FEATURES

- Demonstrates a complete digitally-controlled microphone preamplifier system utilizing the THAT5171 controller IC paired with a THAT1580 preamplifier IC
- Balanced microphone-level audio inputs on XLR connector with switchable phantom power via external 48V supply
- Balanced line input with -20dB pad on TRS connector
- Balanced audio output on XLR and TRS connectors
- Supports pro audio signal levels: +22 dBu input and +22 dBu output
- Easy to use PC Graphical User Interface software provides control of gain, GPO states, and Zero Crossing Detector modes
- Gain (measured input to output) is adjustable in 1 dB steps: 0 dB, and 8 - 63dB
- Direct SPI control and multiple board daisy-chaining is available via on-board headers
- External VCM input available for output stage biasing
- On-board prototyping area

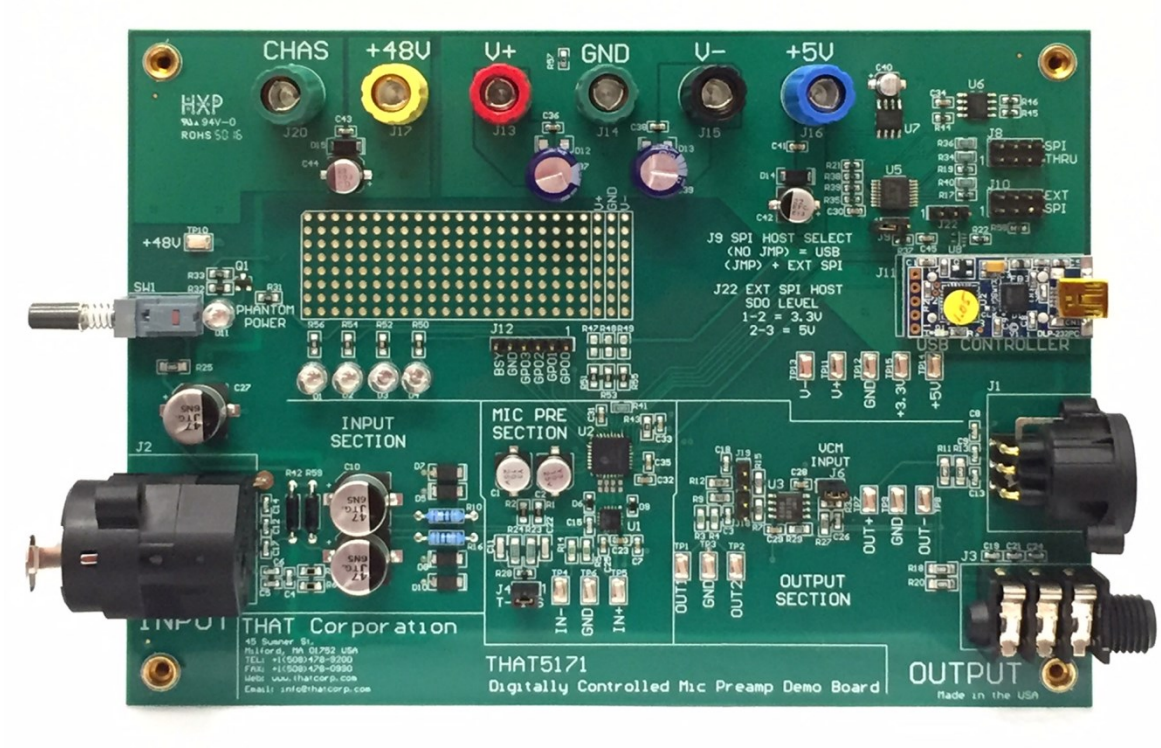


Figure 1. THAT 5171 Demo Board

THAT5171/1580 Overview

The THAT5171 and THAT1580 ICs enable digitally-controlled microphone preamplifier applications with exceptionally high performance. The chipset accepts pro audio input levels (+22 dBu max) without an input pad. Gain is adjustable to 5.6 dB, and 13.6 dB to 68.6 dB in 1 dB increments (a 5.6 dB attenuator at the output offsets the overall gain range to 0 dB, and 8-63 dB). The 5171's built-in zero-crossing detector and other techniques for reducing zipper noise enable very smooth and silent gain changes. A differential servo reduces output offsets to less than 1.5 mV. Four general purpose outputs on the 5171 can be connected to a variety of peripheral functions, e.g. an input pad, phantom power switch, signal routing switches, LEDs, etc. The 5171's addressable SPI interface supports read-back. By separating the analog mic preamp front end (THAT1580) from the digital functions and switched resistor ladder (THAT5171), each IC is optimized for high performance.

The THAT1580 is fabricated using THAT's high-voltage BiCMOS process, yielding extremely high performance. The THAT5171 is fabricated using a high-voltage CMOS process, with proprietary techniques for reducing FET switching glitches. Packaged in 4x4 mm QFN16 and 7x7 mm QFN32 packages respectively, the THAT1580 and THAT5171 require very little PCB area.

