

#### FEATURES

- Demonstrates a complete digitally-controlled microphone preamplifier circuit based on THAT5173 IC
- Controls gain of the 1570 microphone preamplifier.
- Balanced audio input/output on XLR and TRS connectors
- Supports pro audio signal levels: +26 dBu (input and output,  $\pm 15V$  supplies)
- Gain adjustable in 3 dB steps from 0 dB to 60 dB
- Easy to use PC Graphical User Interface software
- Generous prototyping area

#### Description

The THAT 5173-DEMO Digitally-Controlled Mic Preamp Demo Board allows developers to evaluate the THAT5173 digital gain controller IC with any member of the growing family of THAT differential output microphone preamplifiers. A fully-featured

microphone preamplifier is demonstrated with phantom power switching and fault protection, mic/line switching, RFI filtering, and output conditioning. The board is controlled by a user-friendly PC graphical user interface over USB.

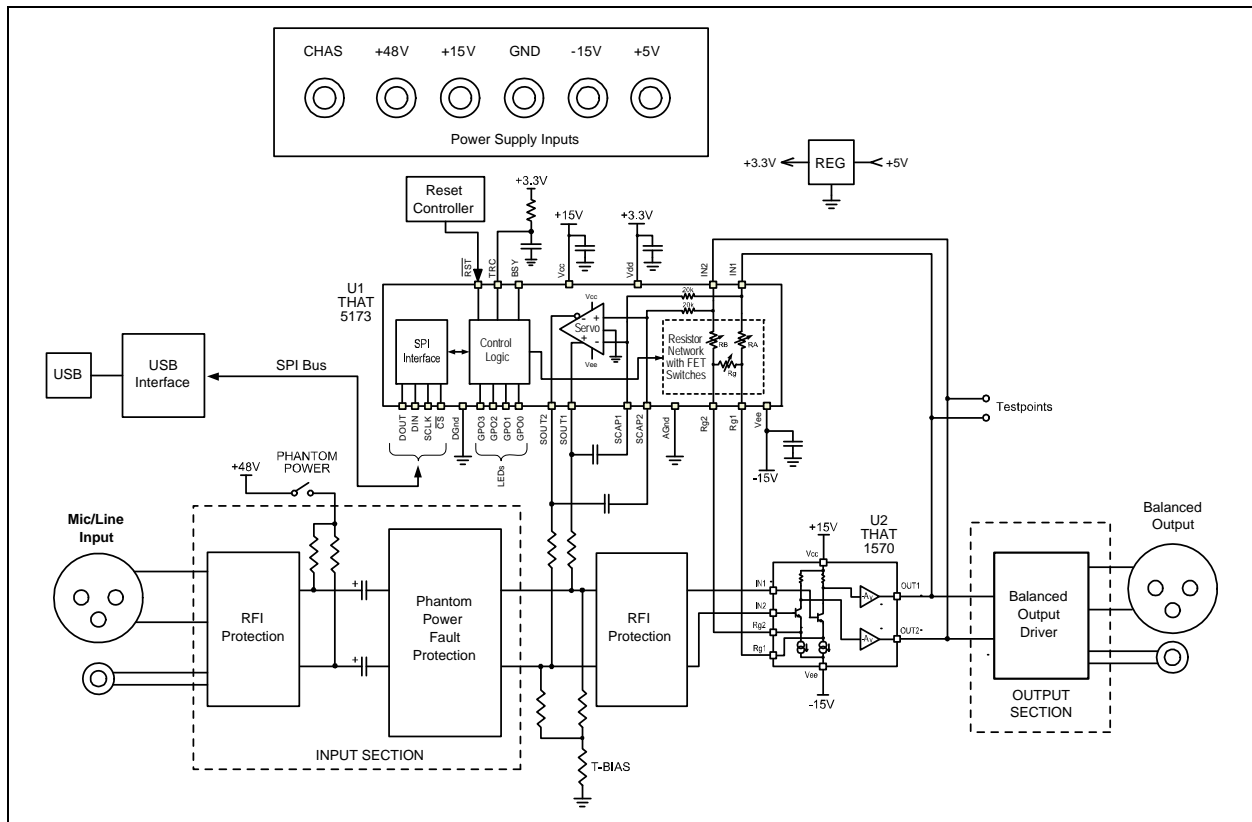


Figure 1. Block Diagram of the THAT 5173 Demo Board

## **Overview**

The THAT5173 is a digital gain controller for low-noise, analog, differential, current-feedback audio preamplifiers. When used in conjunction with an appropriate analog gain block (e.g. THAT1570), the 5173 can digitally control gain from 0dB to 60dB in 3dB steps, while preserving low noise and distortion. It operates from  $\pm 5V$  to  $\pm 17V$  supplies, supporting input signal levels as high as +27 dBu (at 0dB gain,  $\pm 17 V$ ) without an

input pad. A differential servo reduces output offsets to less than 1.75mV.

The THAT5173-DEMO Board demonstrates the 5173 mated with the 1570 mic preamplifier IC in a typical circuit. An easy to use USB Graphical User Interface provides total control over all 5173 features. Developers can take advantage of the generous prototyping area to customize the circuit for their own application.

## **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 1/4" TRS cable. The 1/4" TRS signal path includes a 20dB pad in order to support line levels.

### **Audio Output**

Separate XLR and 1/4" TRS connectors are wired in parallel. differential attenuator/ output buffer (U3) adds a small amount of noise and

distortion to the signal and it is therefore recommended that test points TP10 - TP11 be used to measure performance of the mic preamp circuit in isolation.

### **USB**

A PC must be plugged into the demo board via USB in order to control parameters in the 5173 (e.g. gain). Take care not to hot plug the demo board while the GUI software is running as this will sometimes crash the Windows drivers.

### **General Purpose Outputs (GPO)**

The GPO3:0 pins are connected to header P6. P6 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 5173 device address during reset. Consideration must be given to how any application circuitry that is added interacts with these other functions.

## **Hardware Set-up**

1. Connect a power supply to the V+, V-, +5V, +48V, CHAS and GND connectors. Do not turn on power yet.
2. Plug in the audio input and output
3. Attach a USB cable to the demo board, but do not plug it into the PC yet
4. Turn on the power supply
5. Turn on phantom power to microphone (if appropriate)

6. Plug USB cable into PC. Windows should go through its procedure for discovering the new USB peripheral and loading its driver.

