Evaluation Board for the Secondary-Side Controller with Current Share and Housekeeping

Preliminary Technical Data

EVAL-ADM1041EB

FEATURES

Switching power supply
Current sharing
Voltage feedback loop
Factory calibrated
On board tests for housekeeping functions
12 V/2 A regulated output from 120 V input
SMBus serial interface to PC

CAUTION

This evaluation board uses high voltages and currents. Extreme caution should be taken, especially on the primary side, to ensure safety for the user. It is not recommended to remove the primary side protective cover. It is strongly advised to switch off the evaluation board when not in use. This board is designed for 85 V ac to 132 V ac @ 50 Hz/60 Hz. Do not use with a 220 V ac input. It is recommended to use a current-limited power supply as the input, if available.

ADM1041 EVALUATION BOARD OVERVIEW

This evaluation board allows the ADM1041 to be quickly evaluated in a switching power supply application. Using the evaluation board and its accompanying software, the ADM1041 can be interfaced to any PC running Windows® 2000, Windows NT, or Windows XP via the computer's USB port.

The evaluation board allows all the input and output functions of the ADM1041 to be exercised without external components. The software allows control and monitoring of the ADM1041 internal registers. The board is set up for the ADM1041 to act as a switching power supply, outputting a 12 V/2 A dc supply from a 110 V ac or dc input. By connecting two evaluation boards together, you can exercise and evaluate the share bus and current sharing capability for n + 1 redundant power supply systems.

EVALUATION SYSTEM CONTENTS

The evaluation system package contains the following items:

- Application note
- Two ADM1041 evaluation boards
- USB interface cable
- Two RJ-11 cables
- Evaluation software on CD
- Calibration board

EVALUATION EQUIPMENT

To evaluate this demonstration board, a multimeter, PC, electronic load, and power supply are required. Since this power supply is intended to allow experimentation and probing, consider using a current-limited dc power source or a Variac instead of the ac input.

SIMPLIFIED BLOCK DIAGRAM

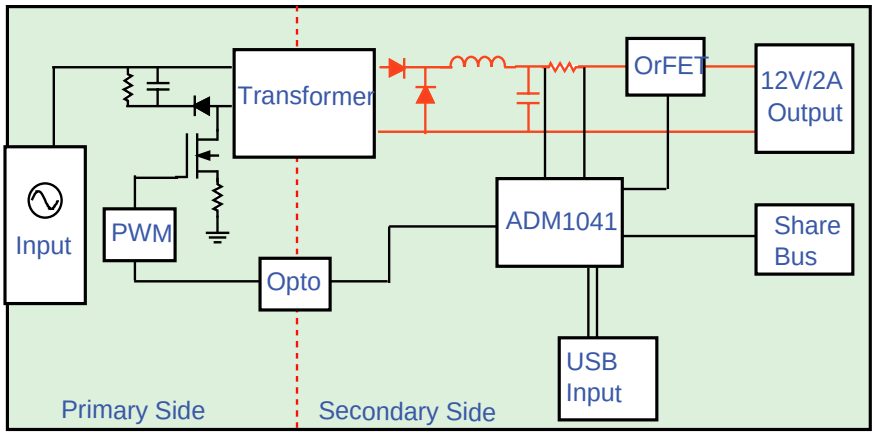

Figure 1.

Rev. PrA

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REVISION HISTORY

11/05—Revision PrA: Preliminary Version

EVALUATION BOARD HARDWARE

A typical ac/dc switching power supply forward converter topology is the basis for the evaluation board. Figure 1 shows a block diagram of the main components on the board. The primary side consists of the input terminals and transformer. PWM of the primary side switch is controlled by the UC3844A, which receives its control signal through the optocoupler. This controls the switching of the transformer. A maximum duty cycle of 50% is allowed. The primary control system is powered by a bleed resistor during startup, and by a tap winding from the power transformer thereafter.

The secondary side power stage consists of the diode rectifiers, output filter, sense resistor, and OrFET. This provides 12 V @ 2 A at the output. The ADM1041 is also located on the secondary side. It provides the feedback signal that is used to regulate the voltage, limit the current, and allow current sharing and shutdown to be implemented. High-side current sensing is used. The ADM1041 also controls the share bus, which allows multiple power supplies to perform load sharing. The ADM1041 feedback to the primary side, through the optocoupler, consists of the voltage sense, current sense, and share bus information.

The USB section is also located on the secondary side. This allows the PC software to communicate with the evaluation board (and with other evaluation boards through the RJ-11 connectors) through the USB port of the PC. You can readily change register settings on the ADM1041 this way and also monitor the status registers.

Various manual controls and indicators, such as LEDs, switches, and buttons, allow you to exercise the voltage control loop and the housekeeping functions. The evaluation board is designed with a 0.1 Ω RSENSE resistor. The power supply is designed to support a maximum continuous output of 2 A. The current sense amplifier is calibrated such that 2 A corresponds to 100% of output current rating. The current limit threshold cannot be programmed beyond 130%.

A variable load is required to perform a thorough evaluation. The output voltage is available between J2 and J3; this is also where the load should be connected. The power supply is in continuous conduction mode (CCM) above 0.5 A load. Below 0.5 A load, the power supply is in discontinuous conduction mode (DCM). A load of greater than 0.2 A is required to ensure stability. The output voltage ripple is approximately 100 mV p-p.

CONNECTORS

The connections to the evaluation board are shown in Table 1.

Table 1. Evaluation Board Connections

Connector	Evaluation Board Function
J1	110 V ac input
J2	VOUT+/LOAD+
J3	VOUT−/LOAD−
J4	Share bus
J5	RJ-11 connector
J6	RJ-11 connector
J7	USB interface
J8	Primary input voltage ground
J9	Primary input voltage

USB INTERFACE CONNECTOR J7

The connections to J7 are shown in Table 2.

Table 2. J7 Connections

J1 Pin	ADM1041 Function
1	5 V
2	SCL
3	SDA
4	Ground

GETTING STARTED

Do not connect the USB cable to the evaluation board until the software is installed.

1. Install the ADM1041 software. If it is already installed, skip to the next step.
2. Connect the evaluation board to the USB port on the computer, using the USB interface cable provided. See Figure 2 to see how to set up the board. Run the software.
3. For the input voltage source, an ac or dc power supply can be used. For an ac source, apply 85 V ac ~ 132 V ac. For a dc source, apply 100 < 150 V dc. This input voltage is the signal that is regulated to provide a 12 V/2 A supply at the output.
4. The evaluation board is now ready to evaluate the ADM1041.

