User Manual

For

LM2000

Hardware Version 1
Manual Version A.1

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1. Introduction

The LM2000 is a DSK daughterboard for the Spectrum Digital/TI TMS320C6416DSK (DSK). The LM2000 when used in conjunction with a DSK, provides 3 standard 32 bit, 33 MHz PCI slots which can be used to expand the capabilities of the DSK.

The LM2000 carrier when coupled with a DSK provides significant value and utility. The additional PCI-DSP data path, suitable for high-speed real-time data transport, complements the I/O handling features of DSP/BIOS™ and enables a wide range of DSP applications. The LM2000 provides extreme leverage for your DSK at very low cost, transforming the standalone DSK into a powerful embedded PCI-based development system.

Please Note: PCI expansion cards which use a PCI to PCI bridge device cannot be used with the LM2000. This is not a limitation of the LM2000, but a limitation of the TMS6416 DSP which cannot perform type 1 configuration cycles.

1.1 Applicable Documents

- Spectrum Digital, TMS320C6416 DSK Technical Reference Manual, 505945-0001 Rev A
- Texas Instruments, TMS320C6000 DSP Peripheral Component Interconnect (PCI) Reference Guide, SPRU581A
- Texas Instruments, TMS Cross-Platform Daughtercard Specification, Revision 0.95

2. Quick Installation Guide

Important Notice

Before installing any PCI cards in the LM2000, the user should ensure that power rating of the PCI card, LM2000 and 6416DSK does not exceed the power rating of the DSK power supply. The DSK power supply is only rated at 15 watts.

The LM2000 and DSK utilize static sensitive components. Please use static safe procedures when installing the LM2000.

2.1 Procedure

This procedure was verified using a Dell computer running Windows 2000.

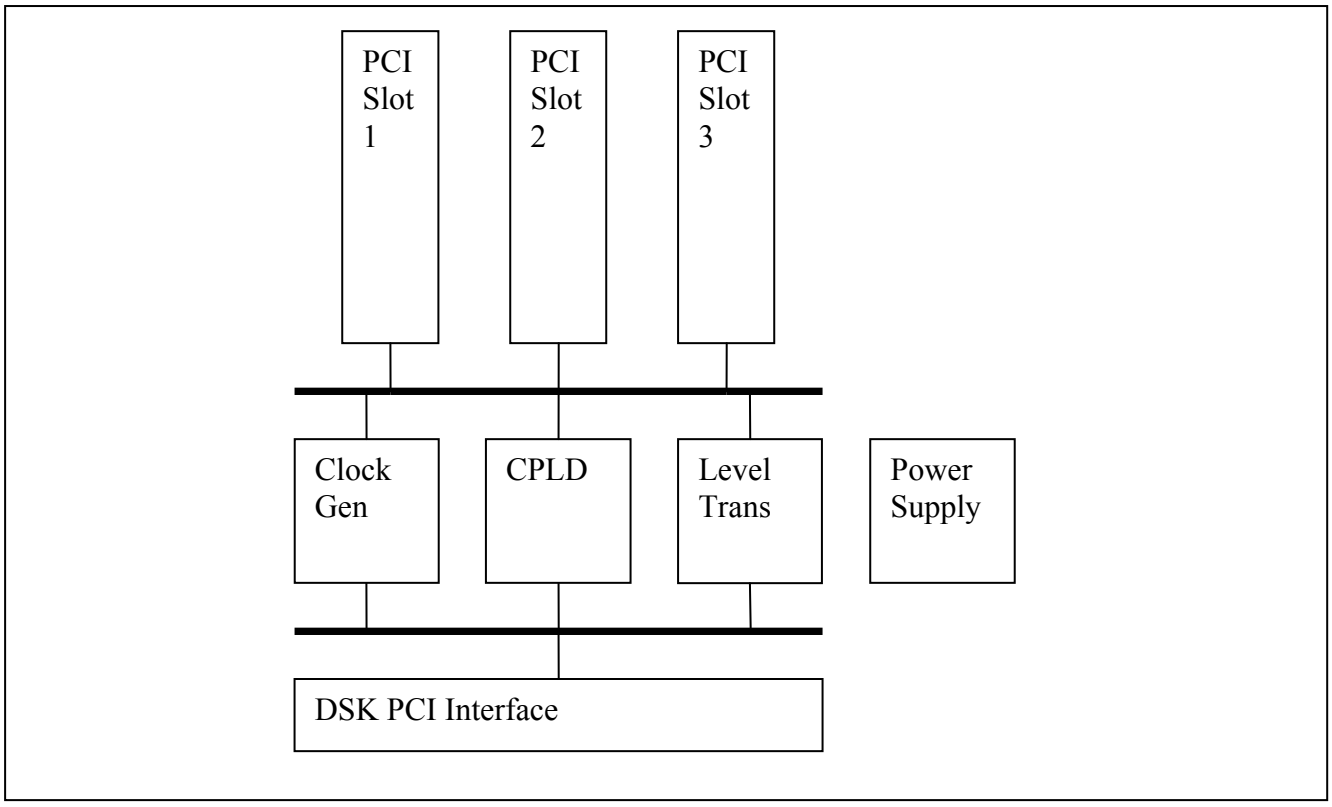
1. Before installing the LM2000 on to the DSK, the user should ensure that the DSK functions properly in a stand alone configuration. Follow all the installation instructions provided with the DSK to ensure it functions properly.
2. If the DSK functions properly in the stand alone configuration, proceed to the next step. If it does not function properly, contact TI or Spectrum Digital.
3. Close down Code Composer Studio (CCS) and disconnect all power from the DSK
4. Using safe ESD procedures, install the LM2000 onto the DSK using the provided standoffs and screws.
5. Reconnect power to the DSK and launch CCS.
6. If CCS comes up then you can proceed to the example program section of the manual.

3. Functional Description

3.1 Block Diagram

The functional block diagram of the LM2000 card is as shown in Figure 1.

Figure 1 LM2000 Simplified Hardware Architecture Diagram



3.2 Description

3.2.1 Clock Generator

The LM2000 provides a 33.333 MHz 100 ppm clock to all PCI devices. Clock lengths are all matched to minimize skew.

3.2.2 Level Translators

Level translators are used to protect the 3.3V PCI interface of the 6416DSK from the 5V levels of the PCI slots.

3.2.3 CPLD

A Xilinx CPLD is used for the PCI arbiter as well as the remaining glue logic on the board. A listing of the CPLD code is provided at the end of this document.

The PCI arbiter is implemented using a round robin arbitration. Arbitration occurs in parallel with bus accesses to minimize arbitration delays. Bus parking is implemented such that the last master maintains ownership if no other device is requesting the bus. An arbitration timeout is also implemented to prevent a PCI device which does not start a bus cycle within the timeout period (16 PCI clocks) from stalling the bus.

3.2.4 PCI Slots

The LM2000 provides 3 identical 32 bit, 33 MHz, 5V PCI slots.

3.2.5 Reset Button

A reset button is provided to reset the LM2000 and the PCI bus in the event of a locked up condition. A reset is asserted to the arbiter, PCI slots, and the DSK's PCI interface.

3.2.6 LED

A single LED is provided that indicates two things. First, it indicates that the board is in a reset state. Whenever the DSK or the LM2000 is reset, this LED is lit. Second, it indicates that the PCI bus is busy. Busy is indicated by either PCI signals FRAME or IRDY being asserted.

3.2.7 Power Supply

The LM2000 provides a 3.3V power supply to drive the +3.3V rail of the PCI slots. While this device is capable of up to 6 Amps, to achieve this rating the user will have to use an auxiliary power supply on the 6416DSK since the DSK power supply is only rated for 15 watts.

3.3 IDSEL Mapping

Each device on the PCI bus requires an IDSEL signal during configuration cycles. The IDSEL is asserted during start of either a configuration read or write cycle and is used to select the device.

