TMS320-F240 CS-MiniDSP Controller Card

Technical Brief

8 September 2008
Manual Revision 1.11
Card Version 1.3

CREATIVE POWER TECHNOLOGIES
P.O. Box 714
MULGRAVE
Victoria, 3170
Australia

Tel: + 61-3-9543-8805
Fax: + 61-3-9543-8802
Email: tech@creativepower.com.au

CS-MiniDSP Manual Revision History

Card Revision 1.0:

No manual produced

Card Revision 1.1:

Version 1.0	-	Initial Release
Version 1.1	-	Major typographical re-work, more complete bug fixes.
Version 1.2	-	Appendix F: Error in test point 1 definition

Card Revision 1.2:

Version 1.3	-	Added J6 pin definitions to Appendix D. Added description for J6 Reset line. Updated Schematics.
Version 1.4	-	Information about plug-in card version included. Minor wording changes.
Version 1.5	-	Updated footers and front page.
Version 1.6	-	Updated misprint in Appendix
Version 1.7	-	Adjusted the contact details

Card Revision 1.3:

Version 1.8	-	Labels altered on the board to reflect new copyright information. Adjusted the contact details
Version 1.9	-	Included details for Plug-In configuration operation and minor updates.
Version 1.10	-	Updated minor typographical error in the Digital I/O and Communications specifications.
Version 1.11	-	Updated minor typographical error in the Mini Bus definition

Table of Contents

TMS320-F240 CS-MiniDSP Controller Board

1.0 The MINI MICRO Concept

The MINI MICRO concept was developed by Bytewyde Systems as a low-cost alternative for developing microprocessor-based industrial controllers.

In essence, the concept is an open-ended standard BUS equivalent set of microprocessor cards, which do not incur the usual cost overheads of back planes and card cages. Unlike fully custom-designed systems, the central microprocessor card will always 'startup', and flexible software support tools are available off-the-shelf. However, unlike BUS based systems, standard MINI cards are relatively low cost, and custom designs can be readily prototyped and incorporated into a system.

All MINI MICRO peripheral cards are small, nominally measuring only 12.7cm by 5.6cm. Each card has three mounting holes, allowing cards to be stacked one on top of the other using head-to-tail mounting supports. A 36-way ribbon cable interconnects between the cards, supporting an 8 bit I/O MINI BUS (similar to the INTEL iSBX microbus). The MINI BUS has address space for up to 24 I/O ports. All standard MINI BUS peripheral cards require only 2 ports to interface to the processor card, allowing for a maximum of 12 I/O cards to be stacked together in any one system.

There are two main processor cards available in the MINI MICRO system, one using a CS-64180 processor and the other using a TMS320F240 DSP. The CS-64180 processor supports up to 64k EPROM, 96k RAM, 2 serial ports, on-card memory management, on-card power supplies and of course the MINI BUS. The TMS320F240 DSP version enables additional features to be made available on a somewhat larger base board. The DSP chip supports 64k x 16bit EPROM, 128k x 16bit RAM, 1 serial port, 8 PWM outputs, 16 analog inputs (10 bits), 16 digital I/O channels, external interrupts, a serial port, a clocked serial port, a JTAG port, on-card memory management, on-card power supplies and of course the MINI BUS. Other standard MINI cards provide digital input/outputs (TTL levels), isolated digital I/O (AC/DC, relays, MOSFETs, Triacs), analog input/output (8 bit and 12 bit), dial-up modems, real time-of-day clock, and 'wake up' data logging.

The use of ribbon cable as the interconnecting bus offers considerable flexibility to the system, since it allows cards not only to be stacked together, but to be mounted to suit an individual system's needs. For example, a keyboard/display card could be mounted on a front panel, and connected to the main MINI MICRO stack by extending and twisting the 36 way MINI BUS ribbon cable. Furthermore, the lack of a card cage means that physically non-standard I/O cards can be accommodated, and even mounted in the card stack if the spacing of the three mounting holes is maintained.

