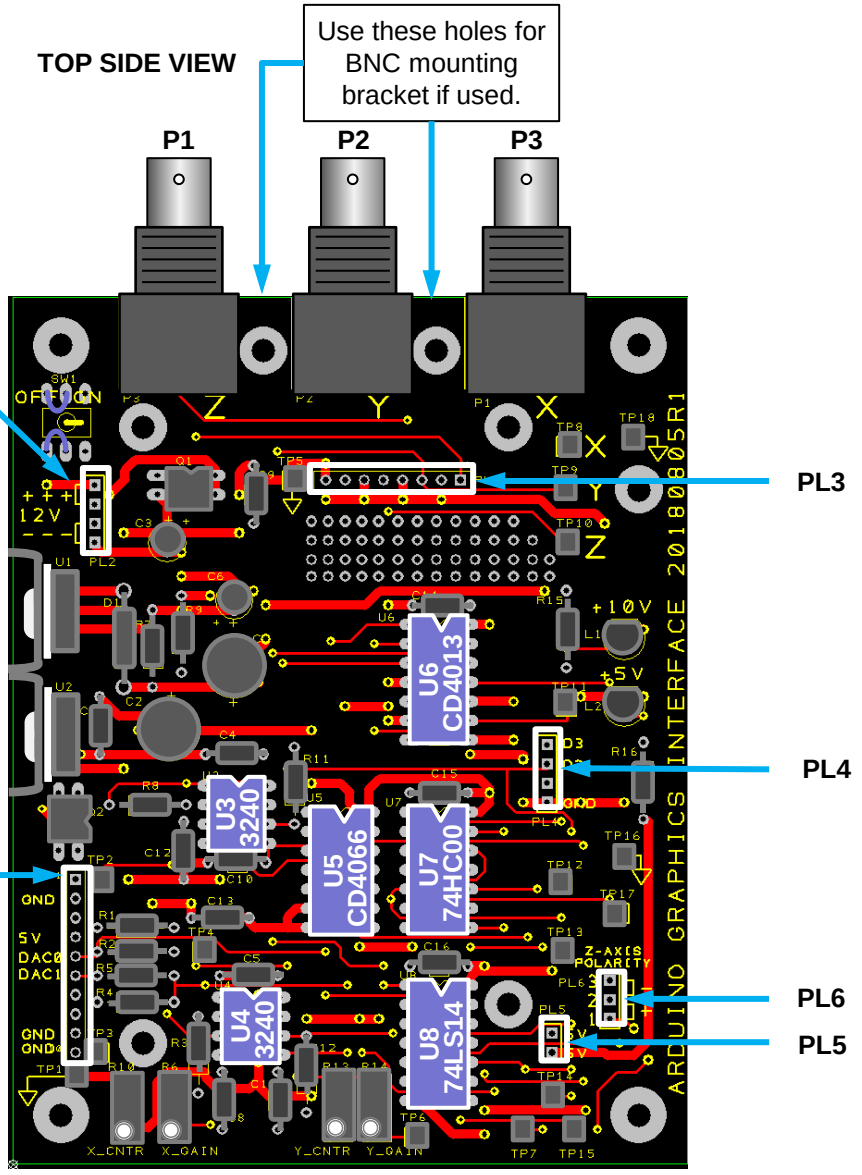
←Note device orientation!

U5	1	CD4066	Install IC into 14 Pin Socket
U6	1	C4013BE	
U7	1	74HC00	
U8	1	74LS14	

←Note device orientation!

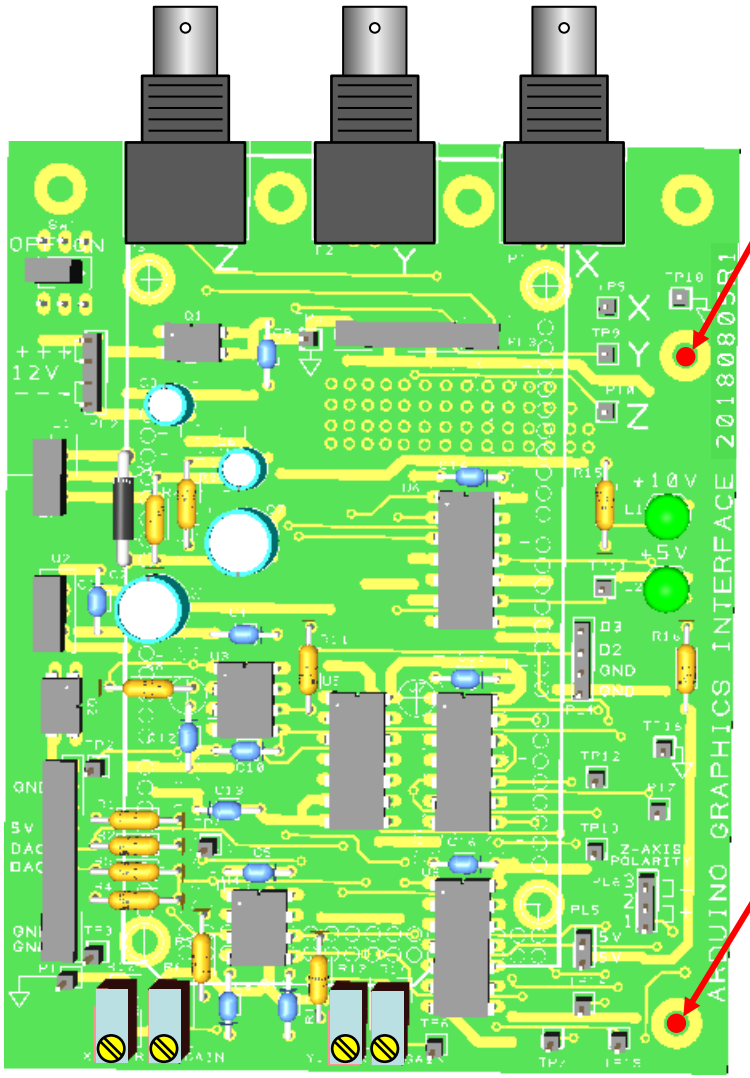
6. Apply +12V power to AGI through PL2 once again and observe proper +9 an 5 V levels.

7. Verify total current draw from 12 V supply < 225 MA *with DUE board attached & connected*.

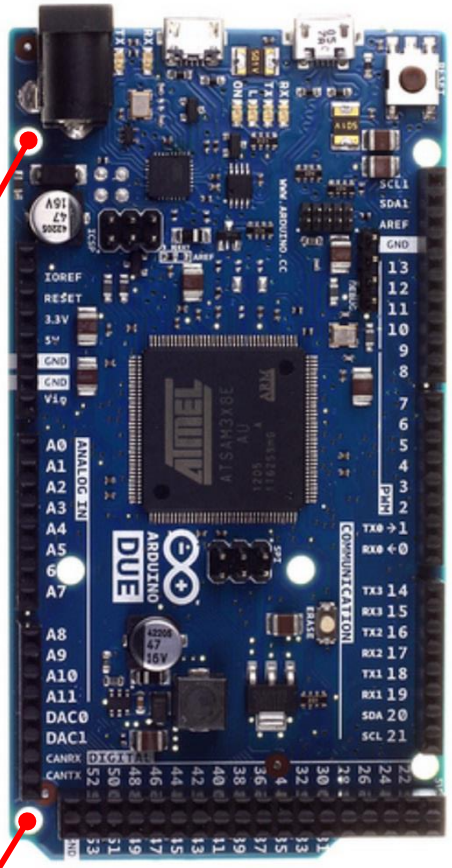


Test Mode Mounting, DUE to AGI PCB

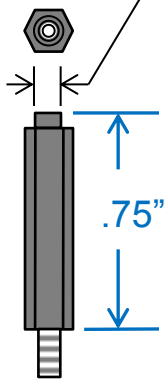
AGI PCB



ARDUINO DUE BOARD



Note: If using metal standoffs, it is necessary to turn down a region at the top of each spacer so that metal of spacer does not short out pads on DUE!



