

DESCRIPTION

Providing power for the Pentium® microprocessor family is not a trivial task by any means. There are currently several different voltage specifications for different versions of the μ P. Future upgrades will further challenge the power supply. In an effort to promote flexible, upgradable power supplies for their current and future microprocessors, Intel has defined a specification for a modularized power system for the CPU. This demo board is designed to accept modules built to the Intel specification and also accept an Intel Power Validator module. The Power Validator generates the fast load transients characteristic of the current generation of Pentium processors.

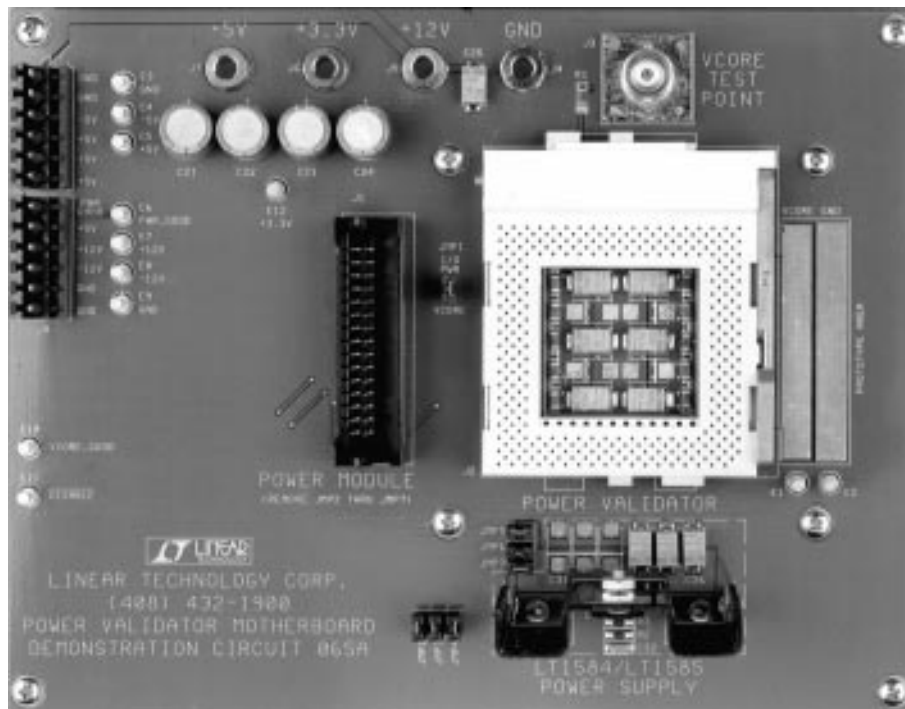
In addition, there is a 5V to 3.3V at 7A, LT®1584 based regulator (DC065A-A) included onboard which meets the needs of a 75MHz, 3.3V \pm 5% Pentium processor. An LT1585 version (DC065A-B) is available which is capable of only 4.6A* but in all other respects is identical to the LT1584 design. Either regulator may be disabled if desired, permitting installation of a plug-in module on the 30-pin header provided.

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 Pentium is a registered trademark of Intel Corporation.

*There is also a 5A version, the LT1585A available. Contact a Linear Technology Corporation sales representative for details.