Standard MINI MICRO cards are all CMOS based, supporting the low power concept. The CS-64180 processor card, for example, only requires 50mA of current and the CS-MiniDSP requires 85mA. Where an I/O card must support significant external load (digital I/O perhaps), alternative power supply connections are provided on the I/O card. Furthermore, MINI MICRO cards are specifically designed for industrial applications, and hence factors such as battery-backup of RAM memory, interference free power supplies, etc are designed into the main processor card.

2.0 Overview of the CS-MiniDSP Controller Board

The CS-MiniDSP controller board is the second-generation main processor board of the MINI MICRO card series. It is a low cost, high performance DSP based controller, intended specifically for applications where a discrete BUS based system would be too expensive, and where time/money/resource constraints make a custom design impracticable. The card is designed around a Texas Instruments TMS320F240 DSP chip, which has been specifically optimised for use in digital motor/motion control applications, running from a 20MHz clock oscillator.

The CS-MiniDSP controller card measures 200mm x 73mm. It has 8 major sections: the TMS320F240 DSP processor itself, the on-card memory, the MINI BUS interface, Analog Inputs, PWM outputs, Digital I/O, Communications and ancillary support circuitry. There are two configurations available of the card; the standard version, which is designed to be a standalone DSP-based controller, and the plug-in version, which is designed to plug into a custom-designed motherboard. The standard card is powered from unregulated ±18V DC supplies, and generates all necessary regulated voltages on-card. The plug-in card requires regulated +/-15V and 5V supplies to be provided from off-card, as detailed in Section **Error! Reference source not found.**.

On-card facilities include:

- A socket for a 64k x 16 EPROM
- 128k x 16bit RAM, arranged as 64k x 16bit program RAM, 32k x 16bit external data RAM
- Power-fail circuitry

The card also has the following peripheral interfaces:

- RS-232 serial interface
- 3 wire clocked serial port (can be configured as master in serial peripheral interface)
- 1 off 16-bit TTL digital I/O ribbon connector, supporting 2 off 8 bit I/O banks
- 16 off single ended analog inputs on a ribbon connector
- 8 bit MINI bus interface (INTEL iSBX compatible)
- 4 bit TTL digital input / external interrupt port
- 8 PWM outputs, arranged as 3 off complementary parts and 2 off independent outputs
- On-card voltage regulation
- JTAG port for software development

Figure 2-1 is a functional block diagram of the CS-MiniDSP controller card, showing all major sections.