FOR TEST AND TROUBLE SHOOTING

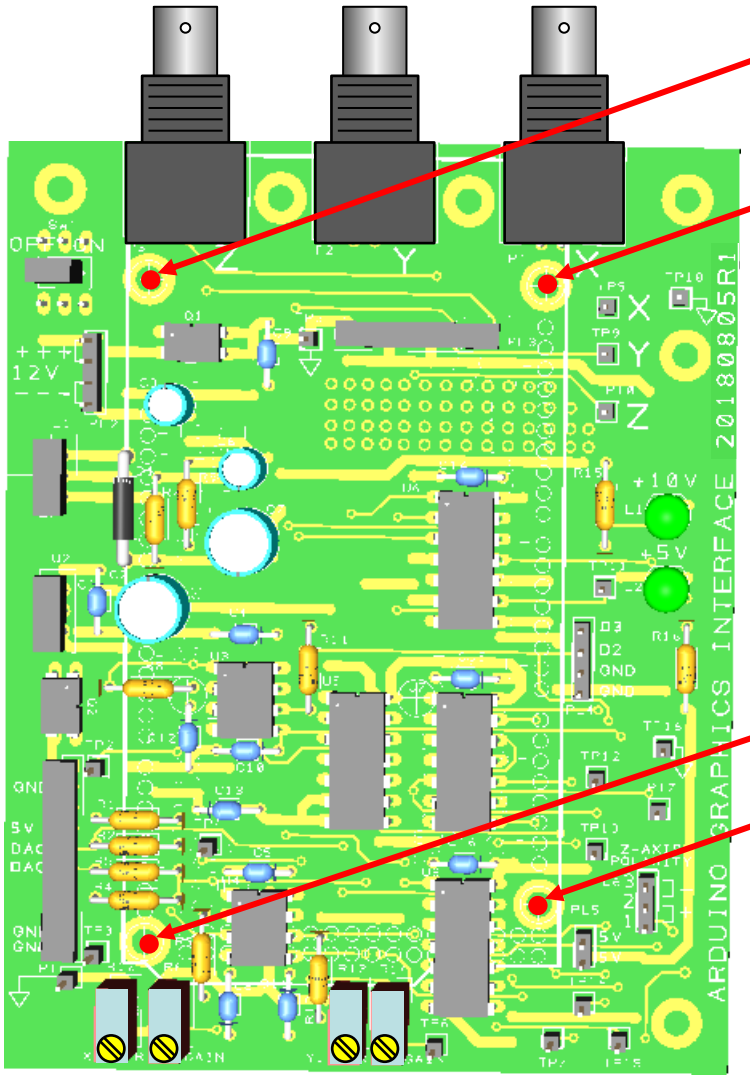
Using 4-40 Standoff Spacers, Arduino DUE can be mounted to TOP RIGHT SIDE of AGI PCB in a *temporary fashion* so as to provide full “scope-probe” test access to the AGI circuit board.

---------- CAUTION ----------

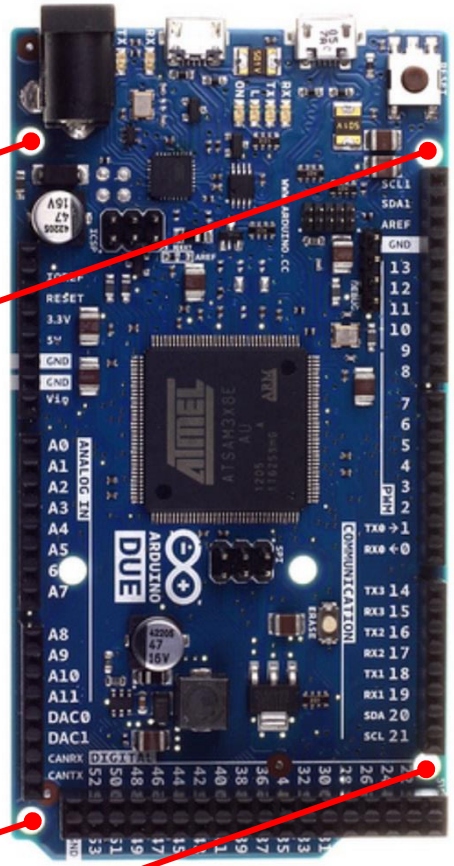
VERIFY SCREWS AND/OR METAL STANDOFFS ARE NOT TOUCHING CIRCUIT PADS, LANDS, OR OTHER PARTS ON THE TOP OR BOTTOM OF ARDUINO-DUE CPU!

Final Mounting of DUE to AGI PCB

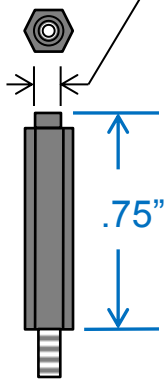
AGI PCB



ARDUINO DUE BOARD



Note: If using metal standoffs, it is necessary to turn down a region at the top of each spacer so that metal of spacer does not short out pads on DUE!



Using 4-40 Standoff Spacers, Arduino DUE can be mounted to TOP of AGI PCB. Additional Arduino Shields can then be installed onto DUE as needed.

---------- CAUTION ----------
VERIFY SCREWS AND/OR METAL STANDOFFS ARE NOT TOUCHING CIRCUIT PADS, LANDS, OR OTHER PARTS ON THE TOP OR BOTTOM OF ARDUINO-DUE CPU!