7. Once the Windows driver has been loaded, launch the THAT Corporation MicPreController GUI application. See software section (below) for further instructions on operating the GUI.

8. When finished, close the MicPreController GUI first, then power down the demo board.

## Software Set-up

### If you see an error during installation

The 5173 Demo Board GUI application requires Microsoft .NET Framework 3 or later to be installed on your computer. If you see an error message during installation stating the application could not be installed, 99% of the time it's because you don't have .NET. Please visit: <http://www.microsoft.com/download/en/details.aspx?id=17718> and install the latest version.

### Installing the 5173 Demo Board Software

NOTE: Do NOT plug the demo board into your PC yet. We'll tell you when to do that.

### PC Software Installation Process

1. Get the software, a single file named THAT5173\_Demo\_Setup.exe. The software is available via download from the THAT Corporation website on the following page: [www.thatcorp.com/Demonstration\\_Boards.shtml](http://www.thatcorp.com/Demonstration_Boards.shtml)

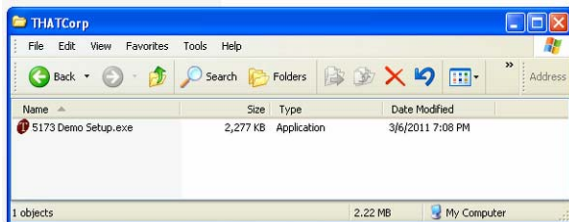


Figure 2. THAT5173\_Demo\_Setup.exe setup program in a folder

2. Double click the THAT5173\_Demo\_Setup.exe icon. Windows might warn you: "The publisher could not be verified. Are you sure you want to run this software?" (Figure 3). This is a standard security warning presented by Windows when files from unknown origins are opened. Consider where you got this. On a bit torrent file sharing site? Don't open it. From us, click RUN.



Figure 3. Windows warning, just click RUN.

3. Next, you must tell Windows to go ahead and install the Software, as shown in Figure 4. Click INSTALL.

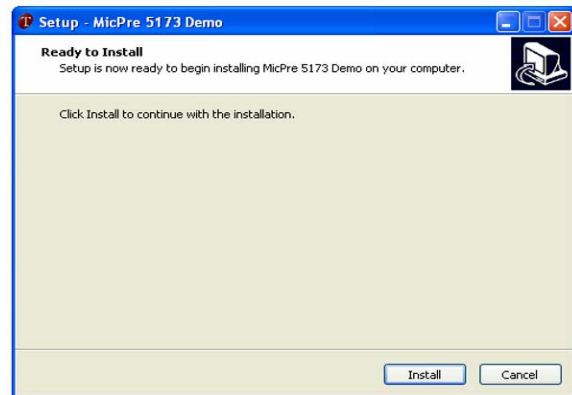


Figure 4. Start the installation process (USB drivers first)

4. You should see the automated wizard step through a series of steps as it plugs in the requisite USB drivers. When it's done, the wizard invites you to install the GUI, as shown in Figure 5. Click NEXT.



Figure 5. Starting the GUI installation process

5. The first thing the wizard asks is where you want to put the GUI (Figure 6). We recommend a THAT Corp folder, as shown in the figure. Navigate to where you want the GUI to be installed, and then click NEXT.

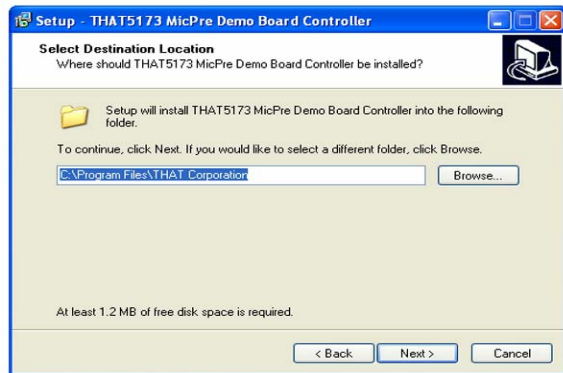


Figure 6. Selecting the software hard disk location

6. Next, Windows asks where it should put the Shortcut icons for the GUI (Figure 7). If you agree with our recommendation, just click NEXT. Otherwise, change this setting to what you want and then click NEXT.

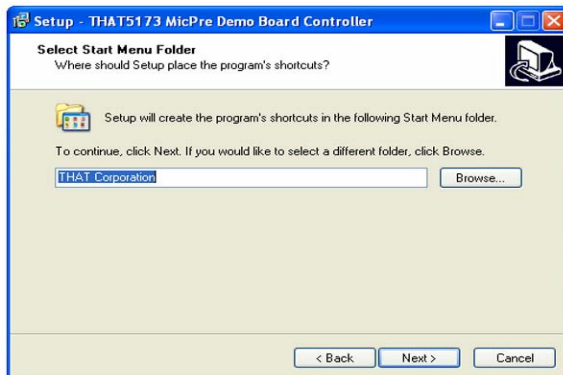


Figure 7. Selecting the start menu folder

7. Now Windows asks if you want a Desktop icon (Figure 8). We will leave that to you to decide (this is your homework). Once you've made your decision, click NEXT.

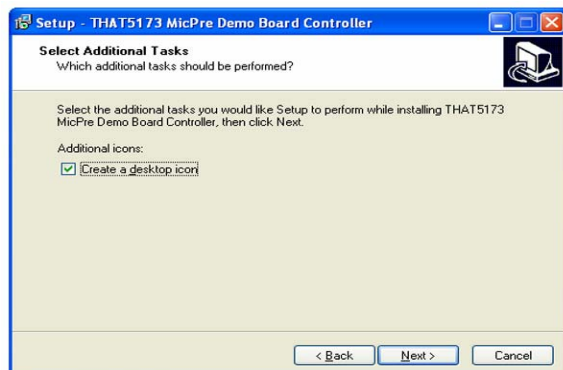


Figure 8. Selecting a desktop icon

8. Finally, the wizard will stop asking you questions and get on with the business of installing the GUI, as shown in Figure 9. Click INSTALL.