The LM2000 maps high order address lines to the IDSEL signals. Each IDSEL gets a unique address bit. This is detailed in the following table:

Table 1 IDSEL Mapping

Address Bit	Device or Slot
A16	DSK PCI Interface
A17	Slot 0
A18	Slot 1
A19	Slot 2

3.4 Interrupt Mapping

The LM2000 utilizes 3 external interrupts on the 6416DSK. All interrupts are active low. This is detailed in the following table:

Table 2 Interrupt Sources

DSK Interrupt	Source
EINT4	PCI Slots INTA, INTB, INTC or INTD
EINT5	DSK PCI Interrupt
EINT6	PCI System Error (SERR)
EINT7	Reserved

4. Configuration Switches

The LM2000 provides a single 4 position DIP switch (SW1) to select the configuration of the board. For normal operation, these switches should all be set to the off position. The following table describes the switches and their function.

Table 3 Configuration Switch Encodings

Switch Position	Description
Switch 1	PCI Enable =On PCI Disabled =Off PCI Enabled* (default)
Switch 2	MCBSP2 Enable =On MCBSP2 Disabled =Off MCBSP2 Enabled* (default)
Switch 3	EEPROM Auto-initialization =On Enabled =Off Disabled* (default) (to use the EEPROM auto-initialization capability, both switches 2 and 3 should be set to the ON position and the EEPROM programmed with valid configuration data)
Switch 4	Not Used (leave off)

To turn a switch on, slide its actuator toward the edge of the card. To turn a switch off, slide its actuator toward the PCI connector.

5. Serial EEPROM

The LM2000 provides a serial EEPROM (U1) which can be used to initialize the DSP's PCI configuration registers with user data. As shipped, this device is disabled but programmed with default values. The device is not required for most applications unless the user needs to use custom configuration values. To enable the device, set switch positions 2 and 3 of SW1 on the LM2000 to the ON position.

Should this device be programmed with incorrect data such that the DSK cannot be accessed using the example software, set switch position 3 of SW1 on the LM2000 to the off position and cycle power to the DSK. This forces the DSP to use its internal values for initialization of the PCI configuration registers. After the system is booted, the EEPROM can now be programmed. After the EEPROM is programmed, set switch position 3 back to the ON position and cycle power to the system. The DSP will now download the new data from the EEPROM.

Table 4 EEPROM Memory Map

Location`	Contents (msb/lsb)	DSP/EEPROM Default Values
0x0	Vendor ID	0x104C
0x1	Device ID	0xA106
0x2	Class Code[7..0] / Revision	0x0001
0x3	Class Code [23:8]	0x0000
0x4	Subsystem Vendor ID	0x0000
0x5	Subsystem ID	0x0000
0x6	Max Latency / Min Grant	0x0000
0x7	PC D1 / PC DO	0x0000
0x8	PC D3 / PC D2	0x0000
0x9	PD D1 / PD D0	0x0000
0xA	PD D3 / PD D2	0x0000
0xB	Data Scale (PD_D3..PC_D0)	0x0000
0xC	0x00 / PMC [14:9] / PMC [5] / PMC [3]	0x0000
0xD	Checksum	0x1be1

6. Connectors

6.1 32 Bit 33 MHz PCI Edge Connector

The LM2000 provides three 32 bit 33 MHz PCI edge connectors. The edge connector is configured for 5V signaling which covers the bulk of 32 bit 33 MHz peripheral cards. The following table provides the pinout of this connector.

Table 5 PCI Edge Connector Pinout

Pin	Description	Pin	Description
A1	-12V	B1	TRST#
A2	TCK	B2	+12V
A3	GND	B3	TMS
A4	TDO	B4	TDI
A5	+5V	B5	+5V
A6	+5V	B6	INTA#
A7	INTB#	B7	INTC#
A8	INTD#	B8	+5V
A9	PRSNT1#	B9	RSVD
A10	RSVD	B10	+VIO
A11	PRSNT2#	B11	RSVD
A12	KEYWAY	B12	KEYWAY
A13	KEYWAY	B13	KEYWAY
A14	RSVD	B14	RSVD
A15	GND	B15	RST#
A16	CLK	B16	+VIO
A17	GND	B17	GNT#
A18	REQ#	B18	GND
A19	+VIO	B19	RSVD
A20	AD31	B20	AD30
A21	AD29	B21	+3.3V
A22	GND	B22	AD28
A23	AD27	B23	AD26
A24	AD25	B24	GND
A25	+3.3V	B25	AD24
A26	C/BE3#	B26	IDSEL
A27	AD23	B27	+3.3V
A28	GND	B28	AD22
A29	AD21	B29	AD20
A30	AD19	B30	GND
A31	+3.3V	B31	AD18
A32	AD17	B32	AD16
A33	C/BE2#	B33	+3.3V
A34	GND	B34	FRAME#
A35	IRDY#	B35	GND
A36	+3.3V	B36	TRDY#
A37	DEVSEL#	B37	GND
A38	GND	B38	STOP#
A39	LOCK#	B39	+3.3V

A40	PERR#	B40	SDONE
A41	+3.3V	B41	SBO#
A42	SERR#	B42	GND
A43	+3.3V	B43	PAR
A44	C/BE1#	B44	AD15
A45	AD14	B45	+3.3V
A46	GND	B46	AD13
A47	AD12	B47	AD11
A48	AD10	B48	GND
A49	M66EN	B49	AD09
A50	KEYWAY	B50	KEYWAY
A51	KEYWAY	B51	KEYWAY
A52	AD08	B52	C/BE0#
A53	AD07	B53	+3.3V
A54	+3.3V	B54	AD06
A55	AD05	B55	AD04
A56	AD03	B56	GND
A57	GND	B57	AD02
A58	AD01	B58	AD00
A59	+VIO	B59	+VIO
A60	ACK64#	B60	REQ64#
A61	+5V	B61	+5V
A62	+5V	B62	+5V

6.2 J1 DSK PCI Interface

The J1 connector is used to connect the PCI slots on the LM2000 to the PCI interface of the DSK. Level translators are used to convert the 5V levels of the PCI slots to the 3V levels required by the DSK. There are several additional signals, exclusive of the PCI signals, which are used to configure the DSK. These signals are described in the following paragraph.

PCI_EN is connected to SW1 position 1, MCBSP2_EN is connected to SW1 position 2 and TBEA13 (eeprom initialization enable) is connected to SW1 position 3. The following table provides the pinout of this connector.

Table 6 J1 PCI Expansion Connector Pinout

Pin	Description	Pin	Description
1	PCI_EN	2	MCBSP2_EN
3	GND	4	HPI_RESET
5	XSP_CS	6	TBEA13
7	GND	8	GND
9	PAD1	10	PCBE0
11	PAD3	12	PAD0
13	PAD5	14	PAD2
15	PAD7	16	PAD4
17	GND	18	PAD6
19	PAD8	20	GND
21	PAD10	22	PAD9

23	PAD12	24	PAD11
25	PAD14	26	PAD13
27	PGND	28	PAD15
29	PCBE1	30	GND
31	GND	32	PPAR
33	PSERR	34	GND
35	GND	36	PSTOP
37	PPERR	38	GND
39	GND	40	PTRDY
41	PDEVSEL	42	GND
43	GND	44	PFRAME
45	PIRDY	46	GND
47	GND	48	PAD16
49	PCBE2	50	PAD18
51	PAD17	52	PAD20
53	PAD19	54	PAD22
55	PAD21	56	GND
57	PAD23	58	PIDSEL
59	PCBE3	60	PAD24
61	GND	62	PAD26
63	PAD25	64	PAD28
65	PAD27	66	PAD30
67	PAD29	68	PGNT
69	PAD31	70	GND
71	GND	72	PRST
73	PREQ	74	GND
75	GND	76	PINTA
77	PCLK	78	GND
79	GND	80	NC

6.3 J2/J3 DSK Expansion Interface

The J2/J3 connectors are used to power the LM2000 from the DSK and provide some low level control signals. Many of these signals are brought out to test points on the LM2000 so they can be accessed.