Block Diagram

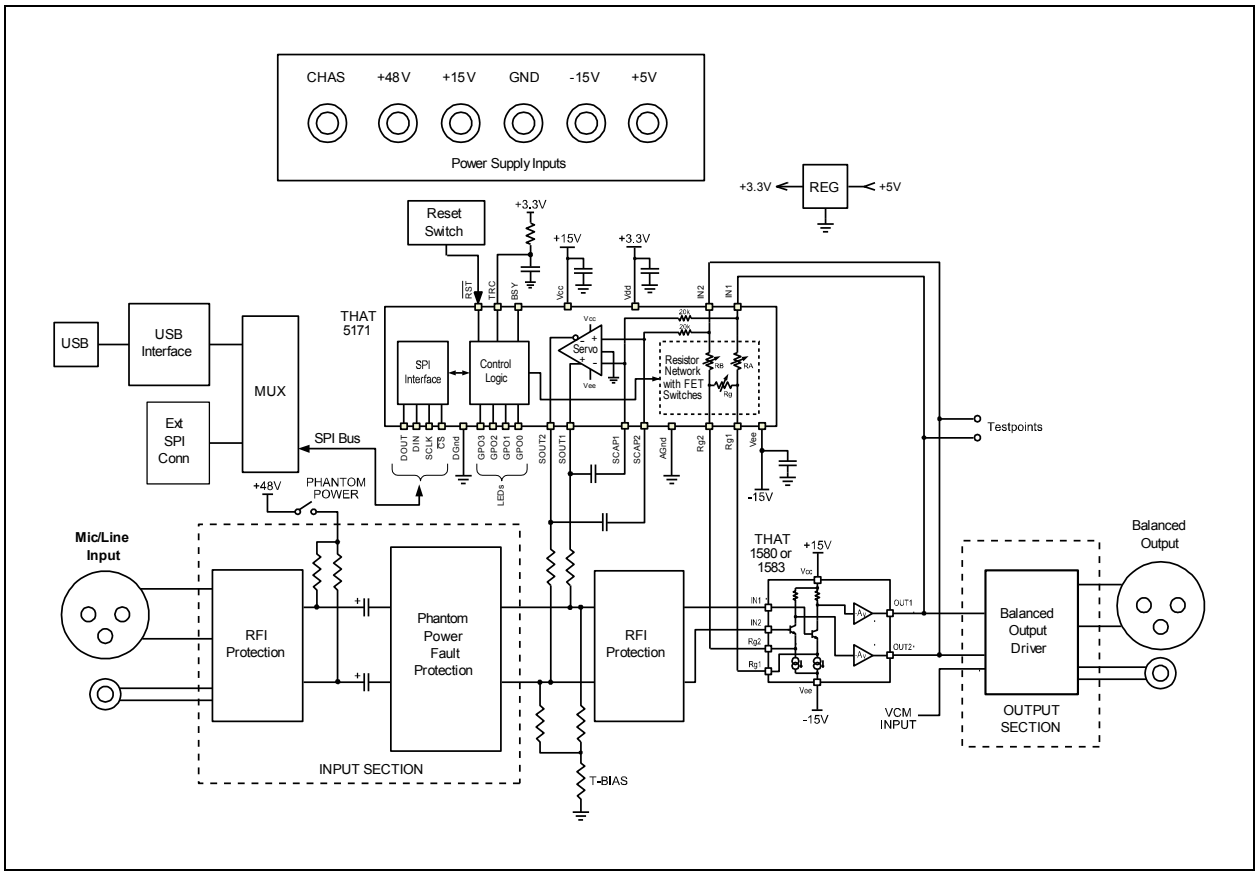


Figure 2. Block Diagram of the THAT 5171 Demo Board

5171 Demo Specifications[1,2,3]

Parameter	Symbol	Typical	Units
Power Supply Voltage	V+ - V-	±15	V
Maximum Input Level (V+ /V- = ±15V)	V_{IN-BAL}	+22	dBu
Maximum Differential Output Level (V+ /V- = ±15V)	V_{OUT}	+22	dBu
Gain (input to output)	A_{dB}	0 8 to 63 in 1dB steps	dB
Gain error (all settings)	A_{err}	±0.15	dB
Total Harmonic Distortion (V_{OUT}=+16dBu ($5V_{RMS}$); R_L=10kΩ C_L=10pF; f = 1kHz; BW = 22 kHz	THD	0.0004 (0dB gain) 0.0003 (20dB gain) 0.0008 (40dB gain) 0.006 (60dB gain)	%
Equivalent Input Noise (main output) (150 Ω source, BW=22kHz)	EIN	-127.9 (60dB gain) -127.1 (40dB gain) -120.0 (20dB gain) -107.0 (0dB gain)	dBu
Supply Current	I_{CC}, $-I_{EE}$, I_{DD}	23 (V+ supply) 23 (V- supply) 0.5 (+5V supply)	mA

1. All specifications are subject to change without notice.
2. Unless otherwise specified, T_A=25ºC, V_{CC}=+15V, V_{EE}=-15V, V_{DD}=+3.3V
3. All audio specifications include the effects of the differential output buffer stage.

Connections

Connections:

Power

The USB interface runs on USB bus power, but the rest of the demo board requires an external power supply. +/-15 V (maximum +/-17V) supplies the analog circuitry. +48V phantom power is input (not generated on the board) and switched on and off via the on-board Phantom Power switch. Note that the ground return for +48V phantom power is via the CHAS (chassis ground) connector. The +5V input is regulated on board to 3.3V and supplies the digital logic.

Audio Input

The Neutrik combo connector accepts an XLR or ¼" TRS cable. Maximum input signal level is +22dBu with ±15 V supplies. The 1/4" TRS signal path includes a 20 dB pad in order to support very high line levels.

Audio Output

Separate XLR and ¼" TRS connectors are wired in parallel. Maximum output signal level is +22 dBu with ±15 V supplies. The differential attenuator/output buffer (U3) adds a small amount of noise and distortion to the signal and it is therefore recommended that test points TP1-TP3 be used to measure performance of the 1580/5171 ICs.

USB

A PC must be plugged into the demo board via USB in order to control the various parameters in the 5171.

General Purpose Outputs (GPO)

The GPO3:0 pins are connected to header J12. J12 is conveniently located near the prototyping area, so the user can easily connect optional circuitry to them. Note that the GPO pins are also connected to LEDs, D1-D4, and pull up and pull down resistors which set the 5171 device address during reset. Consideration must be given to how any application circuitry that is added interacts with these other functions.

A note about the phantom power fault protection circuitry included on the demo board:

Phantom power faults are a serious concern in any preamplifier design and external protection circuitry is always required for safe and reliable operation. A momentary short at the input connector while using phantom power can cause 48 V negative spikes to appear at the preamplifier inputs, often destroying the IC if left unprotected. THAT Corporation has recently revised its protection recommendations which now include:

1) Schottky diodes

2) Larger power supply bypass capacitors. The full details of our latest recommendations can be found in our Design Brief 201, "Revisiting Phantom Power Fault Protection", available on our website here:

www.thatcorp.com/Design_Briefs.shtml

The part number for our recommended Schottky diode can be found in the bill of materials included in this document.

Jumper Options

T-Bias Jumper, J4

The input circuit provides a jumper (J4) which enables/disables the "T-Bias" function. With a shunt installed on J4, T-Bias is disabled and the circuit provides a 1 kΩ common-mode input impedance per input leg to the XLR input. With the shunt removed from J4, T-Bias is enabled and provides a higher common mode impedance(nominally 5.1 kΩ per input leg), which will improve CMRR performance, particularly at low frequencies where mismatches in the input coupling capacitors tend to degrade it. The differential input impedance is 2 kΩ in both cases.