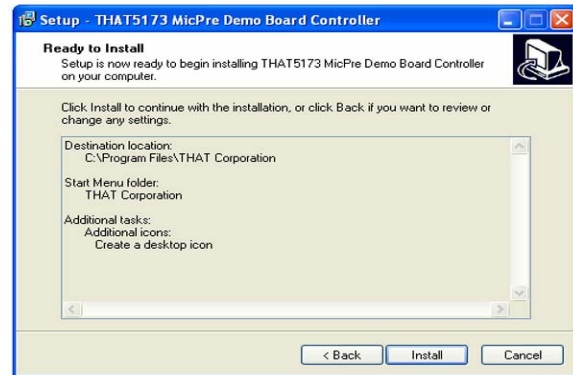


Figure 9. Ready to install

9. When the wizard is finished, you should see the final dialog box shown in Figure 10. Click FINISH.



Figure 10. Finishing the GUI installation process

10. The software installation wizard is done now, but there is one final step. Windows and the 5173 Demo Board must see each other for the first time. Their first encounter is special because it's when Windows discovers a new USB device and attaches those new drivers you just installed to it. It is not required that the Demo Board be connected to an external supply for this process to work, the USB interface on the Demo Board is actually bus-powered by USB. So, plug the Demo Board into your PC and watch them get to know each other (you'll see little messages flash in the lower right corner). Hopefully Windows will report a happy marriage. If not, get a fresh cup of coffee (or whatever you drink in distress), and call our tech support hotline.

11. That's it. You're done. Enjoy.

## Operation

1. Apply power to the demo board, then plug the demo board into the PC via USB.
2. Launch the MicPreController GUI application.
3. The USB interface on the demo board will appear in Windows as a new COM port.
4. The GUI should now be connected to the demo board and ready to control its parameters. The GPO 0 check box is selected by default, and the GPO 0 LED should now be lit on the demo board indicating that communications have been established. If the LED is not turned on, or anytime USB communication has been disrupted, use the "Reconnect" command from the Port drop down menu to re-establish the USB connection.
5. Select "Update immediately" or "Update on zero crossings" from the Gain Mode and GPO Mode drop down menus.

6. Move the gain slider to adjust gain of the 5173. Gains are continuously adjusted as you move the slider. You may also adjust the gain slider by first giving it scope (clicking it with the mouse) and then pressing the UP and DOWN arrow keys on your computer keyboard, or by clicking the up or down arrow buttons next to the numeric gain text box below the gain slider.

### Jumper Options

#### T-Bias Jumper, P7

The input circuit provides a jumper (P7) which enables/disables the "T-Bias" function. With a shunt installed on P7, T-Bias is disabled and the circuit provides a 2k $\Omega$  differential input impedance to the XLR input. With the shunt removed from P7, T-Bias is enabled and provides a high common mode impedance (ideal for both mic and line inputs) but maintains a modest differential impedance.