Wiring AGI To DUE

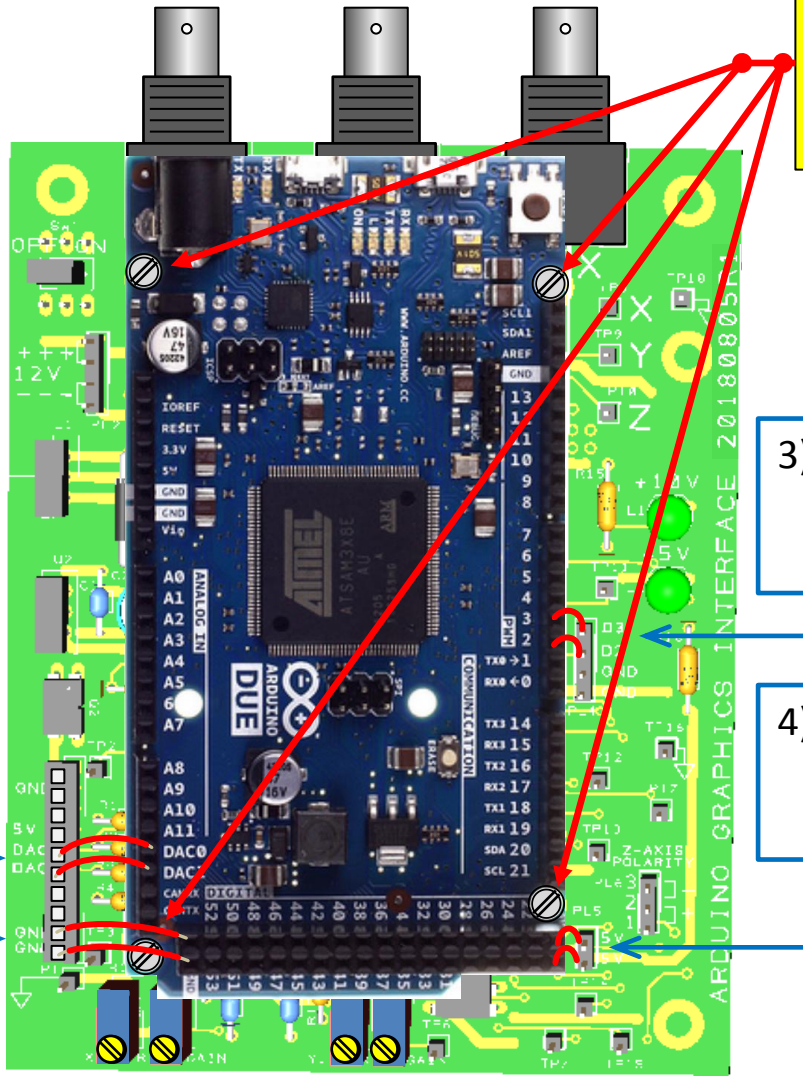
---------- CAUTION ----------
TO AVOID DAMAGE TO DUE CPU OR AGI BOARDS, ONLY CONNECT AND POWER ARDUINO DUE - AGI COMBINATION AFTER POWER CHECKS AS DETAILED ON PAGE 19 HAVE BEEN COMPLETED!

---------- CAUTION ----------
VERIFY SCREWS AND/OR METAL STANDOFFS ARE NOT TOUCHING CIRCUIT PADS, LANDS, OR OTHER PARTS ON THE TOP OR BOTTOM OF ARDUINO-DUE CPU!

CAUTION: Do NOT touch DAC0 or DAC1 wires to +5V or GND connection as this will irreversably damage the DUE CPU!

1) Connect DAC0 & DAC1 wires between AGI and DUE boards as shown.

2) Connect 2 GROUND wires between AGI and DUE boards as shown.



3) Connect D2 and D3 wires between AGI and DUE boards as shown.

4) Connect 2 +5V wires between AGI and DUE boards as shown.

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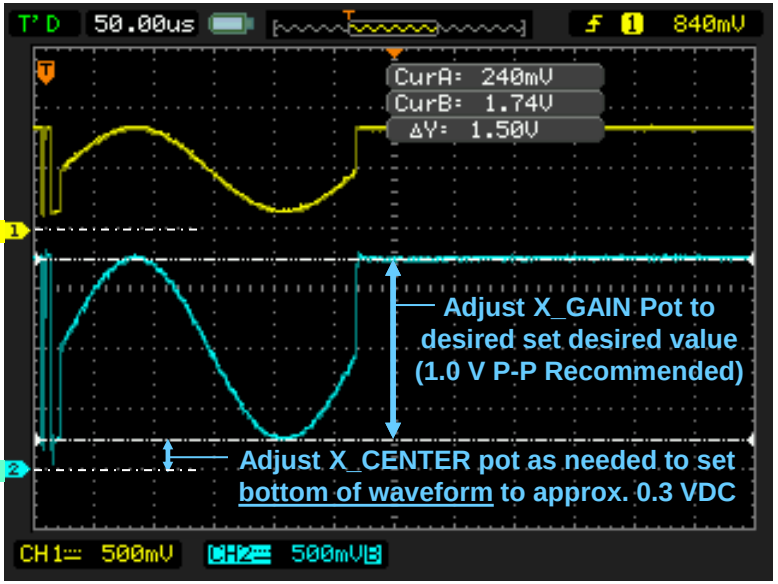
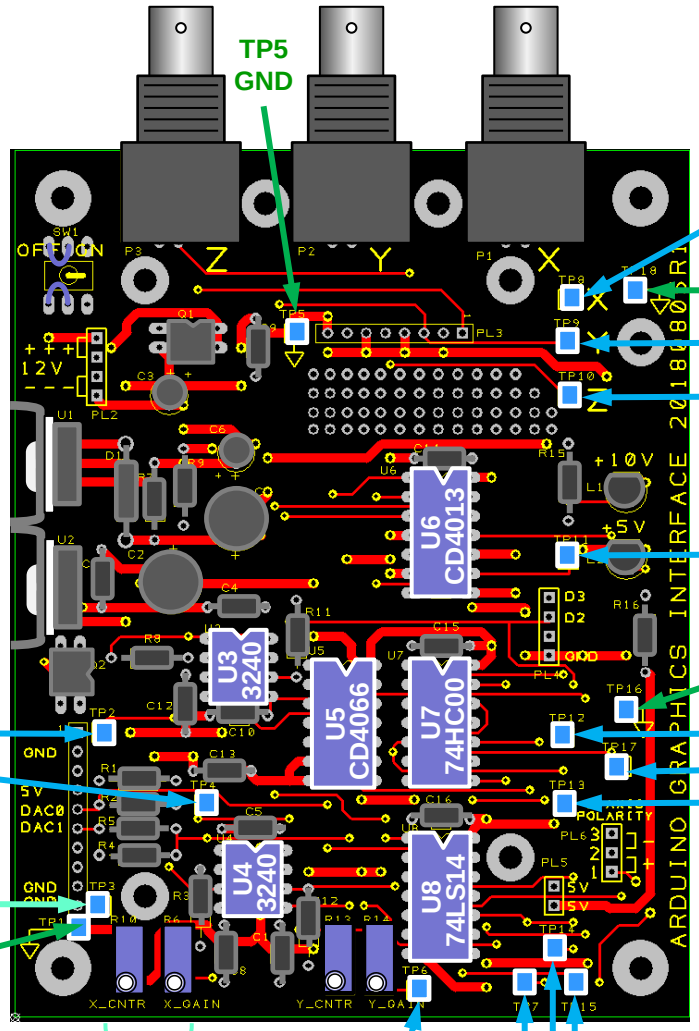
X-Axis Gain and Offset Adjust



X-Gain and Offset Adjustment

1. Connect AGI to Arduino DUE & apply power.
2. Using Arduino IDE, Load and start CRT_SCOPE. Open a Serial Port (Baud=115200, NONE).
3. Select Option 7; This outputs a full scale sine-wave segment to DAC0 and DAC1.
4. Connect an oscilloscope to TP2 and TP3; Trigger on TP2 as shown.
5. Observe approx. 0.7 V P-P signal on TP2 (DAC0 INPUT).
6. Monitor TP3 on scope and adjust X_GAIN (R6) for desired amplitude (1.0 V P-P).
7. Adjust Y-CNTR (R10) pot until bottom of waveform is approximately 0.25-0.3VDC above ground.
8. Connect to scope and place scope in XY mode. Final adjust AGI pots in concert in concert with scope gain & position controls for proper XY display of a circle.