VCM Input Jumper, J6

The output attenuator (U3) is normally biased at 0 VDC via R30 connected to ground through a shunt on jumper J6. If the J6 shunt is removed, a bias voltage may be input via J6, e.g. the common mode voltage output pin (VCOM) of an A/D Converter.

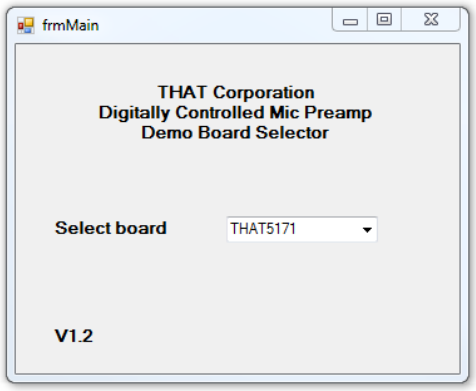
External SPI Host Jumpers & Connectors

The demo board has two connectors, J8 and Jl0, for connecting up to 8 boards to an external SPI master device, such as a microcontroller. J8 is not installed at the factory and it is up to the user to add it if required. Note also that current limiting resistors R34, R36, R40, and R41 must be installed with the appropriate value for the application. Please contact THAT Corporation technical support for assistance.

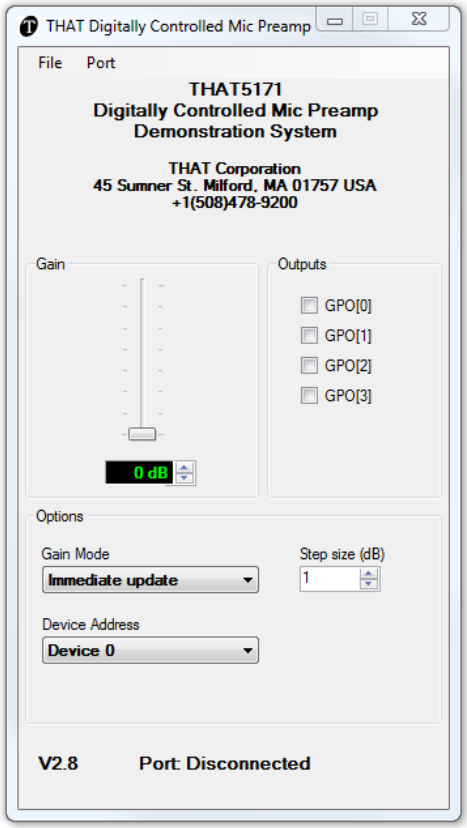
Software Set-up and Operation

Download the latest Demo Board GUI software from the THAT Corporation web site. There is no "installation" process and the .exe file can be placed anywhere convenient on your computer, typically, directly on the desktop. Connect the demo board to your PC using the supplied USB cable and power up the board (don't forget to include the +5V digital power supply in addition to the V+ and V- supplies).

Double click the MicPre.exe icon and the Digitally Controlled Mic Preamp Demo Board Selector will appear. Select the THAT5171 from the drop-down menu

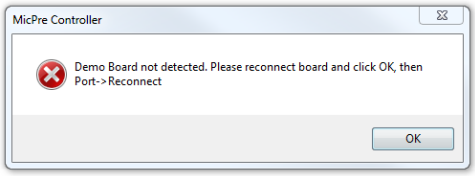


The 5171 GUI should appear:



That's it. Test for connectivity by toggling one of the GPO check boxes and see if the appropriate LED lights up on the board.

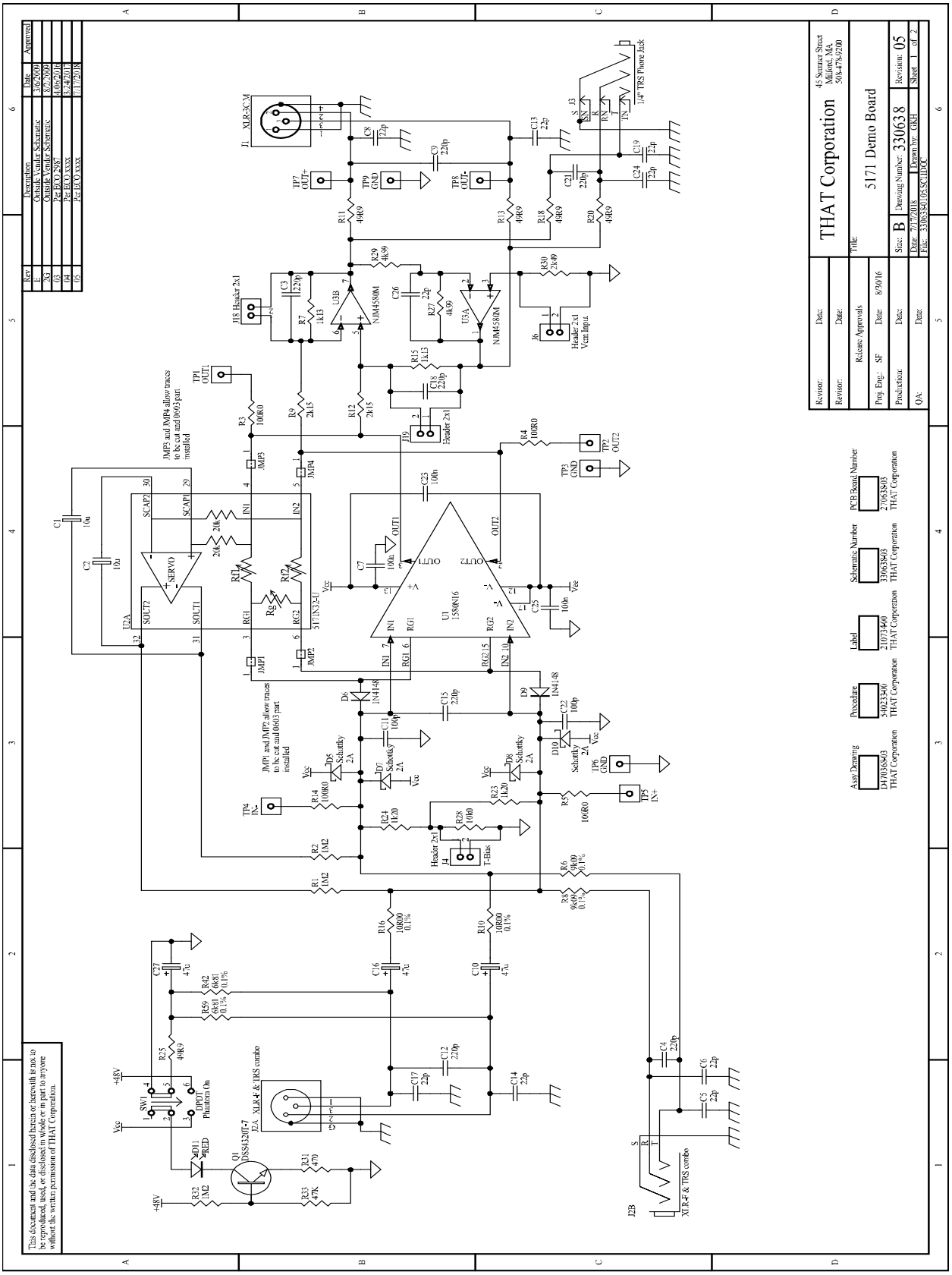
If the GUI fails to recognize the demo board (most likely caused by a missing USB connection) you will see the following error message:



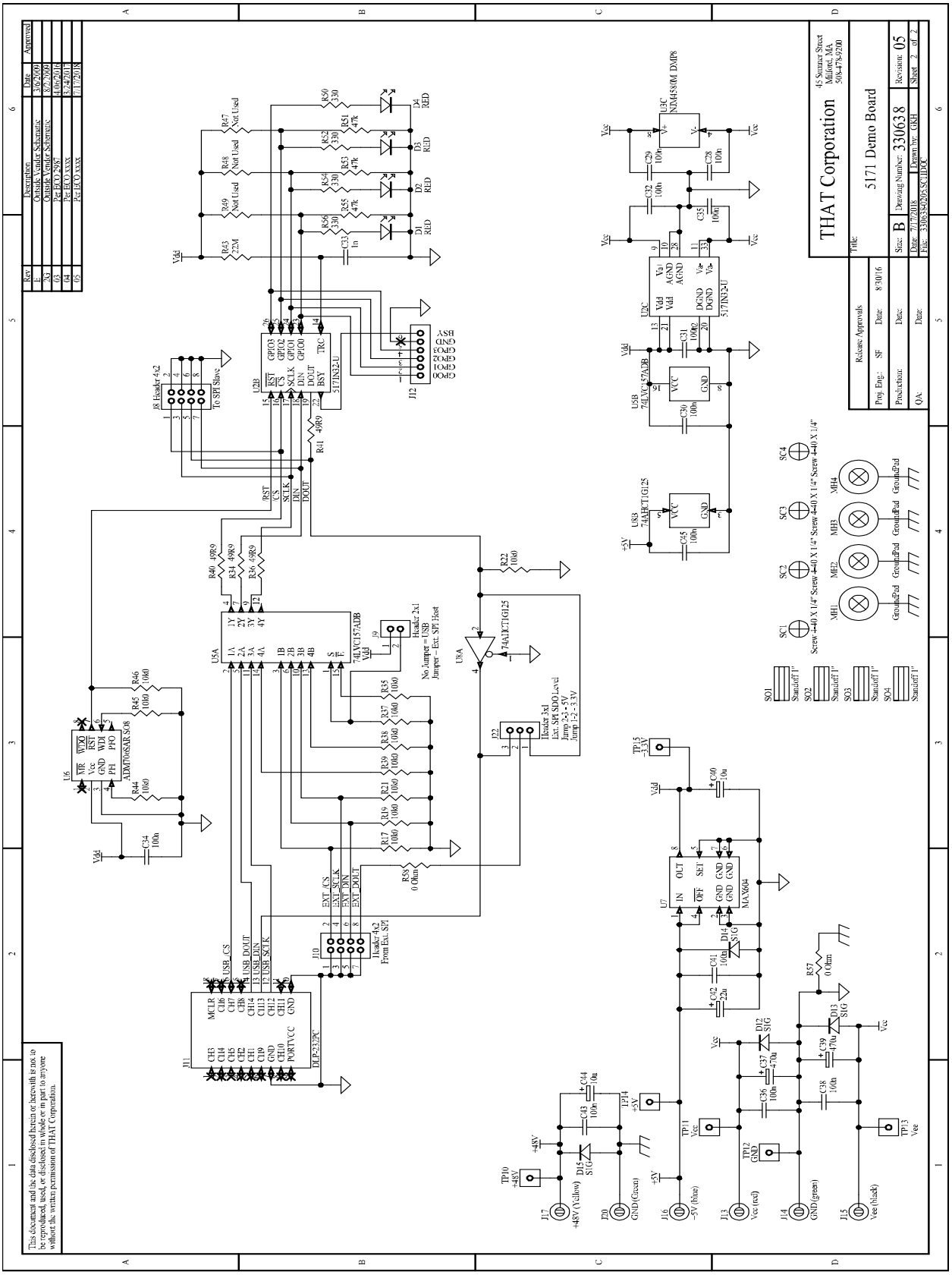
If this message appears, you can click OK and the GUI will open, but there will be no connection to the demo board. Once the source of the problem has been resolved (i.e. Turn on the power or connect the missing USB cable), use the Port=>Reconnect pull down to establish communications.

The Port=>Reconnect pull down can be used any-time to reestablish the USB link between the GUI and demo board.

