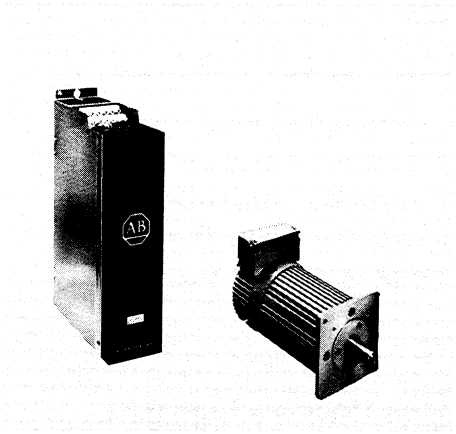

Product Data

Bulletin 1388 DC PWM Servo Controller • Series B

Introduction

The Bulletin 1388 Direct Current Pulse Width Modulated Servo Controller is a dedicated, single axis, AC to DC power converter. It has been packaged to require a minimum amount of panel space while containing, as standard, a number of features required by the machine tool and automated equipment industries.

The Bulletin 1388 will generally be used with a computer controlled, closed loop positioning system to control the position and linear or rotary motion of various machine members on an automated machine. On machine tools, its power ranges will generally be sufficient for machines having main spindle drives rated through 100 HP.

Product Description

The Bulletin 1388 DC PWM Drive converts 3 phase, 50/60 Hz input power to a variable DC voltage and current for controlling the speed and torque of a permanent magnet DC servomotor. The Bulletin 1388 is available in four power levels: 0.75, 1.5, 3.0 and 4.5 kW continuous output. All four power levels are in the same physical size package. The nominal output voltage is 150V DC and the continuous/peak current of each is 10/25, 20/50, 40/100 and 60/150 Amps.

The standard controller package includes all power conversion components, power and control logic, AC line circuit breaker, power line contactor, dynamic braking resistor and shunt regulator. A complete Drive system consists of a Bulletin 1388 Servo Controller, Bulletin 1388 Power Transformer and a Bulletin 1326 DC Servomotor.

All components are mounted in an open framed package with a snap-on cover to protect the logic board components. The controller is intended to be panel mounted in an enclosure and ventilated with filtered or conditioned air. An internal fan is included on 40 and 60 Amp units to pass air over the power heatsink. For further details, refer to Publication 1388-5.1, *Bulletin 1388 Instruction Manual.*

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Operating Characteristics

Velocity Control – On a typical automated machine, the Bulletin 1388 receives a velocity command and an enable signal from a numerical or programmable controller. The servo controller will then output a voltage from 0 to 150V DC that provides a motor speed proportional to the velocity command.

Dynamic Response – The Bulletin 1388 is a high gain servo amplifier that responds quickly to changes in velocity command or torque disturbances. In a typical closed loop system consisting of a Bulletin 1388 and a DC servomotor (with integral tachometer), speed regulation of 0.04% of maximum speed is achievable with a 100% change in load. To attain this performance, the Bulletin 1388 will provide a minimum output of 25% of controller rated current with a .001 volt difference between the velocity command and velocity feedback signal.

The Bulletin 1388 is a full 4 quadrant, regenerative servo controller which allows it to respond almost instantaneously to velocity commands. As the servomotor is decelerated, regenerative energy is forced back into the integral 150V DC power supply. If the motor regenerative energy forces the power supply voltage beyond a preset level, a resistor (R1) is placed across the power supply to dissipate this excess energy. If the energy dissipation demands of the application exceed the controller's capabilities, an external shunt regulator resistor may be connected.

Current/Torque Limiting – The Bulletin 1388 contains an internal current loop. Its main function is to increase the bandwidth and responsiveness of the controller to torque disturbances. In addition, it provides a reference for the current limiting and torque taper functions.

