

Class 5 Control Overview

- Faster processor, over five times faster than previous generation motors
- Faster RS-232 / RS-485 communications speeds, up to 115.2 Kbaud for unparalleled connectivity
- Multi-port simultaneous communications, RS-232 / RS-485 / CAN Bus
- Enhanced Trap Mode Commutation
- Expanded Math Function capability with floating point math and trigonometric functions
- Modulo Encoder Count capability
- Eight priority-stacked, user-definable interrupts
- Four user-definable, independent timers
- DE/Dt: Following error limit rate of change
- Increased I/O interrupt assignments
- Software programmable limits can be set to trigger interrupts without fault
- Enhanced parameter and function-based syntax
- Increased system status bit registers for advanced diagnostics
- Optional onboard expanded I/O: 10 channels, 24 VDC isolated, assignable as inputs or outputs
- Optional 10 additional points of isolated 24V I/O; source up to 300 mA, and read both digital and analog signals
- Four times faster PID update rate (down to 62.5 µsec) enables ultra-precise motion
- Optional CANopen communications with high-speed contouring to sub-millisecond synchronization
- New Sinusoidal Commutation capability delivers smooth and quiet motion, even at low speeds
- Commutative, associative, and distributive math syntax
- Software programmable limits can be used as programmable electronic cam switch triggers
- Optionally communicate with the motor through the serial port, which provides access as a Modbus Remote Terminal Unit (RTU) Slave

Enhanced Trap Mode and Sine Mode Commutation

The motors can be operated with encoder-based commutation that allows for a more precise alignment and association of rotor to stator magnetic phases. The result is a smooth, quiet rotation with very low cogging. As a result, much slower commanded speeds may be achieved with little speed fluctuation.

Higher Frequency PID Update Rate

User selectable PID update rate defaults to 125 microseconds. Optionally, it may be decreased or increased. The faster 62.5 microsecond update rate allows for smoother high-speed operation and faster accel/decel correction under varying load conditions.

Expanded Math Function Capability

Class 5 SmartMotor™ includes:

- Boolean operators such as exclusive OR and modulo
- Trigonometry functions: SIN, COS, TAN, ASIN, ACOS, ATAN
- Absolute value
- IEEE-754 single-precision floats
- Commutative and associative math operations with up to 128 characters on the right side of an equal sign

Advantages Over Conventional Systems

- High noise immunity
- Low electrical noise emissions
- Very high tuning bandwidth (very stable)
- Very compact motion system (shortest axial length closed-loop servo available)

DMX Protocol is Standard on Class 5

- Easily program the SmartMotor through DMX protocol
- Simple/advanced motion control triggered from DMX input
- No control cabinet = smaller machine footprint
- And much more...refer to the website/factory for details

Power and Encoder

Drive Power	+20–48 VDC
Control Power	+20–48 VDC (Must be supplied separately when DE option is ordered)
Expanded I/O Option	+24 VDC Isolated (Must be supplied)
Commutation	Trapezoidal (Default)
	Enhanced Trapezoidal Based on Encoder Position
	Sinusoidal
Encoder Resolution	23 Frame: 4000 Counts per Revolution (Class 5)
	34 Frame: 8000 Counts per Revolution (Class 5)

Processor/Clocks

Processor Clock Speed	32 MHz	
PWM Switching Frequency	16 KHz	
CPU Regulator Frequency	140 KHz +/-10% Load Dependent	
Drive Stage Regulator	100 MHz	
PID Update Rates		
PID1	16 kHz	62.5 μsec update rate
PID2 (Default)	8 kHz	125 μsec update rate
PID4	4 kHz	250 μsec update rate
PID8	2 kHz	500 μsec update rate

Programming

Code	Command Interpretive Text Based
Program	32 K Program / 32 K Data Storage
Subroutines	Up to 1000
Stack Pointers	10 Nested GOSUB() and/or Interrupt Calls

Communications

RS-232	2400 to 115200 Baud	9600 Default
RS-485	2400 to 115200 Baud	9600 Default
(Optional) CAN Bus	20 K to 1 MBaud	125000 Default

Moog Animatics Class 5 D-Style SmartMotor™ Part Numbering Guidelines

Step 1: Basic Part Numbering

NEMA 17



The Brake option cannot be used with any other option. 24V I/O can be used alone or in combination with other options. See part numbers below.

SM17205D-BRK
SM17205D-C
SM17205D-DN
SM17205D-AD1
SM17205D-C-AD1
SM17205D-DN-AD1

NEMA 23



All three options (Brake, 24V I/O, CAN bus) are available in various combinations for the following part numbers.

SM23375D SM23205D
SM23375DT SM23305D
SM23105D SM23405D

The Brake option cannot be used with any other option. 24V I/O can be used alone or in combination with other options. See part numbers below.

SM23165D-C SM23165DT-C
SM23165D-DN SM23165DT-DN
SM23165D-AD1 SM23165DT-AD1
SM23165D-C-AD1 SM23165DT-C-AD1
SM23165D-DN-AD1 SM23165DT-DN-AD1
SM23165D-BRK SM23165DT-BRK