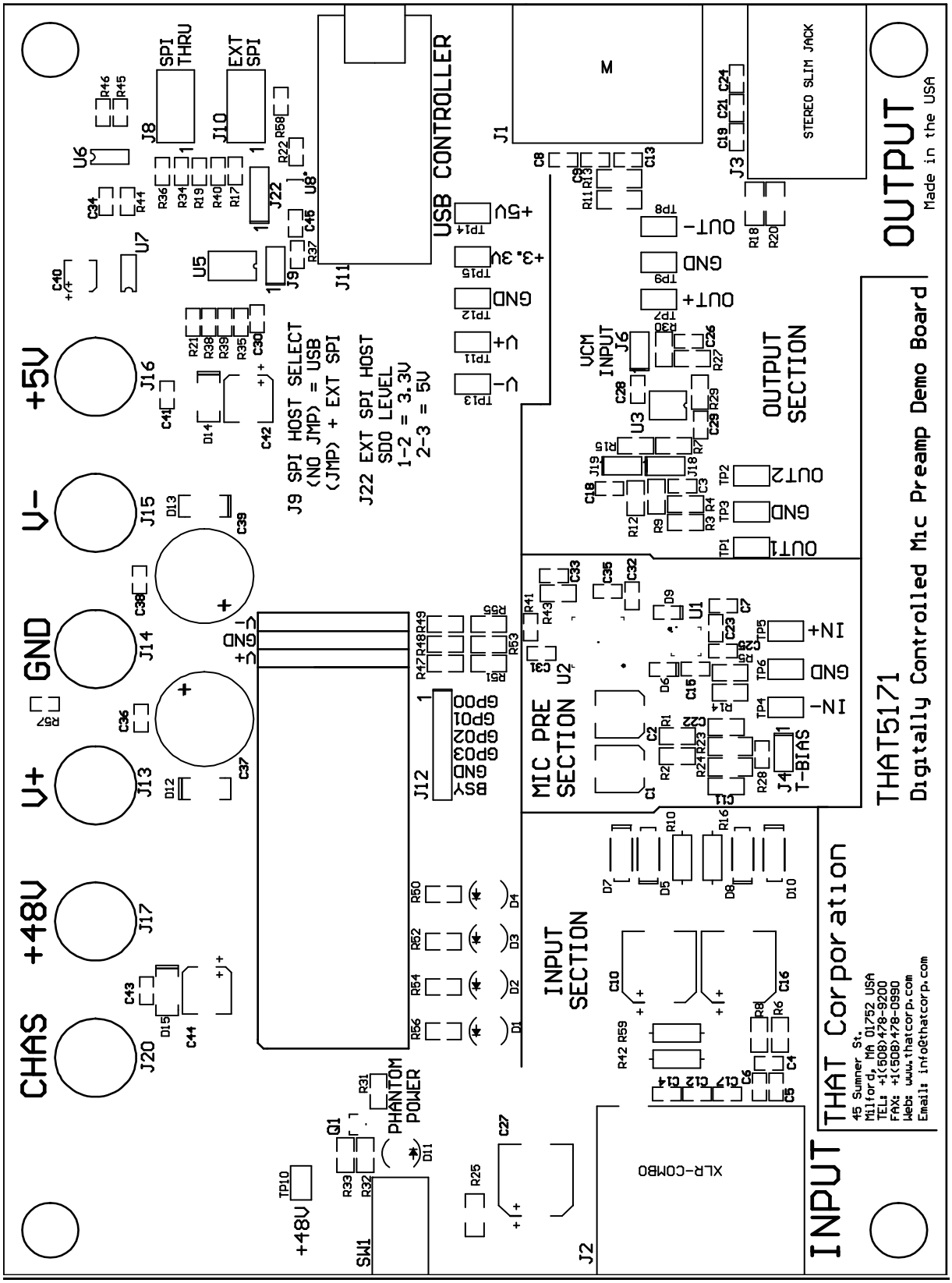
Appendix A. Schematic Diagram (1 of 2)



Appendix A. Schematic Diagram (2 of 2)