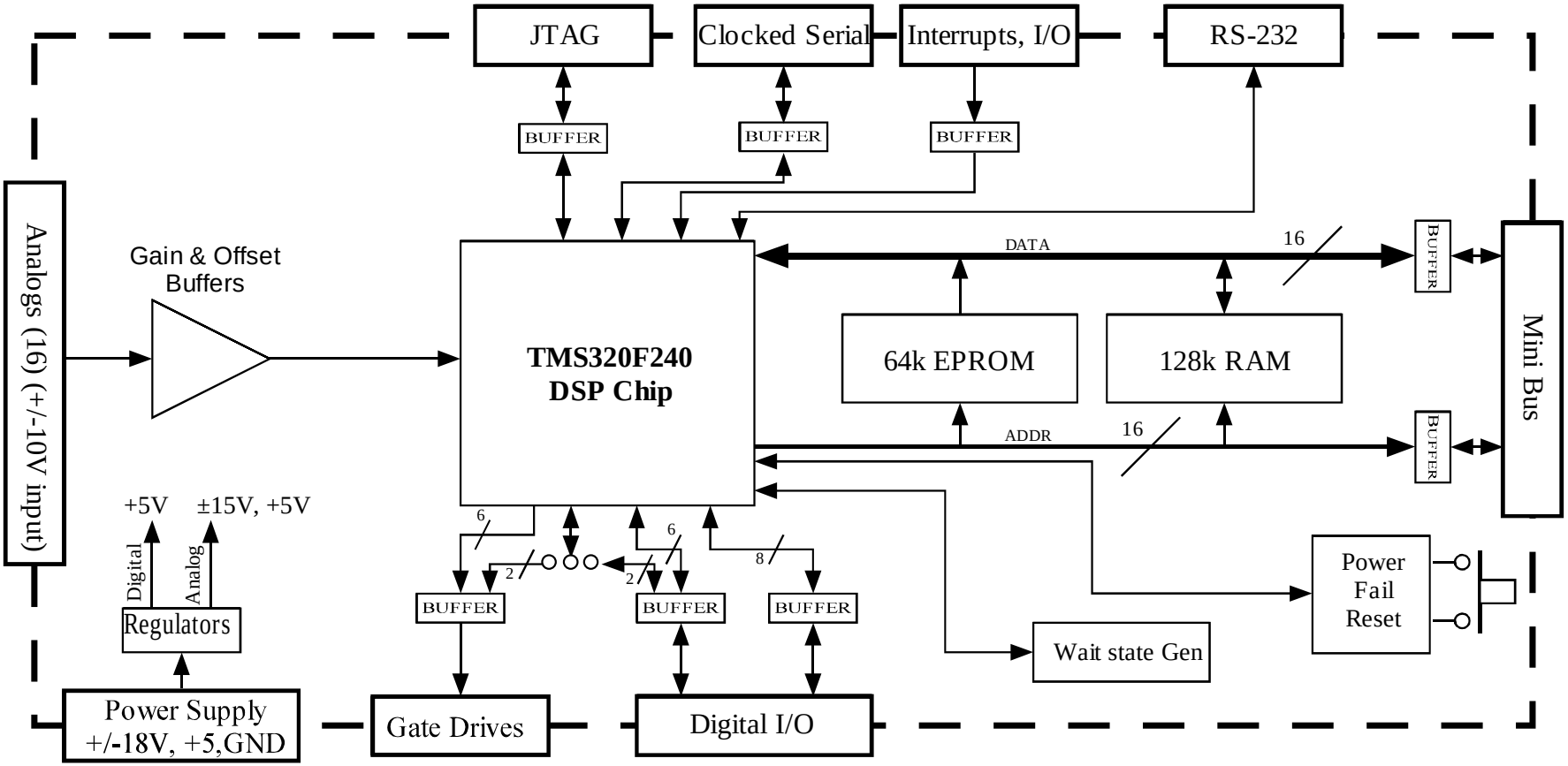


Figure 2-1: Functional Diagram of CS-MiniDSP Controller Board

2.1 Digital I/O

The CS-MiniDSP supports 16 bits of digital I/O, arranged as 2 ports of 8 bits each (ports B & C). Each port can be link selected to be a bank of TTL inputs or outputs, Access is via a buffered 20-way IDC header connector (ribbon cable type connector). Ground and DVCC connections are also brought out to this connector for use by external interface circuitry. Links are used to choose the direction of each port. Two of the pins on port B are linkable to the PWM port to support a fourth PWM phase leg, while Port C has one dual-purpose pin, which can alternatively be used for external triggering of analog-to-digital conversions. These alternative I/O options are hardware link selected on the board.

Four TTL level buffered external interrupts are also provided through a separate 16-way IDC header. Two of these pins can alternatively be software selected as general purpose digital inputs.

2.2 Analog Inputs

The 16 analog inputs accept a ±10V input through a 26-way IDC header connector (normal ribbon cable type connector). These analog inputs are brought in through the dual 10-bit A/D converters with built-in Sample and Hold circuits provided on the DSP chip. This enables two input channels, one on each ADC unit, to be sampled and converted simultaneously. The DSP A/D converter accepts input voltages in the range of 0-5V, and conditioning circuits are provided on-card to translate the incoming ±10V to 0-5V.

2.3 Gate Drive Interface

The CS-MiniDSP controller board contains a 16-way gate drive interface for connection to either a separate gate driver system, or an optical interface board. The port supports 8 PWM outputs, made up of 3 complementary pairs (6 outputs) with programmable deadbands and 2 independent outputs generated by simple compare units. These latter two outputs can alternatively be link selected to be used by port B, as simple digital I/O bits. The PWM outputs are buffered TTL levels. Fault monitoring is supported using the PDPINT external interrupt, which causes the PWM outputs to enter a high impedance state in the event of a fault. This is a hardware-triggered function within the DSP.