TOP SIDE VIEW



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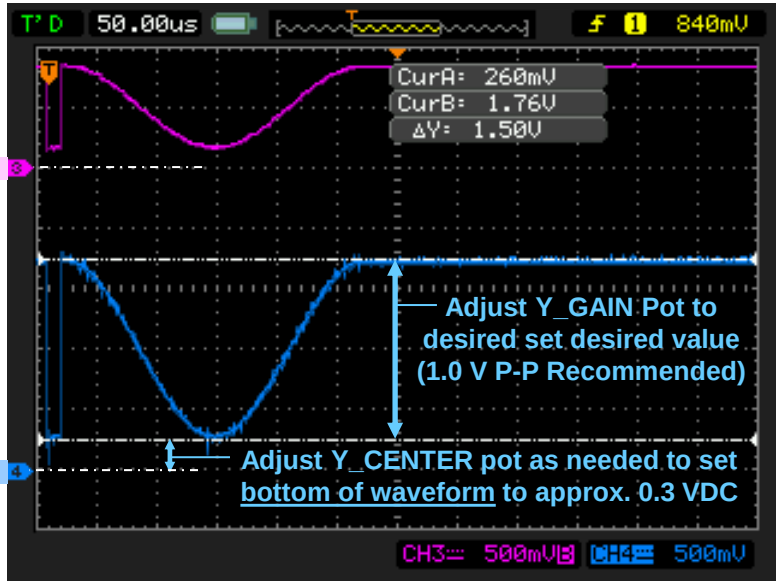
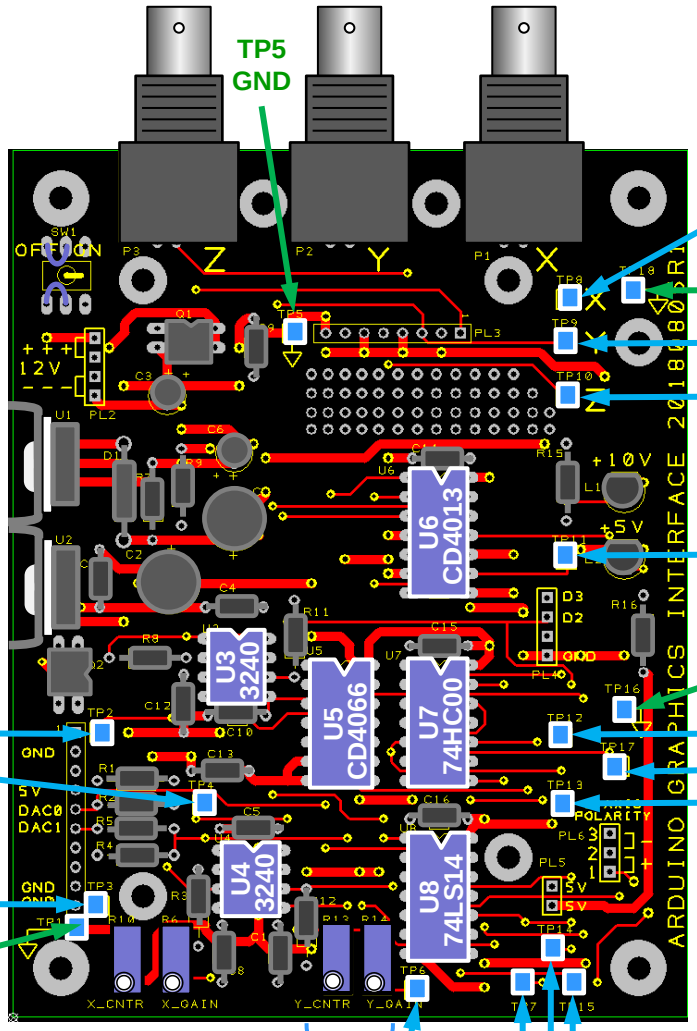
Y-Axis Gain and Offset Adjust



Y-Gain and Offset Adjustment

1. Connect AGI to Arduino DUE and apply power.
2. Using Arduino IDE, Load and start CRT_SCOPE. Open a Serial Port (Baud=115200, NONE).
3. Select Option 7; This outputs a full scale sine-wave segment to DAC0 and DAC1.
4. Connect an oscilloscope to TP4 and TP6; Trigger on TP4 as shown.
5. Observe approx. 0.7 V P-P signal on TP4 (DAC1 INPUT).
6. Monitor TP6 on scope and adjust Y_GAIN (R11) for desired amplitude (1.0 V P-P).
7. Adjust Y-CNTR (R13) pot until bottom of waveform is approximately 0.25-0.3VDC above ground.
8. Connect to scope and place scope in XY mode. Final adjust AGI pots in concert in concert with scope gain & position controls for proper XY display of a circle

TOP SIDE VIEW



TP8 – X OUTPUT
TP18 - GND
TP9 – X-OUTPUT
TP10 – Z-OUTPUT
TP11 – $\overline{\text{POINT CLOCK}}$
TP16 - GND
TP12 – $\overline{\text{SHOW POINT}}$
TP17 – $\overline{\text{DMA CLOCK}}$
TP13 – SHOW POINT
TP2 – DAC0 INPUT
TP4 – DAC1 INPUT
TP3 X-AXIS BUFFER
TP1 - GND
Y-AXIS CENTER & GAIN ADJ.
TP6 Y-AXIS BUFFER
TP15 – CRT ON
TP14 – S/H PULSE
TP17 – DMA CLOCK

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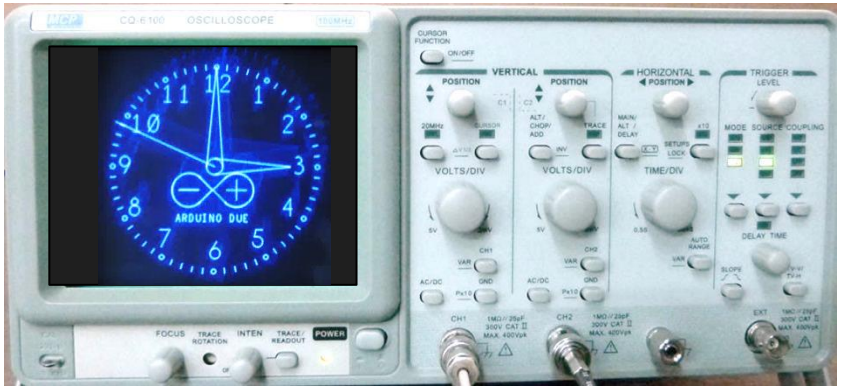
Blanking Select & Wiring AGI To Scope