NEMA 34



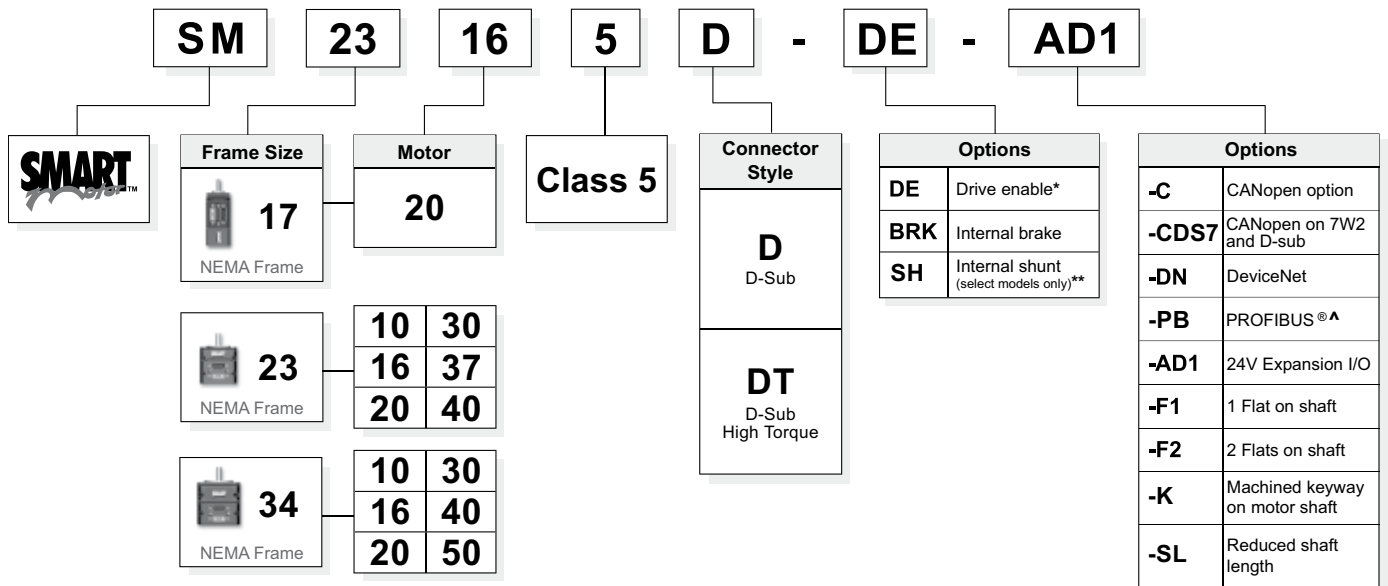
All three options (Brake, 24V I/O, CAN bus) are available in various combinations for the following part numbers.

SM34165D** SM34205D
SM34165DT** SM34305D
SM34105D SM34405D

**SM34165D and SM34165DT are the only models that can have an internal shunt.

To see all possible option combinations for each motor and get the exact part number, use the Part Number Generator available on the website at: <http://www.animatics.com/pngenerator>.
For the CDS7 option, see page 18.

Step 2: Advanced Part Numbering



* Separate drive and control power

** SM34165D and SM34165DT are the only models that can have an internal shunt

^ PROFIBUS option only available on SM23165D and SM23165DT product with no additional options

NOTE: DMX protocol is standard on all Class 5 SmartMotors.

D-Style Motor Comparison Chart

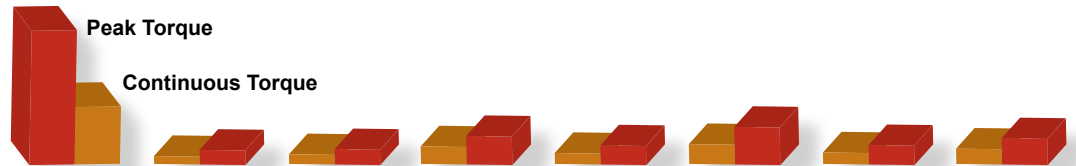


★ BEST VALUE

- All D-style SmartMotors have a primary RS-232 communications port
- All D-style SmartMotors have 7 channels 5V TTL non-isolated I/O
- Optional 10 channels expanded 24 VDC isolated I/O
- Dedicated encoder out

Relative Torque Comparison

NOTE: All torque curves based on 25°C ambient. For ambient temperatures above 25°C, continuous torque must be linearly derated to 0% at 85°C.



		SM17205D	SM23165D	SM23165DT	SM23375D	SM23375DT	SM23205D	SM23305D
Continuous Torque	in-lb	2.08	2.50	4.61	2.86	5.18	2.96	3.98
	oz-in	33	40	74	46	83	47	64
	N-m	0.24	0.28	0.52	0.32	0.59	0.33	0.45
Peak Torque	in-lb	3.82	4.00	7.40	5.00	9.80	5.03	6.86
	oz-in	61	64	118	80	157	80	110
	N-m	0.43	0.45	0.84	0.57	1.11	0.57	0.77
Nominal Continuous Power	Watts	145	181	204	191	186	226	220
No Load Speed	RPM	7,900	10,400	5,200	8,000	4,000	8,100	5,600
Max. Continuous Current	RPM	6,000	6,500	3,800	6,000	3,250	6,900	4,750
	Amps	3.81	4.70	5.074	5.072	4.52	6.02	5.57
Peak Power	RPM	4,200	6,100	3,400	4,750	2,450	5,995	4,100
	Watts	185	183	210	220	235	335	325
Voltage Constant	V/krpm	6.506	4.45	9.08	5.62	10.95	6.137	8.873
Inductance	mH	1.4	0.829	1.31	0.770	0.906	0.40	0.61
Encoder Resolution	Counts/Rev	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Rotor Inertia	oz-in-sec ²	0.00217	0.00099	0.001	0.0019	0.0019	0.00224	0.00332
	10 ⁻⁵ kg-m ²	1.5325	0.6991	0.706	1.342	1.342	1.582	2.344
Weight	lb	1.2	1.0	1.3	2.1	2.2	1.7	2.3
	kg	0.55	0.45	0.59	0.95	0.98	0.79	1.03
Shaft Diameter	in	0.197	0.250	0.250	0.250	0.250	0.250	0.250
	mm	5.00	6.35	6.35	6.35	6.35	6.35	6.35
Shaft, Radial Load	lb	7	7	7	7	7	7	7
	kg	3.18	3.18	3.18	3.18	3.18	3.18	3.18
Shaft, Axial Thrust Load	lb	3	3	3	3	3	3	3
	kg	1.36	1.36	1.36	1.36	1.36	1.36	1.36
DeviceNet Option		Yes	Yes	Yes	Yes	Yes	Yes	Yes
PROFIBUS Option			Yes	Yes				
CANopen Option		Yes	Yes	Yes	Yes	Yes	Yes	Yes

Due to the variety of operating conditions and applications for Moog Animatics' products, the end user is solely responsible for making the final selection of the Moog Animatics products and systems based on their own analysis and testing, and ensuring that all performance, safety and warning requirements for the application and product are met. Please consult factory for any supporting hardware and cables needed, full details and latest information.