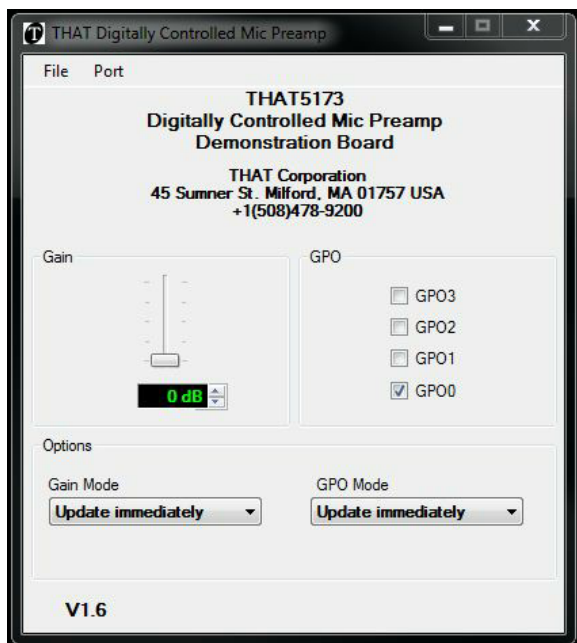
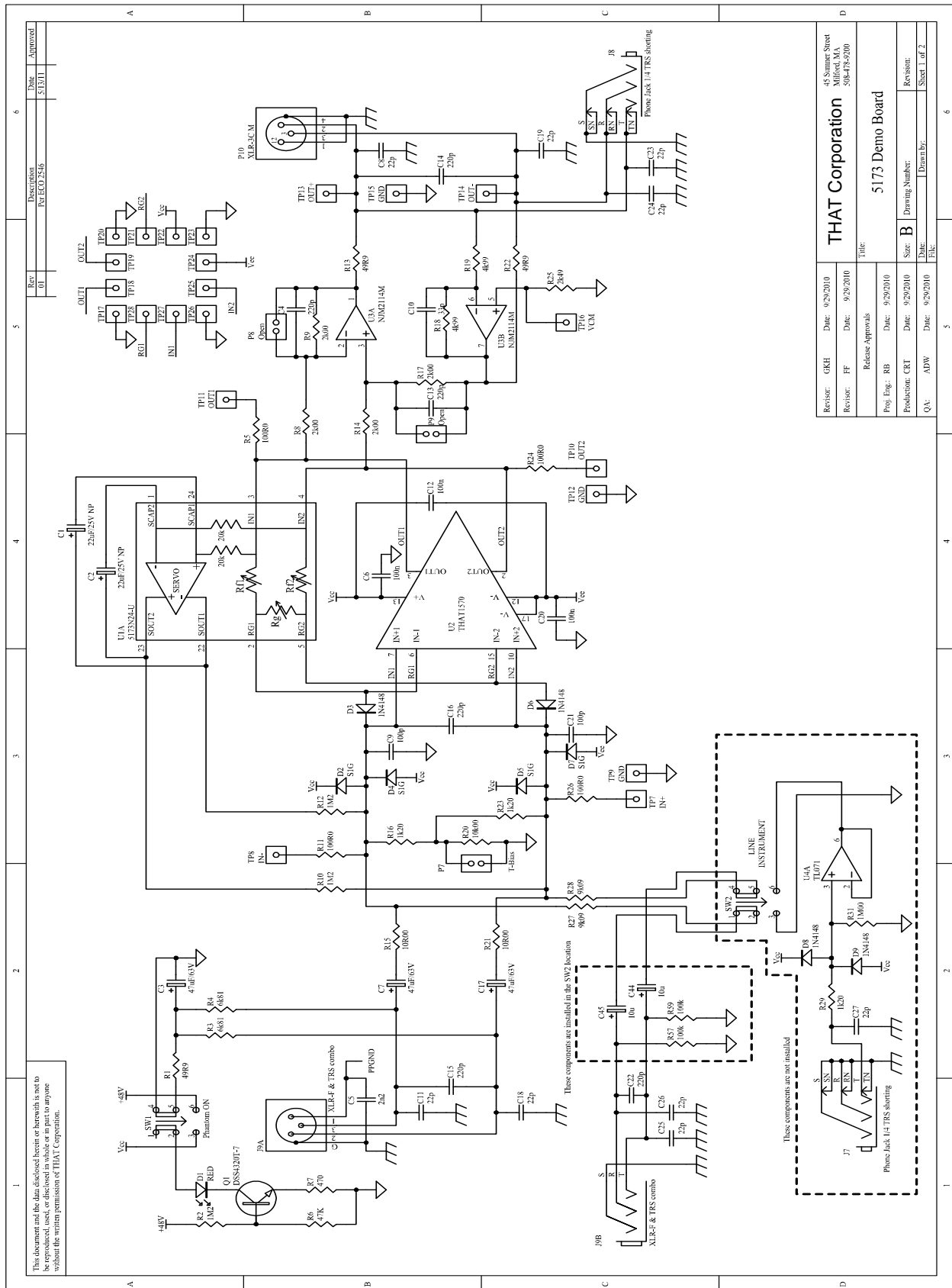
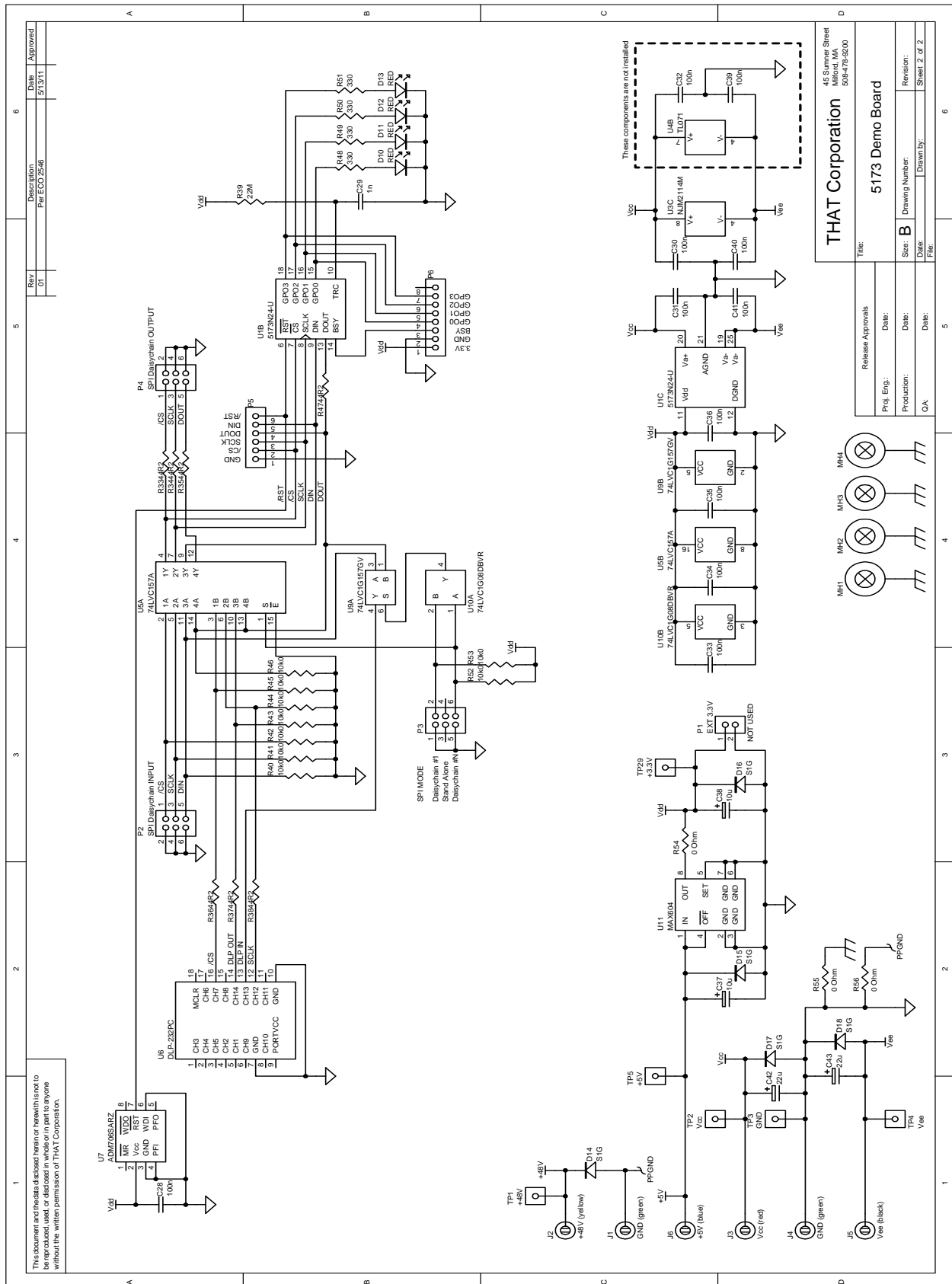