Z-Input *(Typically on Back Panel)*

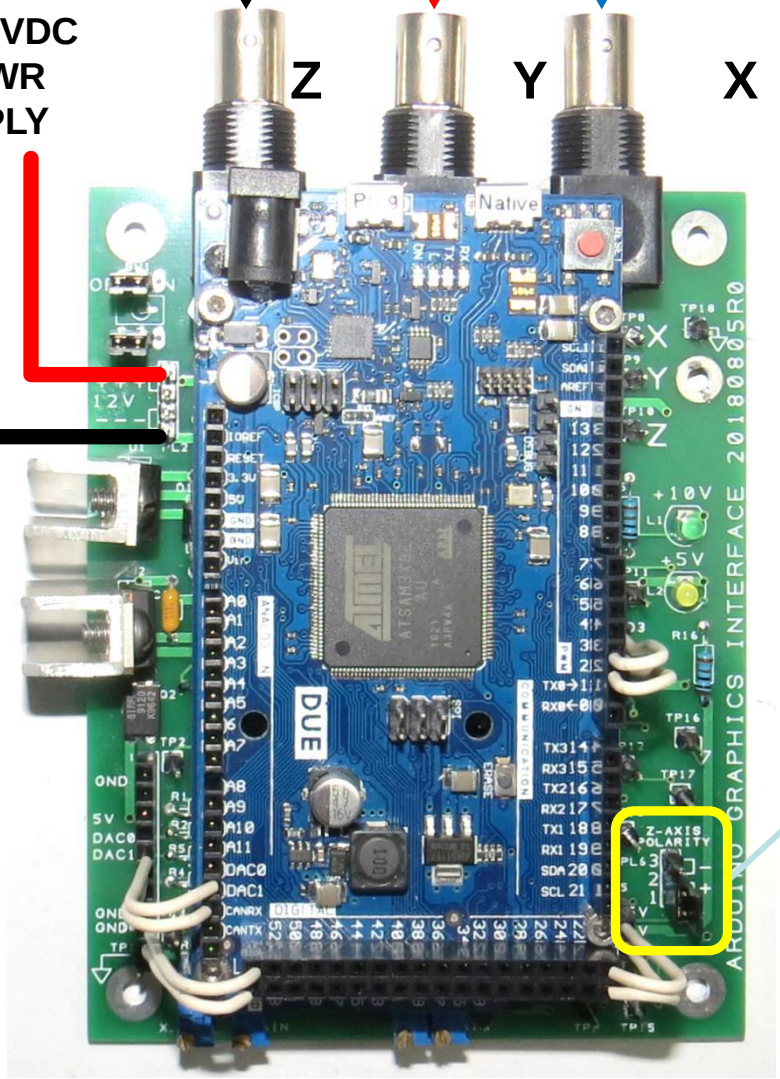
+12 VDC PWR SPLY

Z Y X



Y-Input *(Typically CH 2)*

X-Input *(Typically CH 1)*



PL6 JUMPER SETTINGS

3
2
1

NEGATIVE Z-AXIS LOGIC
Jumper position **2-3** for
Logic 0 = UNBLANK

POSITIVE Z-AXIS LOGIC
Jumper position **1-2** for
Logic 1= UNBLANK

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CRT_SCOPE Test Pattern Descriptions

```
========= CRT_SCOPE_Ver_20.55 =========
  ? = Show this HELP Screen
---- Hardware setup and diagnostics -----
  7 = Analog Signal Scope Pattern for Gain & Center Adj.
  C = Incr DMA Clock Freq by 50 Khz
  c = Decr DMA Clock Freq by 50 Khz
  F = Incr Front-Porch blankCount by 1
  f = Decr Front-Porch blankCount by 1
  B = Incr Back-Porch blankCount by 1
  b = Decr Back-Porch blankCount by 1
  2 = Display Centering Pattern
  v = Peak-to-Peak Vertical Sq-Wv Test Pattern
  h = Peak-to-Peak Horizontal Sq-Wv Test Pattern
  d = Peak-to-Peak Dots_in_the_Corners Test Pattern
---- Test plots for TEXT routines
  i = Decr TEXT intensity for subsequent plots
  I = Incr TEXT intensity for subsequent plots
  0 = Print Numbers Test (Random Number)
  1 = Print Numbers Test with some underlined (Rand Num)
  s = plotChar Test #1
  S = plotChar Test #2
  w = Wakeup from Screen-save timeout
---- Test plots for GRAPHICS routines ----
  + = Incr Graphics Intensity for subsequent plots
  - = Decr Graphics Intensity for subsequent plots
  3 = Display Random Rectangles, Circles, & Ellipses
  4 = Simulated Graph Plot
  5 = Display Random Ellipse
  6 = Display a fixed Ellipse
  8 = Demo Circle arc segments from 0 to 7
  9 = Demo Ellipse arc segments from 0 to 7
---- Simulated Application Screens ----
  l = Plot an animated Arduino Logo
  D = Show AGI Coordinate System Plot
  t/T = TIME - A Simulated Clock Display
  * = Toggle 'SimClock' second-hand On-Off
  p = Pong Simulation
```

This option will load a circular pattern into the XY_List buffer that will output a full-scale partial sin wave pattern out on the X and Y output ports. This can be used to set the gain and centering POTS on the AGI as well as scope gain and centering controls as shown on page 20 & 21.

Use these options to change the DMA_CLOCK frequency while observing the effects on plot quality on your scope.

Use these options to vary the duration and timing of the FRONT and BACK porch BLANKING SIGNAL.

This sends plots a full size circle inside of a full size square and can also be used to set scope gain and centering controls

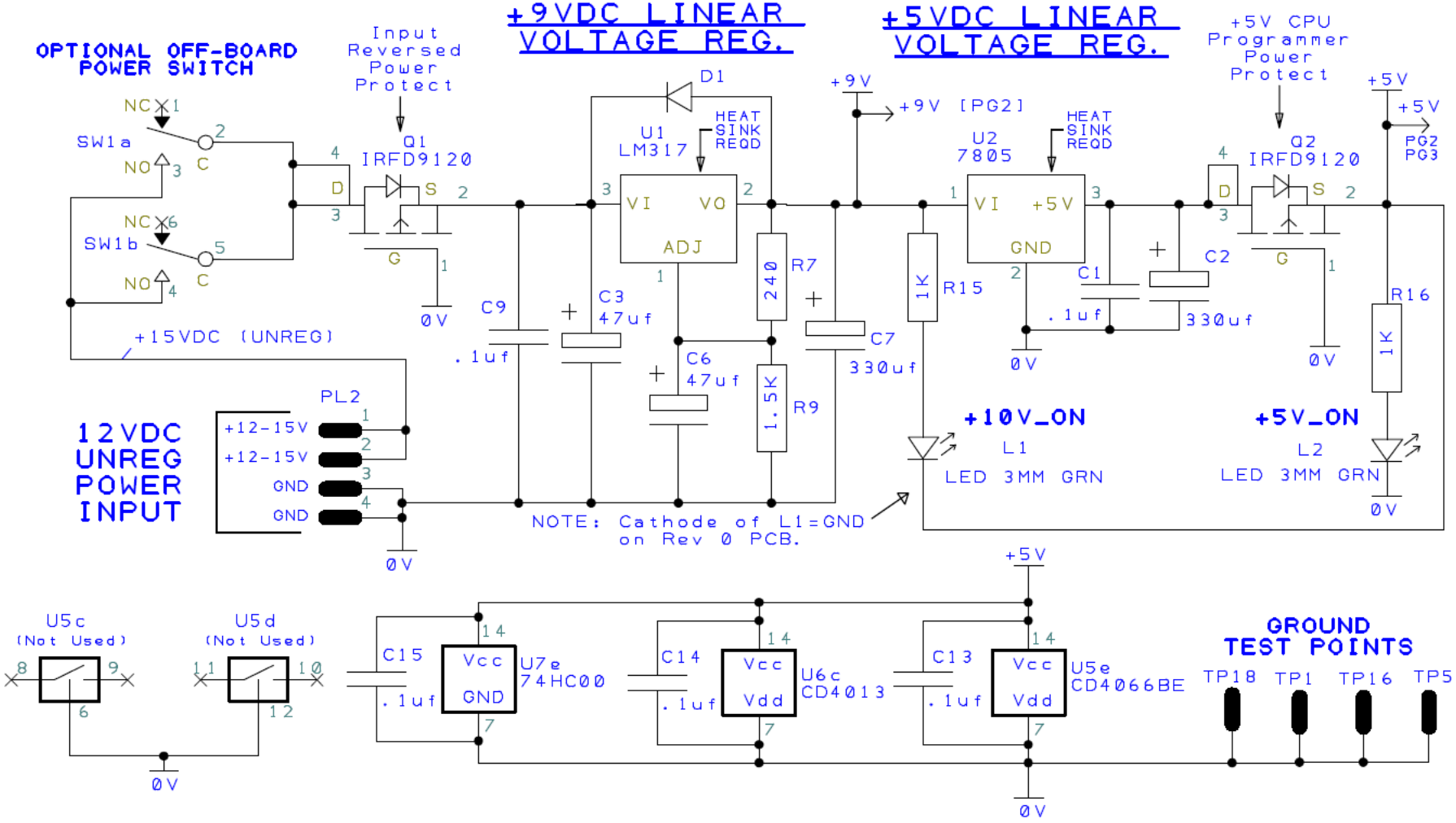
Use this pattern plots to observe accuracy and/or artifacts when driving scope with FULL SCALE square wave pattern. Try varying the DMA_CLOCK (Option: c/C) while viewing these patterns.