BOARD PHOTO

Component Side



PACKAGE AND SCHEMATIC DIAGRAMS

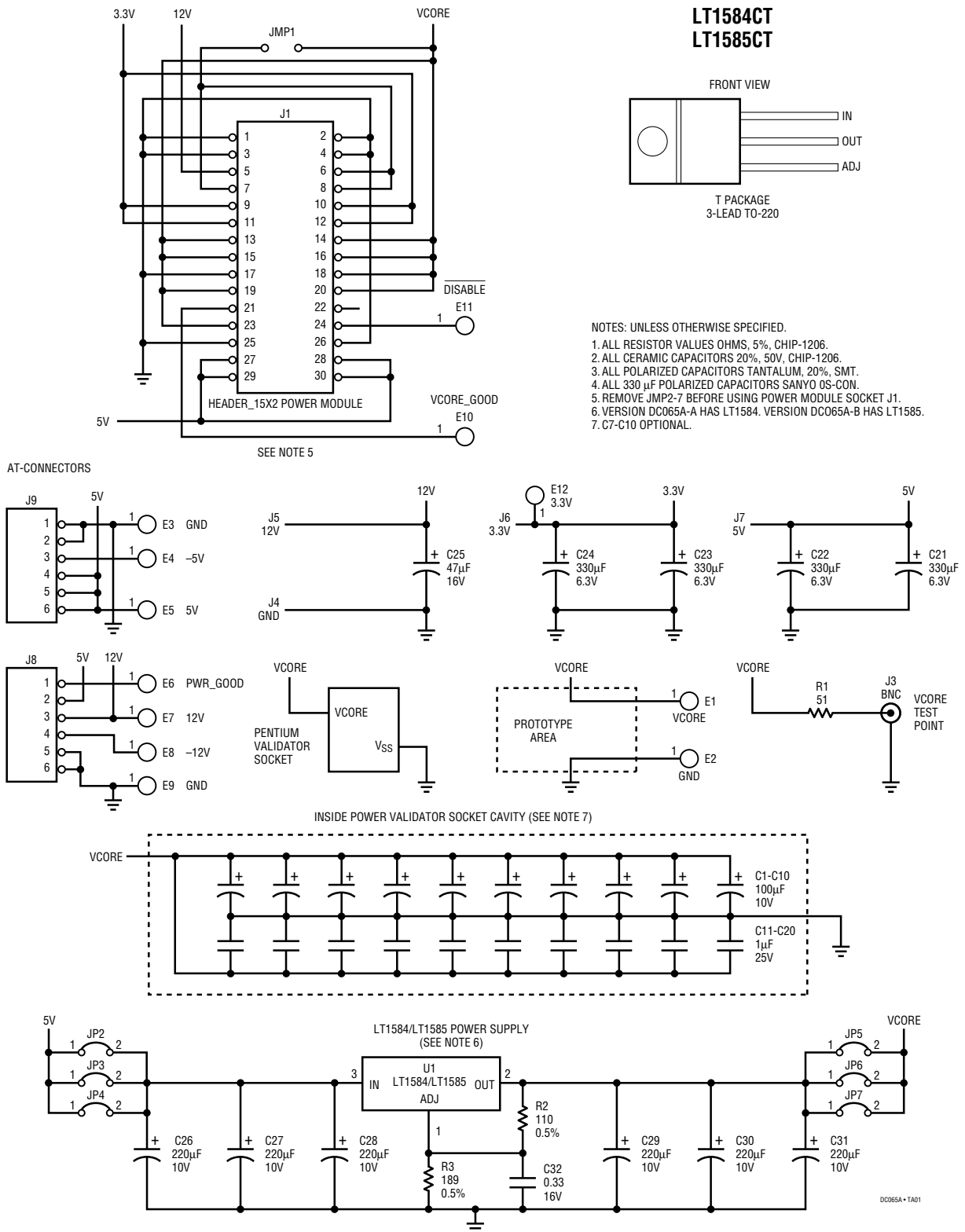


Figure 1. Power Validator Motherboard

PARTS LIST

REFERENCE DESIGNATOR	QUANTITY	PART NUMBER	DESCRIPTION	VENDOR	TELEPHONE
C1-C6	6	TPSD107M010R0100	Cap., Tantalum, 100 μ F, 10V, 20%	AVX	(803) 946-0690
C7-C10	4		Optional		
C11-C20	10	12063G105ZAT2A	Cap., Y5V, 1 μ F, 25V	AVX	(803) 946-0362
C21-C24	4	6SA330M	Cap., OS-CON, 330 μ F, 6.3V, 20%	SANYO	(619) 661-6835
C25	1	TPSD476M016R0150	Cap., Tantalum, 47 μ F, 16V, 20%	AVX	(803) 946-0690
C26-C28	3	TPSE227M010R0100	Cap., Tantalum, 220 μ F, 10V, 20%	AVX	(803) 946-0690
C29-C31	3		Optional		
C32	1	1206YC334KAT2A	Cap., X7R, 0.33, 16V, 10%	AVX	(803) 946-0362
E1-E12	12	1502-2	Terminal, 2-Turret, 0.092"	KEYSTONE	(718) 956-8900
JMP1-JMP7	7	TSW-102-07-G-S	Jumper, 0.100", 2-Pin	SAMTEC	(800) 726-8329
J1	1	1-102567-3	Header, Shrouded, 15 x 2, 30-Pin	AMP	(717) 564-0100
J2	1	916560-2	Socket, PGA, ZIF, 320-Pin	AMP	(717) 564-0100
J3	1	227699-3	Con., PC-MNT, BNC, 50 Ω	AMP	(717) 564-0100
J4-J7	4	575-4	Jack, Banana, .175-ID, Low Profile	KEYSTONE	(718) 956-8900
J8, J9	2	15-48-0406	Header, 6-Pin, Std-AT	MOLEX	(408) 946-4700
R1	1	CR32-510J-T	Res., Chip, 51, 1/8W, 5%	AVX	(803) 946-0524
R2	1	CR32-1100F-T	Res., Chip, 110, 1/8W, 1%	AVX	(803) 946-0524
R3	1	CR32-1820F-T	Res., Chip, 182, 1/8W, 1%	AVX	(803) 946-0524
U1*	1	LT1584CT	IC, +V _{REG} , LT1584	LTC	(408) 432-1900
	7	SNT-100-BK-T	Shunt, 0.100cc	SAMTEC	(800) 726-8329
	8		Standoff, #4-40 x 1/2", F/F, Plastic	ANY	
	8		Screw, #4-40, 3/8", Pan Hd, Phil	ANY	
**	1	7021B-MT	Heat Sink, for LT1584	THERMALLOY	(214) 243-4321

* U1 may be substituted with an LT1585CT for 4.6A design, version DC065A-B.