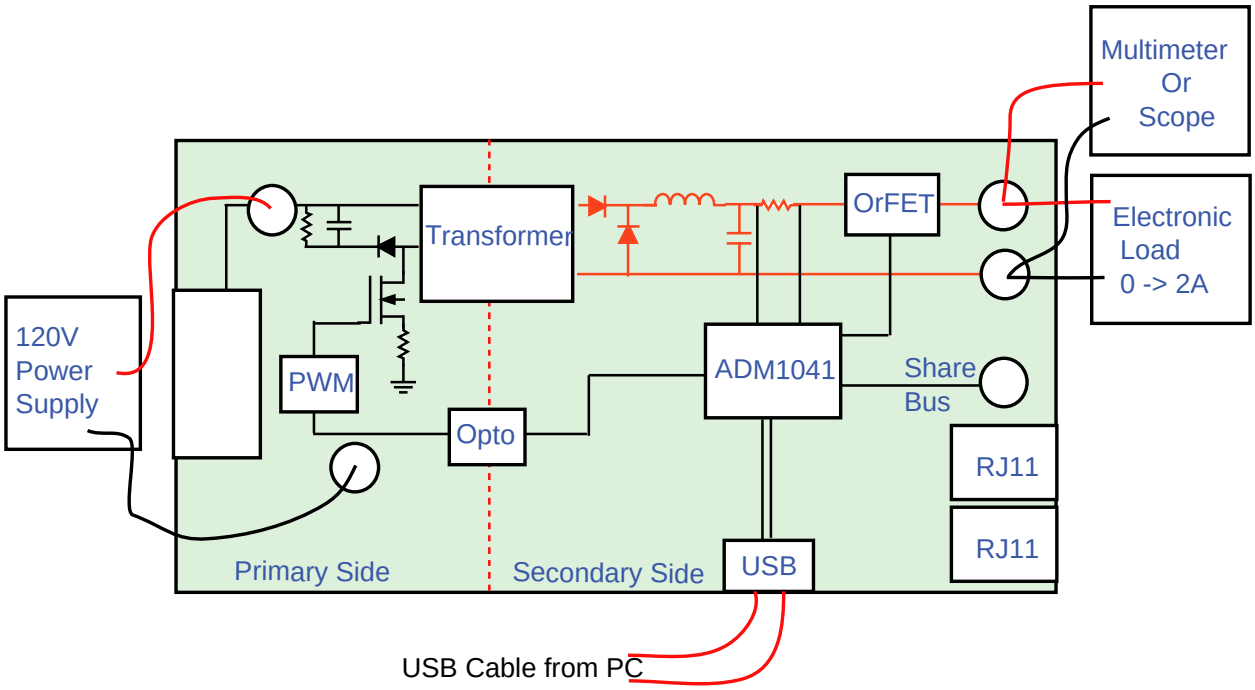

Figure 2. Getting Started

PS_ON

There are two ways to turn the power supply on and off with this control. Use SW2 to toggle the PS_ON pin. Alternatively, the PS_ON polarity can be toggled using the software. This has the same effect as toggling the switch connected to PS_ON to the opposite polarity. In general, it is recommended to use one method or the other.

HOUSEKEEPING EVALUATION

The ADM1041 performs many housekeeping functions in the power supply. The evaluation board allows you to simulate various faults that could affect the ADM1041 in a working system. You can monitor how the ADM1041 handles this event in many ways. One way is to use an oscilloscope and/or multimeter to probe the evaluation board to see various conditions in the system. Many testpoints are provided for this function. You can also use the software to read back register contents, which show the conditions of the ADM1041 and how it has reacted to the event. The software is described in the Evaluation Board Software section. A fault LED on the board can be configured to indicate certain fault conditions. An LED monitors the status of the OR'ing FET to indicate whether the power supply is connected to the output terminals. An LED on the primary side indicates that power is present on the primary side.

OVERCURRENT—SHUTDOWN

The overcurrent protection (OCP) function can be tested by increasing the output current beyond 2 A. Once the load current is greater than the OCP threshold limit (programmable from 105% to 130%), the OCP flag is set. After the OCP timeout (programmable from 1 to 4 seconds) is reached, the ADM1041 turns off the OrFET, which shuts down the power supply. It keeps the power supply in shutdown mode until the load current is reduced below the OCP threshold and you perform a hardware or software PS_ON.

OVERCURRENT—CONSTANT CURRENT OPERATION

Using the ADM1041, the power supply can be configured to operate in a constant current mode. The current limit disable bit of Register 11 needs to be set. An OCP condition can be simulated by applying an electronic load of greater than 2 A. Once the load current is greater than the OCP threshold limit (programmable from 105% to 130%), the OCP flag is set. Unlike in the preceding Overcurrent—Shutdown section, the ADM1041 does not turn off the OrFET. Instead, the power supply operates in constant current mode.

LOAD OVERVOLTAGE

By applying a higher voltage (that is, 13 V) than the load voltage (12 V) to J2, response to a load overvoltage condition can be evaluated. The OR'ing FET is quickly turned off. In software, the Load_OV, Reverse_OK, and OrFET_OK flags are set. Monitor Testpoint 5 to see the gate voltage of the OrFET change. The ADM1041 turns off the output until the fault is removed (when you remove the overvoltage). When the fault is removed, the ADM1041 clears the flags and returns to normal operation. The OrFET gate voltage on Testpoint 5 returns to a low value. In software, go to the **ADM1041 Status Registers** dialog and click **Begin Polling**. Once an overvoltage is present, the Load_OV, Reverse_OK, and OrFET_OK bits go low. When the fault is removed, these bits go high again, indicating normal operation.

CURRENT SHARING

By connecting two evaluation boards together, the ADM1041 can be evaluated in a redundant n + 1 power supply configuration. Figure 3 shows how the two boards should be connected together. Use the black RJ-11 cable when connecting the boards together; the white cable is for connecting to the calibration board.

First, power up each evaluation board. Apply power on the primary side. There should now be 12 V across J2/J3 of each board. Apply the electronic load to Board A. The boards perform current sharing. One way to monitor this is to monitor the voltage drop across each sense resistor. This should be approximately 100 mV when current sharing.