D-Style Motor Comparison Chart



SM23405D	SM34165D	SM34165DT	SM34205D	SM34305D	SM34405D	SM34505D		
4.88	9.67	12.83	7.91	10.87	12.94	16.34	in-lb	
78	155	205	126	174	207	261	oz-in	Continuous Torque
0.55	1.09	1.45	0.89	1.23	1.46	1.85	N-m	
8.04	14.12	30.00	24.91	34.75	40.38	48.19	in-lb	
129	226	480	399	556	646	771	oz-in	Peak Torque
0.91	1.60	3.39	2.81	3.93	4.56	5.44	N-m	
253	235	615	324	400	438	527	Watts	Nominal Continuous Power
5,300	3,100	5,100	4,500	4,100	3,800	3,300	RPM	No Load Speed
4,500	2,400	4,500	3,750	3,600	3,300	3,100	RPM	
6.76	6.02	16.93	8.28	10.31	11.69	14.37	Amps	Max. Continuous Current
4,000	1,900	3,400	2,250	2,500	2,350	2,250	RPM	
345	265	930	455	725	820	925	Watts	Peak Power
9.612	14.98	8.9	10.8	12.1	12.9	14.049	V/krpm	Voltage Constant
0.49	1.72	0.32	0.596	0.490	0.913	0.871	mH	Inductance
4,000	8,000	8,000	8,000	8,000	8,000	8,000	Counts/Rev	Encoder Resolution
0.00439	0.014	0.0142	0.012	0.018	0.024	0.03	oz-in-sec ²	Rotor Inertia
3.100	9.890	10.031	8.448	12.56	17.02	20.92	10 ⁻⁶ kg-m ²	
2.8	5.0	5.5	3.5	4.5	5.5	6.5	lb	
1.27	2.27	2.49	1.59	2.04	2.49	2.95	kg	Weight
0.250	0.375	0.500	0.375	0.375	0.375	0.375	in	
6.35	9.53	12.70	9.53	9.53	9.53	9.53	mm	Shaft Diameter
7	15	30	15	15	15	15	lb	
3.18	6.80	13.61	6.80	6.80	6.80	6.80	kg	Shaft, Radial Load
3	3	3	3	3	3	3	lb	
1.36	1.36	1.36	1.36	1.36	1.36	1.36	kg	Shaft, Axial Thrust Load
Yes	Yes	Yes	Yes	Yes	Yes	Yes		DeviceNet Option
	Yes	Yes						PROFIBUS Option
Yes	Yes	Yes	Yes	Yes	Yes	Yes		CANopen Option

Due to the variety of operating conditions and applications for Moog Animatics' products, the end user is solely responsible for making the final selection of the Moog Animatics products and systems based on their own analysis and testing, and ensuring that all performance, safety and warning requirements for the application and product are met. Please consult factory for any supporting hardware and cables needed, full details and latest information.

D-Style Motor Torque Curves

Overview

Software

C5 D-Style

C5 M-Style

C6 M-Style

C6 Low-Cost

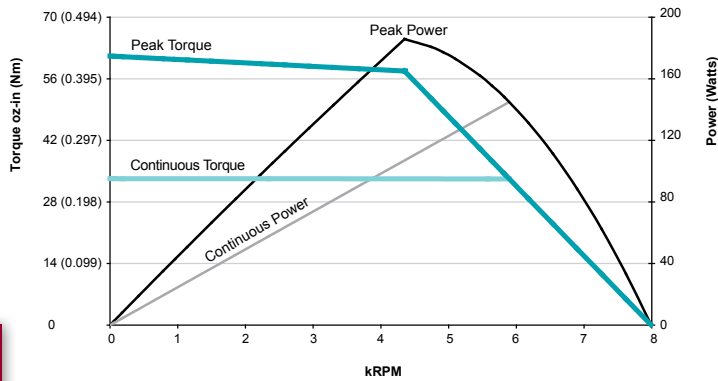
Cables, Etc.