** Heat sink may be substituted with a 7020B-MT for 4.6A design.

OPERATION

PENTIUM POWER DEMANDS

The supply voltage for these processors is clock frequency dependent. The standard Pentium processor has a supply requirement of $3.3V \pm 5\%$, while the Pentium VR processor has a supply spec of $3.3V +5\%/-0\%$. The Pentium VRE processor requires $3.525V \pm 75mV$. In all cases, the CPU can cycle from a standby condition which consumes approximately 200mA to a full load current of approximately 4.0A in 2 clocks or as little as 20ns. The supply must remain within the appropriate voltage limitations at all times, even during these large load transients. Disabling the stop clock modes will not relieve the designer of the need to handle the fast transients. Events such as an "L1 cache miss" will generate transients of similar magnitude during normal operation. As may be imagined, the decoupling network supplying power to the CPU is critical in maintaining a clean voltage supply.

DECOUPLING CAPACITOR NETWORK REQUIREMENTS

For the Pentium VR processor spec, the supply must be designed using a set point of 3.38V with a $\pm 2.5\%$ tolerance. The Pentium VRE processor spec is even tighter. With only $\pm 2\%$ total deviation from the ideal voltage allowed, the magnitude of the transients must be carefully controlled. Some of the error budget must remain for the static tolerances such as line and load regulation, temperature variation and initial set point. Realistically, approximately 45mV peak transient response is obtainable. To achieve this, a large number of low ESR tantalum capacitors must be installed as close to the processor as possible. The microprocessor socket cavity is the best place for these capacitors.