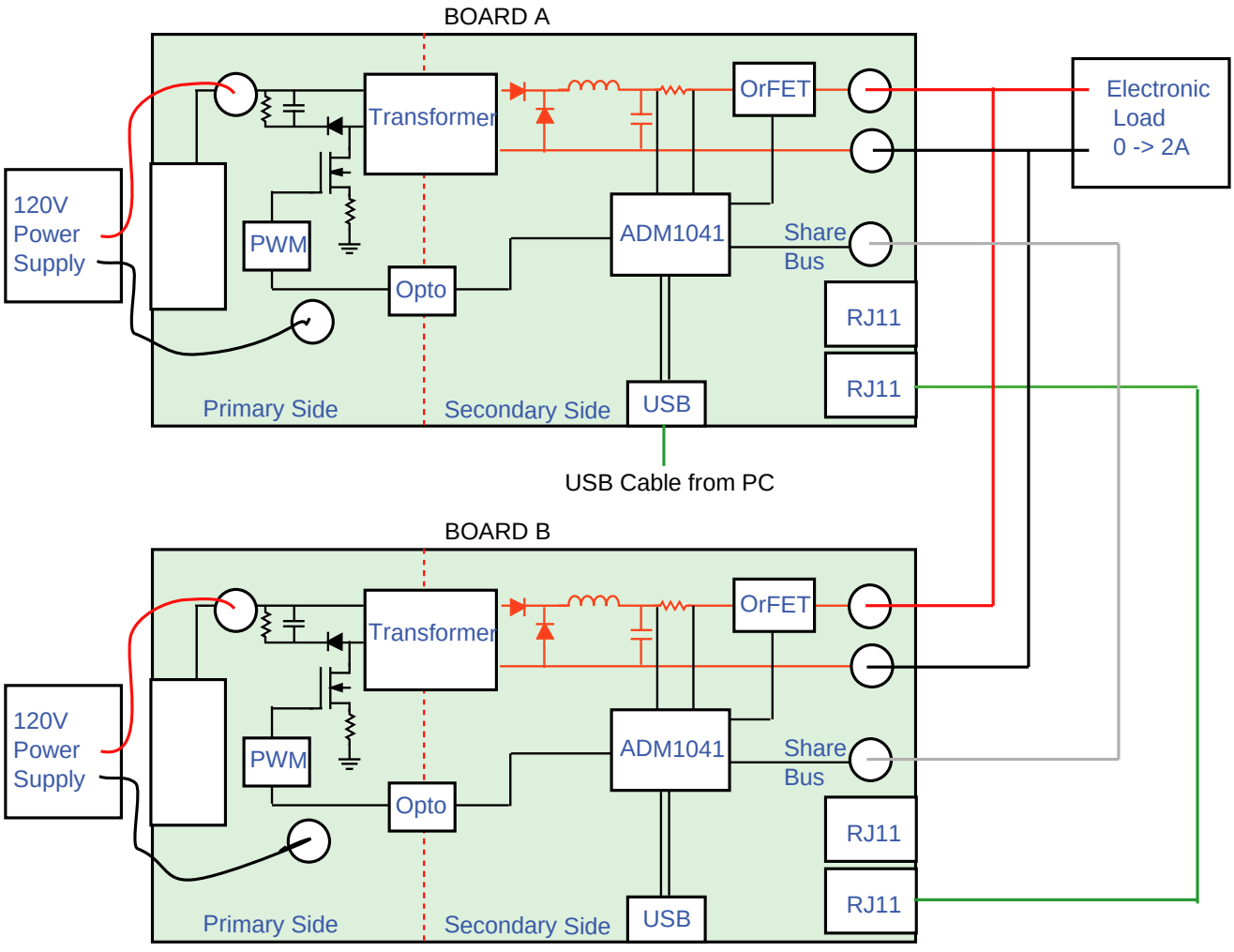

Figure 3. Current Share Configuration

Now remove the connection between both J2 connectors. This means that Board A is now providing all of the power for the load. The voltage drop across the sense resistor on Board A should be approximately 200 mV, and the voltage drop across the sense resistor of Board B should be approximately 0 mV. See Figure 4.

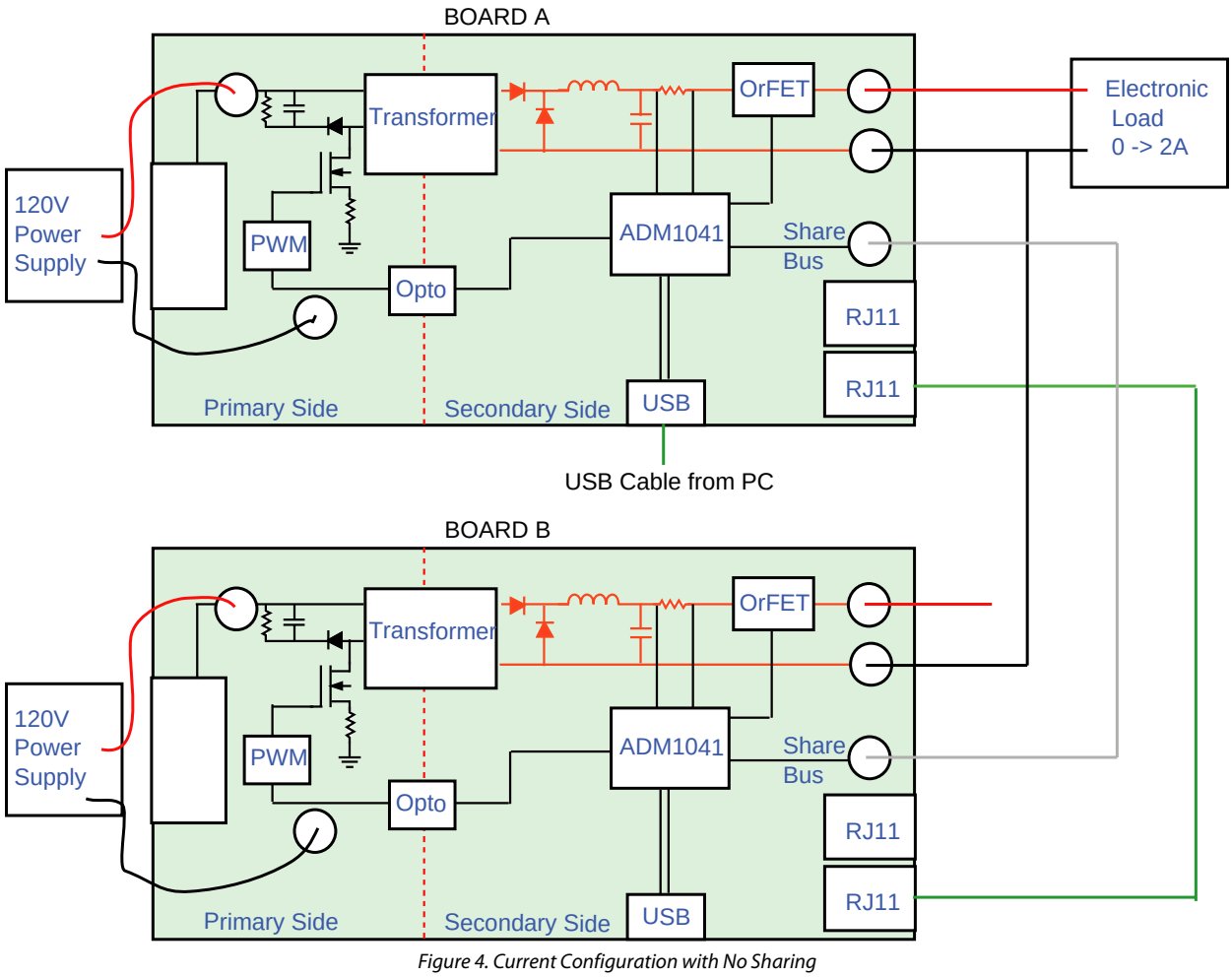

Figure 4. Current Configuration with No Sharing

HOT SWAP

By adding (and removing) the connection between J2 on Board B to Board A, you can evaluate how each board reacts when a new power supply is added to (or removed from) the system.

OVERCURRENT

An OCP condition can also be evaluated. Begin with both boards sharing a 2 A load. Increase the load current to 2.5 A. Remove the J2 connection from Board B to Board A. This means that Board A is now providing all of the power—more power than it is programmed to provide. It goes into OCP condition and shuts down the power supply.

LOCAL SHORT/UNDERVOLTAGE

A short to ground at the negative terminal of RSENSE simulates a local undervoltage fault. Begin by having both boards sharing a 2 A load. Apply the short at RS– (Testpoint 2) of Board B. This causes a Reverse_OK fault on Board B, which turns off its output and contribution to the load. Now Board A must supply all of the current to the load. The multimeter monitoring Board B shows a reduction in voltage drop across its RSENSE to approximately 0 mV. The multimeter monitoring Board A shows an increase in voltage drop as it takes over the system and provides all of the current for the load. The ADM1041 on Board B keeps its contribution to the power supply system turned off until a PS_ON is performed. It then contributes again to the current sharing configuration.