The following tables provide the pinout of these connectors.

Table 7 J2 Peripheral Expansion Connector Pinout

Pin	Description	Pin	Description
1	12 V	2	-12 V
3	GND	4	GND
5	5 V	6	5 V
7	GND	8	GND
9	5 V	10	5 V
11	NC	12	NC
13	NC	14	NC
15	NC	16	NC

17	NC	18	NC
19	3.3 V	20	3.3 V
21	CLKX0	22	CLKS0
23	FSX0	24	DX0
25	GND	26	GND
27	CLKR0	28	NC
29	FSR0	30	DR0
31	GND	32	GND
33	CLKX1	34	CLKS1
35	FSX1	36	DX1
37	GND	38	GND
39	CLKR1	40	NC
41	FSR1	41	DR1
43	GND	44	GND
45	TOUT0	46	TINP0
47	NC	48	EINT5
49	TOUT1	50	TINP1
51	GND	52	GND
53	EINT4	54	NC
55	NC	56	NC
57	NC	58	NC
59	RST#	60	NC
61	GND	62	GND
63	CNTL1	64	CNTL0
65	STAT1	66	STAT0
67	EINT6	68	EINT7
69	CE3	70	NC
71	NC	72	NC
73	NC	74	NC
75	GND	76	GND
77	GND	78	ECLKOUT
79	GND	80	GND

Table 8 J3 Memory Expansion Connector Pinout

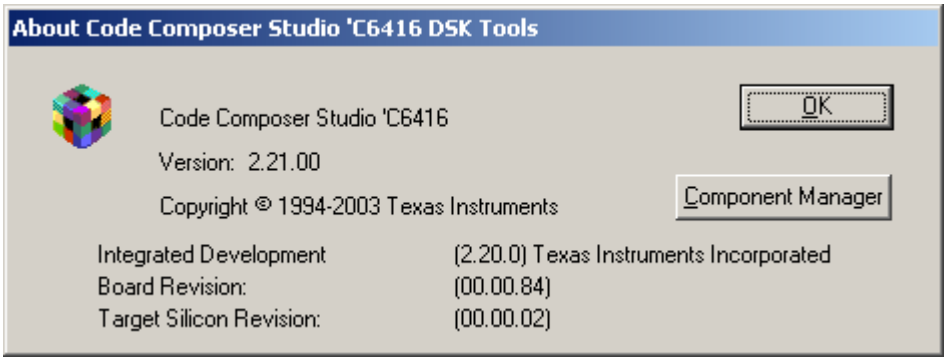
Pin	Description	Pin	Description
1	5 V	2	5 V
3	A21	4	A20
5	A19	6	A18
7	A17	8	A16
9	A15	10	A14
11	GND	12	GND
13	A13	14	A12
15	A11	16	A10
17	A9	18	A8
19	A7	20	A6
21	5 V	22	5 V
23	A5	24	A4
25	A3	26	A2
27	BE3#	28	BE2#
29	BE1#	30	BE0#
31	GND	32	GND

33	D31	34	D30
35	D29	36	D28
37	D27	38	D26
39	D25	40	D24
41	3.3 V	42	3.3 V
43	D23	44	D22
45	D21	46	D20
47	D19	48	D18
49	D17	50	D16
51	GND	52	GND
53	D15	54	D14
55	D13	56	D12
57	D11	58	D10
59	D9	60	D8
61	GND	62	GND
63	D7	64	D6
65	D5	66	D4
67	D3	68	D2
69	D1	70	D0
71	GND	72	GND
73	ARE#	74	AWE#
75	AOE#	76	ARDY#
77	CE3#	78	CE2#
79	GND	80	GND

7. Example Code

Three example Code Composer Studio projects are provided on the LM2000 CD which demonstrate use of the PCI interface.

Example code was built using Version 2.21 of Code Composer Studio ‘C6416.



7.1 PCI Probe Example

This example probes the PCI bus for devices. With the LM2000 installed on the DSK, the DSP will always appear as a device even if no other cards are installed. Typical program output is shown below.

```
PCI Probe Utility
Copyright 2006 LAB Microsystems, LLC
This software is provided free of charge with no warranties
either expressed or implied.  Use at your own risk.

Scanning DSK...
  6416 PCI interface found
    Vendor ID => 0x104c
    Device ID => 0xa106
    Bar 0     => 0xffc00008
    Bar 1     => 0xff800000
    Bar 2     => 0xffffff1

Scanning PCI slots...
  Slot 1, No Device found
  Slot 2, No Device found
  Slot 3, No Device found
```

7.2 PCI Memory Test

This example takes advantage of the fact that the DSP can be a PCI master of its own PCI slave interface. The code first configures the DSP’s slave interface and then performs a memory test through this interface. Typical program output is shown below.

```
PCI Memory Test
Copyright 2006 LAB Microsystems, LLC
This software is provided free of charge with no warranties
```

```
either expressed or implied.  Use at your own risk.

Scanning for DSK...
  6416 PCI interface found
    Vendor ID => 0x104c
    Device ID => 0xa106
  Configuring BAR registers

Testing Memory...Passed
```

7.3 SROM Programming Example

This example code demonstrates how to program the SROM on the LM2000 so that the DSP's PCI interface can be configured using custom values. Typical program output is shown below.

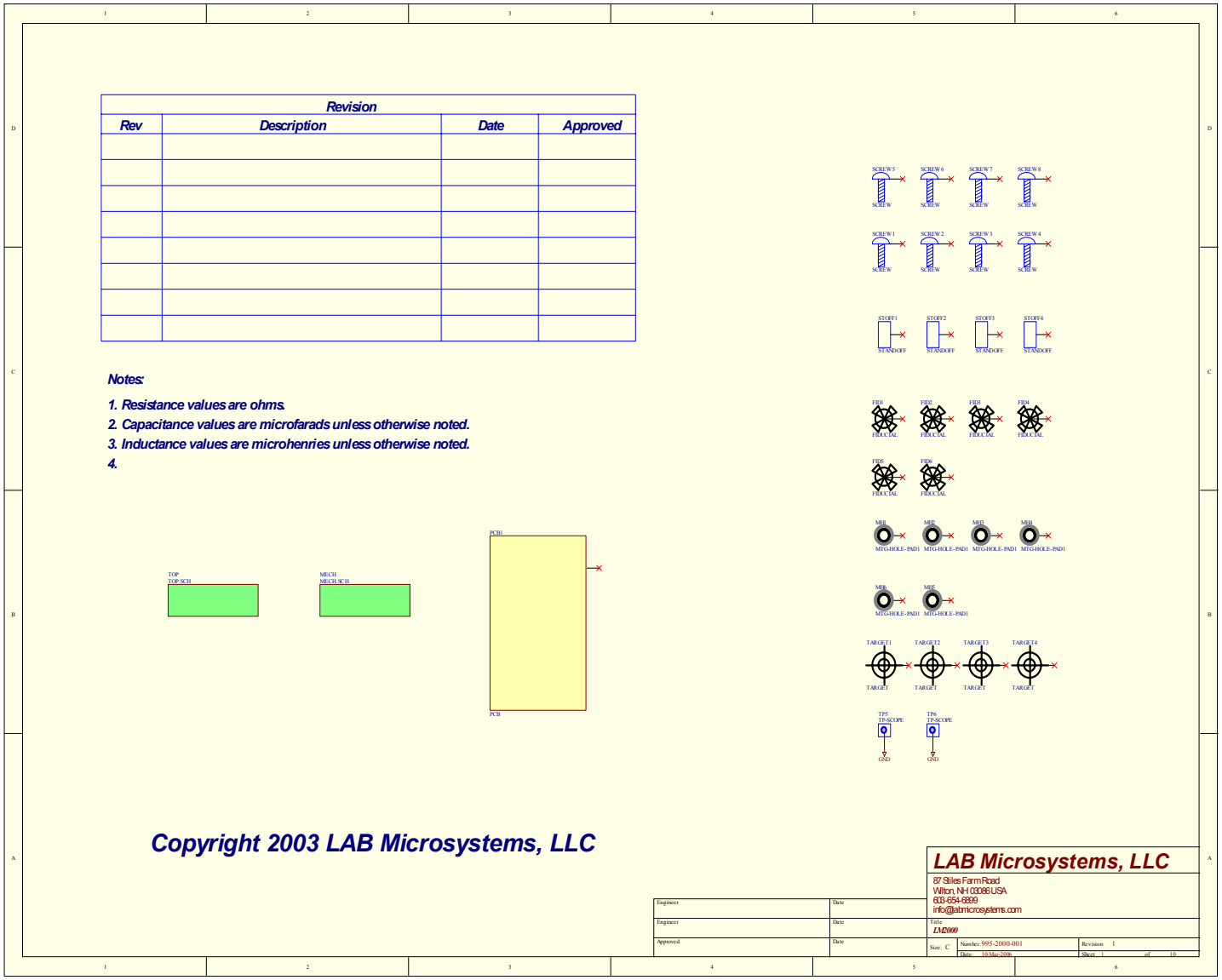
Please Note: Before running this program, the user should check to ensure that switch position 2 of SW1 on the LM2000 is set to the on position. This disables MCBSP2 and enables access to the serial EEPROM.