As an absolute minimum, use 6 pieces of a $100\mu F$, 10V AVX type TPS tantalum for a Pentium VR or VRE processor supply. If more height is available, such as with a ZIF socket, it is preferred to use 6 each, $220\mu F$, 10V parts instead. When using the $100\mu F$ parts there is very little margin in the design. Do not reduce the quantity of the capacitors if larger values are used. The ESR specs are the same for the $100\mu F$, $220\mu F$ and $330\mu F$ capacitors. The reason for paralleling 6 caps is to reduce the ESR as well as providing bulk capacitance. In standard $3.3V \pm 5\%$ applications, a slightly larger transient can be tolerated, so

somewhat less capacitance may be used. It is recommended that you use at least 4 each of the $100\mu F$ AVX tantalums. Intel recommends 24 each, $1\mu F$ ceramic capacitors in addition to the tantalum bulk decoupling. These additional ceramics have little effect on the transient response but do effect the amount of high frequency clock noise reflected back onto the supply by the CPU.

DEMO BOARD CHARACTERISTICS

This demo board has provisions for a pair of standard "AT" style power entry connectors for 5V and 12V power input. Also, along the top of the board are provisions for banana plug inputs for 3.3V, 5V and 12V power. The 3.3V is provided in accordance with the Intel module specification and will only be needed for future upgrade designs. It is not connected to the 3.3V output of the onboard regulator or any of the LTC plug-in modules currently available. All input supplies have onboard decoupling capacitors to reduce the effects of long distribution cables. There are also test points for all input and output voltages as well as access to optional "power good" monitor functions. A BNC type connector is provided for monitoring the CPU supply during testing. This line is terminated into 50Ω and it allows measurement of the "core voltage" at one of the socket pins. This point should be connected to an oscilloscope input with a 50Ω BNC cable. It is not necessary to terminate the oscilloscope end at 50Ω as the edge rates are slow enough not to cause any reflections or unusual perturbations.

The onboard LT1584 with its associated heat sink is set up to provide 3.3V at up to 7.0A. The regulator used is an adjustable device with an external divider. The lower resistor of the divider is bypassed with a $0.33\mu F$ capacitor to speedup the regulator transient response time. Fixed 3.3V regulators are available from LTC. However, due to the inability to add a large value speedup capacitor to the internal feedback divider, there is a substantial increase in the transient response time (approximately 2X). A corresponding increase in the number of decoupling capacitors is required. The addition of the 2 divider resistors and the $0.33\mu F$ ceramic capacitor required by the adjustable regulator more than pay for themselves due to the reduction in bulk capacitance that results compared to the fixed voltage parts.

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The board utilizes 6 each, 100 μ F tantalums and 10 each, 1 μ F ceramics on planes located in the processor socket cavity. Also, an area is provided to the right of the socket for additional capacitors, if it is desired to further reduce the transient magnitude. Jumpers JP-2 thru JP-7 permit disabling the onboard regulator if a plug-in module is to be used. The resistance of the jumpers causes a slight degradation of the load regulation as measured at the CPU.

TEST SETUP

Install the power validator in the socket and connect a 5V “silver box” supply to the input connectors. Be sure to observe the proper connector orientation. The connectors are **not** configured the same as on a normal motherboard. Test points adjacent to the connectors correspond to the supply voltages at those pins. The oscilloscope should be connected to the board with a BNC cable. Be careful of potential ground loop problems. In general it is best to use an isolation transformer for the oscilloscope or use isolated probes. This will eliminate several measurement errors that are likely to exist otherwise. For safety reasons, be sure to keep the off-line case grounded. Voltmeters should be connected to the input and output test points. The power validator should be powered up and set according to the instructions provided by Intel. If the demo board’s onboard regulator is to be used, be sure jumpers JMP2 through JMP7 are installed. If you plan to use a plug-in power supply module, remove these jumpers to isolate the LT1584. Also, a fan which provides approximately 100 linear feet per minute of air flow should be aimed at the LT1584 heat sink or the plug-in module. Jumper JMP1 connects the CPU core and I/O power pins on the power module header together. Leave this jumper installed if the CPU you intend to use only requires a single supply voltage. At this point it should be safe to power up the off-line supply.