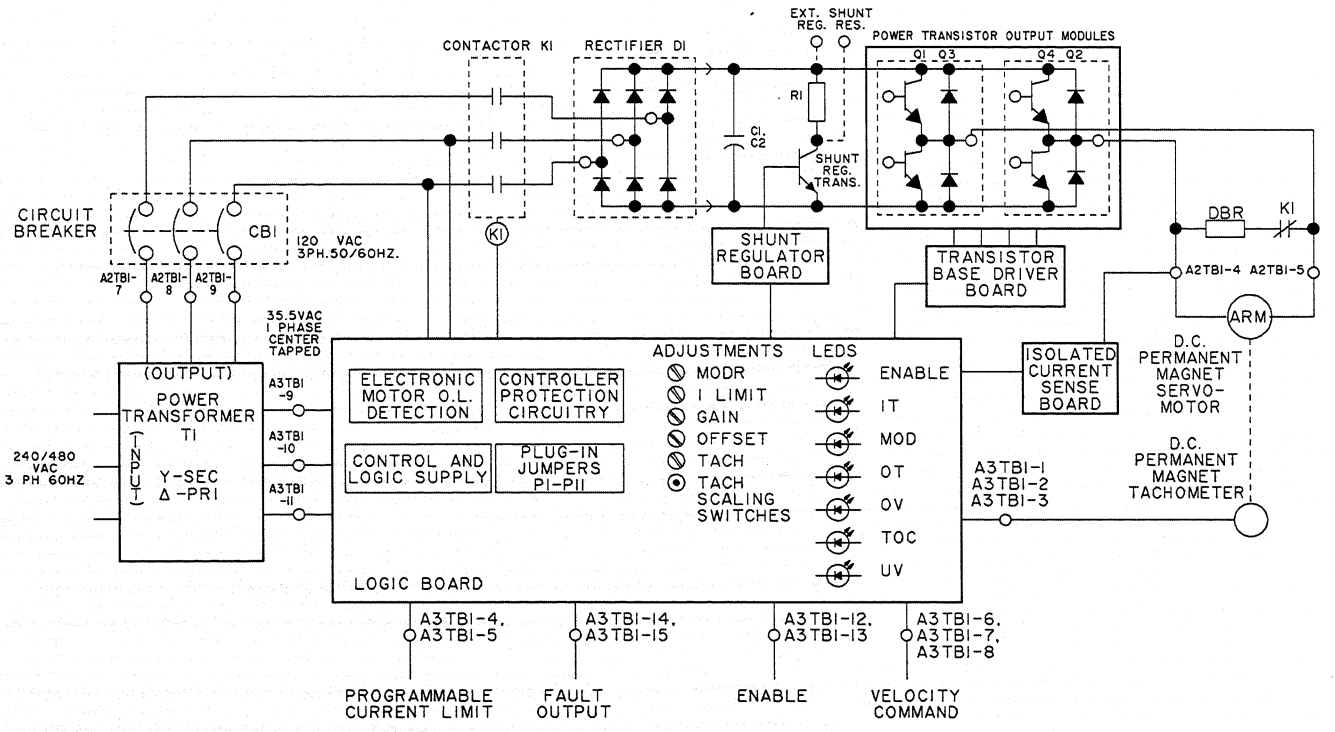
The controller has an adjustable current limiting circuit that restricts the amount of current available to the servomotor from 10 to 250% of the controller's continuous rating. Control of the current limit may also be accomplished externally with the programmable current limit terminals provided.

The Bulletin 1388 contains a torque taper circuit that restricts the DC servomotor to an operating envelope that is within its maximum commutation limit. This circuitry processes the tachometer and current feedback signals from the servomotor and reduces the allowable peak current as the speed increases.

General Description of Operation

Refer to the Bulletin 1388 Servo Controller Block Diagram. 240/480V AC, 3ϕ, 50/60 Hz power is connected to the power input transformer, T1. T1 supplies a 35.5V AC center tapped output to the logic board input terminal block A3TB1 and a 120V AC, 50/60 Hz, 3ϕ output to input power terminal block A2TB1. From power terminal block TB1, 120V AC power is then transferred through the 3 phase input circuit breaker (CB1) to the power line contacts on the contactor, K1. K1 closes when a customer supplied enable signal is received. This charges up capacitor C1 (and C2, present on larger power ratings) through input power rectifier D1 and removes dynamic braking resistor (DBR) from across the servomotor. The nominal bus voltage will be 150V DC under rated load.

During motor regeneration, energy is transferred from the motor to the DC bus, causing the bus voltage to rise. The Shunt Regulator Board monitors the bus voltage and if a preset level is exceeded, the Shunt Regulator Resistor (R1) will be placed across the bus. The excess energy is then dissipated through R1. When the Drive is disabled, resistor R1 also decays the power bus to zero volts



Bulletin 1388 Servo Controller Block Diagram

General Description of Operation *(Continued)*

Depending on the power rating of the Drive, the power transistor output consists of two or four power transistor modules – Q1 and Q2 or Q1 in parallel with Q3 and Q2 in parallel with Q4 – connected in an "H bridge" fashion across the power bus.