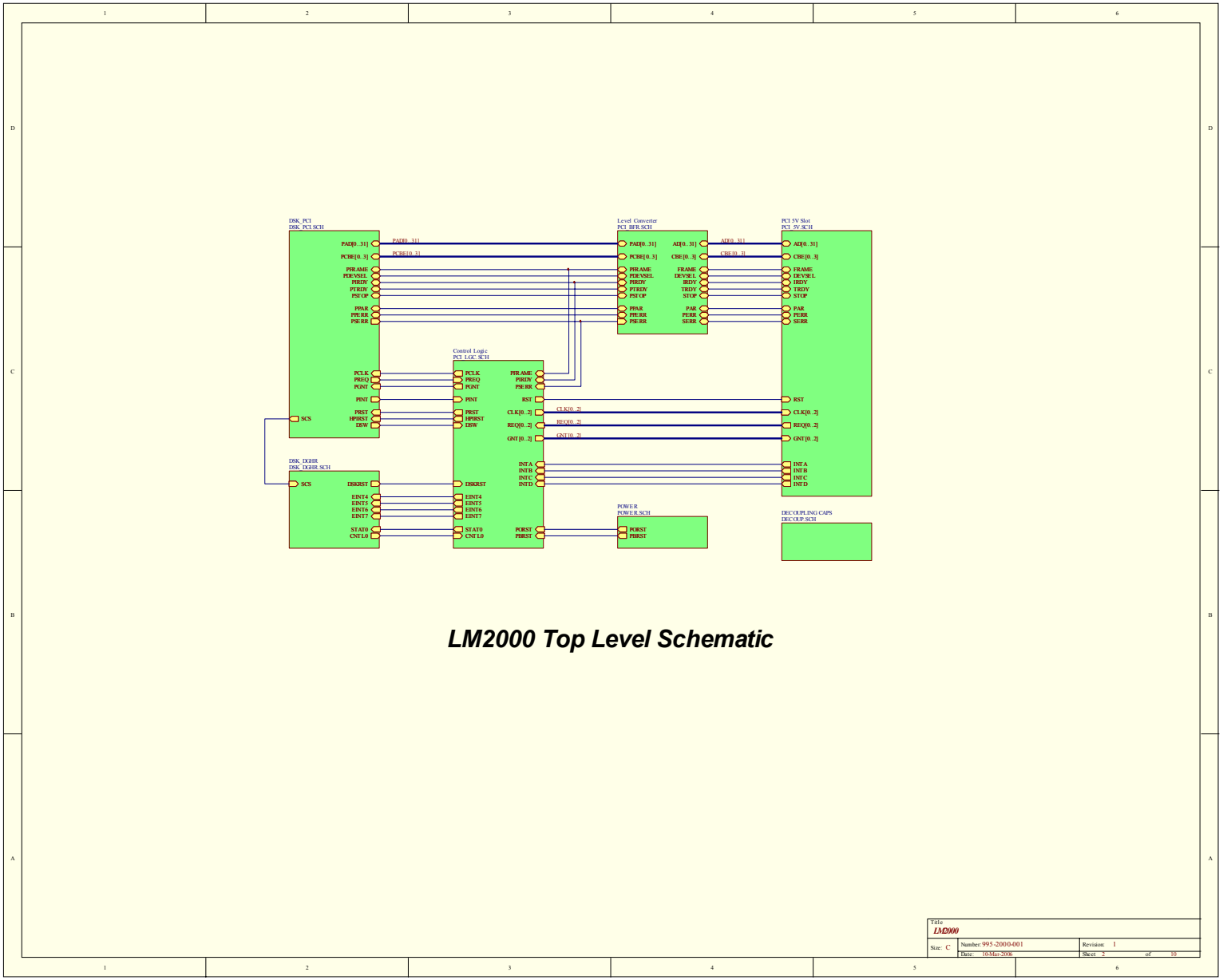
```
SROM Programmer
Copyright 2006 LAB Microsystems, LLC
This software is provided free of charge with no warranties
either expressed or implied.  Use at your own risk.

Enabling device    [.]
Erasing device     [.]
Programming device [..............]
Verifying device   [..............]

Done
```

8. CPLD Source Code

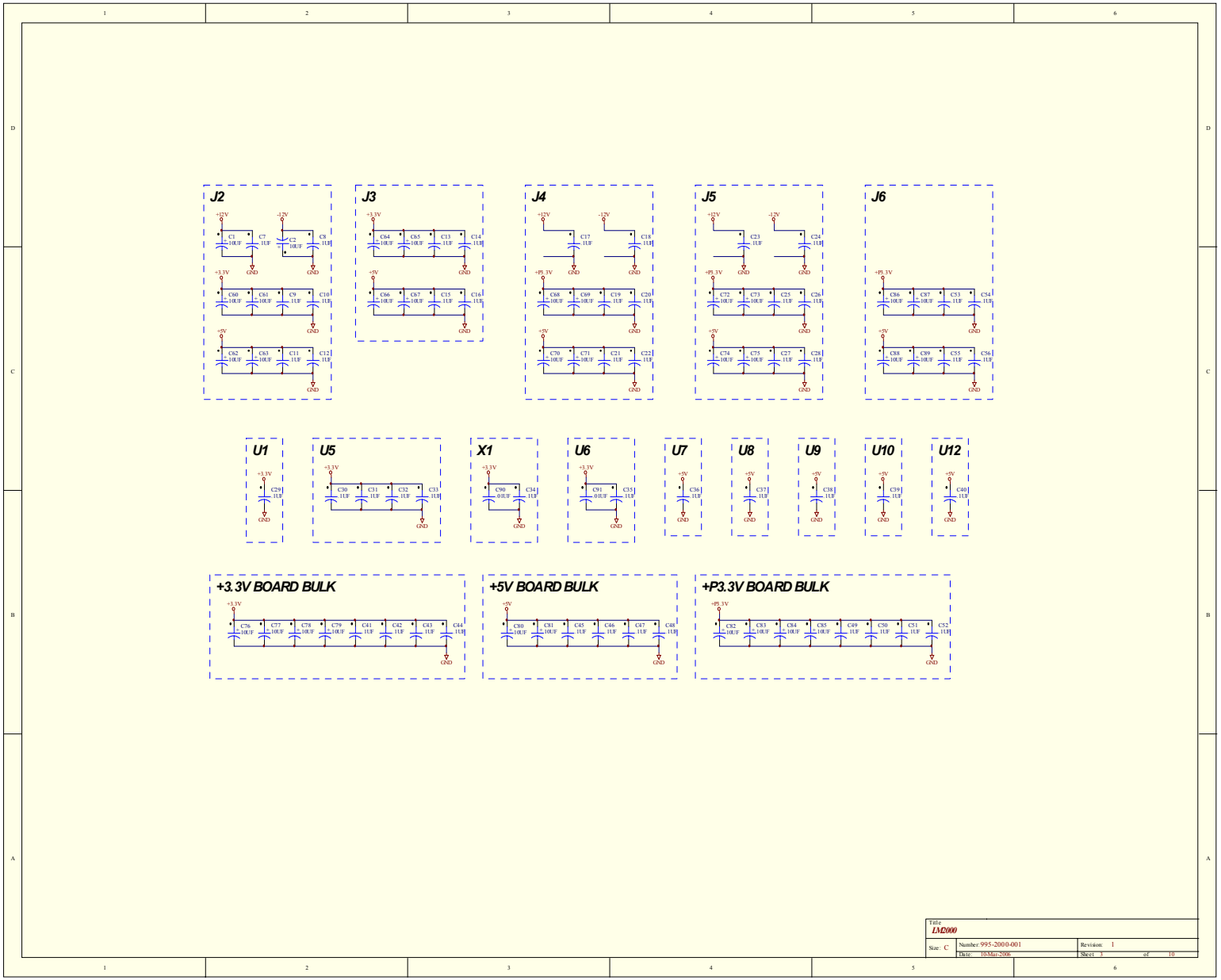
CPLD source code was written using the ABEL language and compiled using the downloadable tools from Xilinx. CPLD source code is available. For further information, please contact LAB Microsystems LLC.