PCB Component Placement

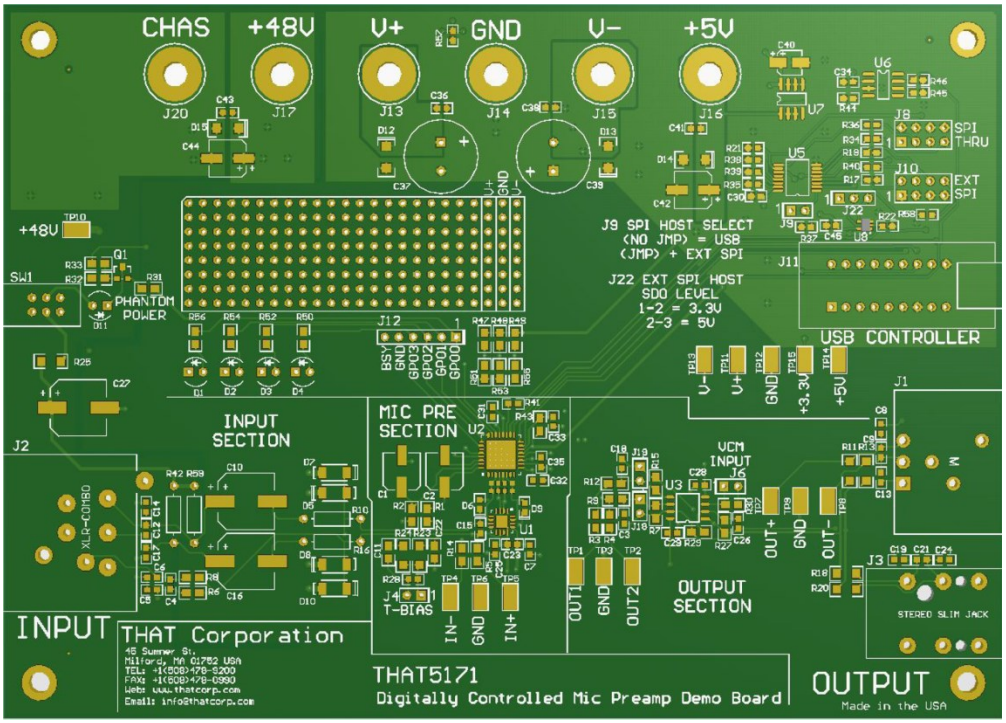


Appendix B. Bill of Materials

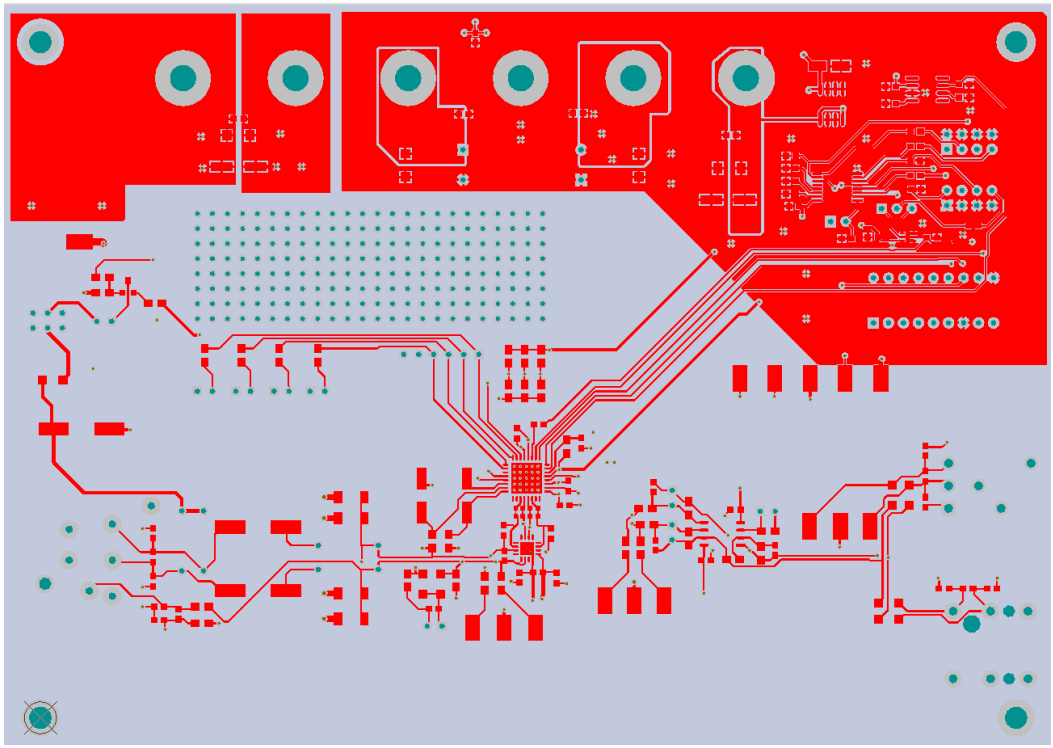
Item	Description	Qty	Designator	Manufacturer	Mfr P/N
1	Printed Circuit Board	1	PCB Board Number	THAT Corporation	270638-03
2	Cap 10u 25V NP 20% Aluminum SMD 5mm	2	C1, C2	Nichicon	UWP1E100MCL1GB
3	Cap 220p 50V 5% NPO Ceramic SMD 0603	7	C3, C4, C9, C12, C15, C18, C21	TDK	C1608C0G1H221J
4	Cap 22p 50V 5% NPO Ceramic SMD 0603	9	C5, C6, C8, C13, C14, C17, C19, C24, C26	KEMET Corporation	C0603C220J5GAC
5	Cap 100nF 50V X7R Ceramic SMD 0603	15	C7, C23, C25, C28, C29, C30, C31, C32, C34, C35, C36, C38, C41, C43, C45	Murata Electronics	GRM188R71H104K
6	Cap 47 uF 63V 20% Aluminum Radial 12.5mm Low ESR	3	C10, C16, C27	Panasonic	EEE-TG1J470P
7	Cap 100p 50V 5% NPO Ceramic SMD 0805	2	C11, C22	Murata Electronics	GRM2165C1H101JA01D
8	Cap 1nF 10% 50V X7R Ceramic SMD 0603	1	C33	AVX Corporation	06035C102KAT2A
9	Cap 470uF 25V 20% Aluminum Radial	2	C37, C39	Panasonic	ECA-1EM471B
10	Cap 10u 25V 20% Aluminum SMD 4.3x4.3	1	C40	United Chemi-Con	EMVA250ADA100MD55G
11	Cap 22uF 25V 20% Aluminum SMD 6.3mm	1	C42	Panasonic	EEV-FC1E220P
12	Cap 10uF 63V 20% aluminum SMD 6.3mm	1	C44	Nichicon	UCD1J100MCL1GS
13	Diode LED T1 RED D-5mm Radial	5	D1, D2, D3, D4, D11	Rohm	SLA-560LT3F
14	Diode Sckottky 60V 2A SMD SOD128	4	D5, D7, D8, D10	Nexperia	PMEG6020AELPX
15	Diode 1N4148 150mA 75V 0603	2	D6, D9	Comchip Technology Corporation	CDSU4148
16	Diode S1G 1A 400V SMD DO-214AC (SMA)	4	D12, D13, D14, D15	Diodes, Inc.	S1G-13-F
17	XLR-3C male right angle chassis mount	1	J1	Neutrik USA Inc.	NC3MAH
18	3p female XLR & TRS chassis mount	1	J2	Neutrik USA Inc.	NCJ6FI-H
19	3P phone female right angle 1/4" slim jack	1	J3	Neutrik USA Inc.	NRJ6HF-1
20	Conn Header 2p Male Vert 0.1 Gold	5	J4, J6, J9, J18, J19	Samtec USA	TSW-102-07-G-S
21	Conn Header 4x2 Male Vert 0.1 Gold	2	J8, J10	3M	2308-6121TG
22	Module USB FT232R W/18F2410	1	J11	DLP Design, Inc	DLP-232PC
23	Conn Header 6p Male Vert 0.1 Gold	1	J12	Molex	22-28-4063
24	5-Way Binding Post Chassis Mount Red	1	J13	Pomona Electronics	3760-2
25	5-Way Binding Post Chassis Mount Green	2	J14, J20	Pomona Electronics	3760-5
26	5-Way Binding Post Chassis Mount Black	1	J15	Pomona Electronics	3760-0
27	5-Way Binding Post Chassis Mount Blue	1	J16	Pomona Electronics	3760-6
28	5-Way Binding Post Chassis Mount Yellow	1	J17	Pomona Electronics	3760-4
29	Conn Header 3p Male Vert 0.1 Gold	1	J22	Molex	22-28-4033
30	Assembly Label	1	Label	THAT Corporation	210734-00
31	Mounting Hole Ground Pad Hole Size 150 mil pad Diameter 250 mil	4	MH1, MH2, MH3, MH4		
32					