TEST RESULTS

The results should look like Figure 2. The test conditions were as follows:

$V_{IN} = 5.0V$, $V_{OUT} = 3.30V$. Load steps from 200mA to 4.0A. It should be noted that as the minimum load current is

raised from 200mA to 3.2A and the load delta held constant at 3.8A, the waveform remains essentially unchanged. The transient droop measures approximately 44mV pk. and is nearly symmetrical. Note the offset voltage between the high load and low load condition on the output waveform. This is the load regulation of the regulator including any distribution (I)(R) drops. When using the socketed modules the additional resistance of the connector pins makes the use of remote sense desirable to ensure that the (I)(R) drops are kept under control.

The photo in Figure 3 shows the same transient at 2 μ s/div. There is a fast leading edge droop followed by one short ring. The output then begins to slowly recover toward its final value. The layout techniques utilized here keep

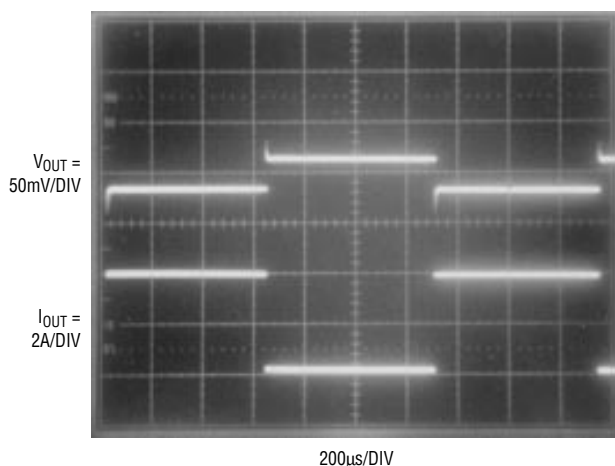


Figure 2. Transient Response

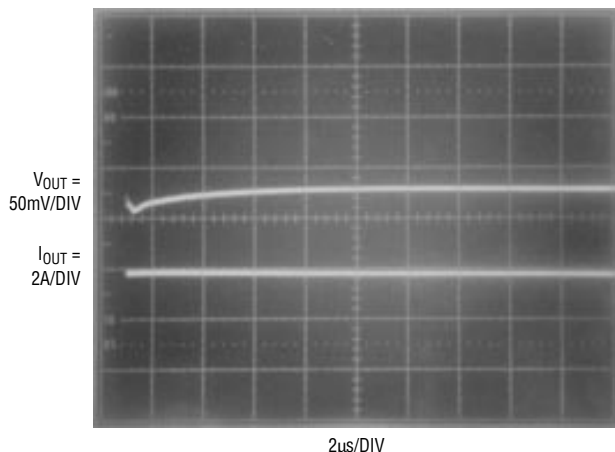


Figure 3. Transient Response

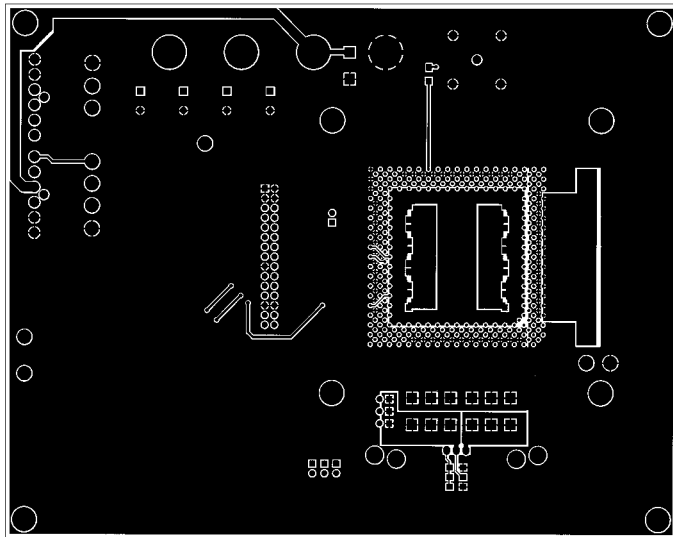
OPERATION

ringing to a minimum. To appreciate the effects of parasitic inductance, try connecting a 100 μ F tantalum capacitor to the area on the right side of the socket and note the difference in transient amplitude, especially the leading edge spike. Now remove the capacitor and solder a couple of inches of 24AWG wire to the capacitor and reconnect it to the power planes. The difference in performance is quite noticeable.