Figure 11. Control GUI

## Appendix A. Schematic (1 of 2)



## Appendix A. Schematic (2 of 2)



THAT Corporation; 45 Sumner Street; Milford, MA 01757-1656; USA  
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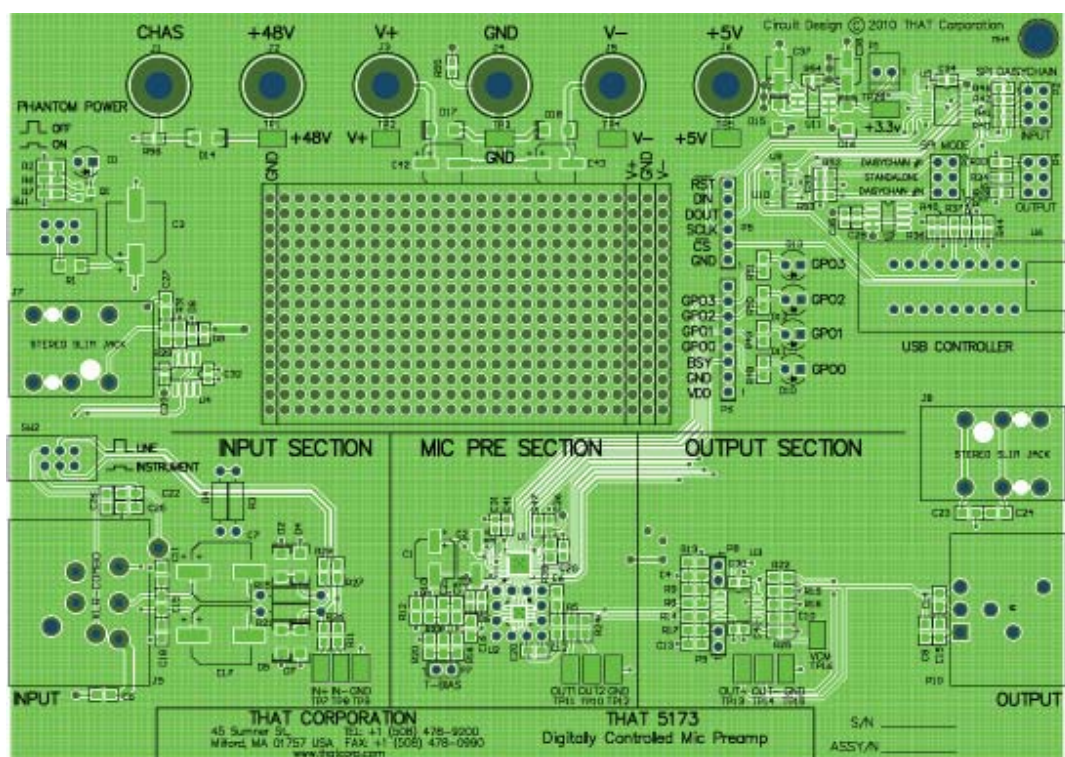
## **Appendix B. Bill of Materials**