EVALUATION BOARD SOFTWARE

The software allows the ADM1041's functions to be controlled from the PC via an easy to use interface operating under the Windows environment. The contents of the device's internal registers can easily be read or altered through a user-friendly graphical interface.

INSTALLING THE SOFTWARE

To install the software:

1. Insert the CD-ROM into the CD-ROM drive. Select **Start** > **Run**, and enter X:ADM1041.exe, where X is the letter of your CD-ROM drive. Click **OK**.
2. To use the software immediately, you must restart your computer so that Windows can update the setup files. To do this, click **Yes**. If you do not want to use the software immediately, click **No**.
3. No matter which option you select, click **Finish** to complete the installation.

USING THE SOFTWARE

Before using the software, ensure that the evaluation board is powered up and connected to the PC. To start the software, select **Start** > **Programs** > **Analog Devices** > **ADM1041 Evaluation Software** > **ADM1041 Evaluation Software**. The main evaluation window appears. The software automatically looks for an ADM1041 on the SMBus. Once it recognizes an ADM1041, it communicates to that SMBus address. Therefore, you should not need to change any settings to begin communication between the software and the evaluation board.

The main window (Figure 5) displays information about the ADM1041's internal registers.

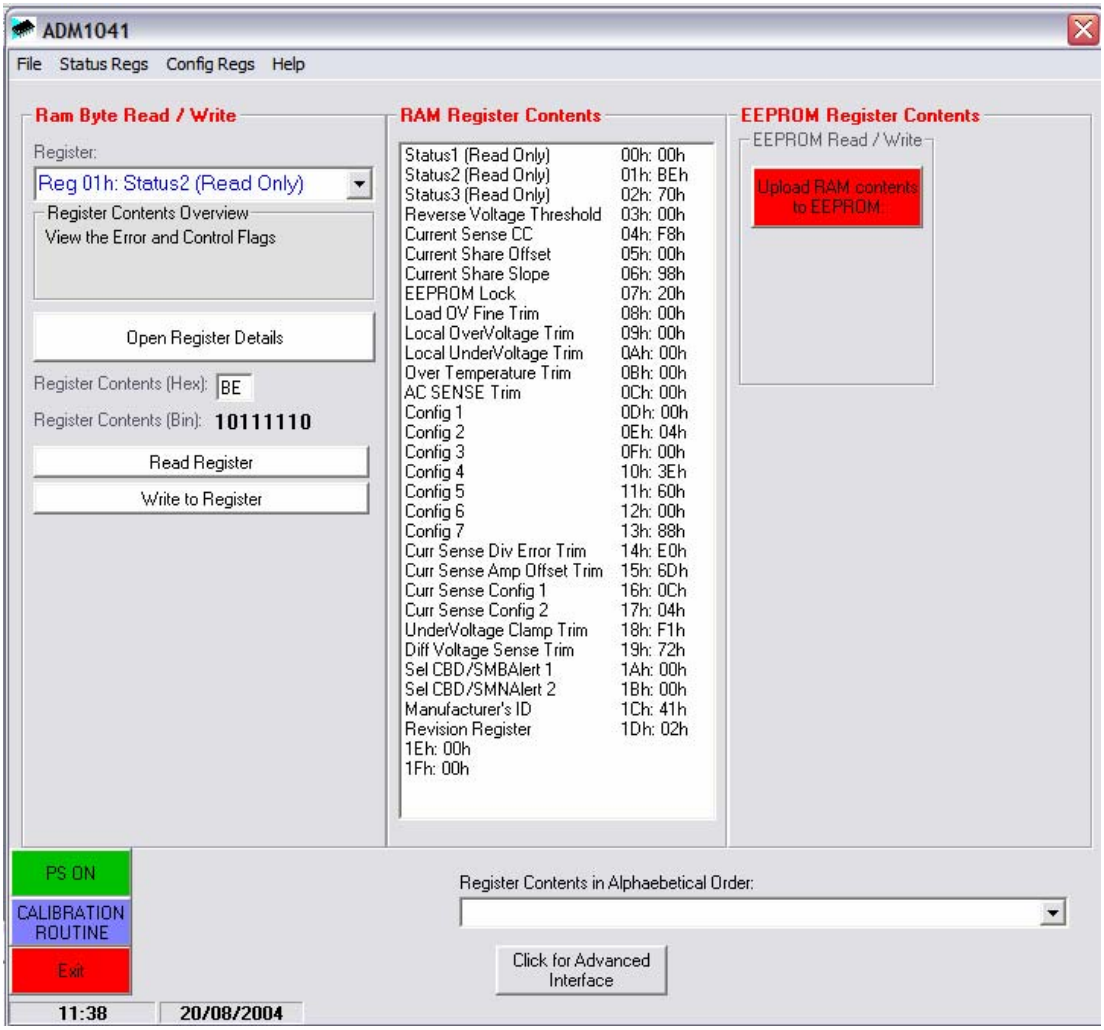

Figure 5. ADM1041 Main Window

COMMUNICATING WITH THE ADM1041

The software automatically finds all ADM1041s on the SMBus. When the main window loads, the address of the ADM1041 is displayed in the **SMBus Address of the ADM1041** box. See Figure 6. If you have more than one board connected together (through the RJ-11 cable), there is more than one ADM1041 on the SMBus. In this case, the software shows the ADM1041 with the highest SMBus address. To communicate with the other ADM1041, simply choose the other ADM1041 from the drop-down menu, using the correct SMBus address. Alternatively, you can write to all ADM1041s on the bus at the same time by choosing **Broadcast Address** from the drop-down menu.

The SMBus address of the ADM1041 can be changed by changing the SW3 switch. This should be done before running the software.

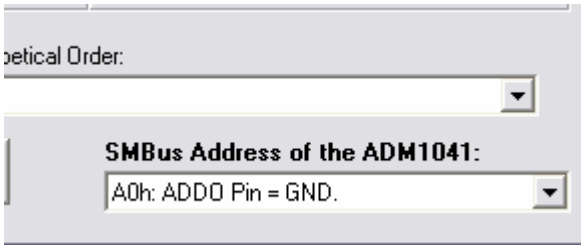

Figure 6. SMBus Address Drop-Down Menu on Main Window

READING AND WRITING TO THE ADM1041

The main ways to communicate with the ADM1041 are all accessed through the main window. See Figure 7. The quickest way is to scroll through the register list of the Ram Byte Read/Write section of the main window. As you scroll, the main window displays the following for the selected register:

- Register name
- Register hexadecimal address
- Register contents overview
- Register contents in hexadecimal and binary

Clicking **Open Register Details** displays a more detailed look at the register selected. You can also click the list of registers in the RAM register contents list. This automatically changes content of the register description, as described previously.