2.4 Communications

The CS-MiniDSP controller board provides a simple serial RS-232 interface and a buffered 3-wire serial peripheral interface. The RS-232 interface is available through a 16-way IDC header connector (normal ribbon cable type connector) and the serial peripheral interface is available through a 10-way IDC header. A JTAG port is also provided for debugging purposes through a 14-way IDC header. The communications ports are not isolated from the board.

2.5 Power Supply

The CS-MiniDSP board has on-card regulators to generate the required voltages, +5V digital and ±15V analog. The digital and analog supplies are generated from the one input supply. Reference ±10V signals are available to the Analog Input connector, but these reference signals do not have any significant current capacity.

2.6 JTAG/programming

The CS-MiniDSP controller board has a JTAG interface for programming the DSP's flash ROM. This port can also be used for debugging purposes in conjunction with TMS320F240 ICE Pack.

3.0 Specifications

3.1 Controller DSP Section

Processor	Texas Instruments TMS320F240 DSP
On-card Memory	128k x 16 RAM – created by using 2 off 128k x 8 RAM chips. Addressed as: 32k x 16 Data space and 64k x 16 Program space. 1 x 40 pin JEDEC socket capable of supporting 64k x 16 EPROM. Addressed as: 4 pages of 16k x 16bit in I/O space
Reset	100ms hardware reset generated on-card from power up. Can be triggered via an on-card link (L4).
Interrupts	Supported for Gate Driver Fault, and 3 off external off-card interrupts.

3.2 Mini Bus Interface

Mini Bus Description	8 data bits, 3 address bits, 3 I/O select lines, control signals (similar to Intel iSBX microbus)
Mini Bus I/O Address Space	24 I/O ports on Mini Bus, accessible as 3 banks of 8 addressable ports. Uses I/O space addresses: 0x0C000 – 0x0C017.
Connector – Standard	36 way IDC header, J1.
Connector – Plug-In	36 way IDC socket, J1.

3.3 Analog Inputs

Number of Channels	16
A/D Resolution	10 bits
A/D Conversion Time	6.6us.
Number of A/D Converters	2 8 channels are multiplexed on-chip to each converter.
Definition	16 off single-ended input connections providing conditioned analog inputs.
Input Voltage Range	±10V Maximum
Dynamic Response	Cut-off frequency >150kHz
Connector – Standard	26-way IDC Header, J4, with ±10V, Signal, external ADC conversion trigger and AGND
Connector – Plug-In	26-way IDC Socket, J4, requiring ±15V analog supply, 16 off analog input signals, external ADC conversion trigger and AGND

3.4 Digital I/O

Definition	2 banks of 8 bit TTL digital I/O. 1 bank of 4 bit TTL external interrupts. Two of the bits can be used as digital inputs. Note: direction of I/O is link selected in groups of 8 (links L8, L10). Bits B0 & B1 are shared with the PWM port and Bit C0 is shared with the external analog trigger (links L5, L6, L7).
Digital high input voltage threshold	3.30V
Digital low input voltage threshold	1.10V
Digital outputs rated at	±35mA per bit, ABSOLUTE MAXIMUM
Typical digital high output voltage @ 10mA source	4.34V
Typical digital low output voltage @ 10mA sink	0.33V
Connector – Standard	20-way IDC header, J2. +5V (DVCC) and DGND made available on connector for external use.
Connector – Plug-In	20-way IDC socket, J2. +5V (DVCC) and DGND made available on connector for external use.
Note: Output voltage specified for +5V VCC.	

3.5 PWM Gate Drive Interface

Definition	A 16-way IDC connector, J7, providing 8 PWM outputs. +5V (DVCC) and DGND made available on connector for external use.
PWM Outputs	8 PWM outputs consist of – 3 complementary pairs (6 outputs) with programmable deadband (0-102µs) 2 independent outputs generated by simple compare units, outputs shared with Digital I/O port B (links L6, L7).
Gate Fault Interrupt	Can be connected to PDPINT*, which when unmasked and active low, causes the timer compare outputs immediately to go to a high impedance state. Pull-down resistors on the PWM outputs act to disable the PWM drive signals.
Connector – Standard	16-way IDC header, J7. +5V (DVCC) and DGND made available on connector for external use.
Connector – Plug-In	16-way IDC socket, J7. +5V (DVCC) and DGND made available on connector for external use.