NOTE: Menu details may vary slightly as new revisions and features are added into the CRT_SCOPE example program.

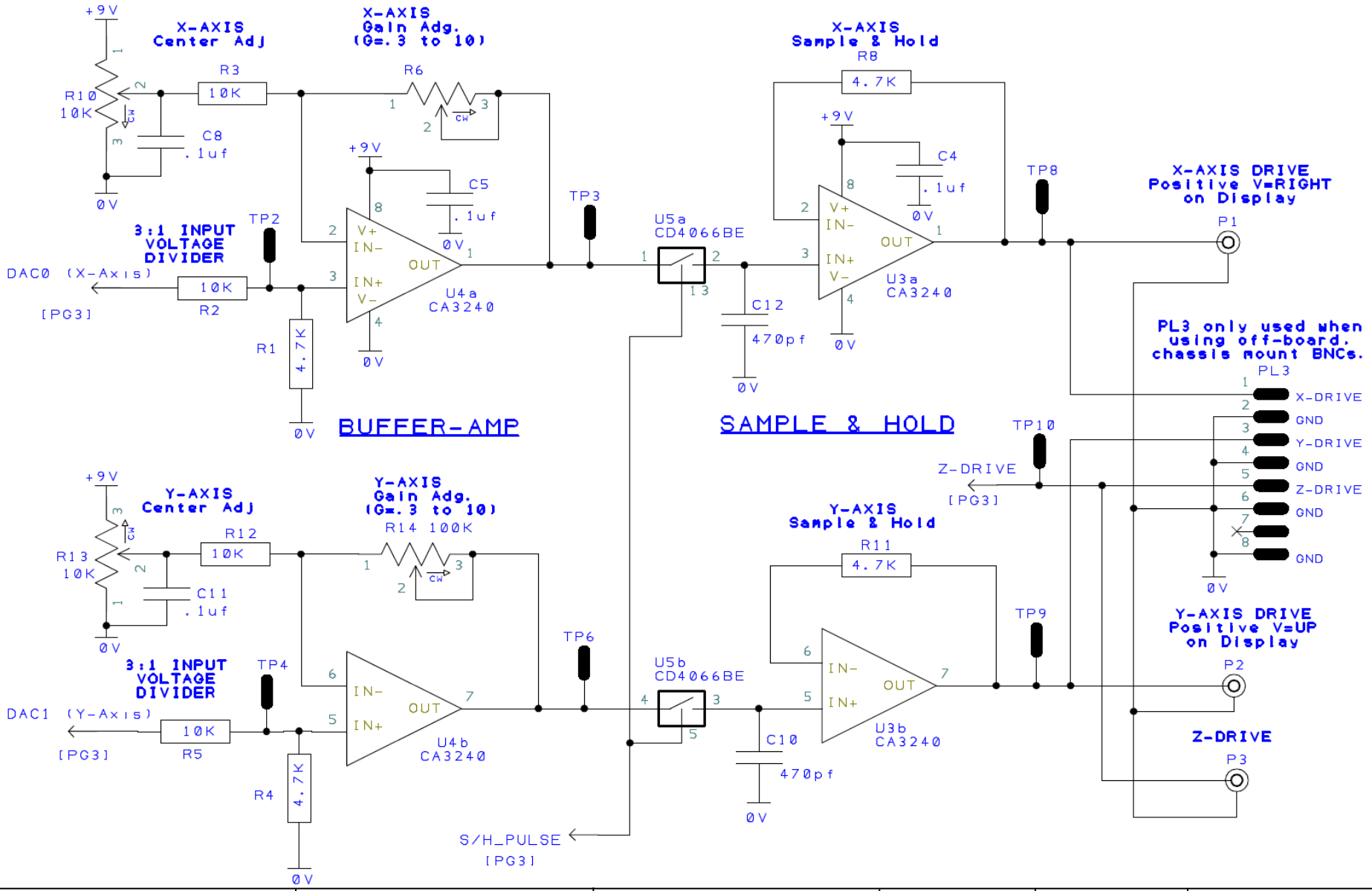
Known Issues

Ref Num	Issue Description	Severity	Status	Evaluation/Solution/Work-Around/Other Actions Taken
1	**AGI POWER LED INDICATION INVALID** When +12V is NOT supplied to AGI but Arduino Due is connected to external computer for programming, Both +5V and +10V LEDs on AGI board illuminate.	LOW	OPEN DATE: 20170920 COSED DATE: 20171024	**ANALYSIS:** +5 V from programming cable feeds back through power supply circuits and energizes the +10V bus on the AGI to approximately a +5V level. This causes +10V LED to illuminate. Since the AGI analog circuits are running in an UNDER-VOLT condition, the XY signals output by the AGI may be distored and of poor quality. **REV 0 PCB CORRECTIVE ACTION:** NONE - Operator must be advised that +10V led will dimly illuminate even when +10 V is in an undervolt condition. **REV 1 PCB CORRECTIVE ACTION:** L1 Cathode connection moved from GROUND to +5V; L1 now operator correcty.
2	**REVERSE POWER CIRCUIT ERROR** Polarity Protection FETs (Q1 & Q2) wired improperly.	MED	OPEN DATE: 20170920 COSED DATE: 20171024	**EVALUATION:** Design review identified that FET power protection was wired improperly on Rev 0 PCB and may not function correctly. If +12VDC is wired improperly, AGI and/or DUE could be damaged. **ANALYSIS:** Polarity Protection FETs (Q1 & Q2) wired improperly. Schematics corrected and Rev R0 PCB rework instructions generated. **CORRECTIVE ACTION:** Schematics and PCB corrected and reissued as Rev R1. Documentation updated, new GERBER FILES generated and put into project repository.
3	**DISPLAYED POINTS ARE "FUZZY"** XY Signal quality needs improvement.	HIGH	OPEN DATE: 20171024 COSED DATE: 20171120	**EVALUATION:** Op-amps show low level ringing which degrades plot quality. **ANALYSIS:** Amplifier stability and ringing is impacted by V+ power supply value. Reducing V+ from 9.75 to 9.0 Volts significantly improves X-Y plot quality. This is accomplished by changing R7 from 220 ohms to 240 ohms. **CORRECTIVE ACTION:** Schematics and BOM reissued as Rev R1. Documentation updated and put into project repository.