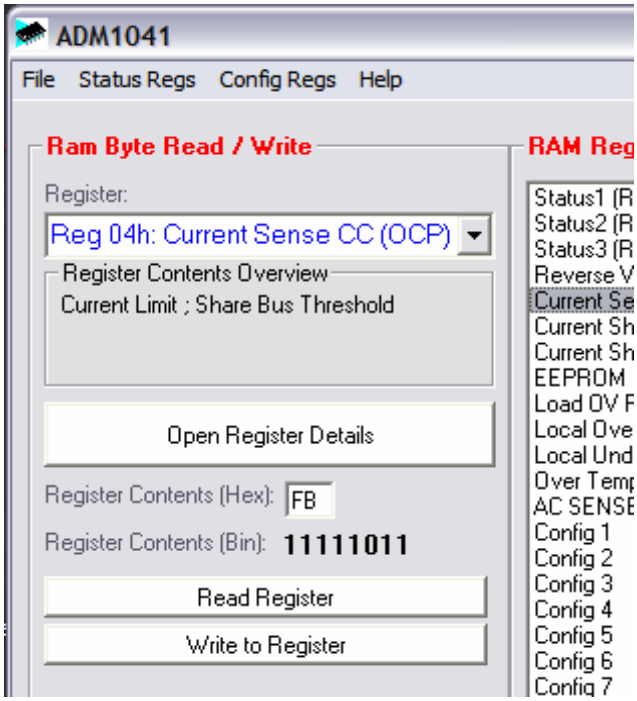

Figure 7. Register Box on Main Window

DATA READ/WRITE

Using the software to read/write data to the ADM1041 can be done in many ways.

Register Read

On the main window, the contents of the selected register are displayed at all times.

Register Write—Basic

1. On the main window, select the register that needs to be changed, as described previously. The contents of the selected register are displayed.
2. Type the new hexadecimal value into the **Register Contents (Hex)** box.
3. Click **Write to Register**. The new value is written to the ADM1041.

Register Write—Detailed

1. On the main window, click the register that you need to change. For example, to change the reverse voltage turn-off threshold, select the **Reverse Voltage Threshold** register.
2. Click **Open Register Details**. This opens the **Reverse Voltage Detector** dialog, which displays details information about the register. See Figure 7.
3. Click the new value of reverse voltage in the **Rev Volt Off** column. The software automatically calculates the hexa-decimal and binary values of the new register contents. It also automatically updates this register in the ADM1041.
4. To return to the main window, click **Exit**.

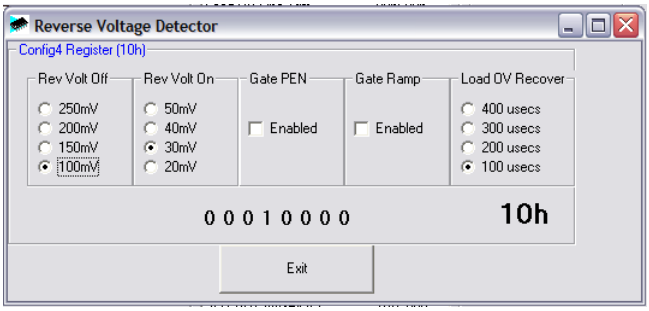

Figure 7. Reverse Voltage Detector Dialog

Continuous Read

Continuous read is for use in exercising fault conditions.

Clicking the **Status Regs** menu opens the **ADM1041 Status Registers** dialog (Figure 8). This is a very useful evaluation tool because you can see the status register contents in real time. Opening this dialog automatically starts the continuous reading of the three status registers. If a fault occurs, the status register reports this fault in real time. This should be used when evaluating the ADM1041's reaction to fault conditions, like those described in the Housekeeping Evaluation section. Clicking **View Latched Registers** opens the **Latched Registers** dialog. If a flag is set and then removed, the latched registers remember the event.

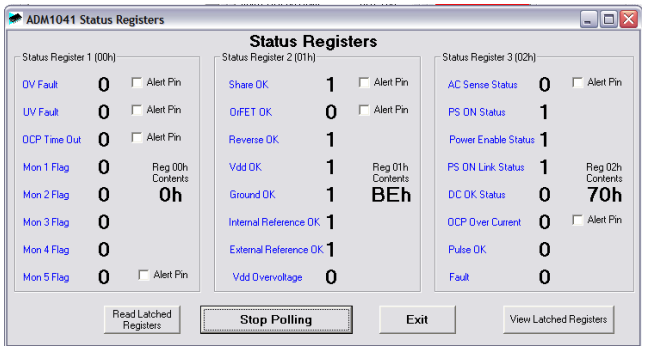

Figure 8. ADM1041 Status Registers Dialog

EEPROM

The EEPROM is controlled on the main window.

To view the contents of each page of the EEPROM, click **Read 32 bytes from EEPROM** after entering the associated page number. This displays the entire contents of that page of the EEPROM.

To view the contents of the entire EEPROM, click **View Entire EEPROM**. This opens the **ADM1041 EEPROM** dialog. Click **Read Entire EEPROM** to view the data.

To exit, click **Exit**.

Saving the Factory EEPROM Values

The EEPROM contents can be saved to a text file for future use. It is advised that you perform this function before evaluating other features of the ADM1041, particularly before writing new values to the EEPROM. This allows you to reprogram the ADM1041 to the original factory settings if the EEPROM data is lost due to incorrect writing to the part. Select **File** > **Save**. Select a folder in which to save the data, enter a new file name or select an existing file name for the data, and click **Save**. The data is stored in a .dat file. To open an existing file, select **File** > **Load** and select the appropriate data file.

Updating the EEPROM

To change any of the EEPROM contents, click **Update RAM Contents to EEPROM** on the main window. See Figure 9. You are then asked to verify this change, because it means that the previous content of the EEPROM will be lost permanently. Click **Yes** to load the new data into the EEPROM. The new values are now stored in EEPROM.

Since the data is transferred from the EEPROM to the part only when the part powers up, nothing happens initially. The new EEPROM data is loaded into the ADM1041 registers only if you power down the ADM1041 and then power it up again.

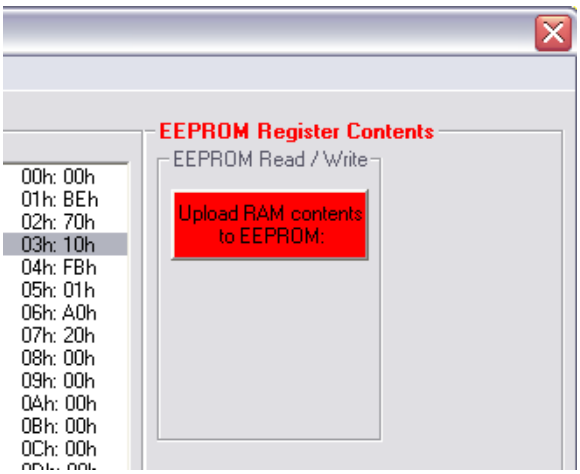

Figure 9. EEPROM Register Contents

EEPROM Data Log

The EEPROM contents can be saved to a text file for future use. This means that you can load up the ADM1041 in your specific default state. It also allows register settings to be easily shared and duplicated between PCs and setups.

Select **File** > **Save**. Select a folder in which to save the data, enter a new file name or select an existing file name for the data, and click **Save**. The data is stored in a .dat file. To open an existing file, select **File** > **Load**. Select the appropriate data file.

CALIBRATION ROUTINE/BOARD

A calibration routine and board are included to demonstrate the ability to automate the calibration and trimming process in a production environment. The calibration board is connected to the evaluation board as shown in Figure 10. (Use the white RJ-11 cable provided. The black cable is for connection between two ADM1041 boards.)