| Item | Qty | Reference   | Value            | Description                                 | Mfr                            | Mfr P/N               |
|------|-----|---|------------------|---|--------------------------------|-----------------------|
| 1    | 3   | R54, R55, R56   | 0 Ohm            | Resistor 100mW 5% Thick Film 200ppm 0603    | Vishay Dale                    | CRCW0805000ZRT1       |
| 2    | 9   | R40, R41, R42, R43, R44, R45, R46, R52, R53           | 10k0             | Resistor 100mW 1% Thick Film 100ppm 0603    | Vishay Dale                    | CRCW06031002FRT1      |
| 3    | 7   | R33, R34, R35, R36, R37, R38, R47                     | 44R2             | Resistor 100mW 1% Thick Film 100ppm 0603    | Xicon                          | 302-44.2              |
| 4    | 2   | R15, R21  | 10R00            | Resistor 1/4W 0%1 MF 50ppm axial            | VPR                            | A010.00M3EB           |
| 5    | 2   | R3, R4  | 6K81             | Resistor 1/4W 0%1 MF 25 ppm axial           | IRC                            | RC55LF-D-6K81-B-B     |
| 6    | 1   | R1  | 49R90            | Resistor 1/4W 0%1 MF 25 ppm 1206            | Vishay Dale                    | TNPW120649R9BEEN      |
| 7    | 2   | R13, R22  | 49R90            | Resistor 1/10W 0%1 Thin Film 25 ppm 0805    | Stackpole Electronics          | RNCS0805BKE49R9       |
| 8    | 2   | R27, R28  | 6k04             | Resistor 63mW 1% Thin Film 100ppm 0603      | Venkel, Ltd.                   | TFCR0603-16W-E-6041FT |
| 9    | 4   | R5, R11, R24, R26                                     | 100R0            | Resistor 100mW 1% Thin Film 25ppm 0805      | VPR                            | A100.00E3EF           |
| 10   | 1   | R20   | 10k00            | Resistor 100mW 0%5 Thin Film 25ppm 0805     | Susumu Co                      | RR1220P-103-D         |
| 11   | 3   | R16, R23, R29   | 1k20             | Resistor 0.25W 0%1 Thin Film 25ppm 0805     | Susumu Co                      | RGH2012-2E-P-122-B    |
| 12   | 1   | R31   | 1M00             | Resistor 0.125W 0%1 Thin Film 25ppm 0805    | Bourns                         | CRT0805-BY-1004ELF    |
| 13   | 3   | R2, R10, R12  | 1M2              | Resistor 0.125W 1% TF 100ppm 0805           |                                |                       |
| 14   | 4   | R8, R9, R14, R17                                      | 2K00             | Resistor 100mW 0%1 Thin Film 25ppm 0805     | Susumu                         | RR1220P-202-B-T5      |
| 15   | 2   | R18, R19  | 4k99             | Resistor 100mW 0%5 Thin Film 25ppm 0805     | Susumu                         | RR1220P-4991-D-M      |
| 16   | 1   | R6  | 47k0             | Resistor 125mW 1% TF 100ppm 0805            | Yageo                          | RC0805FR-0747KRL      |
| 17   | 1   | R7  | 470R             | Resistor 125mW 1% TF 100ppm 0805            | Yageo                          | RC0805FR-07470RL      |
| 18   | 1   | R25   | 2k49             | Resistor 125mW 1% Thin Film 100ppm 0805     | Stackpole Electronics          | RNCP0805FTD2K49       |
| 19   | 4   | R48, R49, R50, R51                                    | 330R             | Resistor 125mW 1% TF 100ppm 0805            | Yageo                          | RC0805FR-07330RL      |
| 20   | 1   | R39   | 22M              | Resistor 125mW 1% TF 100ppm 0805            | Panasonic                      | ERJ-6GEYK226V         |
| 21   | 1   | C29   | 1n               | Capacitor 10% 50V X7R CM 0603               | AVX Corporation                | 06035C102KAT2A        |
| 22   | 11  | C28, C30, C31, C32, C33, C34, C35, C36, C39, C40, C41 | 100n             | Capacitor 10% 50V X7R CM 0603               | Murata Electronics             | GRM188R71H104K        |
| 23   | 3   | C6, C12, C20  | 100n             | Capacitor 10% 50V X7R CM 0805               | Murata Electronics             | GRM21BR71H104KA01L    |
| 24   | 2   | C9, C21   | 100p             | Capacitor 10% 50V X7R CM 0805               | Murata Electronics             | GRM2165C1H101JA01D    |
| 25   | 6   | C4, C13, C14, C15, C16, C22                           | 220p             | Capacitor 5% 50V NP0 CM Low ESR 0805        | Panasonic                      | ECJ-2VC1H221J         |
| 26   | 9   | C8, C11, C18, C19, C23, C24, C25, C26, C27            | 22p              | Capacitor 10% 50V NP0 CM Low ESR 0805       | Panasonic                      | ECJ-2VC1H220J         |
| 27   | 1   | C10   | 33p              | Capacitor 5% 50V NP0 CM Low ECR 0805        | Panasonic                      | ECJ-2VC1H330J         |
| 28   | 1   | C5  | 2n2              | Capacitor 20% 100V X7R CM 0805              | Johanson Dielectrics Inc       | 101X15W222MV4E        |
| 29   | 2   | C37, C38  | 10u              | Capacitor 20% 25v aluminum SMT              | United Chemi-Con, Inc.         | EMVA250ADA100MD55G    |
| 30   | 2   | C42, C43  | 22u              | Capacitor 20% 25v aluminum Low Imp SMT      | Panasonic                      | EEV-FC1E220P          |
| 31   | 3   | C3, C7, C17   | 47u              | Capacitor 20% 63V AL Low ESR SMT            | Panasonic                      | EEV-TG1J470P          |
| 32   | 2   | C1, C2  | 22u              | Capacitor 20% 25v aluminum NP SMT           | Nichicon                       | UWP1C220MCL1GB        |
| 33   | 9   | D2, D4, D5, D7, D14, D15, D16, D17, D18               | S1G              | Diode rectifier 1A 400V DO-214AC            | Diodes, Inc.                   | S1G-13-F              |
| 34   | 4   | D3, D6, D8, D9  | 1N4148           | DIODE SWITCHING 75V 150MA 0603              | Comchip Technology Corporation | CDSU4148              |
| 35   | 1   | Q1  | DSS4320T-7       | TRANS BIPO NPN 20V 2A SOT-23                | Diodes, Inc.                   | DSS4320T-7            |
| 36   | 5   | D1, D10, D11, D12, D13                                | Red              | LED High Brightness                         | Rohm                           | SLA-560LT3F           |
| 37   | 1   | U7  | ADM706SAR        | IC 3V uProcessor Supervisory Circuit SOIC-8 | Analog Devices                 | ADM706SARZ            |
| 38   | 1   | U11   | MAX604CSA        | IC Voltage Regulator Low Drop 3.3V SO-8     | Maxim / Dallas                 | MAX604CSA             |
| 39   | 1   | U4  | TL071IDT         | IC Low Noise JFETsingle Op Amp SOIC-8       | ST Microelectronics            | TL071IDT              |
| 40   | 1   | U3  | NJM2114M         | IC Op Amp dual low noise DMP-8              | NJR Corporation                | NJM2114M              |
| 41   | 1   | U5  | 74LVC157A DB,112 | IC Quad 2 Input Multiplexer                 | NXP                            | 74LVC157ADB,112       |