Item	Description	Qty	Designator	Manufacturer	Mfr P/N
33	Binding Post/Standoffs Procedure	1	Procedure	THAT Corporation	540233-00
34	Transistor DSS4320T NPN 20V 2A SOT-23	1	Q1	Diodes, Inc.	DSS4320T-7
35	Res 1M2 1% 0.125W Thick Film SMD 0805	3	R1, R2, R32	Vishay Dale	CRCW08051M21FKEA
36	Res 100R0 1% 100mW Thin Film 25ppm SMD 0805	4	R3, R4, R5, R14	KOA Speer Electronics	RN732ATTD1000F25
37	Res 9k09 0%1 0.125W Thin Film 25ppm SMD 805	2	R6, R8	Susumu	RG2012P-9091-B-T5
38	Res 1k13 0%5 100mW Thin Film 25ppm SMT 0805	2	R7, R15	Susumu	RR1220P-1131-D-M
39	Res 2k15 0%5 100mW Thin Film 25ppm SMT 0805	2	R9, R12	Susumu	RR1220P-2151-D-M
40	Res 10R00 0.1 0.25W Metal Film Axial	2	R10, R16	TE Connectivity	YR1B10RCC
41	Res 49R90 1% 0.25W Thick Film SMD 1206	5	R11, R13, R18, R20, R25	Panasonic	ERJ-8ENF49R9V
42	Res 10k0 1% 0.1W Thick Film SMD 0603	12	R17, R19, R21, R22, R28, R35, R37, R38, R39, R44, R45, R46	Vishay Dale	CRCW06031002FRT1
43	Res 1k20 0%1 0.25W Thin Film 25ppm SMD 1206	2	R23, R24	Vishay Dale	TNPW12061K20BEEN
44	Res 4k99 0%5 100mW Thin Film 25ppm SMD 0805	2	R27, R29	Susumu	RR1220P-4991-D-M
45	Res 2k49 1% 125mW Thin Film 100ppm SMD 0805	1	R30	Susumu	RR1220P-202-B-T5
46	Res 470R 1% 0.125W Thick Film SMD 0805	1	R31	Yageo	RC0805FR-07470RL
47	Res 47k0 1% 0.125W Thick Film SMD 0805	4	R33, R51, R53, R55	Yageo	RC0805FR-0747KL
48	Res 49R9 1% 100mW Thick Film SMT 0603	4	R34, R36, R40, R41	Vishay Dale	TNPW120649R9BEEN
49	Res 6k81 0%1 1/4W Metal Film 25ppm axial	2	R42, R59	IRC	RC55LF-D-6K81-B-B
50	Res 22M 1% 125mW Thiin Film 100ppm SMD 0805	1	R43	Panasonic	ERJ-6GEYK226V
51	Res 330R 1% 0.125W Thick Film SMD 0805	4	R50, R52, R54, R56	Yageo	RC0805FR-07330RL
52	Res 0R Thick Film SMT 0603	2	R57, R58	Panasonic	ERJ-3GEY0R00V
53	Screw 4-40 X 1/4" PHILLIPS PAN HEAD SS	4	SC1, SC2, SC3, SC4	McMaster-Carr	91772A106
54	Schematic	1	Schematic Number	THAT Corporation	330638-03
55	Standoff 4-40 X 1/4" X 1" HEX AL	4	SO1, SO2, SO3, SO4	RAF Electronic Hardware	2112-440-AL-7
56	Switch DPDT push-push action	1	SW1	E-Switch	PBH2UEENAGX
57	Test Point SMT 2.5 X 4.50	15	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15	Keystone Electronics Corporation	5016
58	IC 1580N16-U Mic Preamp 16QFN	1	U1	THAT Corporation	
59	IC 5171N32-U Mic Preamp Gain Controller 32QFN	1	U2	THAT Corporation	5171N32-U
60	Opamp dual	1	U3	NJM Corporation	NJM4580M
61	IC 74LVC157 Quad 2-In Multiplexer 16SSOP	1	U5	NXP	74LVC157ADB,112
62	IC 3V uProcessor Supervisory Circuit	1	U6	Analog Devices	ADM706SARZ
63	IC MAX604 Volt Reg Adj 3.3V 0.5A 8SOIC	1	U7	Maxim / Dallas	MAX604CSA
64	IC 74HCT1G125 Single Bus Buffer with Tri-state Output	1	U8	Texas Instruments	SN74AHCT1G125DCK

Appendix C. PCB Layout (1 of 3)