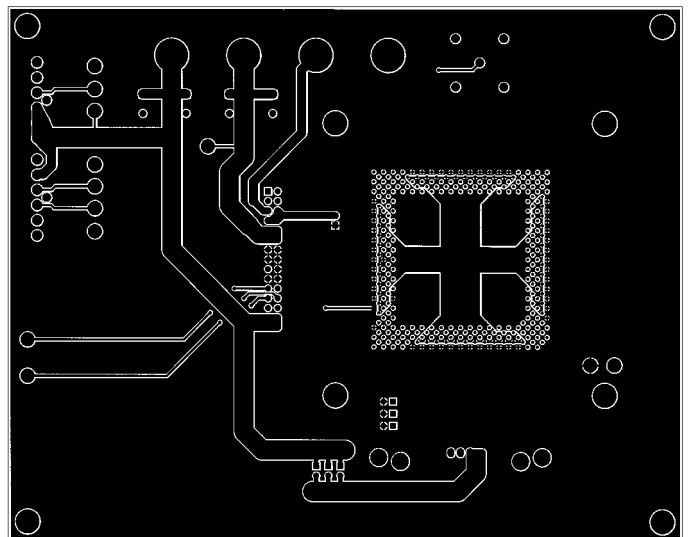
AVAILABLE PLUG-INS

Several additional boards are available for use with the Power Validator demo board. Both linear and switching regulators have been designed and built to comply with the Intel module specification. We anticipate developing additional designs as technology improvements warrant. Contact Linear Technology for further details.