To perform a calibration

1. Click **CALIBRATION ROUTINE** on the main window. A **Calibration** dialog appears.
2. Click **Remove Previous Calibration Settings**.
3. Input the required output voltage and the share bus maximum and minimum load voltages.
4. Click **Calibrate** to perform the calibration.

A mulitmeter on the load voltage (across J2 and J3) and on the share voltage (across J4 and J3) can be used to monitor the calibration. After about 30 seconds, the calibration is complete. The load voltage and the share bus maximum and minimum load voltages now match the values that you input before calibration.

CALIBRATION ROUTINE PROCEDURE

The calibration routine is as follows:

1. Remove the OCP and OVP limits.
2. Calculate the correct current sense gain setting.
3. Determine the polarity of the common-mode error and adjust if necessary.
4. Calculate and program Register 14h to remove the common-mode error.
5. Program Register 19h to achieve the desired load voltage.
6. Apply full load and adjust the share bus slope to calibrate the share bus.
7. Remove load.
8. Replace the OCP and OVP limits.

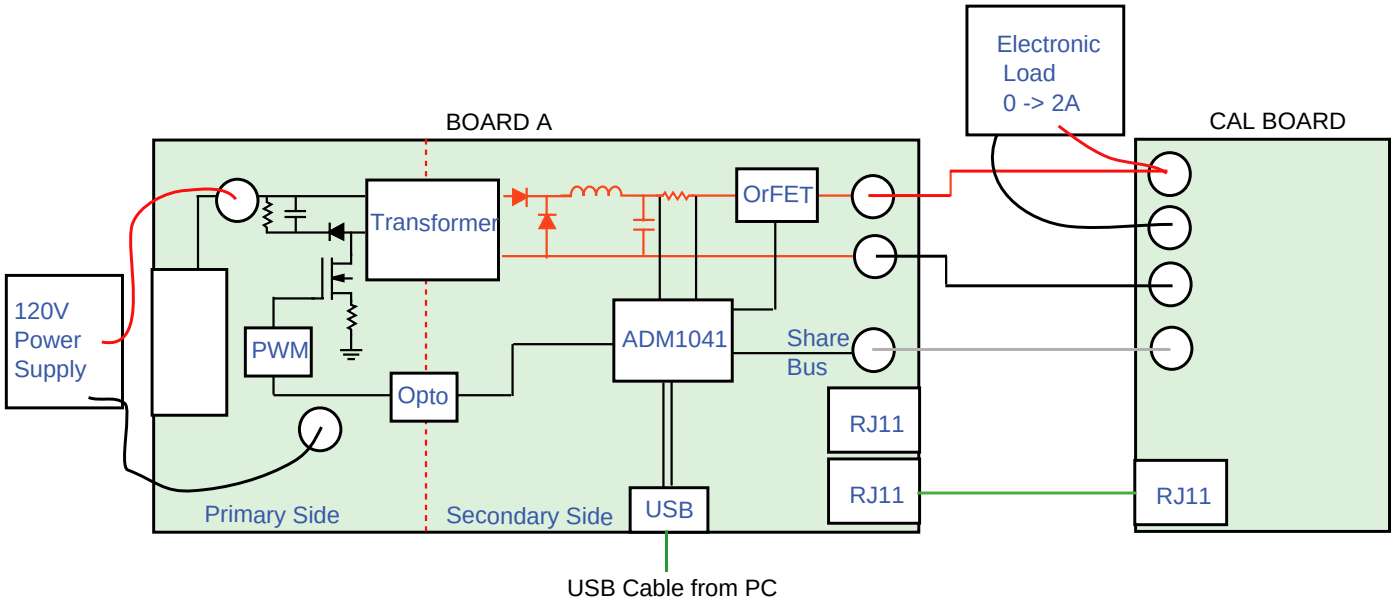

Figure 10. Calibration Board Setup

SILKSCREEN

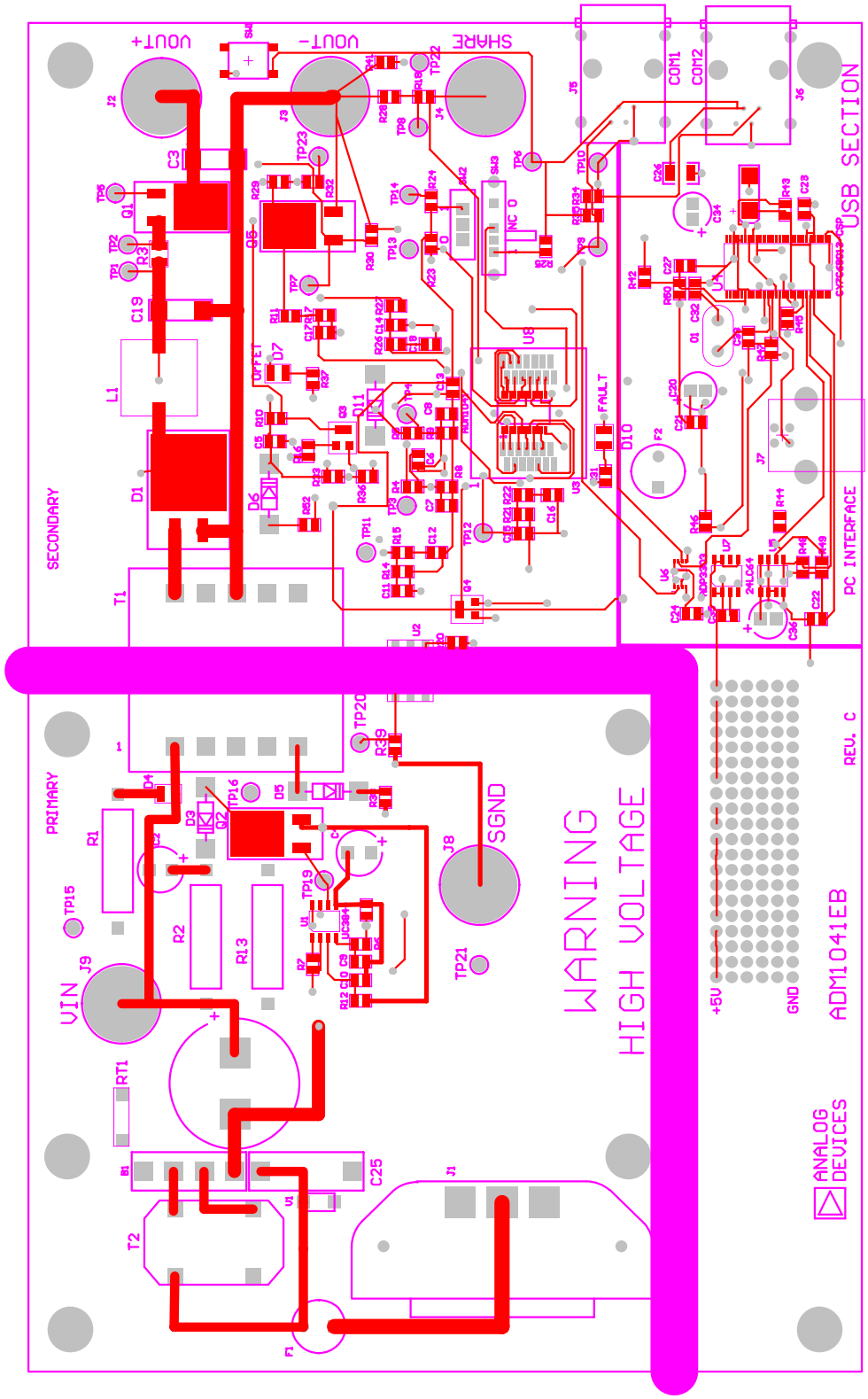

Figure 11. ADM1041 Evaluation Board Silkscreen

SCHEMATICS

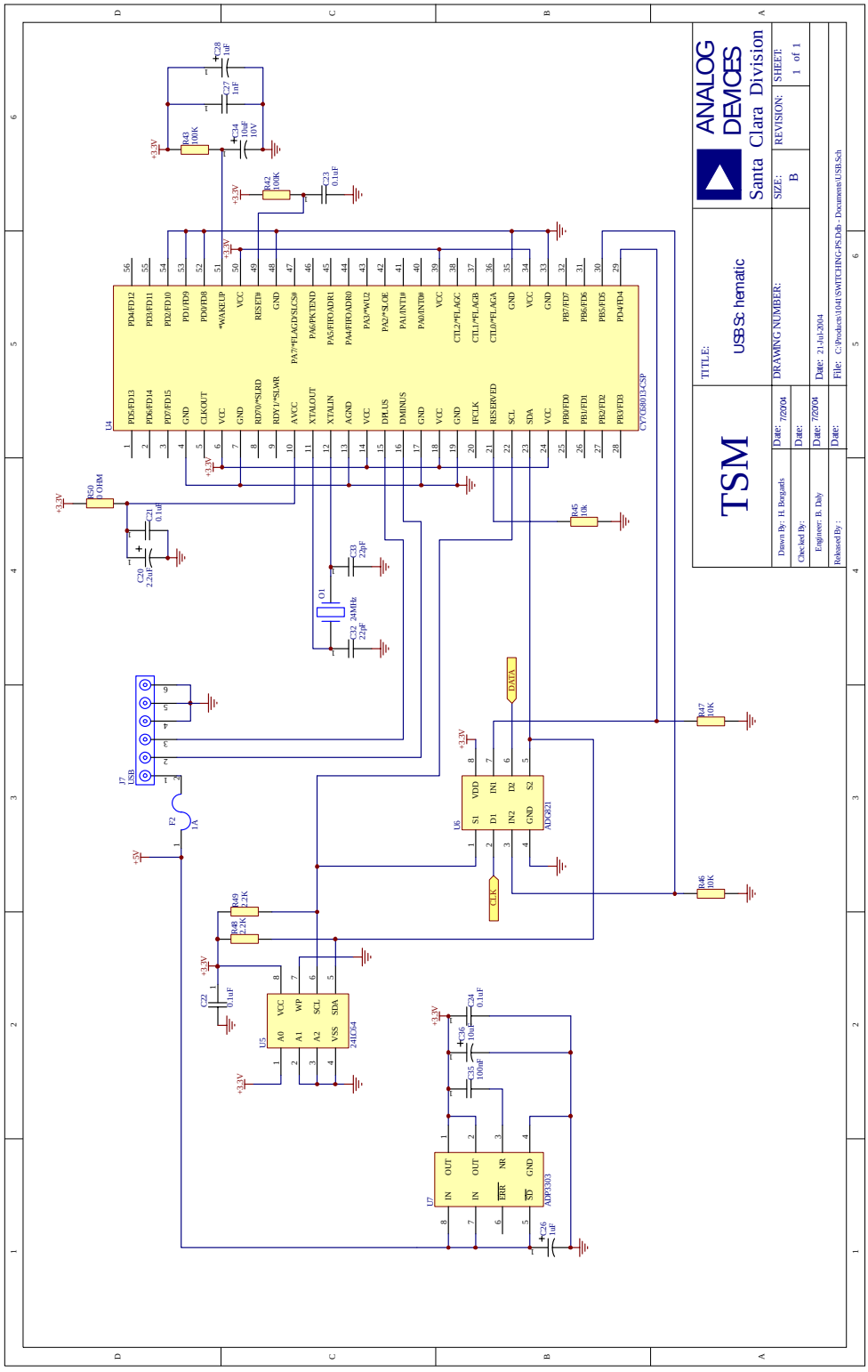

Figure 12. ADM1041 Evaluation Board Schematic

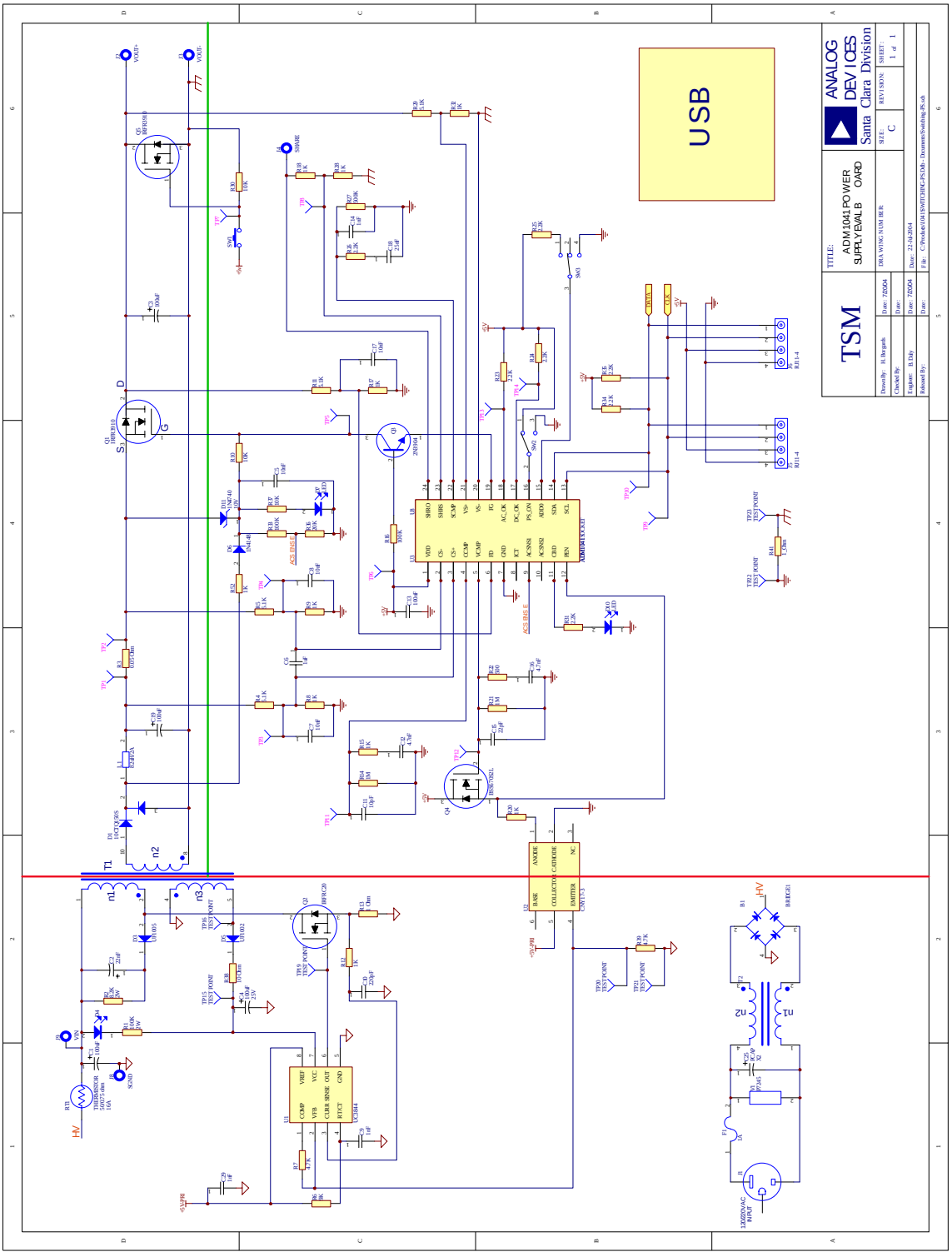

Figure 13. ADM1041 Evaluation Board Schematic

PARTS LIST

Table 3. Parts List for EVAL-ADM1041EB

Name	Part Type	PCB Decal	Value	Farnell Part No.	Comment