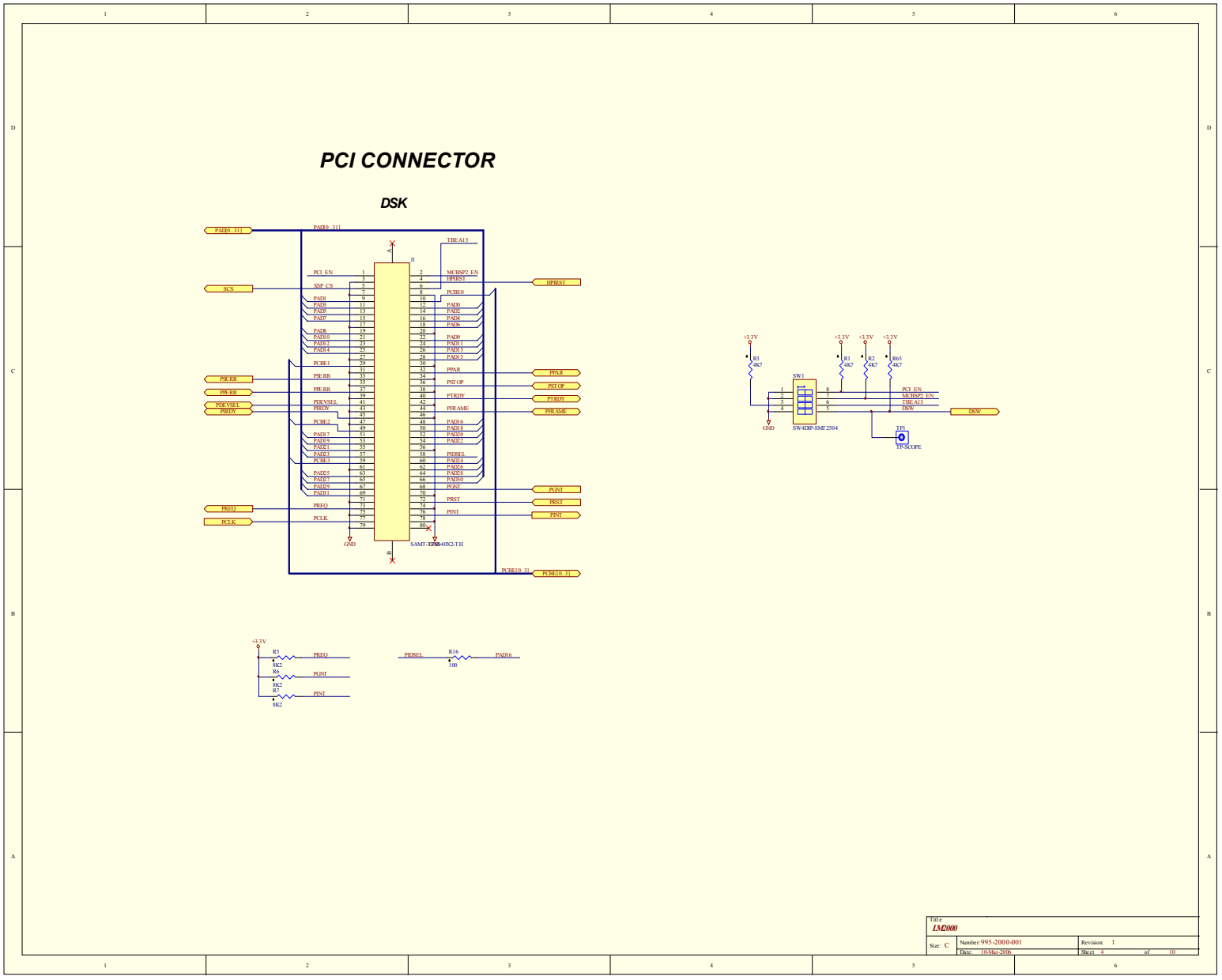
9. Schematics

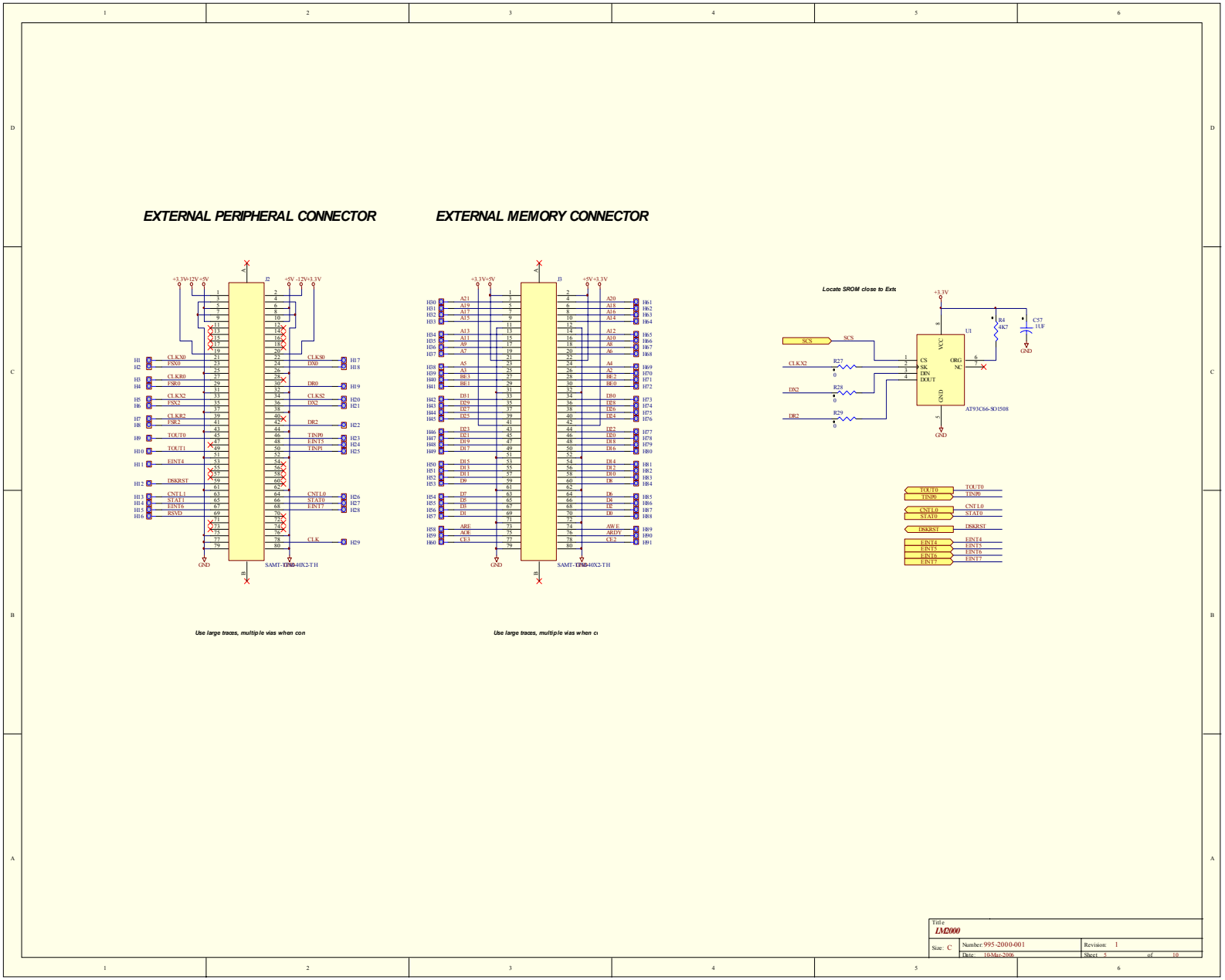


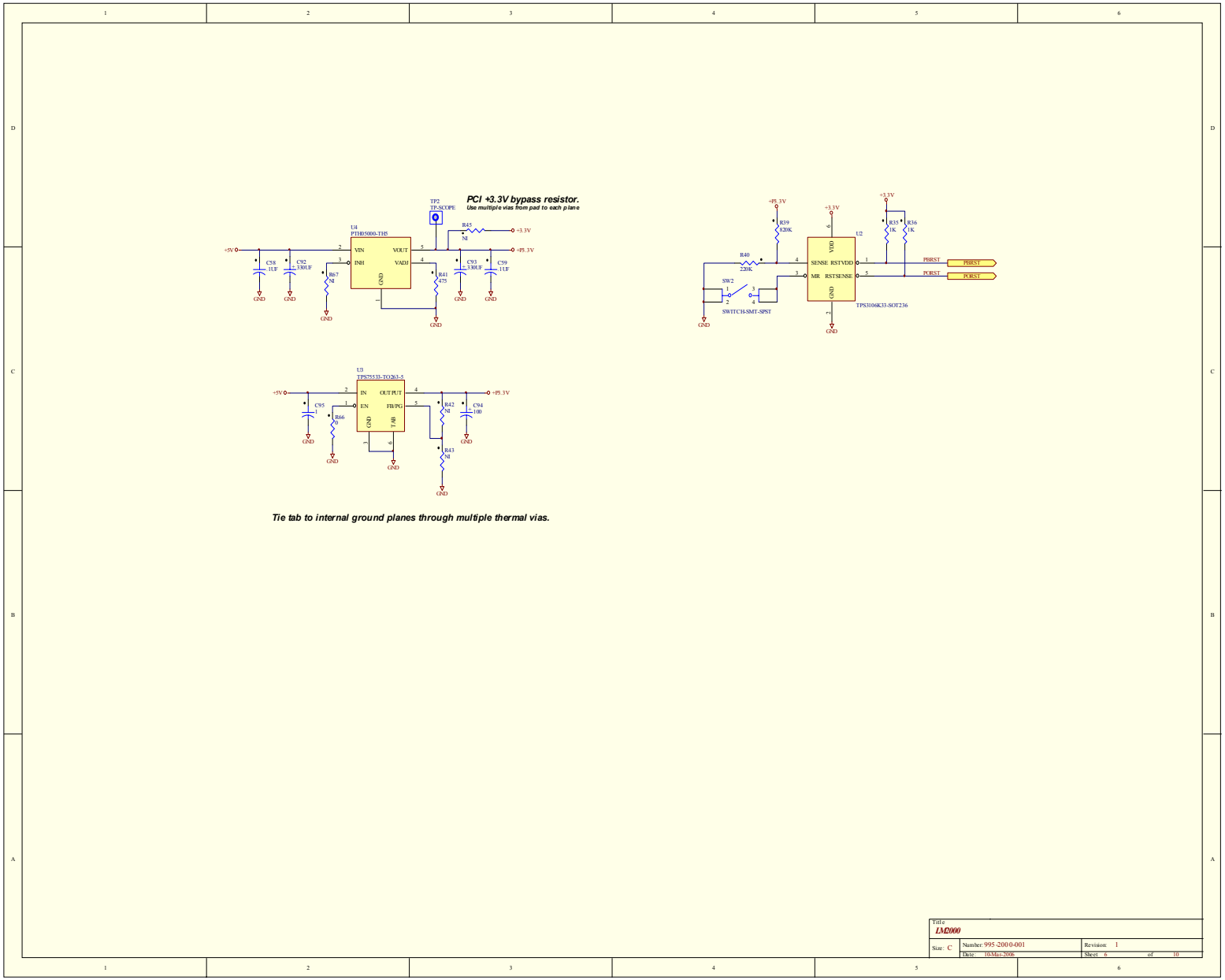


LM2000 Top Level Schematic


J2
J3
J4
J5
J6
U1
U5
X1
U6
U7
U8
U9
U10
U12
+3.3V BOARD BULK
+5V BOARD BULK
+P3.3V BOARD BULK
Title
LM2000
Size: C
Number 995-2000-001
Revision: 1
Date: 10-Mar-2006
Sheet 3 of 10


PCI CONNECTOR
DSK
PAD[0..31]
SCS
PSERR
PPERR
PDEVSEL
PIRDY
PREQ
PCLK
HPIRST
PPAR
PSTOP
PTRDY
PFRAME
PGNT
PRST
PINT
PCBE[0..3]
TBE A13
MCBSP2_EN
PCI_EN
DSW
SW4DIP-SMT2504
TP1
TP-SCOPE
LM2000
Number 995-2000-001
Revision 1
Date 10-Mar-2006
Sheet 4 of 10


EXTERNAL PERIPHERAL CONNECTOR
EXTERNAL MEMORY CONNECTOR
Locate SROM close to Extn
Use large traces, multiple vias when con
Use large traces, multiple vias when c
Title
LM2000
Size: C
Number 995-2000-001
Revision: 1
Date: 10-May-2006
Sheet 5 of 10