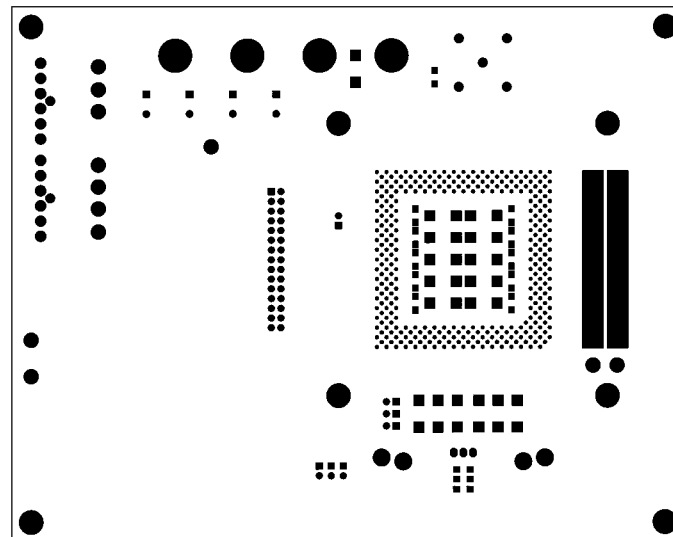
PCB LAYOUT AND FILM



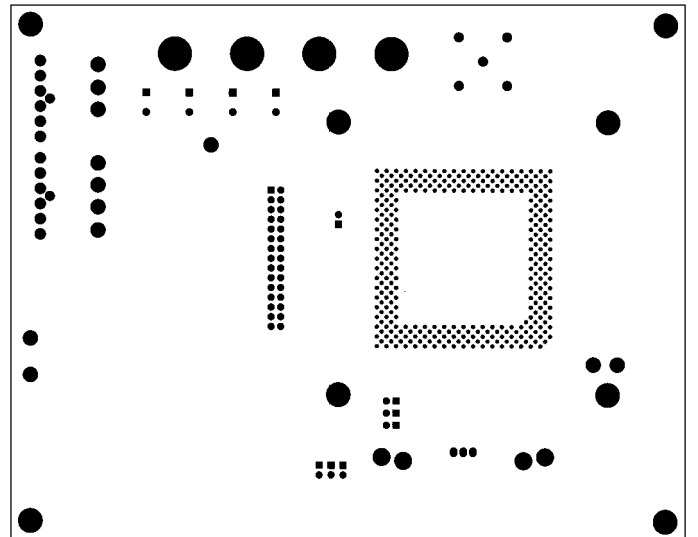
Component Side Copper



Solder Side Copper

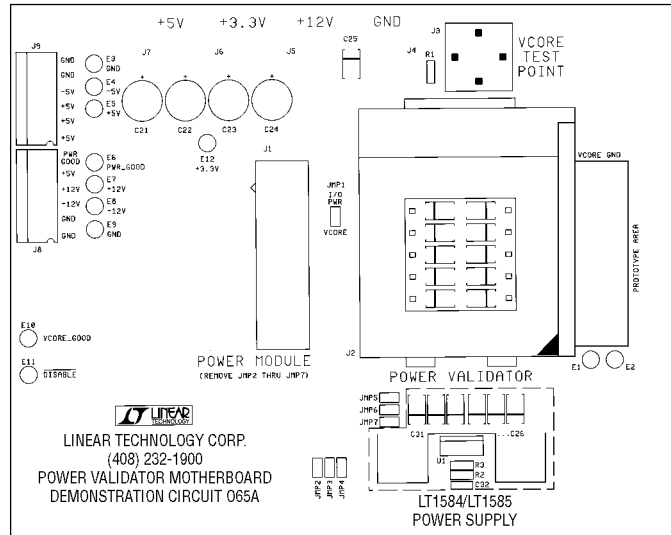


Component Side Solder Mask



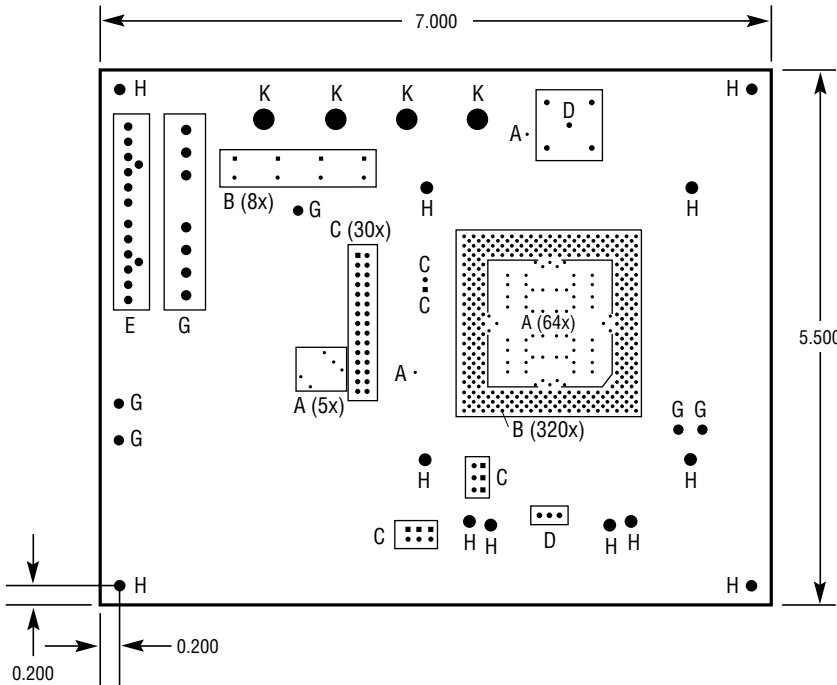
Solder Side Solder Mask

PCB LAYOUT AND FILM



Component Side Silkscreen

PC FAB DRAWING



- NOTES: UNLESS OTHERWISE SPECIFIED.
1. FINISHED MATERIAL IS FR4, 0.062" THICK, 2-OZ COPPER.
 2. PCB WILL BE DOUBLE-SIDED WITH PLATED THROUGH HOLES.
 3. PTH SIZES AFTER PLATING, 0.001" MIN WALL THICKNESS.
 4. USE PADMASTER PROCESS.
 5. SOLDER MASK BOTH SIDES USING PC-401 OR EQUIVALENT.
 6. SILKSCREEN COMPONENT SIDE USING WHITE NONCONDUCTIVE INK.
 7. ALL DIMENSIONS IN INCHES, $\pm 0.005"$.
 8. ALL HOLE SIZES AFTER PLATING, $\pm 0.003"$ MAX.

HOLE CHART		
SYMBOL	DIAMETER	NUMBER OF HOLES
A	0.020	71
B	0.030	328
C	0.040	44
D	0.045	8
E	0.075	14
G	0.094	12
H	0.120	12
K	0.210	4
TOTAL HOLES		493

DC065A • PCB01

DEMO MANUAL DC065A

NO DESIGN SWITCHER

U.S. Area Sales Offices

NORTHEAST REGION

Linear Technology Corporation

3220 Tillman Drive, Suite 120

Bensalem, PA 19020

Phone: (215) 638-9667

FAX: (215) 638-9764

Linear Technology Corporation

266 Lowell St., Suite B-8

Wilmington, MA 01887

Phone: (508) 658-3881

FAX: (508) 658-2701

SOUTHEAST REGION

Linear Technology Corporation

17000 Dallas Parkway

Suite 219

Dallas, TX 75248

Phone: (214) 733-3071

FAX: (214) 380-5138

CENTRAL REGION

Linear Technology Corporation

Chesapeake Square

229 Mitchell Court, Suite A-25

Addison, IL 60101