C1	CAP	603	47n	FEC 431-965	
C2	CAP	603	100n	FEC 317-287	
C3	CAP	603	10n	FEC 499-146	
C4	CAP+	CAP\TAJ_C	100 µF	FEC 197-180	
C5	CAP	603	10n	FEC 499-146	Not inserted
C6	CAP	603	100n	FEC 317-263	Not inserted
C7	CAP	603	10p	FEC 499-110	Not inserted
C8	CAP	603	27n		
C9	CAP+	CAP\TAJ_B	0.33 µF	FEC 197-040	
C10	CAP+	CAP\TAJ_C	100 µF	FEC 197-180	
C11	CAP	603	100n	FEC 317-287	
C12, C13	CAP	805	1µ	FEC 317-640	
C14, C15	CAP	603	10n	FEC 499-146	
C16	CAP	805	4.7nF	FEC 578-307	
C17, C18	CAP	603	470p	FEC 753-579	
C19	CAP+	CAP\TAJ_C	100 µF	FEC 197-180	
C20	CAP	603	10p	FEC 499-110	
C21	CAP	603	1n	FEC 317-202	
Cx	CAP	1205	1µ		
D1, D6	1N4148	DO35		FEC 368-118	
D3, D4, D5, D7	LED	LED_SMT		FEC 515-620	
D8, D9, D10, D11	1N4148	DO35		FEC 368-118	
J1	CENTRONICS	36WAY		FEC 147-753	
J2	CON\POWER	CON\POWER		FEC 304-4889	
J3	CON\POWER4	CON\POWER4		FEC 148-086	
J4	CON-BARREL	CON\BARREL		FEC 224-959	
J5	CON\POWER	CON\POWER		FEC 304-4889	
J6	CON\POWER3	CON\POWER3		FEC 304-4890	
K1, K2, K3	RELAY-G6AU234P	RELAY-G6A-234P		FEC 175-032	
Q1	2N3904	TO-92		FEC 933-673	
Q2	IRFR_U9014_D2PAK	D2PAK_MODIFIED		FEC	
Q3, Q4, Q5, Q6	2N3904	TO-92		FEC 933-673	
Q7	IRFR_U3910_D2PAK	D2PAK_MODIFIED		FEC 706-486	
Q8	IRFR_U9014_D2PAK	D2PAK_MODIFIED		FEC	
Q9, Q10	2N3904	TO-92		FEC 933-673	
R1	RES	603	10 kΩ	FEC 612-601	
R2	RES	603	1 kΩ	FEC 360-2576	
R3	RES	805	15 kΩ	FEC 196-411	
R4	RES	805	5.1 kΩ	FEC 196-356	
R5	RES	603	10 kΩ	FEC 612-601	
R6	RES	805	1.5 kΩ	FEC 196-290	
R7	RES	603	1 kΩ	FEC 360-2576	
R8	RES	805	1.5 kΩ	FEC 196-290	
R9	RES	603	1 kΩ	FEC 360-2576	
R10	RES	603	500R	311-499HCT-ND	Digi-Key
R11, R12	RES	805	1 MΩ	FEC 196-630	
R13	RES	603	200R	311-2.0KGCT-ND	Digi-Key