Actuators

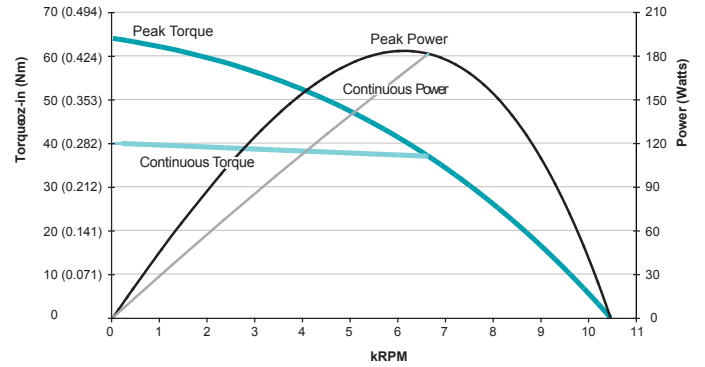
Gearheads

Power Supplies

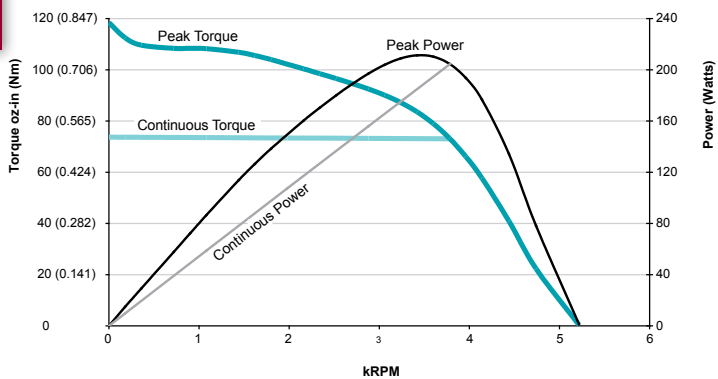
SM17205D



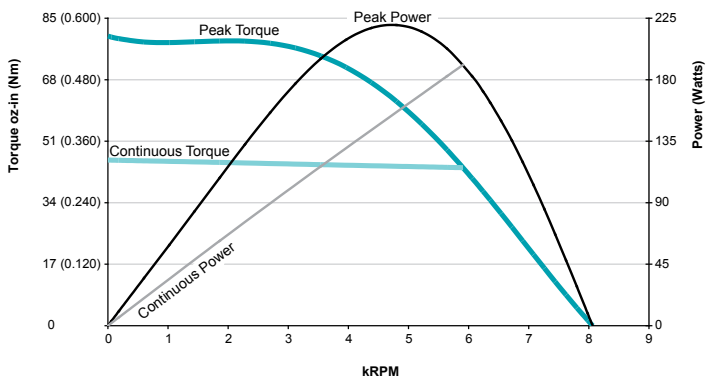
SM23165D



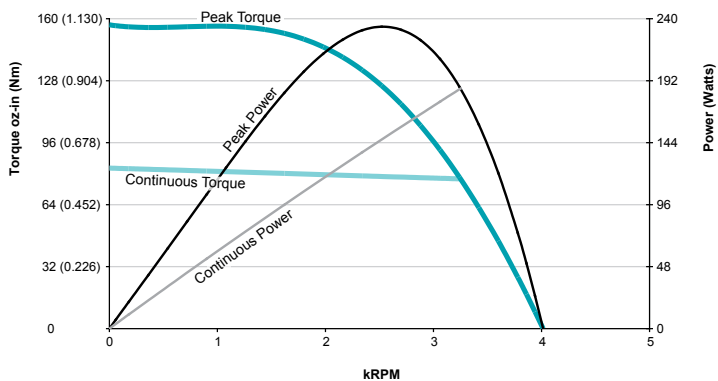
SM23165DT



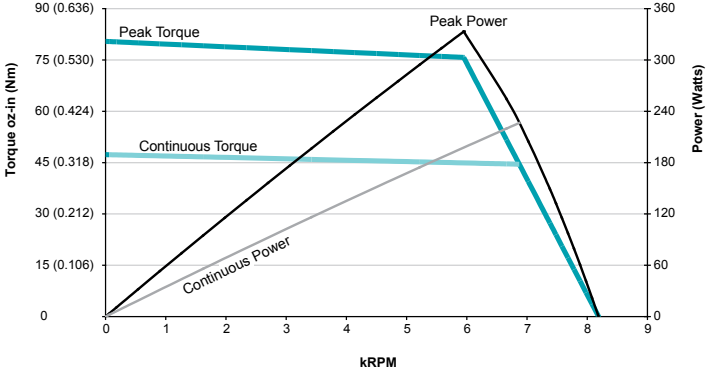
SM23375D



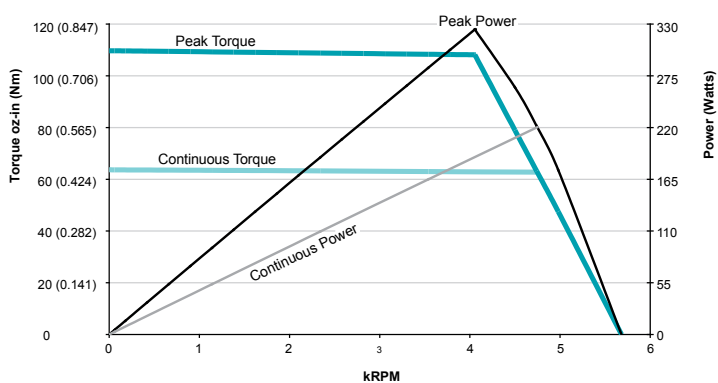