PCI +3.3V bypass resistor.
Use multiple vias from pad to each plane
TP2
TP-SCOPE
U4
PTH05000-TH5
VIN
VOUT
INH
VADJ
GND
+5V
+3.3V
+P5.3V
R45
Nl
C58
1UF
C92
330UF
R67
Nl
R41
475
C93
330UF
C59
1UF
U3
TPS75533-TO263-5
IN
OUTPUT
EN
FB/PG
TAB
C95
1
R66
0
R42
Nl
C94
100
R43
Nl
U2
SENSE
RSTVDD
MR
RSTSENSE
R39
820K
R40
220K
R35
1K
R36
1K
PBRST
PORST
SW2
SWITCH-SMT-SPST
TPS3106K33-SOT236
Tie tab to internal ground planes through multiple thermal vias.
Title
LM2000
Size: C
Number: 995-2000-001
Revision: 1
Date: 10-Mar-2006
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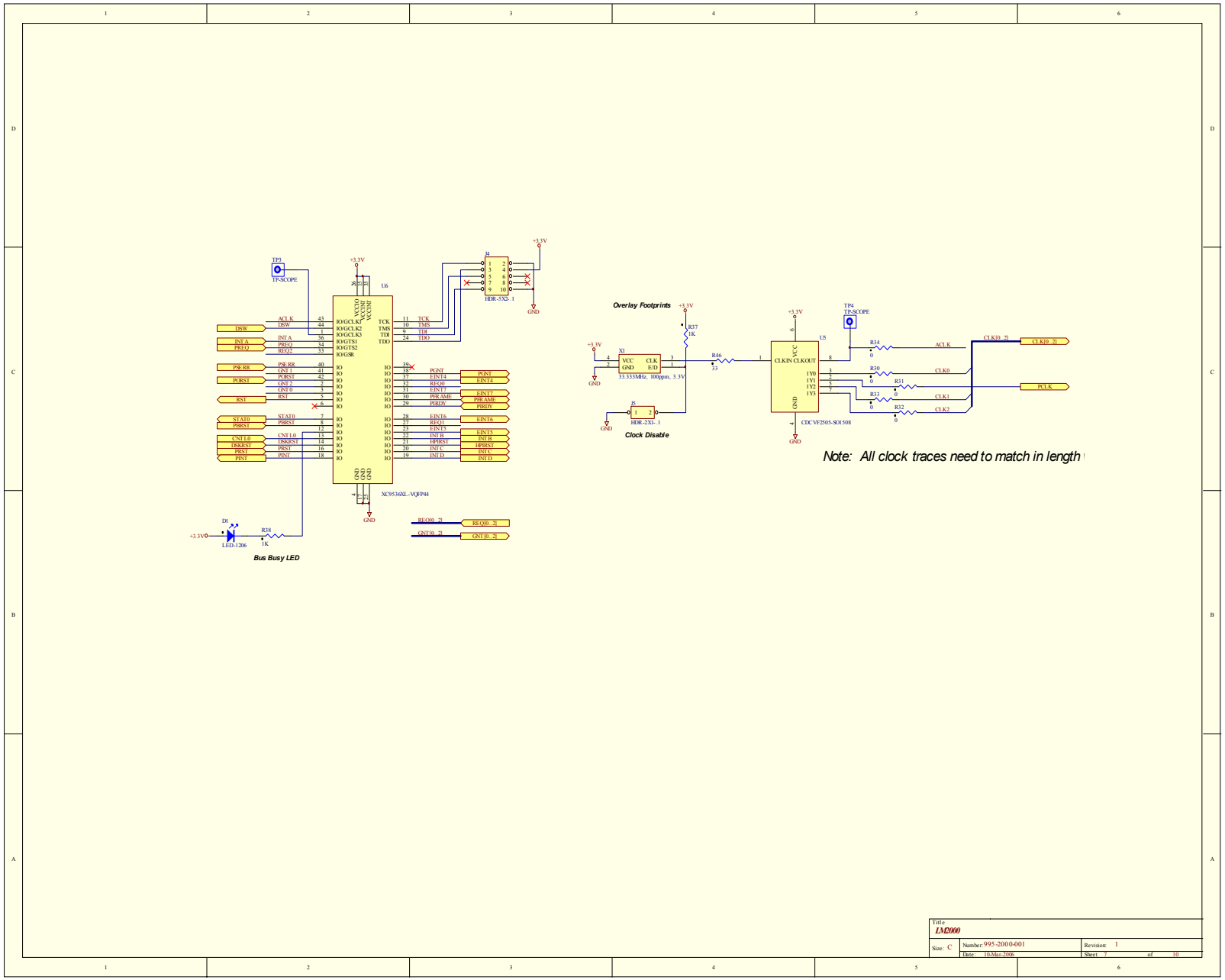
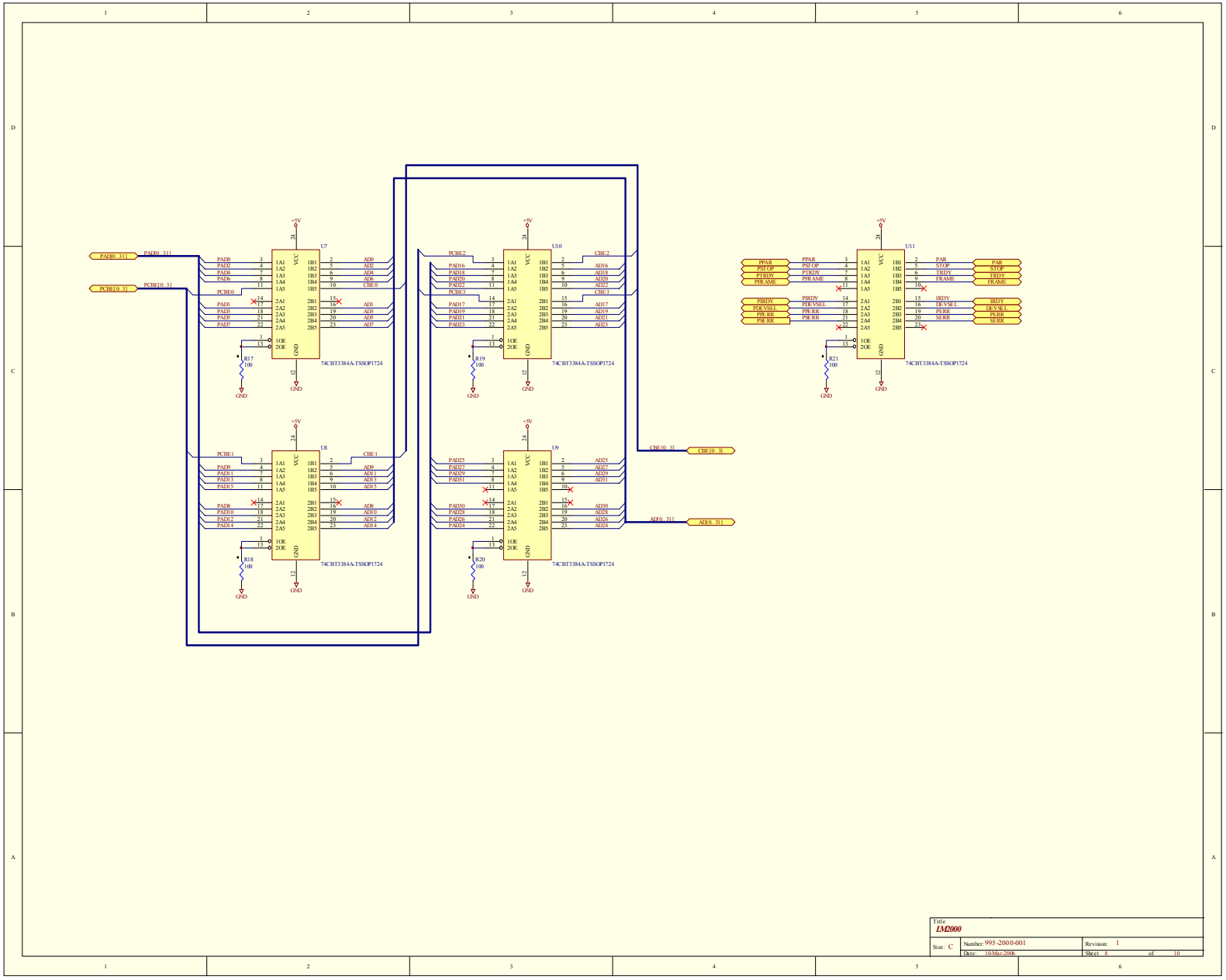
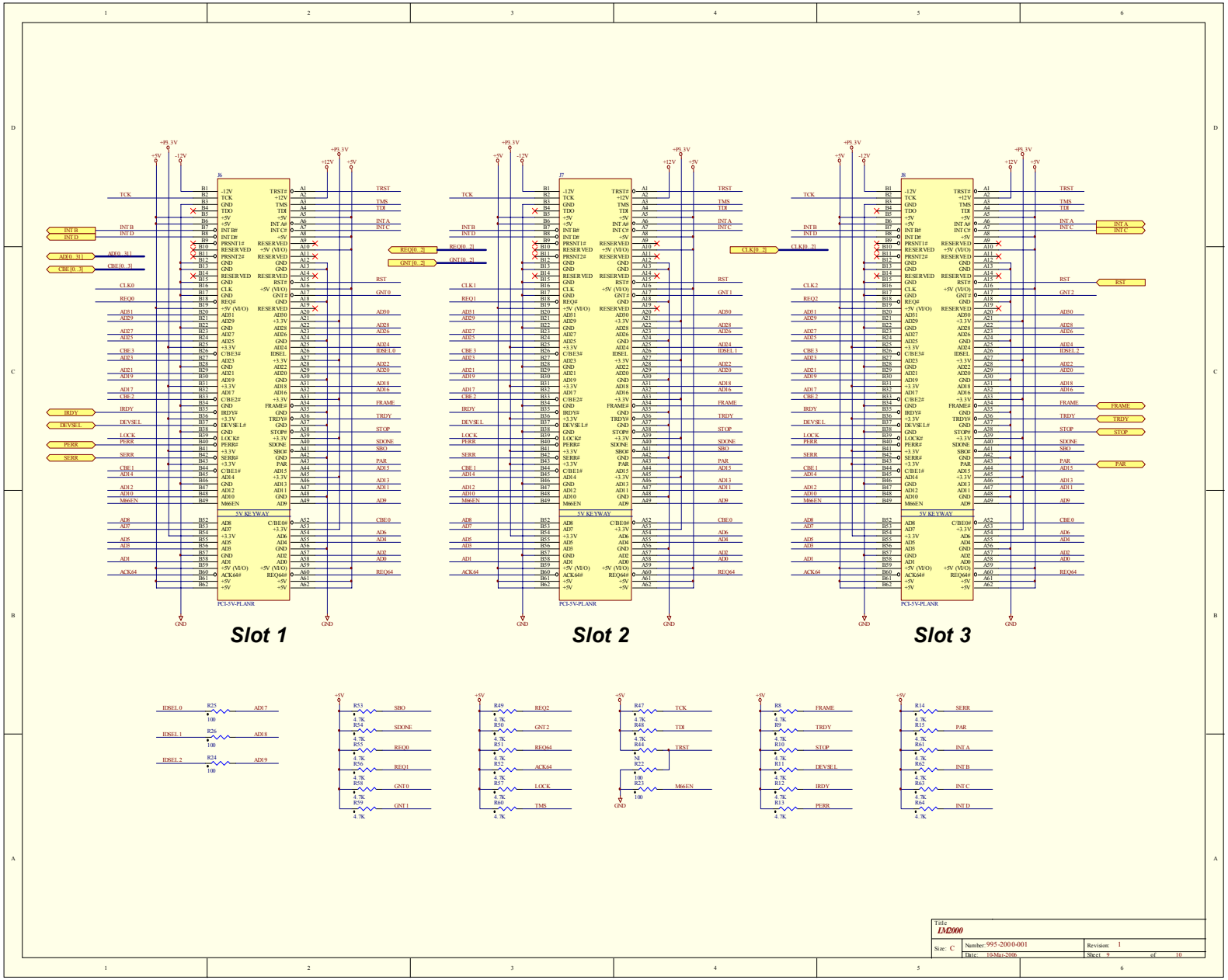
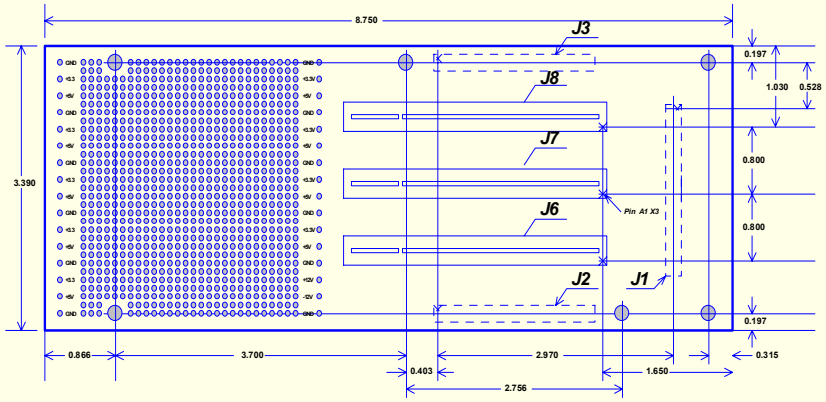