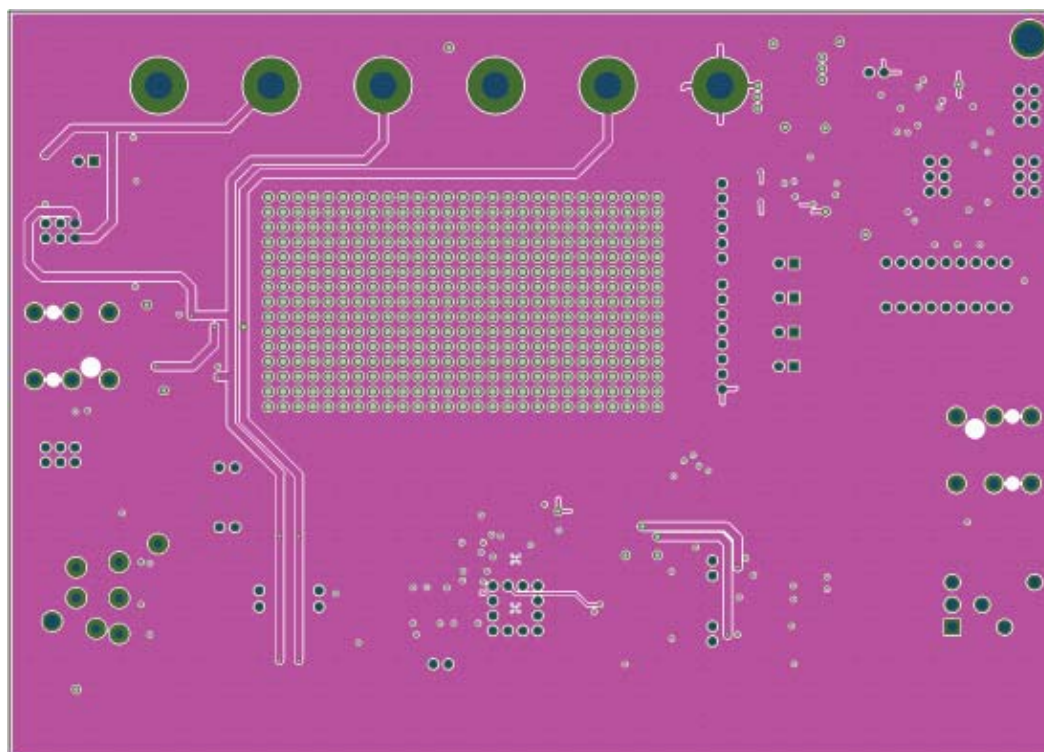
| Item | Qty | Reference  | Value                 | Description                                   | Mfr                              | Mfr P/N          |
|------|-----|--|-----------------------|---|----------------------------------|------------------|
| 42   | 1   | U9   | 74LVC1G157GV,125      | IC Single 2 Input Multiplexer                 | NXP Semiconductors               | 74LVC1G157GV,125 |
| 43   | 1   | U10  | SN74LVC1G08DBVR       | IC Single 2 input positive AND GATE SMT       | Texas Instruments                | SN74LVC1G08DBVR  |
| 44   | 1   | U2   | 1570N16-U             | IC Differential Output Mic Pre QFN16 RoHS     | THAT Corporation                 | 1570N16-U        |
| 45   | 1   |  | 470645-00             | Label white polyester 1.07" x 0.24"           |                                  |                  |
| 46   | 2   | SW1, SW2   | DPDT                  | Switch PUSHBUTTON 2 POLE                      | E-Switch                         | PBH2UEENAGX      |
| 47   |     |  |                       |   |                                  |                  |
| 48   | 1   | J6   | Binding Post          | Connector 1p female chassis mount blue        | Pomona Electronics               | 3760-6           |
| 49   | 1   | J2   | Binding Post          | Connector 1p female chassis mount yellow      | Pomona Electronics               | 3760-4           |
| 50   | 3   | P2, P3, P4   | 3 x 2                 | Connector 6p male gold 0.1"                   | 3M                               | 2306-6121TG      |
| 51   | 3   | P7, P8, P9   | 2 x 1                 | Connector 2p male gold 0.1"                   | Samtec USA                       | TSW-102-07-G-S   |
| 52   | 1   | P5   | 6 x 1                 | Connector 6p male gold 0.1"                   | Molex                            | 22-28-4063       |
| 53   | 1   | P6   | 8 x 1                 | Connector 8p male gold 0.1"                   | Samtec USA                       | TSW-108-07-G-S   |
| 54   | 1   | P1   | 2 x 1                 | Connector 2p male locking gold 0.1"           | Molex                            | 22-11-2022       |
| 55   | 1   | J3   | Binding Post          | Connector 1p female chassis mount red         | Pomona Electronics               | 3760-2           |
| 56   | 2   | J1, J4   | Binding Post          | Connector 1p female chassis mount green       | Pomona Electronics               | 3760-5           |
| 57   | 1   | J5   | Binding Post          | Connector 1p female chassis mount black       | Pomona Electronics               | 3760-0           |
| 58   | 16  | TP1, TP2, TP3, TP4, TP5, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP29 | 1 x 1                 | Connector 1p Test Point SMT 0.015 thick       | Keystone Electronics Corporation | 5016             |
| 59   | 1   | P10  | XLR-3C                | Connector 3p male right angle                 | Neutrik USA Inc.                 | NC3MAH           |
| 60   | 1   | J9   | XLR-combo stereo      | Connector 3p female right angle               | Neutrik USA Inc.                 | NCJ6FI-H         |
| 61   | 2   | J7, J8   | 1/4" stereo slim jack | Connector Phone 3p female right angle         | Neutrik USA Inc.                 | NRJ6HF-1         |
| 62   | 4   | MH1, MH2, MH3, MH4   | #4-40 x 3/4"          | Standoff swage 1/4" hex aluminum              | Concord Electronics Corporation  | 627A-9486-16     |
| 63   |     |  |                       |   |                                  |                  |
| 64   | 1   | U6   | DLP-232PC             | PCB Assembly, USB Microcontroller Module      | DLP Design, Inc                  | DLP-232PC        |
| 65   | 1   | U1   | 5173N24-U             | IC Audio PreAmp Digital Controller QFN24 RoHS | THAT Corporation                 | 5173N24-U        |



## Appendix C. PCB Layout (2 of 3)



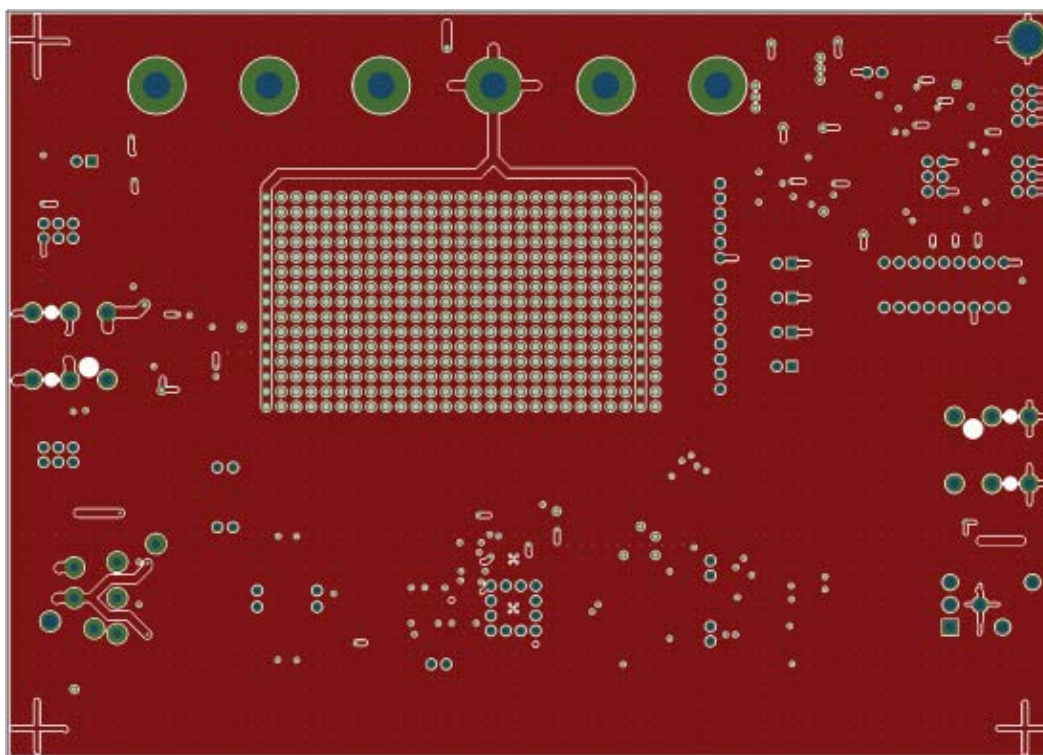
Layer 1 (Top with component screen)