3.6 Communications Interface

Definition	The CS-MiniDSP controller board has an RS-232 communication port, a 3 wire clocked serial port and a JTAG interface.
Configuration	All three can operate simultaneously.
Isolation	No.

3.6.1 RS-232 Interface

Definition	A 16-way IDC connector, J5, providing two-pin serial communications for interface to a standard PC serial port.
Standard	MAX232 generated serial transmit and receive signals are provided on card
Plug-In Version	TTL level serial transmit and receive signals.
Compatibility	Links (L14) provided to enable the board to be configured as a DTE or a DCE. Default configuration is as a DCE.
Connector – Standard	16-way IDC header, J5. DGND made available on connector for external use.
Connector – Plug-In	16-way IDC socket, J5. DGND made available on connector for external use.

3.6.2 Clocked Serial Port Interface

Definition	A 10-way IDC connector, J9, providing 2 wire serial communications with a clocked serial output. +5V (DVCC) and DGND made available on connector for external use. Includes a chip select pin.
Compatibility	Unbuffered 3 wire I/O clocked serial communications protocol.
Connector – Standard	10-way IDC header, J9. DVCC and DGND made available on connector for external use.
Connector – Plug-In	10-way IDC socket, J9. DVCC and DGND made available on connector for external use.

3.6.3 JTAG

Definition & Connector	A 14-way IDC header, J8, which enables the TMS320F240 to interface to the emulator to provide a real-time debugging environment.

3.7 Software

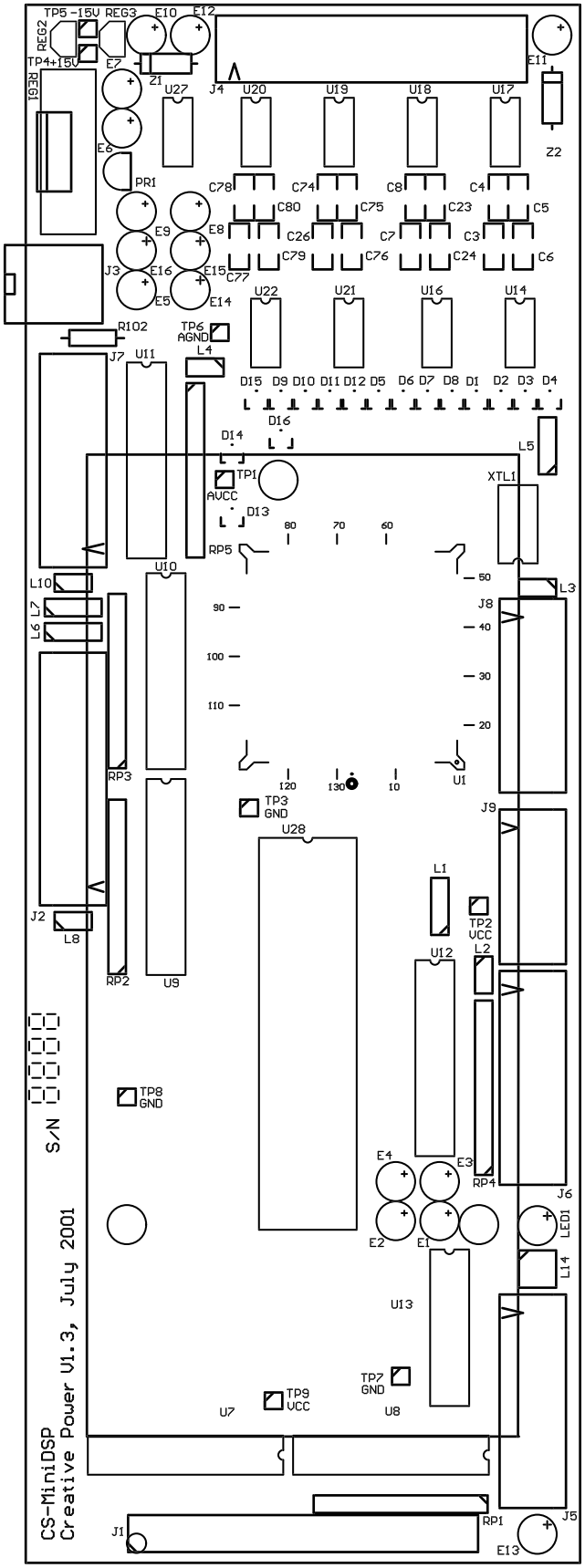
Support Software	Monitor Program, standard library source code, sample programs Texas Instruments: TMS320C2x/C2xx/C5x Optimizing C Compiler