The voltage to the servomotor is varied from 0 to 150V DC by switching the output transistors across the 150V DC bus at a fixed frequency of 5,000 Hz and varying the width of the pulses. The output voltage, filtered by the motor inductance, varies in direct proportion to the pulse width. The Logic Control Board generates the appropriate switching signals based on the velocity command input and directs the appropriate transistors to switch via the transistor Base Driver Board. The Logic Control Board also receives current feedback from the Isolated Current Sense Board to provide current limiting and a wider bandwidth. In addition, electronic motor thermal overload and Drive protection circuitry are on the Logic Control Board.

Standard Features

The Bulletin 1388 contains a number of standard features required in an automated machine servo system. These are:

- A Transient Voltage protected input.
- A Power Line / Loop Contactor which opens the AC line to the controller and inserts a dynamic braking resistor across the servomotor armature whenever the Drive is disabled.
- An Integral Circuit Breaker which will open all three AC line leads in the event of a controller Fault condition.
- An Electronic Motor Thermal Overload Detection Circuit which has been designed to closely follow the overload characteristics of a DC servomotor.
- A Standard 150V DC Power Bus Supply that includes an integral shunt regulator.
- A Dynamic Braking Resistor to dissipate the rotating energy of the motor when the Drive is disabled under load.
- A Torque Taper Circuit that automatically reduces the current available to the servomotor as speed increases.

Standard Features *(Continued)*

- A Tachometer Voltage Input Range which will accept from 3 to 135V DC at maximum motor speed.
- Velocity Loop Compensation Components that cover a range of system inertias from .03 to 1.0 in.-lbs.-sec^2. Additional standoffs are included to allow the insertion of custom components.
- A Logic Board that can be quickly removed and easily interchanged with other boards for troubleshooting and diagnostics.
- Four Controller Ratings that are in the same physical package and have identical mounting dimensions.
- Externally Programmable Current Limit that is adjustable from 10 to 250% of the controller rating.

Diagnostic/Protection Features

A number of controller conditions and Fault sensing circuits are integral and standard. The status of these conditions are annunciated on the Logic Control Board. The conditions displayed include:

¤ ENABLE – The application of an enable signal by the machine position controller will cause the ENABLE LED to illuminate.

¤ IT (Current Foldback) – The controller contains a time vs. current overload circuit which monitors the current through each leg of the output bridge. If a fixed-time vs. current-product is exceeded, the IT LED is illuminated. The intensity of the LED varies in proportion to the overload. This condition can either cause a controller Fault, or reduce the current limit of the unit. The mode of operation is jumper selectable.

¤ MOD (Motor Overload Detection) – If the motor overload detection trip point is exceeded, the controller Faults and the MOD LED is illuminated.

¤ OT (Overtemperature) – The controller has thermal switches located on the power heatsink and the shunt regulator resistor. If the temperature of either of these devices is exceeded, the controller Faults and the OT LED is illuminated.

Diagnostic/Protection Features *(Continued)*

- OV (Overvoltage) – The power bus voltage is continuously monitored. If it exceeds a preset level of 265V DC, the controller disables itself and illuminates the OV LED.

- TOC (Transistor Overcurrent) – The current through all four of the power output transistors is monitored. If the current through any of them exceeds a fixed level (greater than 400% of Drive rating), the TOC LED is illuminated and the controller disables itself.

- UV (Undervoltage) – If the power bus voltage drops below 75V DC or the logic supply voltage drops 10% below nominal, a Fault occurs and the UV LED is illuminated.

Adjustments

- Tachometer Scaling – A twenty-turn pot is used to scale the tachometer feedback to the velocity command voltage. This is used in conjunction with three plug-in jumpers that set the proper adjustment range.

- Velocity Loop Offset – A twenty-turn pot is used to compensate for input or velocity loop offset voltages.

- Gain – A single-turn, calibrated pot is used in conjunction with the three sets of velocity loop compensation components to adjust for various mechanical system characteristics.

- Current Limiting – A single-turn, calibrated pot will set the peak current limit as a percent of controller continuous current rating.