SM23375DT



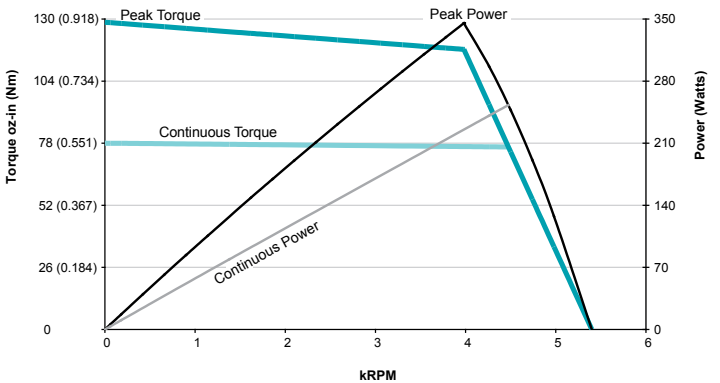
SM23205D

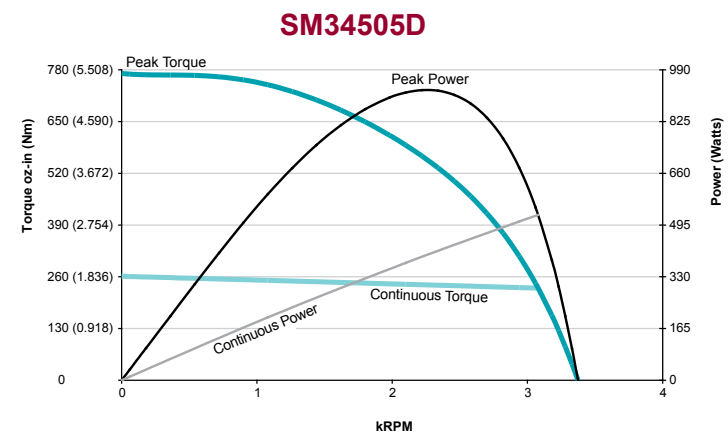
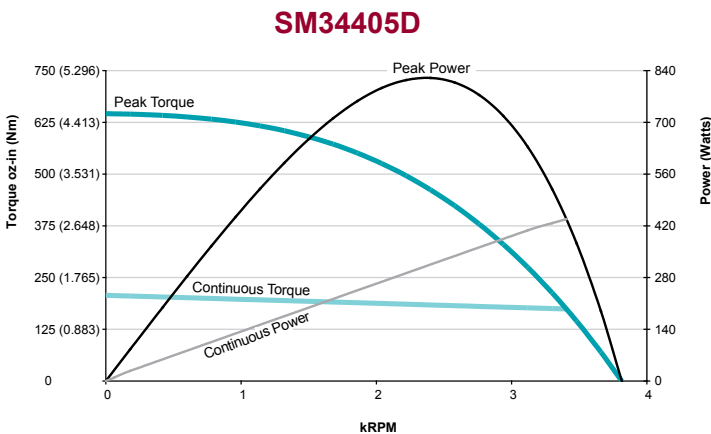
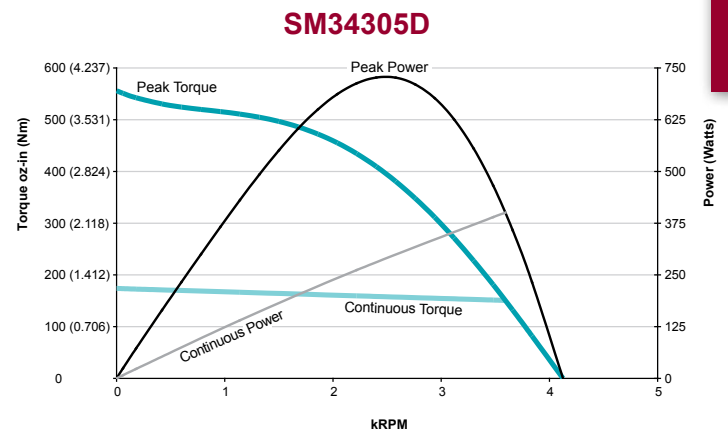
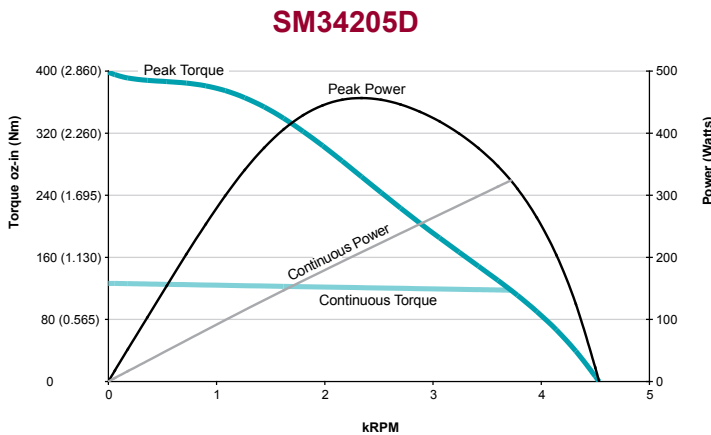
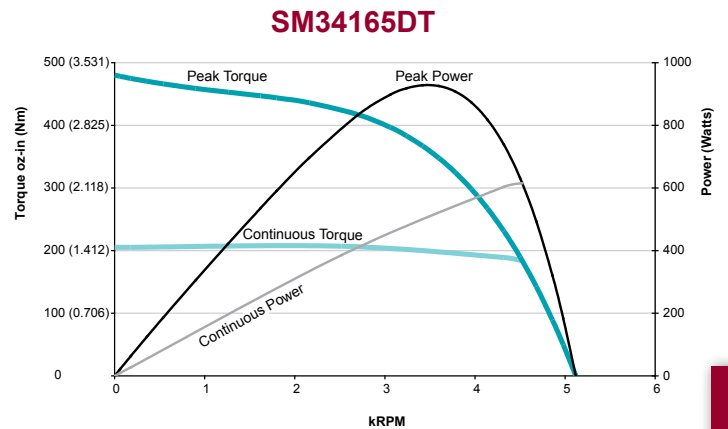
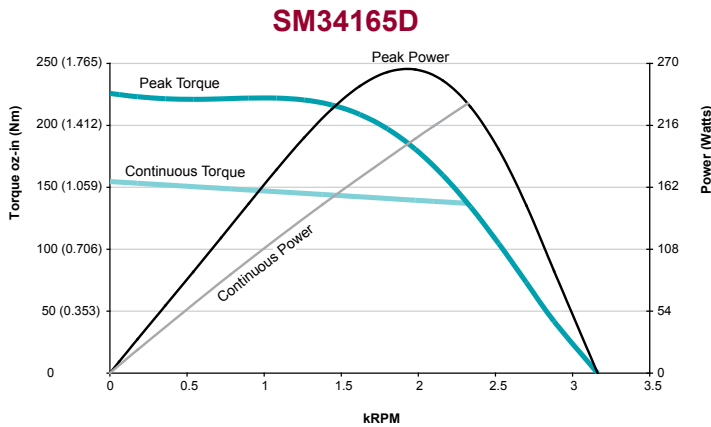


