CPT-DTB Card

TMS320F2810 MCU Distributed Thyristor Controller Card

Technical Brief

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CPT-DTB Manual Revision History

CARD VERSION 1.0: Initial Board for prototype purposes.

No Manual Released

CARD VERSION 1.1: Updated for production release

Release 1.00 – Initial Manual Release

Table of Contents

CPT-DTB MCU Based Inverter Controller

1.0 Overview of the CPT-DTB

The CPT-DTB is a low cost, high performance MCU based thyristor controller designed for applications requiring distributed gate driver boards to control an external thyristor stack.

The board is compatible with any DA Series Controller, however this Technical Brief directly relates to the CPT-DA2810 MCU processor card which uses a Texas Instruments TMS320F2810PBK MCU. This MCU has been specifically developed for use power electronic based applications, and the CPT-DTB/CPT-DA2810 combination contains on-card all necessary functions to control a complete thyristor system.

The CPT-DTB card measures 300mm x 155mm.

On-card facilities (with CPT-DA2810 connected) include:

- TMS320F2810PBK MCU processor
- 64k x 16 Flash (128k x 16 Flash on TMS320F2811PBK)
- 1k x 16 OTP ROM
- 4k x 16 Boot ROM
  - Software Boot Tables
  - Standard Math Tables
- 18K x 16 Single Access RAM (SARAM) made up of:
  - L0 and L1: 2 Blocks of 4K x 16 Each SARAM
  - H0: 1 Block of 8K x 16 SARAM
  - M0 and M1: 2 Blocks of 1K x 16 Each SARAM
- Serial Flash Memory with 1Mbit of non-volatile storage
- 1 off Power LED
- 8 off indication LEDs
- 4 off DIP switches
- 2 off isolated digital inputs
- 2 off MOSFET switch isolated outputs
- 1 off isolated SPI ADC interface.
- 1 off Clean Contact output
- 6 off AC current inputs
- 6 off differential AC voltage inputs, (Three-phase + neutral input)
- Differential Digital I/O signals
- Reset/Power-On Circuitry
- Switch Mode Power Supply to generate all on-card supplies
- Power supply operation from 200 - 440VAC 3-ϕ

The card also supports the following peripheral interfaces:

- JTAG interface for software development
- 1 off isolated +5V RS485 serial interface
- 1 off isolated +5V RS232 serial interface or 1 off isolated +5V RS485 serial interface

Figure 1-1 shows a functional block diagram of the CPT-DTB card, illustrating all major sections.

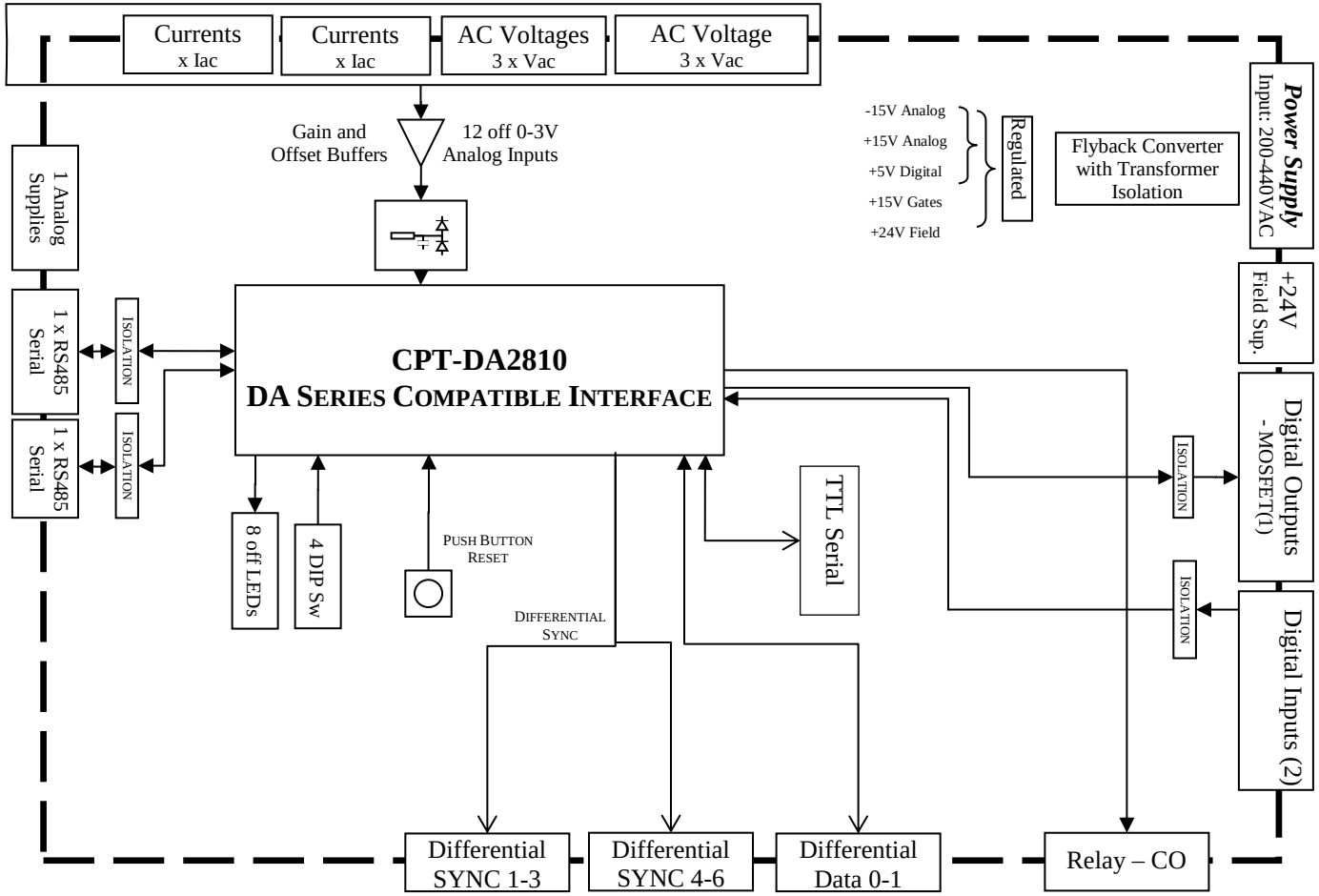


Figure 1-1: Functional Diagram of CPT-DTB Inverter Controller Board

1.1 Analog Inputs

The TMS320F2810 MCU has 16 off ADC inputs that accept voltages in the range of 0-3V. The analog inputs are divided into two banks of 8 (ADCINA0-7 and ADCINB0-7). Each bank feeds into an 8 to 1 analog multiplexer with a sample and hold circuit. The outputs from the two sample and hold circuits are fed directly into a single 12-bit ADC Module. The ADC module can interleave ADC conversions between the two banks to achieve a "pipelined" conversion process. This reduces the overall time required for "simultaneous" conversions. The maximum total conversion time for each ADC unit is 80ns (with a 25MHz ADC clock).

The CPT-DA2810 analog inputs are configured to provide 4 off precision reference inputs for self-calibration and 12 off filtered external inputs to the TMS320F2810.

The CPT-DA2810 card has on-card precision +2.5V and +1.25V references that should be used for calibration of the internal ADC. Each ADC bank has a +1.25V and +2.5V reference fed to channels 6 and 7 for calibration purposes. It is strongly recommended that the ADC be software calibrated for both gain and offset. Please consult the Texas Instruments documentation on the ADC converter for further information. *TMS320x281x MCU Analog-to-Digital Converter (ADC) Reference Guide*, Literature Number: *SPRU060D*.

The twelve filtered analog inputs are interfaced from the CPT-DTB as 6 off AC currents and 6 off AC voltages. Each input on the CPT-DA2810 has a low pass "glitch" filter and a diode clamp circuit before the signals are fed into the MCU.

The six AC current inputs can operate from an off-card LEM module with a nominal voltage input signal, such as supplied from a current transducer. Separate grounds are provided on each current connector so that each current input can be connected using individual twisted pair wires. Common overcurrent detection is provided for both AC current inputs, with the trip level determined by resistor **R146** (IAC1-3)**, R167** (IAC4-6).

The AC voltage inputs are separated into two groups of three. Each group is a differential high impedance circuits, allowing the line-line AC voltages to be measured from a three-phase + neutral system. One input voltage in each group supports a zero-crossing detect circuit, which drives a MCU capture input.

1.2 Digital I/O

The CPT-DTB card supports 6 bits of digital Input, consisting of 4 bits for local I/O and 2 bits interfacing to external circuitry and 18 bits of digital outputs.

The local I/O consists of 8 bits driving LEDs mounted on-card (**H6** – **H13**), 4 bits of DIP switch inputs (**S2**),

The isolated I/O consists of 2 off isolated digital inputs, 1 off isolated MOSFET output and a clean-contact relay output. In addition there are 8 bits of differential outputs that are used for off-card synchronization and data transfer.

The isolated digital inputs are driven using the on-card +24V field supply. A LED indicator is provided on the isolated side of each input as a visual indication of its state.

The 1 off MOSFET output is powered from the +24V field supply. LED indication is provided on the isolated side of the output as a visual indication of its state.

1.3 Communications

The CPT-DTB controller board supports three communication protocols: one off 3.3V-TTL Serial Port or RS485 serial communications interface (SCIA) (software selectable), a synchronous serial peripheral interface (SPI) (connector on the CPT-DA2810) and an isolated RS485 serial communications interface (SCIB).

1.4 On-card memory (CPT-DA2810)

The CPT-DA2810 controller board supports 64k x 16-bit of on-card Flash (128k x 16-bit with the TMS320F2811), 18k x 16-bit of SARAM and a 4k x 16 Boot ROM. Programs can be directly executed from RAM, via the JTAG interface or from Flash. By default, the card runs programs from the flash memory. Links are provided to enable RAM, SCI or SPI program operation.

In addition to the on-chip memory the CPT-DA2810 has a 1Mbit SPI interfaced Flash Memory chip for external data storage.

1.5 Power Supply

The CPT-DTB controller board is available in a standard three phase supply configuration. It contains an on-card switch mode power supply that accepts an input voltage in the range of 210V – 480V AC line-lone. The SMPS generates all necessary on-card supplies as well as an isolated current-limited +24V field supply for off-card use.

1.6 JTAG/programming

The CPT-DA2810 controller board has a JTAG interface for programming the MCU's Flash ROM or RAM. This port can also be used for emulator/debugging purposes using the Code Composer Studio Pod.

2.0 Specifications

2.1 Controller MCU Section

Processor	Texas Instruments TMS320F2810 (optional TMS320F2811)
On-card Memory	64k x 16 Flash Memory (128k x 16 TMS320F2811) 18k x 16 RAM 4k x 16 Boot ROM 1k x 16 OTP ROM
Reset	120ms hardware reset generated on-card from power up and supply failure. Can also be triggered via an on-card push button (**S2**)
Non-Volatile Memory Storage	1Mbit of memory storage using an SPI flash ROM chip Accessed via SPI interface on MCU
Interrupts	2off masked external interrupts (XINT1, XINT2)
Interface	DA Series Compatible

2.2 Analog Inputs

Number of Channels	16	
A/D Resolution	12 bits	
A/D Conversion Time	80ns	
Number of ADC's	1 (8 channels are multiplexed on-chip to form a bank)	
Number of S/H units	2 (each bank has one sample and hold unit)	
Reference Voltages	ADCINA6, ADCINB6	+2.5V
	ADCINA7, ADCINB7	+1.25V

2.2.1 AC Current Inputs - Input

Definition	3 off twisted pair 2-wire connections providing conditioned voltage output LEM compatible AC current inputs. ADCINA0 (IAC1), ADCINA1 (IAC2), ADCINA2 (IAC3)
Input Current Range	1100A rms nominal range (set by off-card CT voltage module) Full Measurement range: -3032A to +3316A
Overcurrent Protection	IAC1-3: Accessible through Test Point **TP25**: I_OC. Interrupt through XINT1. Trigger level set by resistor **R146** **DEFAULT:** 2077.8Arms
Dynamic Response	Cut-off frequency >150kHz
PCB Connections	6-way Phoenix MCV1,5 3.81mm spacing connector. Designed for individual twisted pair connection (labelled as **X3**).

2.2.2 AC Current Inputs - Transformer

Definition	3 off twisted pair 2-wire connections providing conditioned voltage output LEM compatible AC current inputs. ADCINA3 (IAC4), ADCINA4 (IAC5), ADCINA5 (IAC5)
Input Current Range	110A rms nominal range (set by off-card CT voltage module) Full Measurement range: -331A to +362A
Overcurrent Protection	IAC1-3: Accessible through Test Point **TP26**: I_OC. Interrupt through XINT2. Trigger level set by resistor **R167** **DEFAULT:** 226.8Arms
Dynamic Response	Cut-off frequency >150kHz
PCB Connections	6-way Phoenix MCV1,5 3.81mm spacing connector. Designed for individual twisted pair connection (labelled as **X4**).

2.2.3 AC Voltage Inputs - Input

Definition	3 off AC voltage differential analog inputs: ADCINB5 (VAC1), ADCINB4 (VAC2), ADCINB3 (VAC3)
Input Voltage Range	±430 Vac maximum peak
Input Protection	High input impedance, 450kΩ in default configuration
Zero-Crossing Detect	ZX-VAC1 – connects to CAP2 MCU input
Dynamic Response	Cut-off frequency >700kHz
PCB Connections	7-way Phoenix MSTBVA 5.08mm spacing connector (**X1**)

2.2.4 AC Voltage Inputs - Output

Definition	3 off AC voltage differential analog inputs: ADCINB2 (VAC4), ADCINB1 (VAC5), ADCINB0 (VAC6)
Input Voltage Range	±568 Vac maximum peak
Input Protection	High input impedance, 476kΩ in default configuration
Zero-Crossing Detect	ZX-VAC2 – connects to CAP1 MCU input
Dynamic Response	Cut-off frequency >700kHz
PCB Connections	7-way Phoenix MSTBVA 5.08mm spacing connector (**X2**)

2.2.5 Voltage Inputs – Logic Level

Definition	1 off Analog input to SPI interface chip. Isolation provided
Input Voltage Range	0-5V
Input Protection	Isolated – nominal 1000V, current limited measurement.
Dynamic Response	Cut-off frequency >700kHz
PCB Connections	3-way Phoenix MCV1,5 3.81m spacing connector (**X11**)

2.3 Digital Inputs

2.3.1 Isolated Digital Inputs

Definition	2 bits of optically isolated digital inputs, clean contact compatible
Minimum Input Voltage	+12V DC

Maximum Input Voltage	+30V DC
Dynamic Response	0.1ms propagation delay 0-24V rising input 2ms propagation delay 24-0V falling input
Isolation	Optical Isolation Withstand Voltage: 1500V peak (1 minute)
PCB Connections	3-way Phoenix MCV1,5 3.81mm spacing connector, with signal, signal ground and a +24V field supply (**X12**, **X13**)

2.4 Digital Outputs

2.4.1 Differential Outputs (SYNC and DATA Signals)

Definition	8 off RS-422 transmitter digital output signals
Digital Output Source	SYNC1 – SYNC16 sourced from GPIOA0 – GPIOA5 D0 – GPIOD1, D1 GPIOD0
Digital outputs rated at	5mA, ABSOLUTE MAXIMUM
PCB Connection	3 off 6 way Phoenix MCV1,5 3.81mm spacing connectors (**X8 – X10**).

2.4.2 Isolated MOSFET Outputs

Definition	1 off optically isolated MOSFET switched output
I_{source}	2.4mA @24V, through 10kΩ pull up resistor
I_{sink}	1A absolute maximum [Note 1]
Switch Configuration	Single pole, normally open. Direct connection to separate isolated ground
Isolation	Isolation Withstand Voltage to DGND: 1500V peak (1 minute)
PCB Connections	3-way Phoenix MCV1,5 3.81mm spacing connector, with signal, signal ground and a +24V field supply (**X14**)

Note 1: Only one MOSFET output used.

2.5 Communications Interface

Definition	The TMS320F22810 has two off serial communications interface ports (SCIA and SCIB), two off serial peripheral interfaces (SPI and McBSP)
Configuration	SCIA configurable to support either 3V-TTL Level or an isolated RS-422/485 communication mode. Both modes cannot operate simultaneously SCIB is configured as an isolated RS485 serial port

2.5.1 Serial Communication Interface – SCIA – 3V-TTL (CPT-DA2810)

Definition	Two-wire asynchronous serial port (UART) that supports a 16-level, receive and transmit FIFO for reducing servicing overhead. The receiver and transmitter are double buffered with separate enable and interrupt bits **DEFAULT MODE:** 3.3V-TTL level serial connection, providing two pin serial communications for interface to an off-card 3.3V-TTL level to RS232 translation card. This is necessary for interfacing to a standard PC serial port. Activate by driving EN232A signal HIGH.
Communications Port	SCIA
Isolation	None
PCB Connections	4-way MOLEX 0.1" connector with VCC and GND connections (located on **CPT-DA2810:X3**)

2.5.2 Serial Communication Interface – SCIA – RS485

Definition	Two-wire asynchronous serial port (UART) that supports a 16-level, receive and transmit FIFO for reducing servicing overhead. The receiver and transmitter are double buffered with separate enable and interrupt bits RS485A mode providing a multi-drop communications interface using a differential signal serial connection. Activate by driving EN232A signal LOW.
Communications Port	SCIA
Isolation	ACSL-6310 1000V isolation (Please consult the datasheet for this component for full isolation information) Isolated On-Card power supply via (**T6**) NKE0505SC.
Bus termination	Linkable 220 ohm termination (**LK1**)
PCB Connections	4-way Phoenix MCV1,5 3.81mm connector with +5V_ISOA (+5V), differential A/B output and DGND_ISOA connections (**X6**)

2.5.3 Serial Communication Interface – SCIB

Definition	Two-wire asynchronous serial port (UART) that supports a 16-level, receive and transmit FIFO for reducing servicing overhead. The receiver and transmitter are double buffered with separate enable and interrupt bits **DEFAULT MODE:** RS485B mode providing a multi-drop communications interface using a differential signal serial connection
Communications Port	SCIB
Isolation	ACSL-6310 1000V isolation (Please consult the datasheet for this component for full isolation information) Isolated On-Card power supply via (**T7**) NKE0505SC.
Bus termination	Linkable 220 ohm termination (**LK2**)
PCB Connections	4-way Phoenix MCV1,5 3.81mm connector with +5V_ISOB (+5V), differential A/B output and DGND_ISOB connections (**X7**)

2.6 JTAG (CPT-DA2810)

Definition	MCU interface connection, which enables the TMS320F2810 to interface to an ICE to provide a real-time debugging environment
Compatibility	Compatible with IEEE 1149.1 standard for scan-based emulation
PCB Connection	See CPT-DA2810 manual

2.7 General

Physical Dimensions	L: 300mm
	W: 155mm
	H: 50mm approx.
Mounting Arrangement	10 off 3.5 mm holes – please consult the mechanical layout diagram in the appendix for full details
Environmental	-20 – 75°C ambient operating temperature 5% - 95% non-condensing humidity