- Motor Overload Detection Reference – A single-turn calibrated pot is used to set the electronic motor thermal overload detection and torque taper circuit. In addition, three direct reading switches and plug-in jumpers are set to properly scale the torque taper.

- Adjustment/Set-up – Plug-in jumpers P1 through P11 are used to set and scale various circuits and options.

Options and Modifications

The Bulletin 1388 contains most functions needed in a servo system. Occasionally, an application will require some functions not in the standard controller. These can be accommodated with standard options or customer modifications. Standard options available include:

- Contactor Auxiliary Switch
  A Form C Contact is mounted on the main power contactor and wired to the power terminal block. These contacts can be used in a motor brake control circuit or as an indicator that the contactor has closed.

- Lower Current Output
  For applications where it is necessary to operate small motors (4 to 10 Amp continuous current ratings), the 20 Amp servo can be rescaled to provide 10 Amp continuous/25 Amp peak output. This will allow the motor overload and tapered current limit circuits to work properly on the smaller motors.

- Current or Torque Amplifier Operation
  When the velocity loop is being closed as part of the position control system, the Drive can be configured to operate as a current or torque amplifier. If an analog voltage proportional to motor speed is also supplied, the speed dependent current limit will be functional.

- External Shunt Regulator Resistor
  The internal power resistor that is part of the Bus Voltage Shunt Regulator can dissipate 4,500 watts peak and 50 watts average power. Some applications such as an overhauling load have excessive regenerative energy to dissipate. For these applications, an external shunt regulator resistor rated at 2,000 watts peak, 900 watts continuous can be supplied for customer mounting.

Other types of special requirements will be treated as custom modifications. These could include special velocity loop compensation components, special motor overload or torque taper characteristics, analog outputs proportional to motor current, etc.

Transformers

The Bulletin 1388 must operate from an isolation transformer having a three-phase, 120V AC output and a single-phase, 35.5V AC output. A standard line of open core transformers have the necessary secondaries and terminal connections to operate up to four (4) Drives and include a N.C. thermal switch and a secondary neutral grounding point.

To select the correct transformer, add up the continuous current rating of the motors being driven from this transformer and multiply by 0.05. Select the transformer kVA rating that is equal or larger than this number. If all motors must simultaneously supply continuous rated output at speeds exceeding one third of rated speed, contact your Allen-Bradley Sales Representative for assistance.

Catalog Number	Rating (kVA)	Primary Voltage and Frequency
1388-T012DR	1.25	
1388-T025DR	2.5	240/480V AC, 3ϕ, 60 Hz
1388-T050DR	5.0	*Other voltages & 50/60 Hz ratings*
1388-T075DR	7.5	*are available.*
1388-T100DR	10.0	

Inductors

The Bulletin 1388 has very low minimum inductance requirements and usually does not require the use of a motor armature circuit inductor. The minimum inductance allowed is found in the following table. If the motor inductance is less than the minimum value, the series inductor must be added in the armature circuit. If printed circuit armature motors or other very low inductance motors are used with the 40 Amp or 60 Amp controller, two inductors in series will be required.

Bulletin 1388 Rating	Minimum Inductance	Series Inductor Rating
10 Amp	0.9 mH	1.0 mH
20 Amp	0.5 mH	0.5 mH
40 Amp	0.4 mH	0.2 mH
60 Amp	0.4 mH	0.2 mH