Phone: (708) 620-6910

FAX: (708) 620-6977

SOUTHWEST REGION

Linear Technology Corporation

22141 Ventura Blvd.

Suite 206

Woodland Hills, CA 91364

Phone: (818) 703-0835

FAX: (818) 703-0517

NORTHWEST REGION

Linear Technology Corporation

782 Sycamore Dr.

Milpitas, CA 95035

Phone: (408) 428-2050

FAX: (408) 432-6331

International Sales Offices

FRANCE

Linear Technology S.A.R.L.

Immeuble "Le Quartz"

58 Chemin de la Justice

92290 Chatenay Malabry

France

Phone: 33-1-41079555

FAX: 33-1-46314613

KOREA

Linear Technology Korea Branch

Namsong Building, #505

Itaewon-Dong 260-199

Yongsan-Ku, Seoul

Korea

Phone: 82-2-792-1617

FAX: 82-2-792-1619

TAIWAN

Linear Technology Corporation

Rm. 602, No. 46, Sec. 2

Chung Shan N. Rd.

Taipei, Taiwan, R.O.C.

Phone: 886-2-521-7575

FAX: 886-2-562-2285

GERMANY

Linear Technolgy GmbH

Untere Hauptstr. 9

D-85386 Eching

Germany

Phone: 49-89-3197410

FAX: 49-89-3194821

SINGAPORE

Linear Technology Pte. Ltd.

507 Yishun Industrial Park A

Singapore 2776

Phone: 65-753-2692

FAX: 65-754-4113

UNITED KINGDOM

Linear Technology (UK) Ltd.

The Coliseum, Riverside Way

Camberley, Surrey GU15 3YL

United Kingdom

Phone: 44-1276-677676

FAX: 44-1276-64851

JAPAN

Linear Technology KK

5F NAO Bldg.

1-14 Shin-Ogawa-cho Shinjuku-ku

Tokyo, 162 Japan

Phone: 81-3-3267-7891

FAX: 81-3-3267-8510

World Headquarters

Linear Technology Corporation

1630 McCarthy Blvd.

Milpitas, CA 95035-7487

Phone: (408) 432-1900

FAX: (408) 434-0507

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