TP3
TP-SCOPE
+3.3V
U6
XC9536XL-VQFP44
J4
HDR-5X2-.1
DSW
INT A
PREQ
REQ2
PSERR
GNT 1
PORST
GNT 2
GNT 0
RST
STAT0
PBRST
CNTL0
DSKRST
PRST
PINT
TCK
TMS
TDI
TDO
PGNT
EINT4
REQ0
EINT7
PFRAME
PIRDY
EINT6
REQ1
EINT5
INT B
HPIRST
INT C
INT D
REQ0..2]
GNT0..2]
D1
LED-1206
R38
1K
Bus Busy LED
Overlay Footprints
X1
33.333MHz, 100ppm, 3.3V
R37
1K
R46
33
J5
HDR-2X1-.1
Clock Disable
U5
CDCVF2505-SOI508
TP4
TP-SCOPE
R34
R30
R31
R33
R32
0
ACLK
CLK0
CLK1
CLK2
CLK0..2]
PCLK
Note: All clock traces need to match in length
Title
LM2000
Size: C
Number 995-2000-001
Revision 1
Date: 10-Mar-2006
Sheet 7 of 10

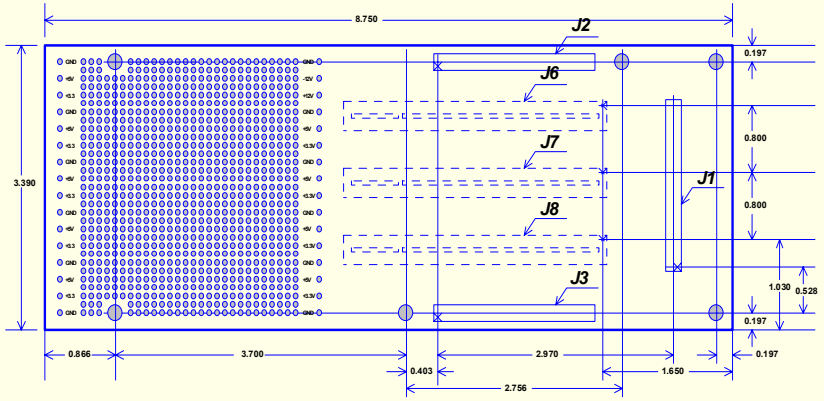

U7
U8
U10
U9
U11
74CBT3384A-TSSOP1724
PAD[0..31]
PCBE[0..3]
CBE[0..3]
AD[0..31]
R17
R18
R19
R20
R21
100
GND
+5V
Title
LM2000
Size: C
Number: 995-2000-001
Revision: 1
Date: 16-Mar-2006
Sheet 8 of 10


Slot 1
Slot 2
Slot 3
5V KEYWAY
PCI-5V-PLANR
Title
LM2000
Size: C
Number: 995-2000-001
Revision: 1
Date: 16-Mar-2006
Sheet 9 of 10

Component Side



Solder Side



Title: LM2000
Size: C | Number: 995-2000-001 | Revision: 1
Date: 16-Mar-2006 | Sheet 10 of 10

10. Support

The best way to contact LAB Microsystems LLC for support is via email. Please send support requests to support@labmicrosystems.com. We try to respond to all support requests within 24 hours during normal business hours.