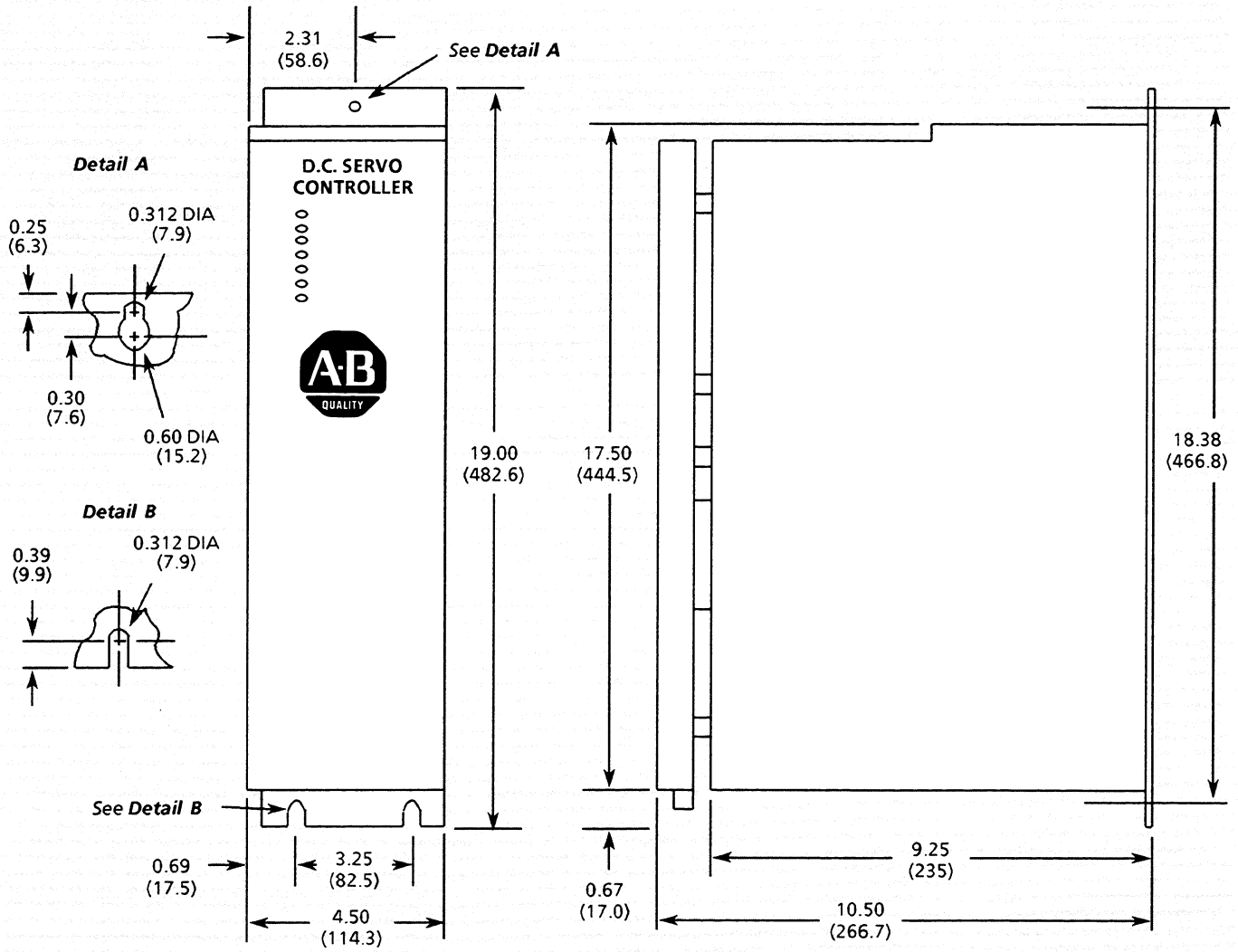
General Specifications

	1388B -AV10	1388B -AV20	1388B -AV40	1388 -AV60
Nominal Output Voltage	150V DC	150V DC	150V DC	150V DC
Continuous Current	10 A	20 A	40 A	60 A
Peak Current	25 A	50 A	100 A	150 A
Continuous Power Output	.75 kW	1.5 kW	3.0 kW	4.5 kW
Peak Power Output	3.75 kW	7.5 kW	15 kW	22.5 kW
Minimum Circuit Inductance	0.9 mH	0.5 mH	0.4 mH	0.4 mH
Dynamic Braking Resistor	2.0 Ohms	1.5 Ohms	1.0 Ohm	0.75 Ohms
Input Circuit Breaker Rating	8.5 A/RMS	16 A/RMS	25 A/RMS	35 A/RMS
Circuit Breaker Interrupt Rating	3500 A	3500 A	5000 A	5000 A
Static Gain	2.5 A/mV	5 A /mV	10 A /mV	15 A /mV
Unit Weight in lbs. & (kg)	22 (9.97)	23 (10.42)	23 (10.42)	34 (15.40)