SM23305D



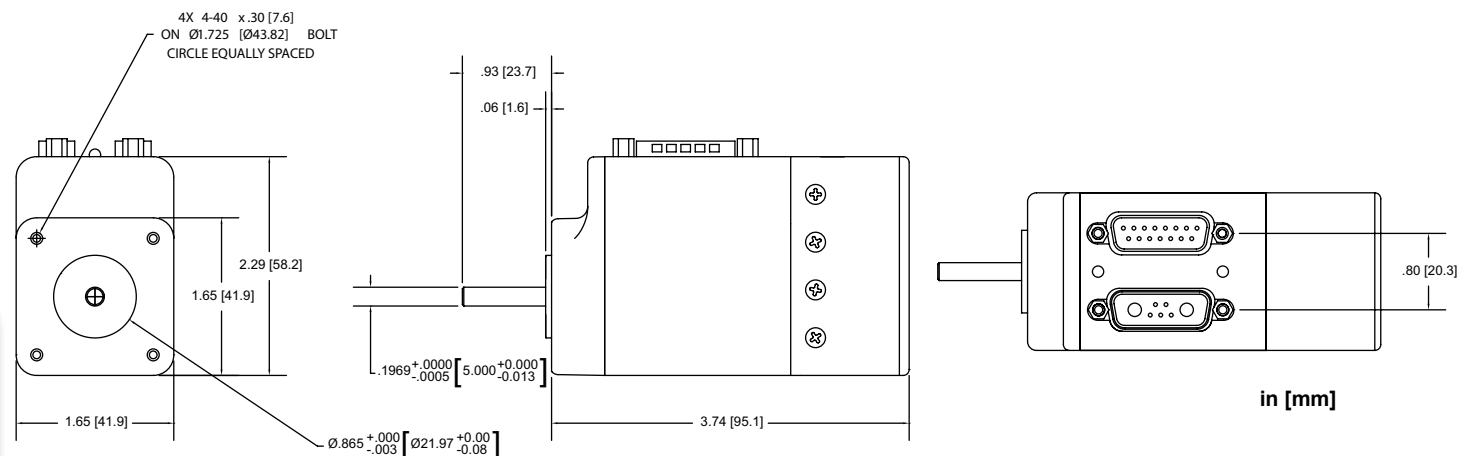
SM23405D



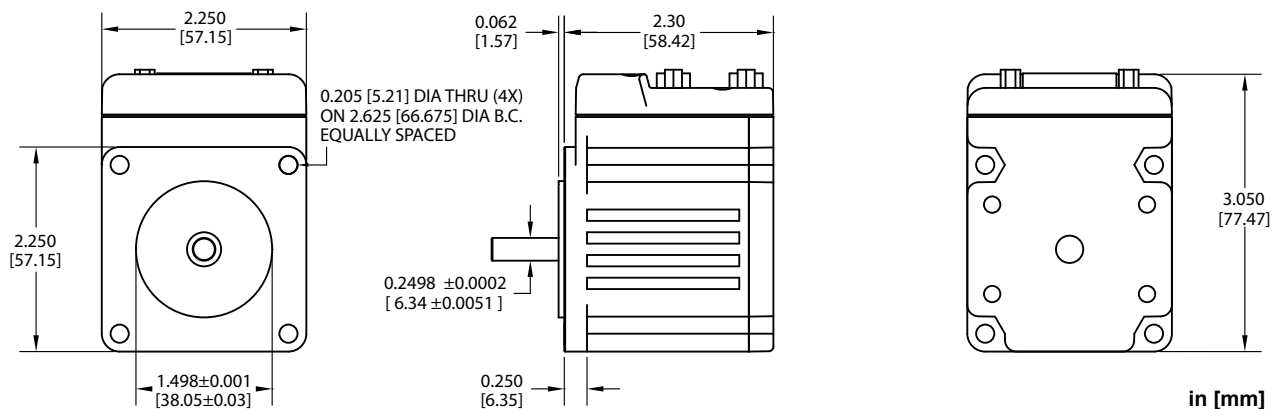


All torque curves based on 48 VDC at 25°C ambient with rise to 85°C.
 Motors were operated using MDT (Trapezoidal Drive Mode) Commutation.
 For ambient temperatures above 25°C, continuous torque must be linearly derated to 0% at 85°C.
 Operating temperature range: 0°C – 85°C.
 Storage temperature range: -10°C – 85°C, noncondensing.