PAGE 1: AGI POWER SUPPLY



PAGE 2: ANALOG CIRCUITS



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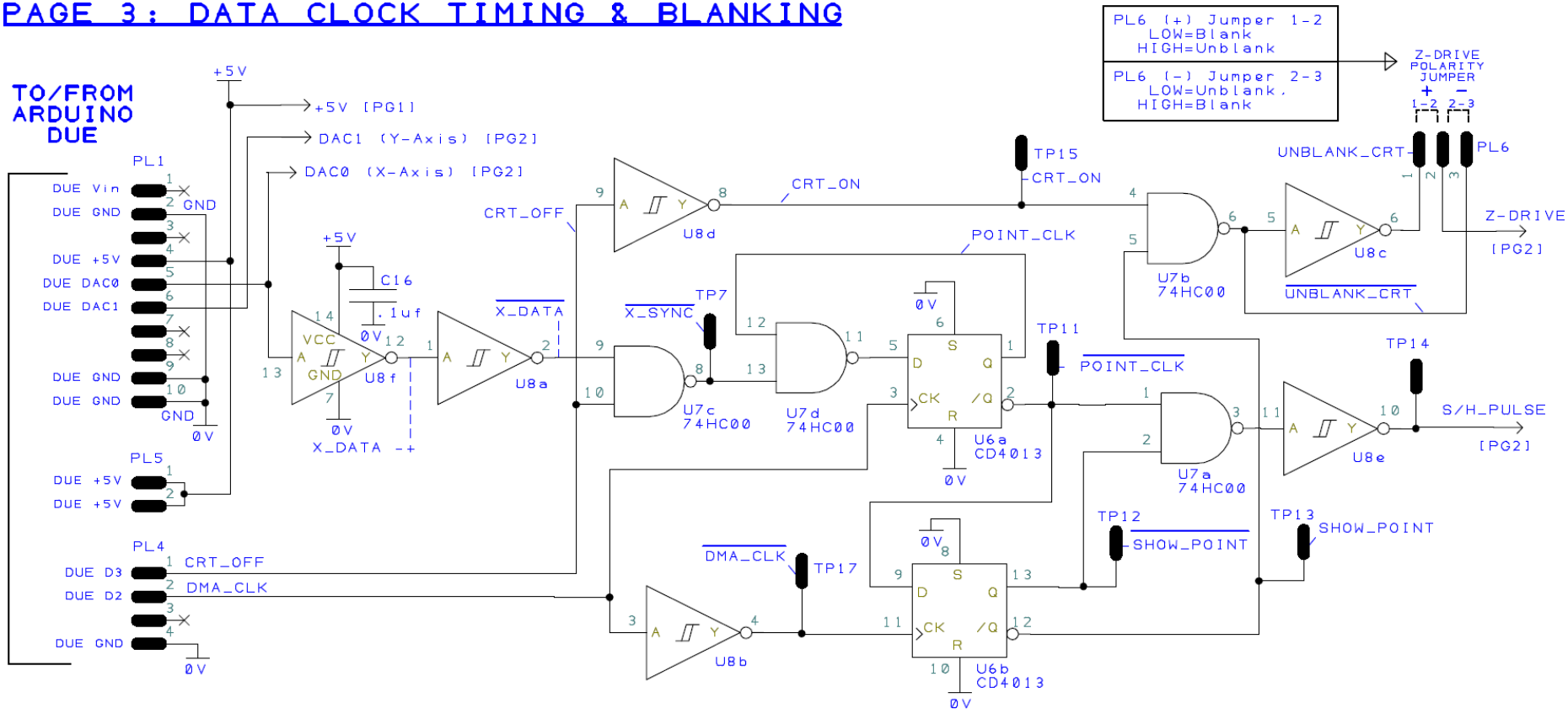
PAGE 3: DATA CLOCK TIMING & BLANKING



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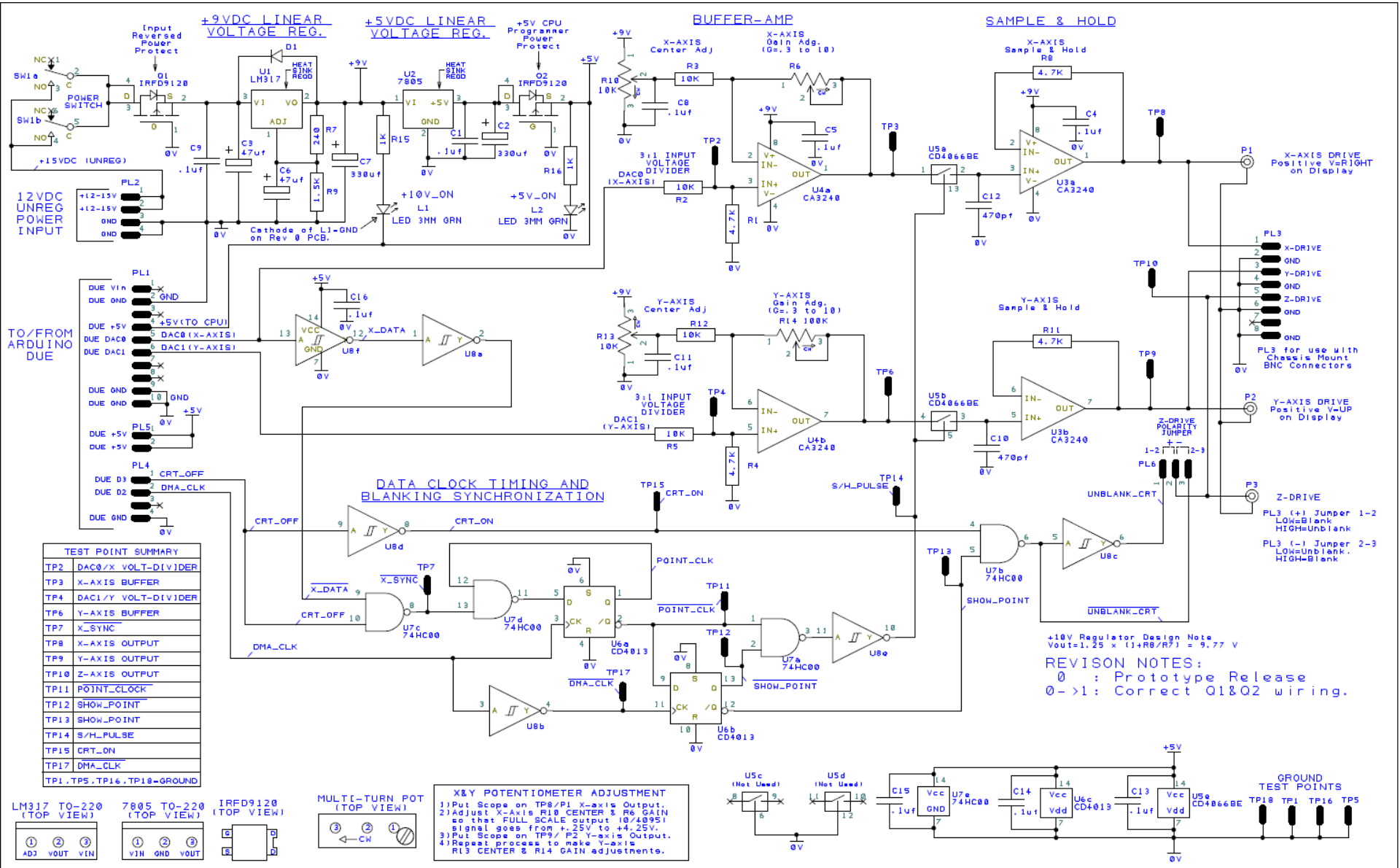