R14	RES	603	0R		
R15, R16, R17	RES	603	10 kΩ	FEC 612-601	
R18	RES	603	500R	311-499HCT-ND	Digi-Key

Name	Part Type	PCB Decal	Value	Farnell Part No.	Comment
R19, R20	RES	603	2.2 kΩ	FEC 911-276	
R21	RES	805	4.7 kΩ	FEC 196-356	
R22, R23	RES	805	680R	FEC 196-253	
R24	RES	603	1 kΩ	FEC 360-2576	
R25	RES	603	2.2 kΩ	FEC 911-276	
R26	RES	603	2 kΩ	311-2.0KGCT-ND	Digi-Key
R27	RES	805	82R	FEC 612-960	
R28, R29	RES	603	2.2 kΩ	FEC 911-276	
R30	RES	805	1.5 kΩ	FEC 196-290	
R31, R32	RES	805	120R	FEC 911-124	
R33, R35,R36, R37	RES	805	5 kΩ	FEC 771-429	
R34, R38,	RES	603	10 kΩ	FEC 612-601	
R39	RES	805	120R	FEC 911-124	
R40, R41	RES	805	5 kΩ	FEC 771-429	
R42	RES	603	10 kΩ	FEC 612-601	
R43, R44	RES	805	1.5 kΩ	FEC 196-290	
R45	RES	805	120R	FEC 911-124	
R46, R47, R48	RES	603	1 kΩ	FEC 360-2576	
R49, R50	RES	805	3.3 kΩ	FEC 196-332	
R51, R552	RES	603	1 kΩ	FEC 360-2576	
R53	RES	805	0R		
R54, R55	RES	603	1 kΩ	FEC 360-2576	
R56	RES	603	500 kΩ	311-500KHCT-ND	Digi-Key
R57	RES	805	2K2	FEC 911--276	
R58	RES	603	1 kΩ	FEC 360-2576	
R59	RES	603	10 kΩ	FEC 612-601	
R60	RES	805	100 MΩ		
S1, S2	SW-PUSH-SMD	SW_PB_SMD_6MM		FEC 177-807	
T1	T12	TESTPOINT	TESTPOINT		FEC 240-333
U1	ADM1041	QSOP-24		ADM1041ARQ	
U2	OP284	SO8NB		OP284ES	
U5	ADG715	TSSOP24		ADG715BRU	
U6	MC7805CT	TO-220		FEC 701-853	
U7	74AC05M	SO14NB		Radionics 833-096	
U8	ADM8828	SOT23-6	ADM8828	ADM8828	
U10	ADG715	TSSOP24		ADG715BRU	

ORDERING INFORMATION

ORDERING GUIDE

Model	Package Description
EVAL-ADM1041EB	Evaluation Board

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

NOTES

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