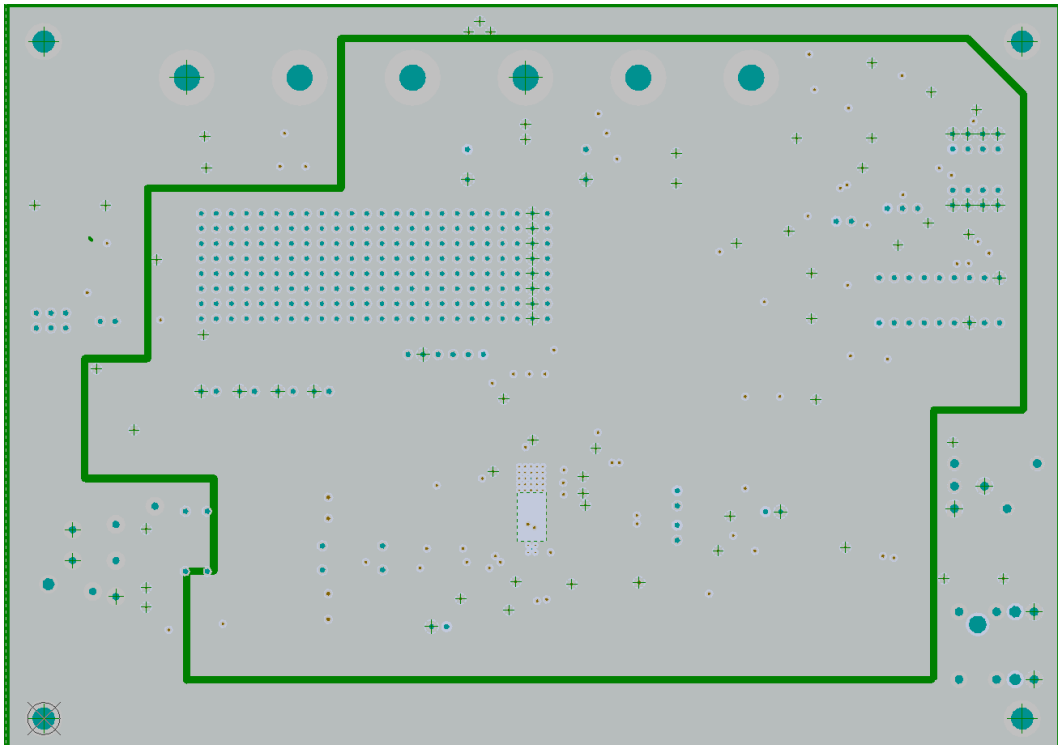


PCB Layout –Top Layer Silkscreen

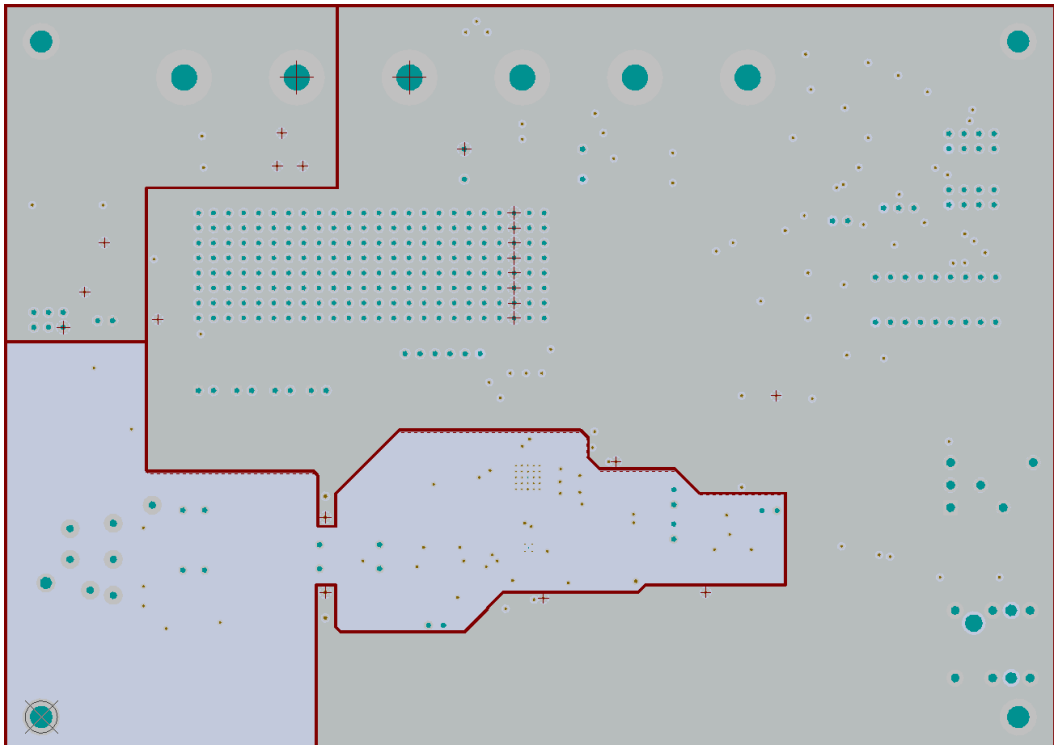


PCB Layout – Top Layer

Appendix C. PCB Layout (2 of 3)

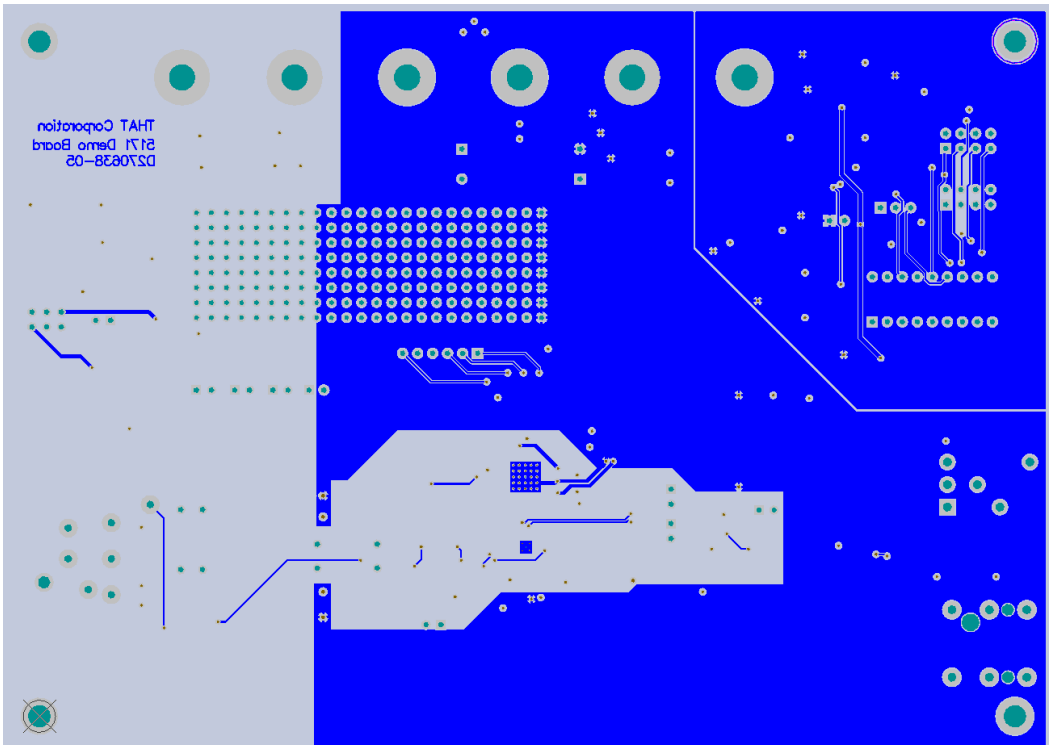


PCB Layout – Internal Layer 1



PCB Layout – Internal Layer 2

Appendix C. PCB Layout (3 of 3)



PCB Layout – Bottom Layer

Revision History

Revision	ECO	Date	Changes	Page
00	—	10/08/15	Initial Release	—
01	3035	08/15/18	Redrawn and formatted	—

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