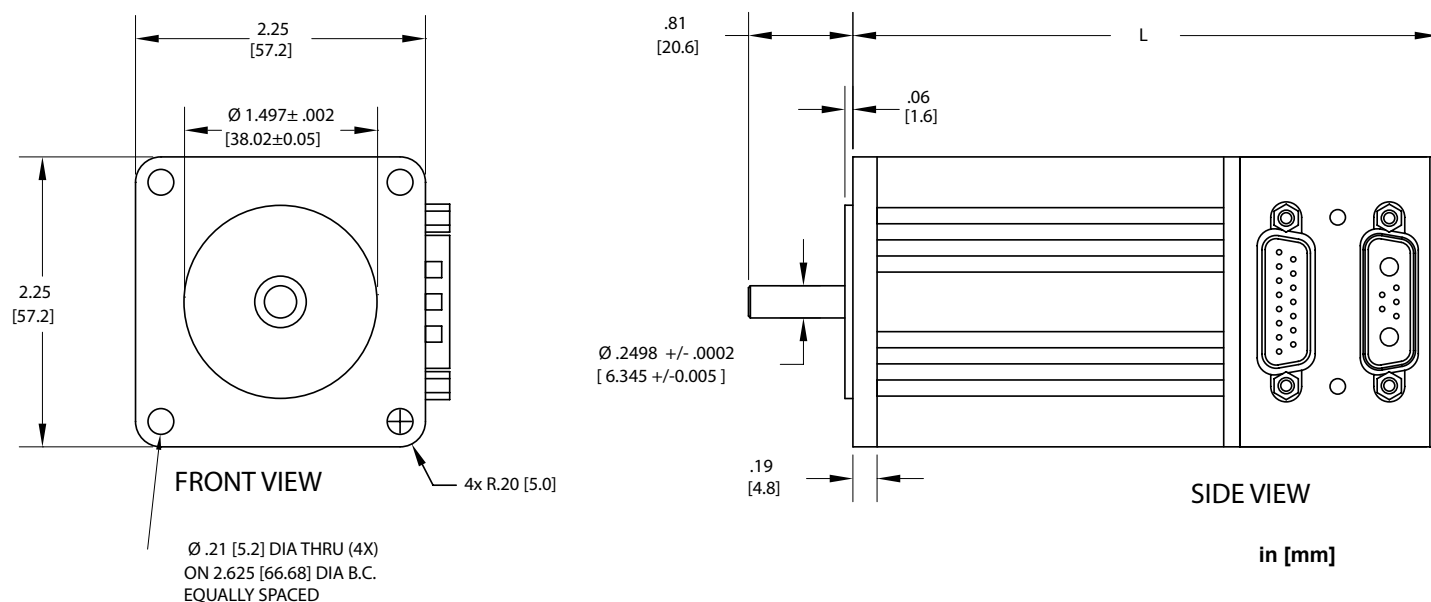
SM17205D (No Options) CAD Drawing



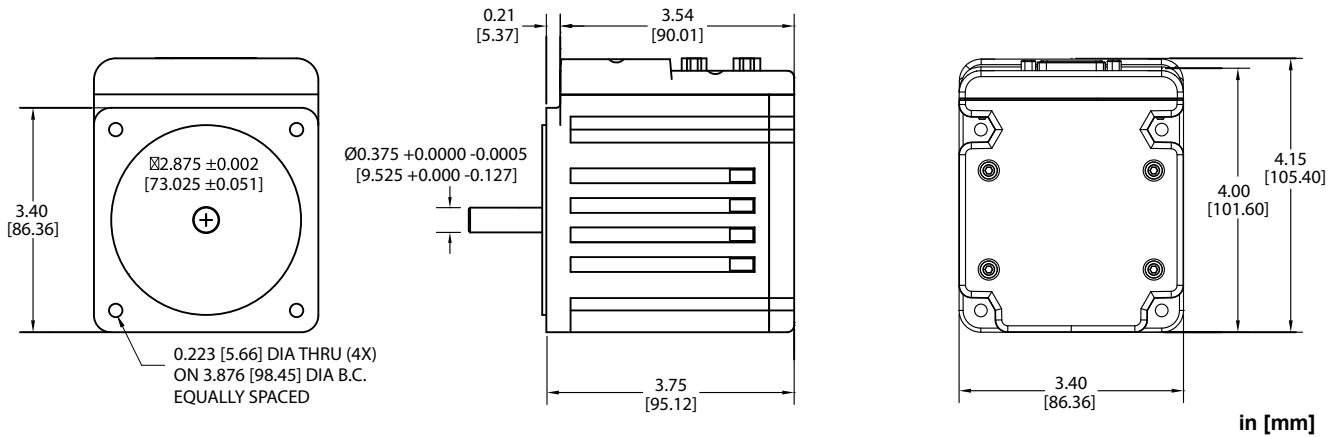
SM23165D/DT (No Options) CAD Drawing



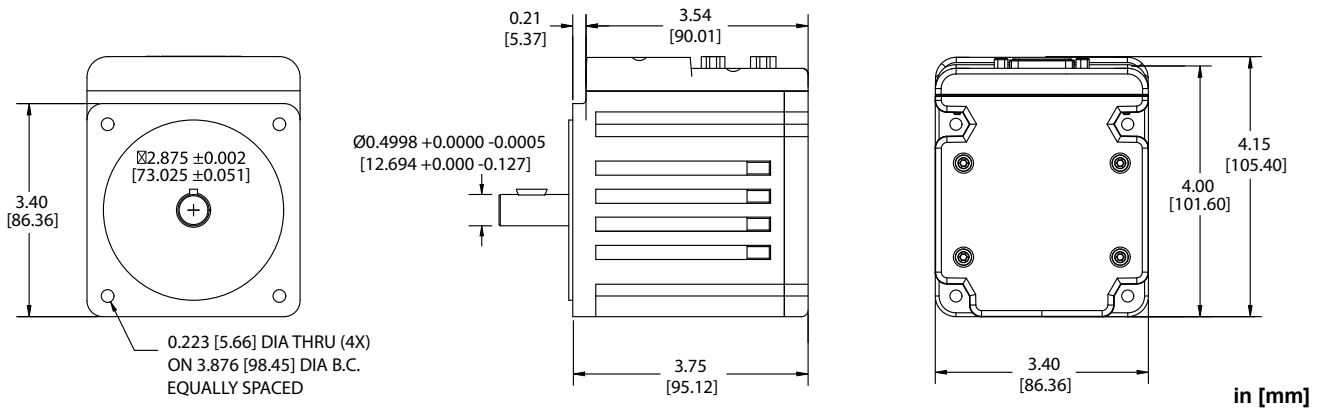
SM232x5D-SM234x5D (No Options) CAD Drawing