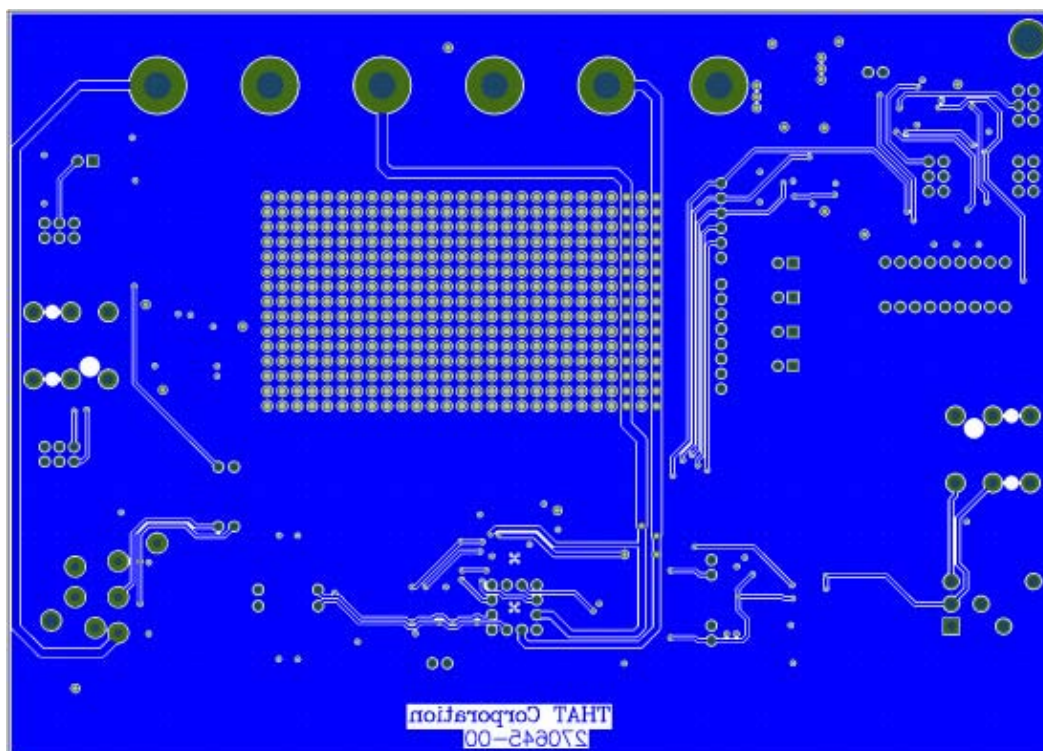
Layer 2 (Power)



## **Appendix C. PCB Layout (3 of 3)**



Layer 3 (Ground)



Layer 4 (Bottom)

## **Appendix D. 5173 + 1570 Specifications<sup>1</sup>**

| Parameter  | Symbol   | Typical  | Units |
|--|--|--|-------|
| Power Supply Voltage   | V+ - V-  | ±15  | V     |
| Maximum Input Level<br>(V+ /V- = ±15V)   | V <sub>in-BAL</sub>                                  | +26.8  | dBu   |
| Maximum Differential Output Level<br>(V+ /V- = ±15V)   | V <sub>OUT</sub>                                     | +26.8  | dBu   |
| Gain (input to output)   | A <sub>dB</sub>                                      | 0 to 60 in 3dB steps   | dB    |
| Gain error (all settings)  | A <sub>err</sub>                                     | ±0.2 (typical)   | dB    |
| Total Harmonic Distortion + N<br>(V <sub>OUT</sub> = +16dBu (5V <sub>RMS</sub> ); R <sub>L</sub> = 10kΩ;<br>C <sub>L</sub> = 10 pF; f = 1kHz; BW = 22 kHz) | THD+N  | 0.0005 (0dB gain)<br>0.0005 (+21dB gain)<br>0.001 (+39dB gain)<br>0.006 (+60dB gain)   | %     |
| Equivalent Input Noise, Main Output<br>(R <sub>SOURCE</sub> =150 Ω, BW=22kHz)  | EIN  | -127.3 (+60dB gain)<br>-125.3 (+39dB gain)<br>-117.4 (+21dB gain)<br>-104.8 (0dB gain) | dBu   |
| Equivalent Input Noise, 1570 Output<br>(R <sub>SOURCE</sub> =150 Ω, BW=22kHz)  | EIN  | -127.3 (+60dB gain)<br>-125.3 (+39dB gain)<br>-117.5 (+21dB gain)<br>-106 (0dB gain)   | dBu   |
| Supply Current   | I <sub>CC</sub> ; -I <sub>EE</sub> , I <sub>DD</sub> | 27 (V+ supply)<br>27 (V- supply)<br>15 (+5V supply, all LEDs on)                       | mA    |

1. All specifications are subject to change without notice.

2. Unless otherwise specified, T<sub>A</sub>=25°C, V<sub>CC</sub>=+15V, V<sub>EE</sub>=-15V, V<sub>DD</sub>=+3.3V

### **FCC Warning**

This device is only intended for laboratory test environments. It may radiate radio frequency energy and has not been tested for compliance with subpart

J of part 15 of the FCC regulations. Operation of this device in other environments may cause interference with radio communications.

**Revision History**

| <b>Revision</b> | <b>ECO</b> | <b>Date</b> | <b>Changes</b> | <b>Page</b> |
|-----------------|------------|-------------|----------------|-------------|
| 00              | —          | 04/09/2012  | Released       | —           |
|                 |            |             |                |             |
|                 |            |             |                |             |



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