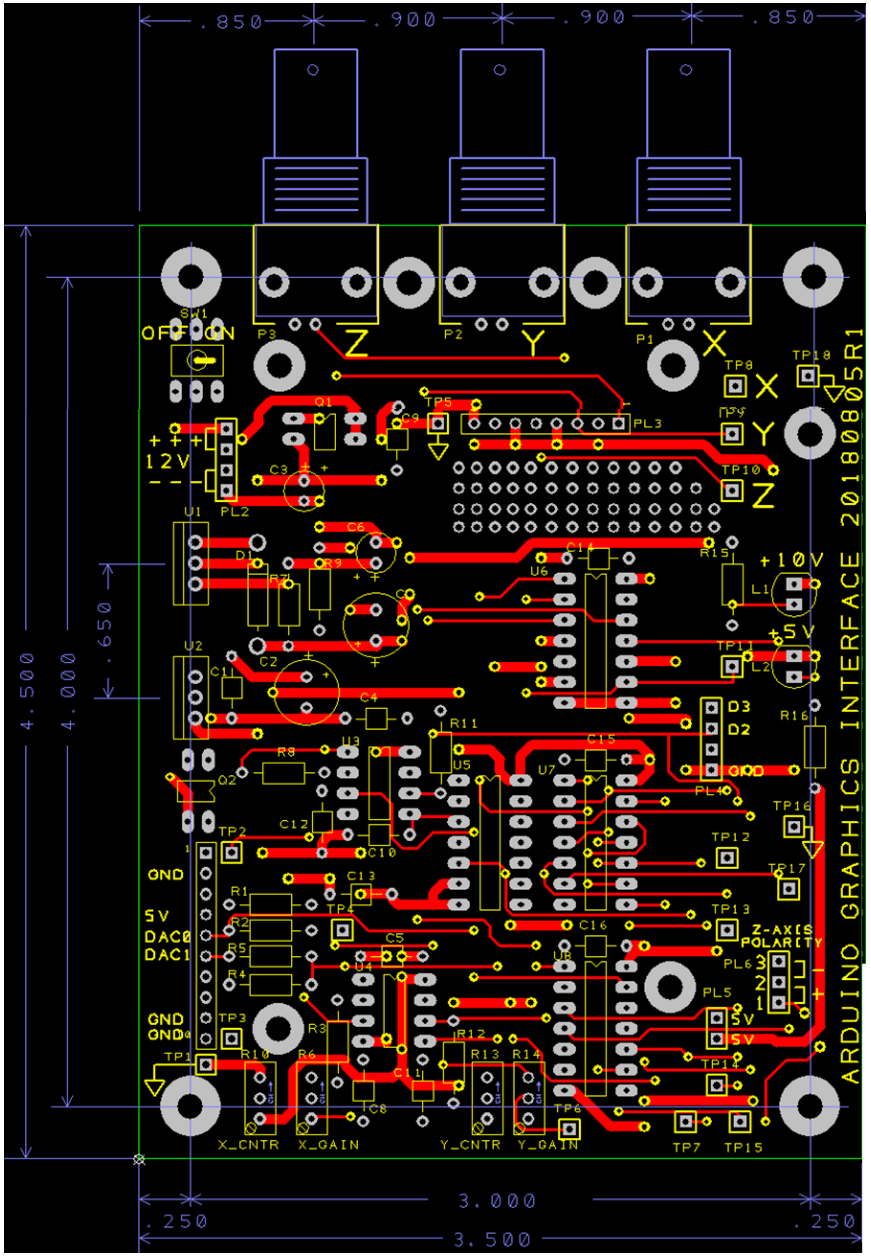
TEST POINT SUMMARY	
TP2	DAC0/X VOLT-DIVIDER
TP3	X-AXIS BUFFER
TP4	DAC1/Y VOLT-DIVIDER
TP6	Y-AXIS BUFFER
TP7	X_SYNC
TP8	X-AXIS OUTPUT
TP9	Y-AXIS OUTPUT
TP10	Z-AXIS OUTPUT
TP11	POINT_CLOCK
TP12	SHOW_POINT
TP13	SHOW_POINT
TP14	S/H_PULSE
TP15	CRT_ON
TP17	DMA_CLK
TP1,TP5,TP16,TP18=GROUND	

LM317 TO-220 (TOP VIEW) — ADJ VOUT VIN
7805 TO-220 (TOP VIEW) — VIN GND VOUT
IRFD9120 (TOP VIEW)
MULTI-TURN POT (TOP VIEW) — CW

E	D	C	B Rev 1 102417	A Rev 0 080817	Drawn EWA 5-16-2017	Check EWA 8-8-2017	Projection Do Not Scale	AGI:ARDUINO-DUE GRAPHICS INTERFACE
Drn	Drn	Drn	Drn EWA 102417	Project AGI GRAPHICS INTER'FC		Client N&V Article		E. ANDREWS
Chk	Chk	Chk	Chk EWA 102417	Title 20180805R0 (SCHEMATIC)		Filename X-Y Graphics Intfc(Rev_1).sch	Drawing No. X-Y Graphics Intfc(Rev_1).sch X-Y Graphics Intfc(Rev_1).pcb	AMC Consulting Brookfield, WI 53045 Sheet 1 of 1

APPENDIX 2 Test Points & Dimensions

TEST POINT SUMMARY	
TP2	DAC0/X VOLT-DIVIDER
TP3	X-AXIS BUFFER
TP4	DAC1/Y VOLT-DIVIDER
TP6	Y-AXIS BUFFER
TP7	$\overline{\text{X\_SYNC}}$
TP8	X-AXIS OUTPUT
TP9	Y-AXIS OUTPUT
TP10	Z-AXIS OUTPUT
TP11	$\overline{\text{POINT\_CLOCK}}$
TP12	$\overline{\text{SHOW\_POINT}}$
TP13	SHOW_POINT
TP14	S/H_PULSE
TP15	CRT_ON
TP17	$\overline{\text{DMA\_CLK}}$
TP1 . TP5 . TP16 . TP18 = GROUND	



APPENDIX 3 Libraries and IDE Setup

1. Here's a link to an overview guide for installing Arduino Libraries https://www.arduino.cc/en/Guide/Libraries
2. Download and install the DueTimer library from: Arduino.org site; it is also available from author at https://github.com/ivanseidel/DueTimer
3. Download and install the XYscope library from: https://github.com/Ed-EE-Eng/XYscope
4. When you are done installing the DueTimer and XYscope library, your Arduino library files structure should resemble the following: