

MaxPlus® PowerBlok™

1000 and 2000 Series



High performance
digital direct PWM
servo drives.

The MTS PowerBlok™ is a direct PWM controlled, universal servo-drive, integrated into a Power Hybrid Module. The PowerBlok is designed to be controlled by a direct PWM Servo Controller. The MTS PowerBlok is focused on the demanding needs of design engineers in OEM and systems integration applications. These high performance digital direct PWM servo drives become a “platform” you can configure for all multi-axis applications, whether you’re running brushless servo motors, AC vector servos or linear motors.

For very demanding motion applications, the combination of the PowerBlok digital current feedback, with a PWM Motion Controller enables the user to perform in very high bandwidth applications.

In less demanding, positioning applications, especially high inertia applications, substituting an AC motor with an encoder for a traditional brushless

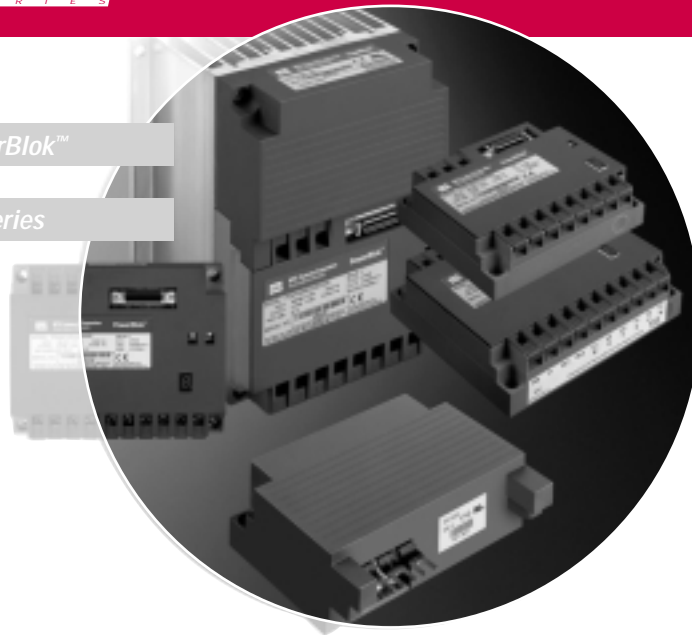
servo motor and gearbox can result in significant cost savings without a performance penalty. PowerBlok gives you the flexibility to make that choice.

PowerBlok is a fully fault protected motor drive. The drive is hardware protected from over-voltage, short circuit, and both instantaneous and average over current conditions. The PowerBlok’s input logic also protects it from faulty PWM signals. All inputs and outputs are digital and optically isolated. Precision motor phase current is optically isolated and processed through a serial analog to digital converter to insure noise free, robust feedback.

PowerBlok is the plug-and-play choice for OEMs and system integrators requiring the flexibility to independently optimize the drive, heat sink and power supply, based on their specific application needs. PowerBlok’s small modular footprint enables it to be mounted to all types of heat sinks, cabinets and enclosures.

MaxPlus[®] PowerBlok™

1000 and 2000 Series



Operation Features

- Direct Off-Line operation
200-480 VAC +/- 10%
47-66 Hz
- 1 to 21.5 kw. Cont. Drive Power Output
Up to 28 Arms continuous
Up to 56 Arms Peak (3 sec)
150% of continuous rating for 1 minute

Command Interface Features

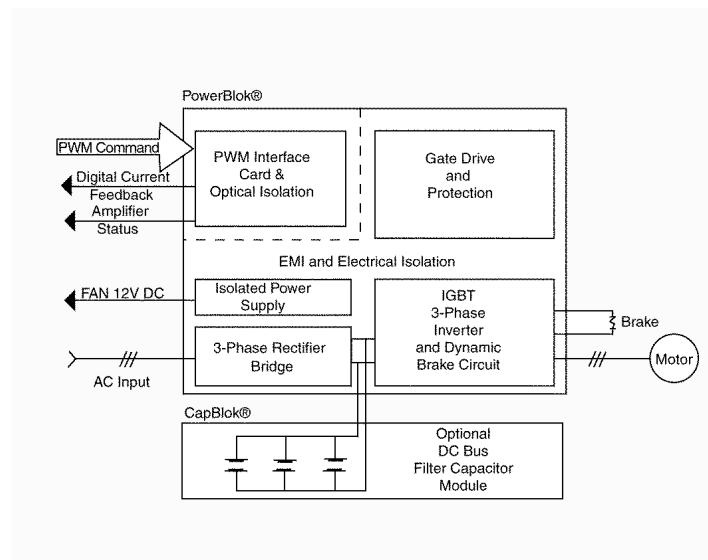
- Optically isolated PWM commands
- Adjustable PWM frequency to 10kHz
- “Dead Time” logic to prevent shoot-through
- Serial A/D motor current feedback
- 12VDC power for external fan
- 7-segment fault/status display

Environmental Features

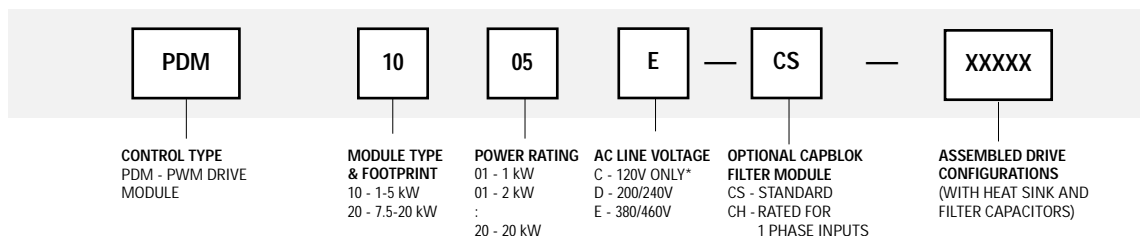
- UL recognition
- CE certification
- Max operating temp: -20 to +70 C (module)
-20 to +50 C assembled Conf.)
- Enclosure: IP-20
- Efficiency 95-97%

Protection Features

- Short circuit and ground fault
- Instantaneous over-current protection
- Over-voltage, under-voltage protection
- Base plate over temperature
- PWM frequency fault
- Serial fault status feedback



Part Number System



PowerBlok Module Only

The first 8 digits of the ordering part number identifies the basic PowerBlok module as described in this data sheet.

PowerBlok with CapBlok™ DC Bus Filter Capacitor

By including the additional capacitor assembly part number to the module ordering number, the module would be supplied with the appropriately rated electrolytic filter CapBlok capacitor assembly. The capacitor assembly and PowerBlok are shipped together in the same box, however final assembly is required. Please refer to the PowerBlok User Manual for assembly instructions.

Assembled PowerBlok Configurations

MTS Automation offers standard assembled drive configurations that include the CapBlok, heat sink, fan and other options. Refer to this selection guide or contact the factory for availability and form factor specifications.

Nominal Drive Ratings

The PowerBlok family of Integrated Drive Modules spans a wide range of applications nominally rated from 1 to 21.5kW at 120VAC, 230VAC and 460VAC line inputs. The nominal drive ratings refer to the maximum continuous power output of the drive on a suitable heat sink. These modules can also be applied in applications requiring higher peak power or higher ambient temperature conditions up to 70°C with the proper thermal design.

Equivalent IGBT Module Ratings

The PowerBlok utilizes state-of-the-art IGBTs and ultrafast recovery diodes to achieve high performance three phase inverter operation. The equivalent IGBT module ratings are available from MTS Automation for each rating to further assist in selecting the proper module for the application. These ratings are also typically used to establish the maximum operating limits of a drive system.

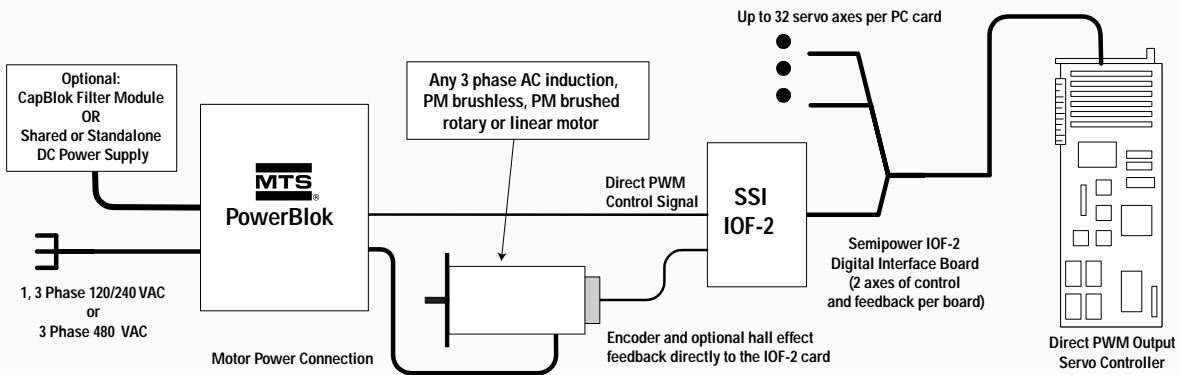
Thermal Considerations

Under each PowerBlok rating, the module thermal impedance and maximum power dissipation are listed to assist in the thermal design. Additional information required to select the right module and heat sink design are: ambient temperature conditions, enclosure ventilation, heat sink thermal impedance and air flow/fan cooling. MTS Automation offers thermal analysis tools to complete an optimized thermal and heat sink design.

Single Phase Operation

The PowerBlok can be applied in single phase AC input applications by connecting two of the 3-phase input terminals. Derating may be required depending on the capacitance and ripple current rating of the DC bus filter capacitor design. MTS Automation offers two versions of its CapBlok module. The “CH” version provides the extra capacitance necessary for single-phase applications up to 2kW shaft power.

PowerBlok System Components and Connections

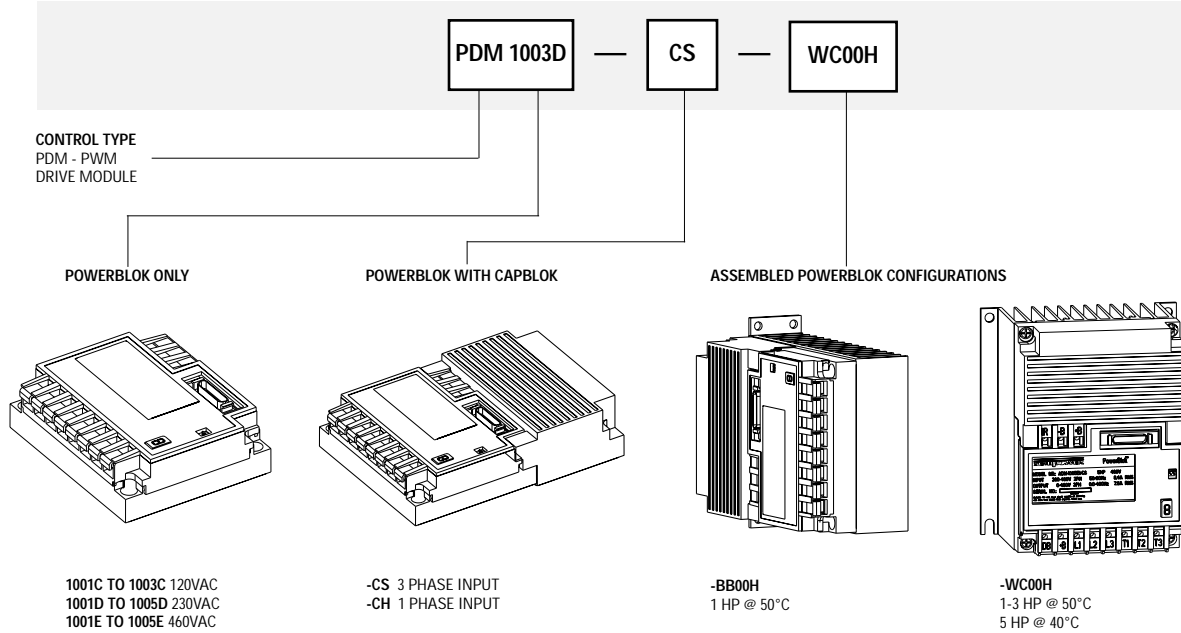


Note: We have chosen the Delta Tau PMAC2 as a working example of a PWM Motion Controller interfacing to the MTS PowerBlok.

System Specifications

Parameter	Rating	Conditions
Environmental		
Enclosure	IP-20	PDM 1000 Series Module and CapBlok
	IP-20	PDM 2000 Series Module and CapBlok
	IP-20	PDM 1000 Series Assembled Drive Config
	IP-20	PDM 2000 Series Assembled Drive Config
Max Operating Ambient Temperature	-20 to +70°C	Module with Sufficient Heat Sinking
	-20 to +50°C	Assembled Drive Configurations
Max Substrate Temp	+90°C	Thermostat Protected
Storage Temperature	-20 to +100°C	
Humidity	10 to 95%	Non-Condensing
Altitude	1000m (3300 ft.)	Maximum for Full Rating
Altitude Derating	2% for every 330m (1000ft)	Not Rated for Use Above 4000m (13200ft)
Vibration	IEC68-2	
Electrical		
AC Line Input Freq	47 to 66Hz	
	97%	5-20kw Ratings
Efficiency	95%	1-3kw Ratings
PWM Frequency	0-10 kHz	User adjustable, PWM frequencies above 5kHz may require module power derating under some conditions
Protection Functions	Instantaneous Over Current, Ground Faults, Short Circuits, Over-Voltage, Under-Voltage, Substrate Over Temp, PWM Frequency Fault	

Series 1000 Standard Configurations and Ratings



PowerBlok Technical Specifications

PowerBlok Module Type Number	Units	1001C	1002C	1003C	1001D	1002D	1003D	1005D	1001E	1002E	1003E	1005E
Output Power Ratings												
Drive Power ¹	kW	0.75	1.40	2.00	1.40	2.70	3.80	6.00	1.40	2.70	3.80	6.00
Motor Shaft Power ²	kW	0.59	1.10	1.60	1.10	2.10	3.00	4.80	1.10	2.10	3.00	4.80
Cont. Current-RMS ³	A	4.00	7.20	10.40	3.60	6.80	9.60	15.20	1.80	3.40	4.80	7.60
Peak Current*-RMS	A	8.00	14.40	20.80	7.20	13.60	19.20	30.40	3.60	6.80	9.60	15.20
Input Ratings												
AC Input Line Voltage**	VAC	120V ± 10%			200/240V ± 10%			380/480V ± 10%				
VAC Input Freq.	Hz	47 to 66 Hz			47 to 66 Hz			47 to 66 Hz				
PWM Freq.	kHz	User Defined (0-10kHz)			User Defined (0-10kHz)			User Defined (0-10kHz)				
Module Thermal Ratings												
Temp Range	°C	20 to +70°C			-20 to +70°C			-20 to +70°C				
Power Dissipation	W	32.00	57.00	76.00	35.00	64.00	94.00	137.00	49.00	77.00	101.00	140.00
Thermal Impedance	°C/W	.04°C/W			.04°C/W			.04°C/W				
Module Dimensions	mm	122 x 37.5 x 100mm										

1 Drive Power (kW)=(Input Voltage rms)*(Cont Current rms)*SQRT(3)

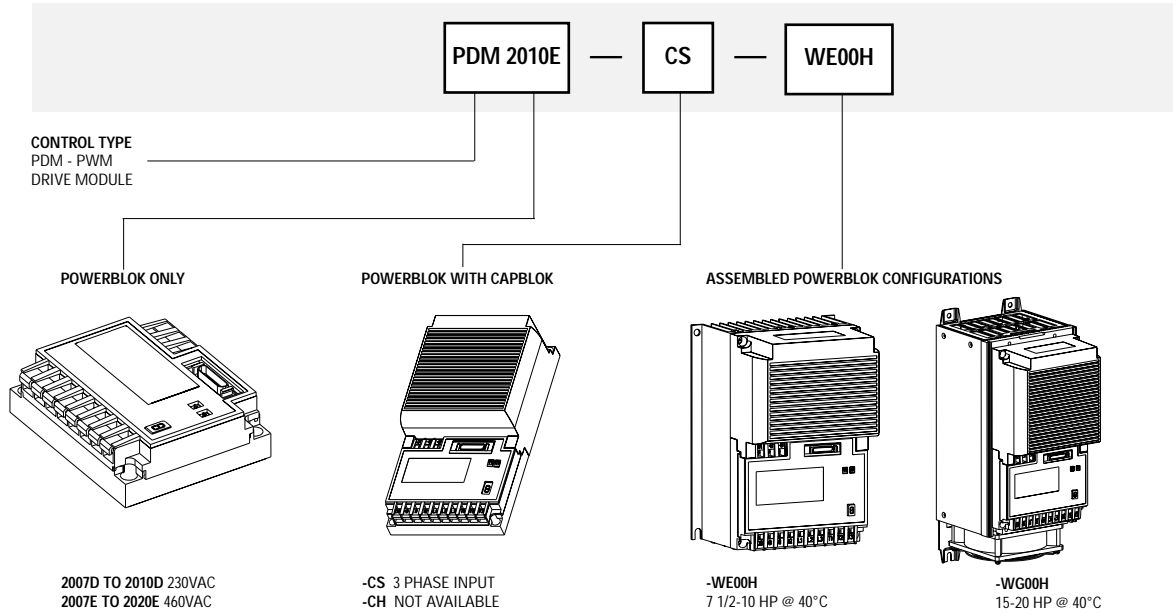
2 Motor Shaft Power (kW)= (RMS Input Voltage)*(RMS Cont Current)*SQRT(3)*(typical motor power factor)*(typical motor efficiency)

3 Rated stall current is 75% of continuous current when the stall condition exceeds 1 minute.

* Full peak current available for up to 3 secs, 150% of continuous current available for up to 1 minute.

** An external capacitor assembly is required for direct off-line operation. Heatsinks, capacitors, and power dump resistors are specified by the load and duty cycle. Please consult MTS Automation for assistance in specifying these components. MTS Automation also has a variety of pre-engineered systems available.

Series 2000 Standard Configurations and Ratings



PowerBlok Technical Specifications

PowerBlok Module Type Number	Units	2007D	2010D	2007E	2010E	2015E	2020E
Output Power Ratings							
Drive Power ¹	kW	8.70	11.20	8.80	11.20	16.70	21.50
Motor Shaft Power ²	kW	6.90	8.80	6.90	8.80	13.10	16.90
Cont. Current-RMS ³	A	22.00	28.00	11.00	14.00	21.00	2.00
Peak Current*-RMS	A	44.00	56.00	22.00	28.00	42.00	54.00
Input Ratings							
AC Input Line Voltage**	VAC	200/220V ± 10%			380/480V ± 10%		
VAC Input Freq.	Hz	47 to 66 Hz			47 to 66 Hz		
Module Thermal Ratings							
PWM Freq.	kHz	User Defined (0-10kHz)			User Defined (0-10kHz)		
Temp Range	°C	-20 to +70°C			-20 to +70°C		
Power Dissipation	W	215.00	276.00	192.00	240.00	346.00	436.00
Thermal Impedance	°C/W	.03°C/W			.03°C/W		
Module Dimensions	mm	142 x 37.8 x 116mm					

1 Drive Power (kW)=(Input Voltage rms)*(Cont Current rms)*SQRT(3)

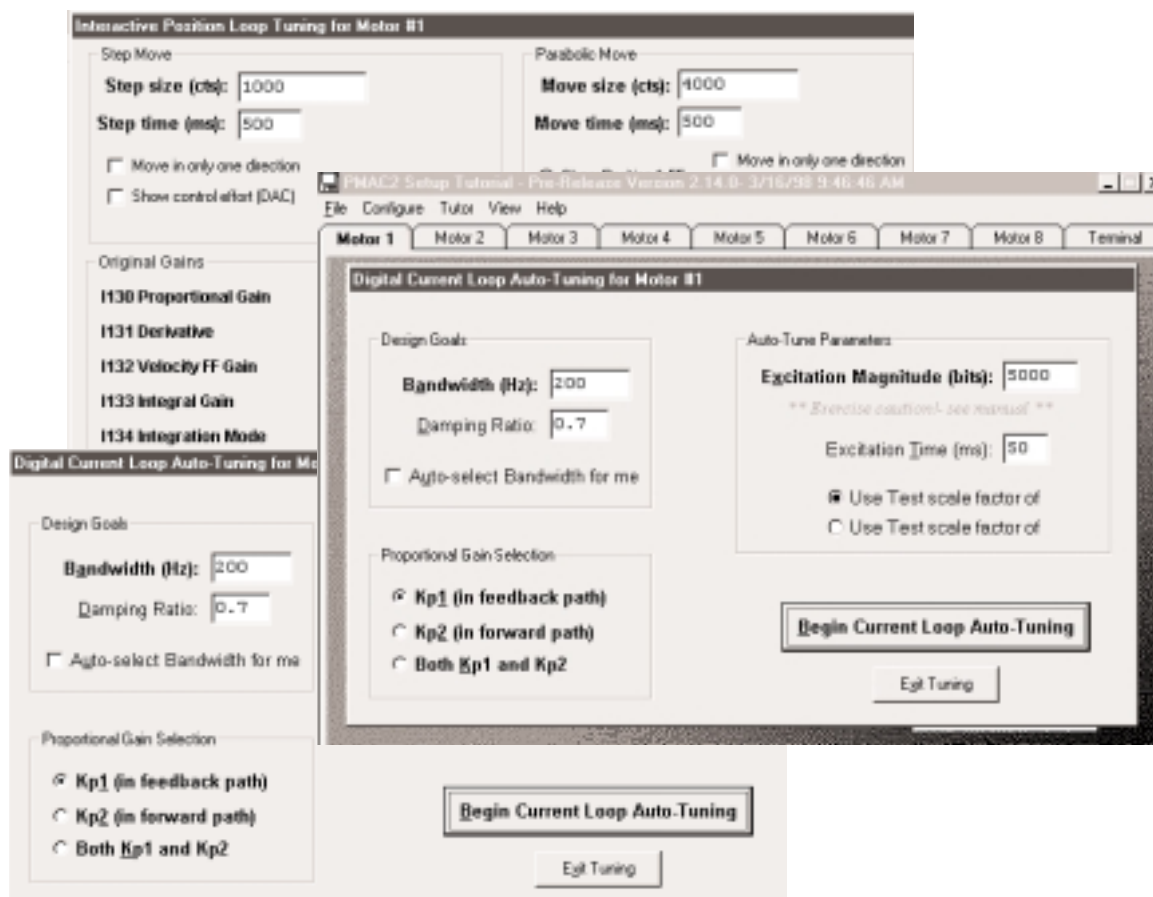
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Delta Tau PMAC2 Setup Software Reference



PMAC2 Setup Software

Delta Tau's PMAC2 servo control card is available with an easy to use, 32 bit software setup package. This menu driven software package facilitates configuring the PMAC2 card to control the PowerBlok in PWM mode. The user is prompted to enter motor, encoder and bus voltage information. This information is used to automatically tune the PMAC2's torque, velocity and position loops. All motor commutation and control is handled by the PMAC2.

Please contact Delta Tau at (818) 717-5600 to receive more detailed information on PMAC2 software. All PMAC2 software is a copyright of Delta Tau Data Systems.

Note: We have chosen the Delta Tau PMAC2 as a working example of a PWM Motion Controller interfacing to the MTS PowerBlok.

Functional Description (Power Hybrid Selection)

Introduction

The PowerBlok module contains all the power electronic protection and interface circuits required to precisely drive AC induction and DC Brushless motors in a variety of applications. Each section of the drive has been carefully engineered for utility, ruggedness and performance in a wide range of operating conditions. As a whole, they form a flexible, reliable motor drive platform for almost any application.

3-phase Bridge Rectifier

A rugged, avalanche-rated, 3-phase bridge rectifier / converter is provided to rectify the 1-phase or 3-phase AC line and provide a DC bus to the inverter section. Avalanche-rated rectifier diodes improve the reliability by their capability of absorbing significant transient energy without failure, making the PowerBlok virtually immune to externally induced line transients.

Inverter

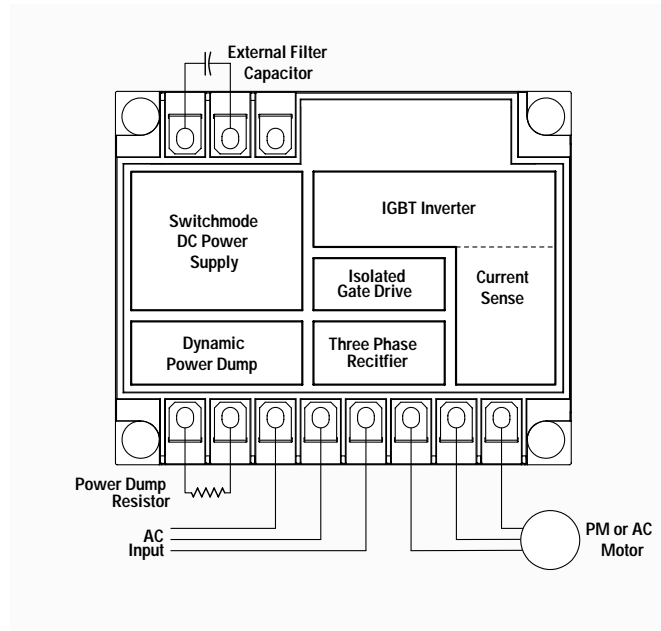
A 3-phase IGBT voltage source inverter is provided to convert the DC bus voltage to a variable voltage, variable frequency AC output via PWM modulation. State-of-the-art fast switching IGBTs and ultrafast freewheeling rectifiers, in a 6-transistor inverter topology, are used to provide high performance control with low losses.

Motor Phase Current Sensing

Accurate, stable phase output current sensors measure the actual motor output currents for precise control. Currents are sampled such that switching transients and noise are rejected for smooth noise-free current regulator operation. Current sensors are factory calibrated and require no user adjustment.

Dynamic Brake Chopper

A single-transistor dynamic brake chopper with freewheeling catch diode is provided to regulate the DC bus voltage during rapid deceleration of large inertial loads. The braking resistor is not provided — it must be appropriately sized and applied externally when it is required. Details for selecting the proper braking resistor may be found in the PowerBlok User's Manual.



Switched Mode Power Supply

An off-line transformer isolated flyback converter powers the internal circuits, interface boards and cooling fan. It operates off the DC bus, and so stays alive even during momentary power outages and surges, and allows a clean, worry free source of bias power.

Gate Drive

An optically isolated Gate Drive buffer array translates the PWM commands into appropriately scaled IGBT drive signals to reliably produce the PWM power waveforms required. IGBT switching speeds, losses and dv/dt's are controlled by appropriate Gate Drive circuit design techniques for trouble-free, low noise inverter operation.

Fan Power Supply

The on-board flyback converter generates power for external accessories. A switched +12V is provided to operate a DC brushless cooling fan if needed to control the heat sink temperature. Fan power is thermostatically controlled based on power substrate temperature.

Functional Description (Protection Features)

Introduction

The following faults are automatically detected by the PowerBlok hardware and reported to the PMAC2 control card. Some faults cause the drive to shut down to protect itself from damage. All faults can be reset by the PMAC2 card. Power cycling the PowerBlok to reset faults is not required. Please note that while the PowerBlok protects itself from over-voltage, over current, and over temperature conditions, the PMAC2 must be properly configured to protect the motor from damage due to over current or over temperature.

PowerBlok Fault Definitions

- **Watchdog Timer Timeout** - Delta Tau's PMAC2 controller queries the PowerBlok for phase current information four times per PWM cycle. These 2 current signals are sent serially back to the PMAC2. The PowerBlok's PWM interface circuit also uses the timing of this query to determine the presence of a noise-free, properly configured command signal. If the control interface fails, the PowerBlok reports a timeout error.
- **Short Circuit/Ground Faults** - The PowerBlok is protected from short circuit conditions by automatically shutting down without damage to any components. Any output phase may be shorted to another, or the positive or negative side of the DC bus. The PowerBlok will stop operating when the phase current reaches approximately 5 times the current rating of the inverter or brake IGBT. The dynamic brake output circuit is also protected from excessive current. The PowerBlok is protected from ground fault conditions by automatically shutting down without damage to any components. Any output phase can be shorted to ground. The module will stop operating when the ground current reaches approximately 5 times the current rating of the inverter or brake IGBT.
- **Substrate Over Temperature** - The PowerBlok substrate temperature is measured and monitored. If the measured temperature exceeds 92°C, the PowerBlok will stop operating and report a fault. Fan operation via the 12 V DC internal fan power supply is controlled by measurement of the substrate temperature. Fan power is cycled automatically based on this temperature measurement.

- **PWM Frequency Fault** - The PowerBlok's PWM interface logic protects the gate drivers, and IGBTs from damaging switching frequencies. Since switching losses go up as the PWM frequency increases, PowerBlok's may need to be derated from published power ratings in some applications when the user selectable switching frequency is greater than 5kHz. Frequencies above 10kHz trigger a fault.

Error Code Chart

Seven Segment LED indicates the following fault and status conditions:

Fault Code	Description
0	No Fault
1	Average Over Current
2	Watchdog Timer Timeout
3	Motor / Ground Short
4	IGBT Saturation Fault
5	Substrate Over Temperature
6	PWM Frequency Fault
7	Substrate Temp Sensor Fault
8	Control Mode Fault
9	DC Link Under-Voltage
A	DC Link Over-Voltage
b	Logic Power Supply Fault

- **Control Mode Fault** - Delta Tau's PMAC2 controller can be set up to run in a number of different servo control modes. The PowerBlok logic detects this PMAC2 setup error and prevents any drive damage.
- **DC Link Under-Voltage** - The PowerBlok will report under-voltage conditions. If an under-voltage condition exists, the module will stop operating and report a fault condition. An under-voltage condition will not harm the drive. The under-voltage trip point is 170 VDC for 230 VAC rated modules and 340 VDC for 460 VAC modules.
- **DC Link Over-Voltage** - The PowerBlok protects against over-voltage conditions. If an over-voltage condition exists, the module will stop operating and report a fault condition. The module will trip at a bus voltage of 450 VDC for 230 VAC modules and 900 VDC for 460 VAC modules.

Note: We have chosen the Delta Tau PMAC2 as a working example of a PWM Motion Controller interfacing to the MTS PowerBlok.

Functional Description (Control System)

PWM Interface Card

The PWM Interface Card uses a Gate Array that contains all the input and output logic to convert the PWM commands into signals that can be safely sent to the IGBT gate drivers. The card also includes optical isolation circuitry to safely and robustly convert the PWM commands into signals that can be sent to the IGBT gate drivers.

PWM Interface Logic

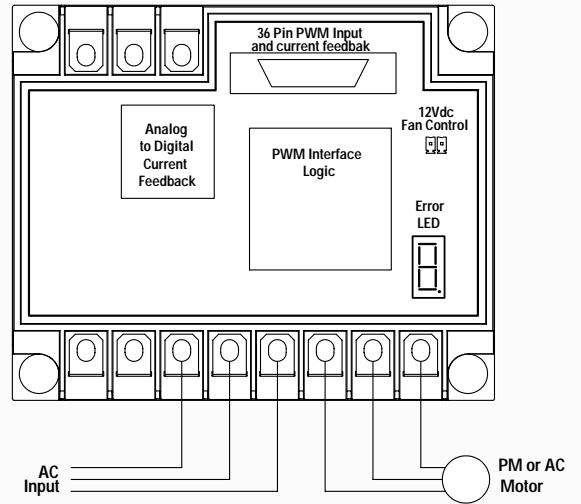
This logic inserts "dead time" into the PWM signal to prevent inadvertently connecting the positive and negative sides of the DC link. The logic also limits the allowable input PWM frequency to 10kHz. Other logic functions include monitoring the substrate temperature and controlling the DC fan power output, and monitoring, decoding and reporting the drive status to the PMAC2.

Error LED

This 7 segment display visually reports PowerBlok status. When the DC link is present, and no error conditions exist, a zero is displayed. The decimal point indicates that the PowerBlok is enabled. Status information is also sent to the PMAC2.

Motor Phase Current Feedback

High fidelity current feedback, critical to any high performance servo system, is guaranteed with the PowerBlok's serial analog to digital converters (ADCs). Two phases of factory calibrated, optically isolated, analog current signals are fed into a serial ADC. The PMAC2 polls each ADC 4 times per PWM cycle. This synchronized current feedback and control is one of the keys to the superior servo performance possible with an all digital PowerBlok / PMAC2 system. This method of current feedback allows the highest bandwidth current response available on the market. Current bandwidths of 800-1000Hz are possible with a thermally efficient PWM frequency of only 5kHz. PWM frequency is user selectable from 0-10kHz. An amplifier status word is also appended to the current feedback serial signal. The PMAC2 decodes this status word, disables the PowerBlok if an error condition exists, and makes this status available to the user control programs running in the PMAC2.

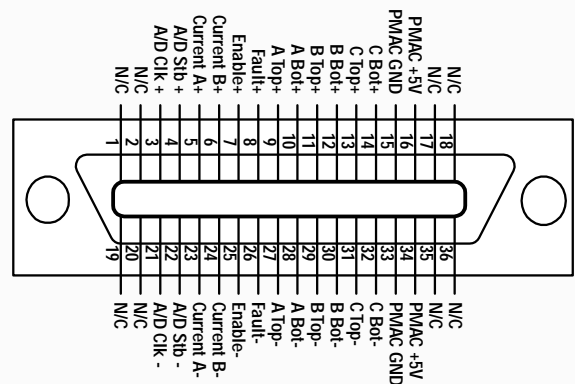


12V DC Fan Output

A 12V DC output is present to power external 12V DC fan(s) to provide forced air cooling of the heat sink the PowerBlok is mounted on. The fan is controlled by continuously monitoring the PowerBlok substrate temperature. The maximum allowable current is shown below.

Module Type	Allowable Fan Start Current	Allowable Fan Run Current	Voltage
Series 1000	600 mA	300mA	12V
Series 2000	1.2A	800 mA	12V

PWM Interface Pin Out



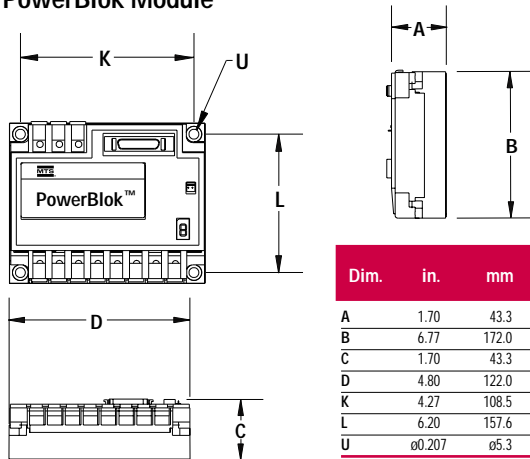
36-pin Mini-D Connector

Note: We have chosen the Delta Tau PMAC2 as a working example of a PWM Motion Controller interfacing to the MTS PowerBlok.

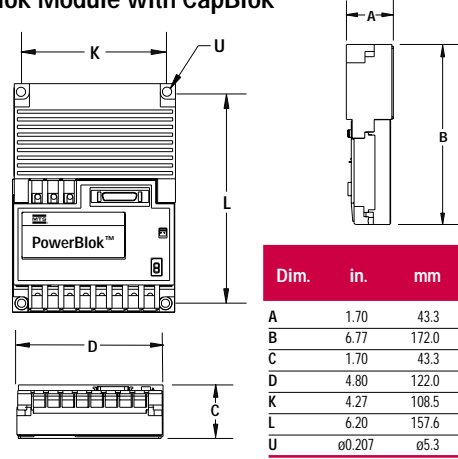
PRODUCT SPECIFICATION

Series 1000 Dimensions

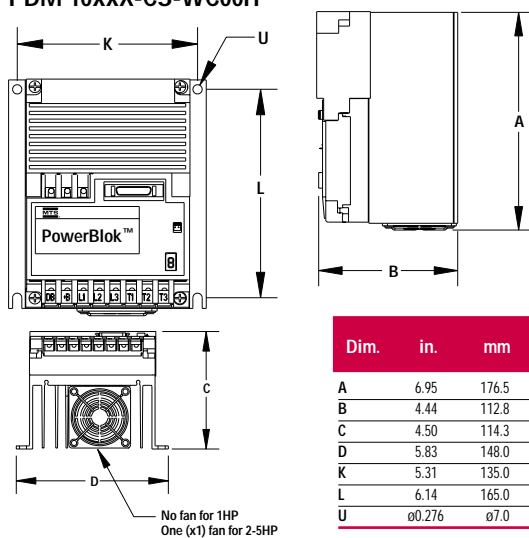
PowerBlok Module



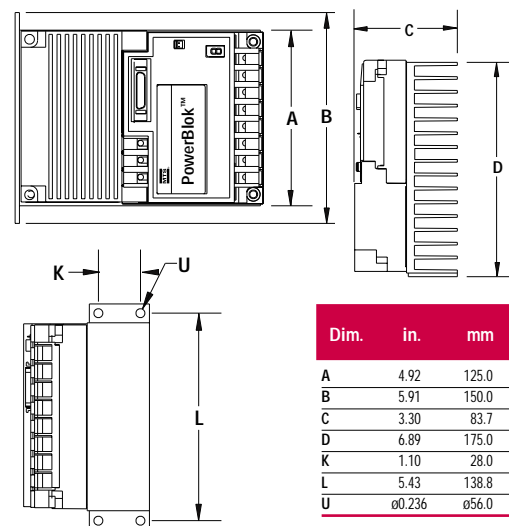
PowerBlok Module with CapBlok



PDM 10xxX-CS-WC00H

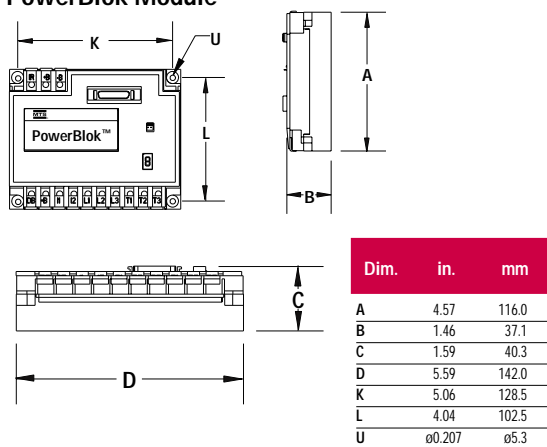


PDM 10xxX-CS-BB00H

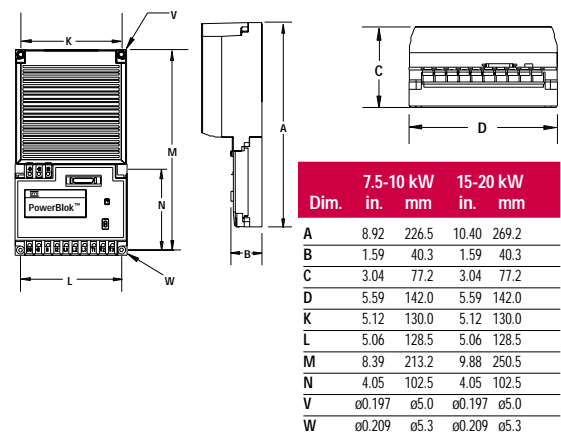


Series 2000 Dimensions

PowerBlok Module

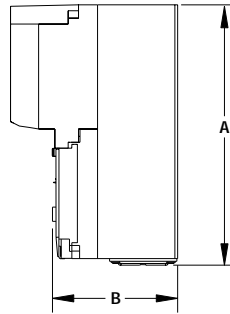
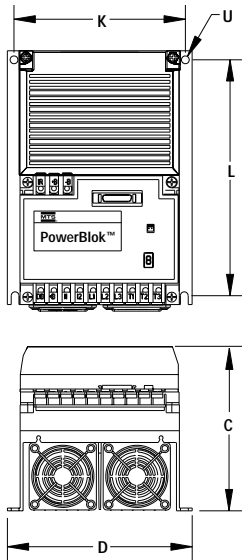


PowerBlok Module with CapBlok



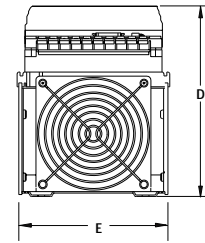
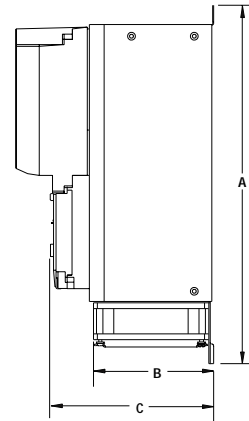
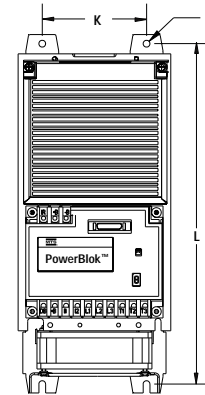
Series 2000 Dimensions

PDM 20xxX-CS-WE00H



Dim.	in.	mm
A	9.21	233.9
B	4.40	111.6
C	5.85	148.6
D	6.50	165.0
K	6.02	153.0
L	8.29	210.5
U	ø0.276	ø7.0

PDM 20xxX-CS-WG00H



Dim.	in.	mm
A	14.61	371.0
B	4.90	124.4
C	6.65	169.0
D	8.11	205.9
E	6.08	154.4
K	4.25	108.0
L	13.87	352.4
U	ø0.276	ø7.0

At MTS Automation our experienced application engineers are ready to work with you to design motor, amplifier and motion control packages to meet your performance, size and durability requirements exactly. For specific ordering information, please visit our web site at www.mtsautomation.com, or call the factory at 1-800-967-1785.

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