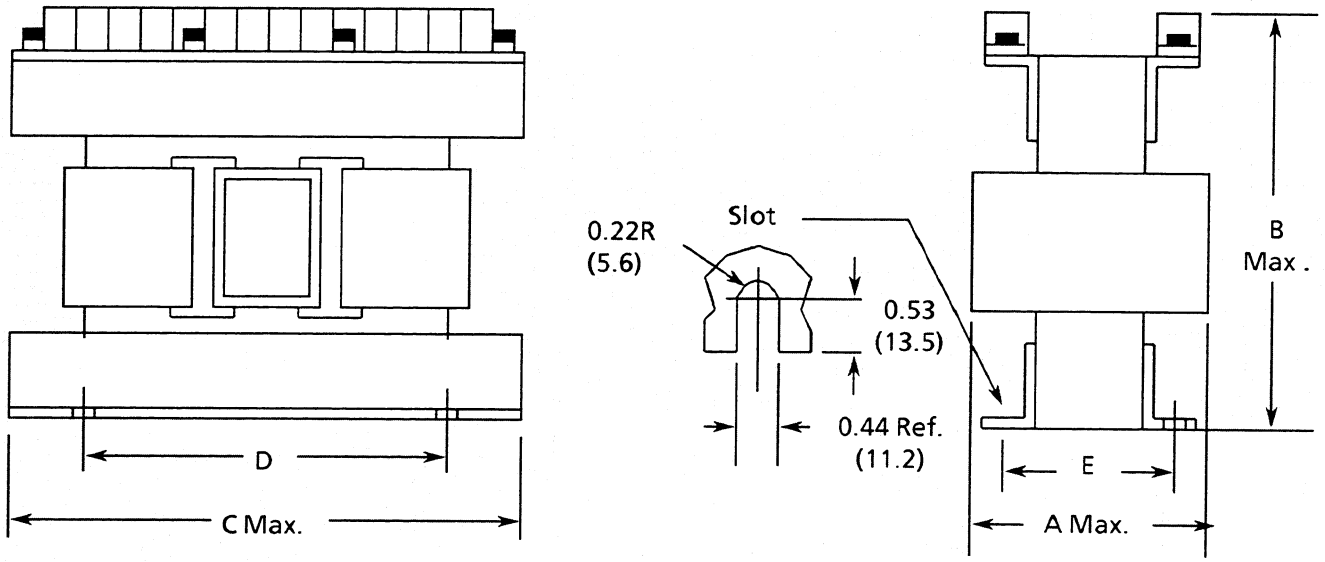
Form Factor (@ minimum inductance)	1.03 or Less
Peak Current Limit Adjust	10 to 250% of Rated Current
Drive Efficiency (Minimum @ rated load)	85%
Modulation Frequency	5000 Hz (± 10%)
Drift (referred to input)	10 µV / °C
Ambient Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	0° to 65° C (32° to 149° F)
Input Voltage	
Power Transformer	240/480V AC (+ 10/-15%), 3 ϕ, 60 Hz (± 3Hz) 240/380/415/480V AC (+ 10/-15%), 3 ϕ, 50/60 Hz (± 3Hz) 200/220/240/480V AC (+ 10/-15%), 3 ϕ, 50/60 Hz (± 3Hz)
Controller	Power: 120V AC, 3 ϕ Control: 35.5V AC C.T., 1 ϕ
Relative Humidity	5 to 95% Non-Condensing
Deadband	Zero
Altitude	1000 Meters (3300 Feet)
Integral Fan Output (when included)	50 CFM (Unloaded)
Max. RMS Short Circuit Current (Asymetrical)	1600 A

Servo Controller Dimensions

Dimensions in Inches and (mm)



Power Transformer Dimensions



Dimensions in inches and (mm)

Power Transformer Dimensions and Weights

Catalog Number (kVA)	Wt. lbs (kg)	Dimensions in inches and (mm) A	B	C	D	E
1388-T012DR (1.25)	25 (11.3)	9.00 (228)	10.00 (254)	13.00 (330)	5.00 (127)	3.06 (77)
1388-T025DR (2.5)	42 (19.0)	11.00 (279)	11.00 (279)	14.00 (355)	6.00 (152)	3.29 (83)
1388-T050DR (5.0)	75 (34.0)	11.00 (279)	11.00 (279)	14.00 (355)	6.00 (152)	5.25 (133)
1388-T075DR (7.5)	92 (41.7)	12.00 (304)	12.50 (317)	*16.00 (406)	8.00 (203)	5.69 (144)
1388-T100DR (10.0)	112 (50.8)	12.00 (304)	12.50 (317)	*16.00 (406)	8.00 (203)	5.84 (148)

* On optional 6 axis units this dimension has a maximum of 19" (483mm)

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