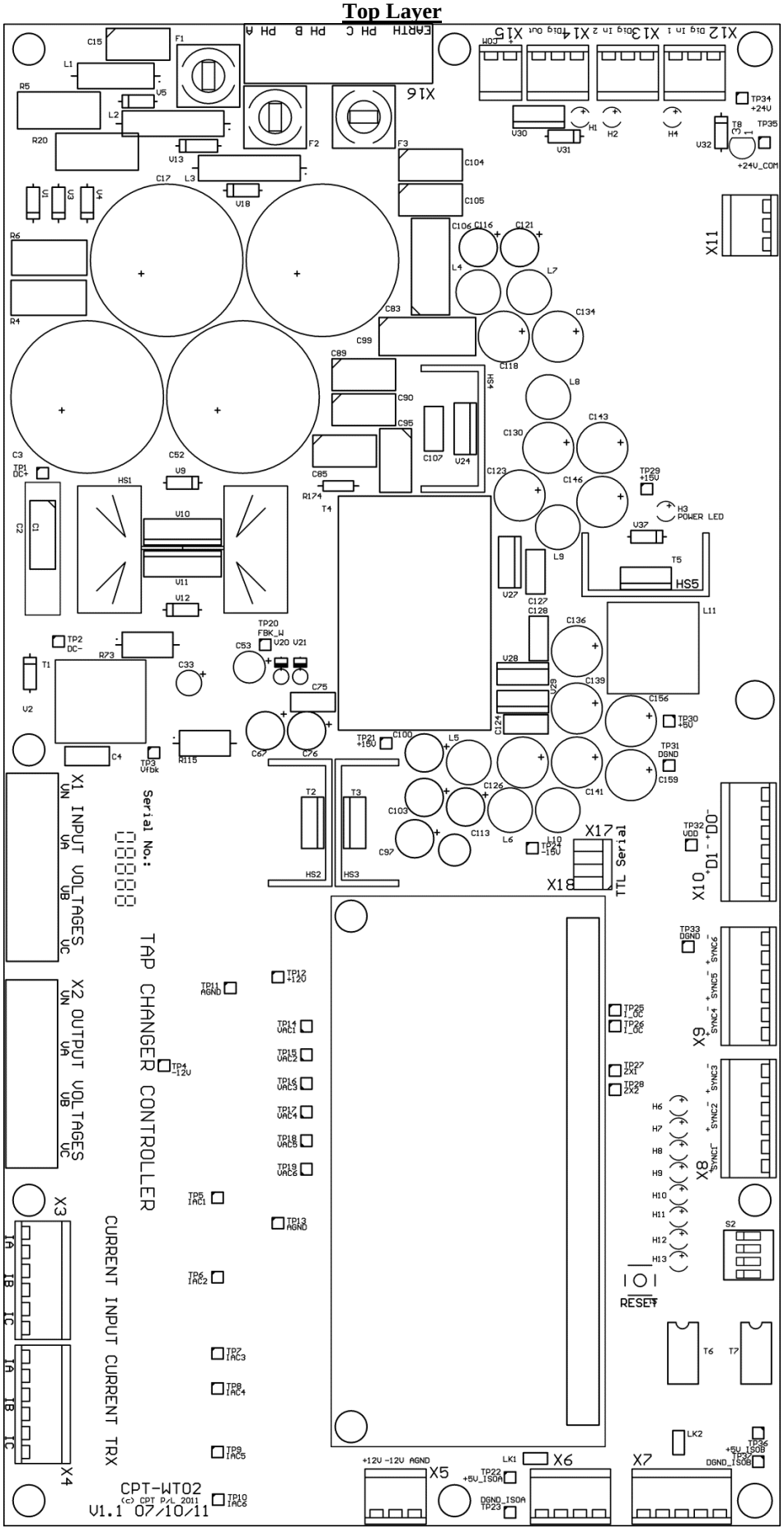
2.8 Power Supply

<table>
<tr><td>Input Voltage Range</td><td colspan="2">200 - 440VAC
(Also available in ULV (50 - 150VDC), LV (85 – 265VAC) and U05 (24VDC) versions)</td></tr>
<tr><td>Standalone Input Current</td><td colspan="2">10-30mA (depending on the active sections within the MCU and supply voltage)</td></tr>
<tr><td>Max Input Power</td><td colspan="2">Approx. 40W</td></tr>
<tr><td>Protection</td><td colspan="2">800mA Input Fuse (F1) to on-card SMPS</td></tr>
<tr><td rowspan="8">Supplies Generated on-card</td><td>GND (EARTH)</td><td>+V1 (+12V) Gate Driver Power Supply</td></tr>
<tr><td rowspan="5">DGND
Digital Ground
(47µH to EARTH)</td><td>+DIG_V (+12V) used for generating digital on-card regulated positive power supplies</td></tr>
<tr><td>+15V Analog Supply</td></tr>
<tr><td>-15V Analog Supply</td></tr>
<tr><td>DVCC (+5V) Digital Supply</td></tr>
<tr><td>3.3V (+3.3V) Digital</td></tr>
<tr><td>DGND_ISOB
Isolated Ground</td><td>+2.5V Analog Reference
VISOB (+3.3V) Communications supply</td></tr>
<tr><td>+24V_COM
(10kΩ to EARTH)</td><td>+24V Field Supply</td></tr>
<tr><td>Input Power Connector</td><td colspan="2">Standard configuration:
7-way Phoenix MSTBVA 5.08mm spacing connector with Active, Neutral, EARTH. (X16)</td></tr>
</table>

Appendices

Appendix A Component Layout

Top Layer



Bottom Layer