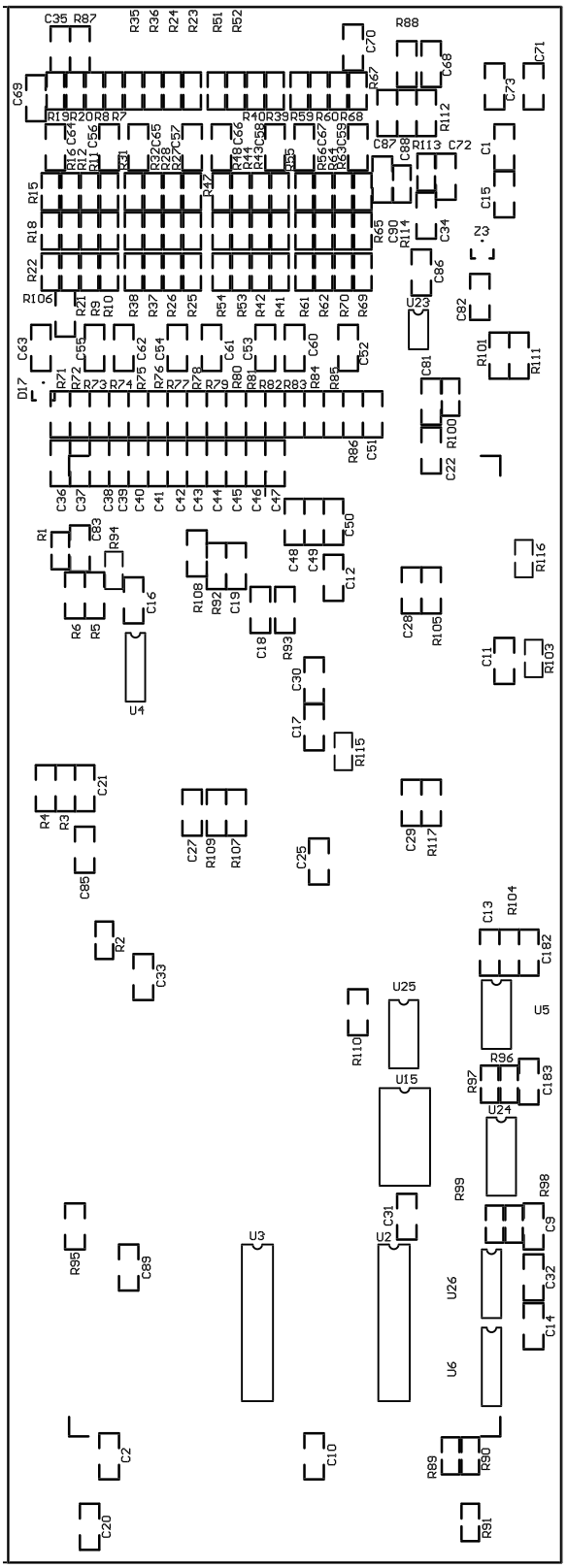
3.8 General

Physical Dimensions	L: 200mm
	W: 73mm
	H: 30mm approx.
Power Supplies Standard Version Only	±18V. On-card 5V switcher generates regulated digital supply (1A capacity). On-card regulators generate ±15V Analog supply (300mA capacity) and +5V Analog reference (generated from +15V by TL431ACZ voltage reference).
Standalone Current Drain	+85 mA (+18V supply) -14 mA (-18V supply) NOTE: Analog inputs must not be floating.
Power Connector	+5V, +18V,DGND, -18V - 4- Pin MASCON.
Environmental	0 – 50°C Ambient operating temperature 5% - 95% non condensing humidity

Appendix

Appendix A Component Layout





Appendix B Link and Test Point Locations