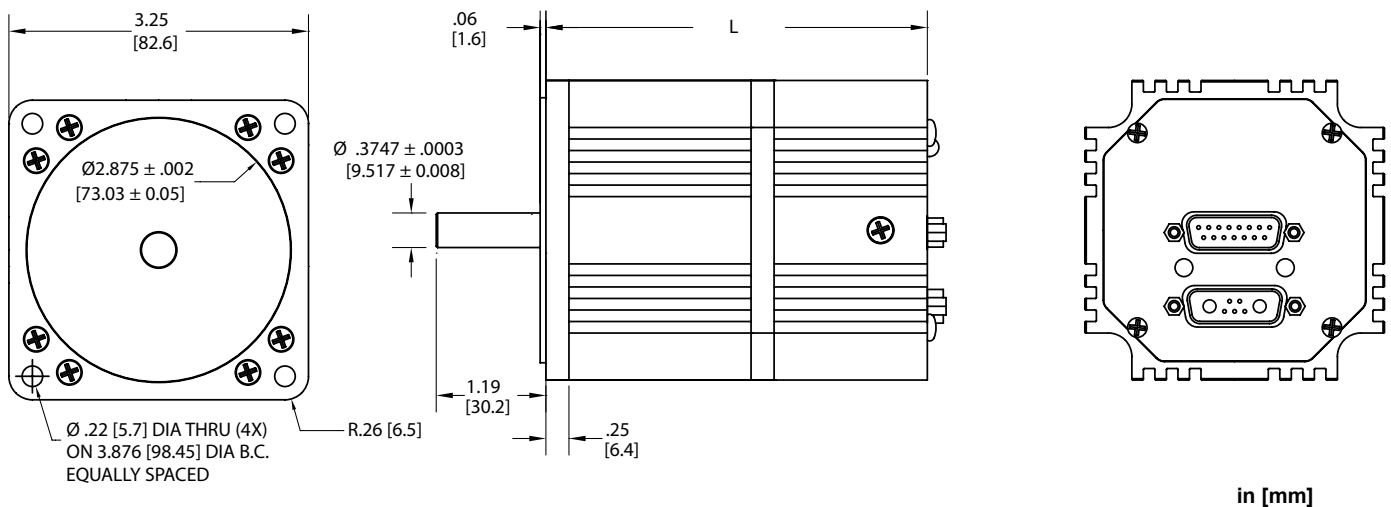
SM34165D (No Options) CAD Drawing



SM34165DT (No Options) CAD Drawing



SM34205D-SM34505D (No Options) CAD Drawing



Class 5 D-Style Connector Pinouts

Overview

Software

C5 D-Style

C5 M-Style

C6 M-Style

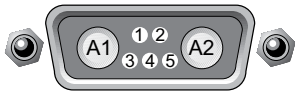
C6 Low-Cost

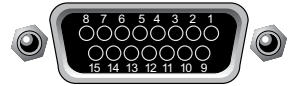
Cables, Etc.

Actuators

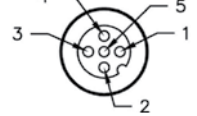
Gearheads

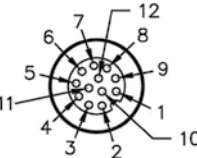
Power Supplies

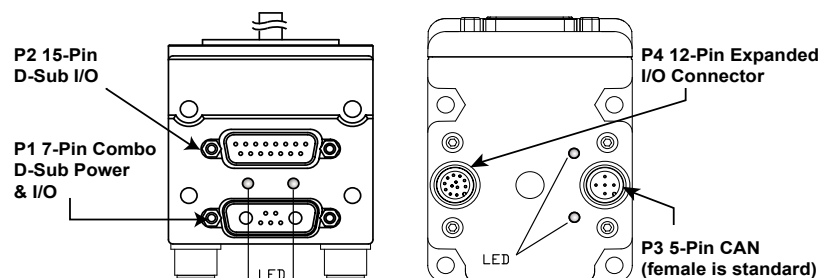
PIN	Main Power	Specifications	Notes	P1
1	I/O – 6 GP, Index Input or “G” Command For -CDS7, CAN-L only	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	Redundant Connection on I/O Connector	 <p>7W2 Combo D-Sub Connector</p>
2	+5 VDC Out; For -CDS7, CAN-H only	50 mAmps Max. (Total)		
3	RS-232 Transmit	Com ch. 0	115.2 Kbaud Max.	
4	RS-232 Receive	Com ch. 0	115.2 Kbaud Max.	
5	Common Ground (Typ. SIG Ground)			
A1	Main Power: +20-48 VDC			
A2	Common Ground (Req'd POWER Ground)		Must be Main Power Ground	

PIN	I/O Connector (5 VTTL I/O)	Specifications	Notes	P2
1	I/O – 0 GP or Encoder A or Step Input	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	1.5 MHz Max. as Encoder or Step Input	 <p>P2 DB-15 D-Sub Connector</p>
2	I/O – 1 GP or Encoder B or Direction Input	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	1.5 MHz Max. as Encoder or Direction Input	
3	I/O – 2 Positive Over Travel or GP	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D		
4	I/O – 3 Negative Over Travel or GP	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D		
5	I/O – 4 GP, IIC or RS-485 A (Com ch. 1)	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	115.2 Kbaud Max.	
6	I/O – 5 GP, IIC or RS-485 B (Com ch. 1)	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	115.2 Kbaud Max.	
7	I/O – 6 GP, Index Input or “G” Command	25 mAmp Sink or Source 10 Bit 0-5 VDC A/D	Redundant Connection on Main Power Connector	
8	Phase A Encoder Output			
9	Phase B Encoder Output			
10	RS-232 Transmit; For -CDS/7, CAN-L Only	Com ch. 0	115.2 Kbaud Max.	
11	RS-232 Receive; For -CDS/7, CAN-H Only	Com ch. 0	115.2 Kbaud Max.	
12	+5 VDC Out	50 mAmp Max. (Total)		
13	Common Ground (Typ. SIG Ground)			
14	Common Ground			
15	Main Power: +20-48 VDC	If DE Option, Control Power Separate from Main Power		

Note: I/O ports input impedance = 5 kohm (5 kohm pull-up resistor)

PIN	CAN bus	Connection	Notes	P3
1	NC	NC		 <p>M12 5-PIN FEMALE END VIEW</p>
2	+V	NC Except DeviceNet	Input Current < 10 mA	
3	-V (Ground, Not Common)	CAN Ground	Isolated	
4	CAN-H	1 Mbaud Max.		
5	CAN-L	1 Mbaud Max.		

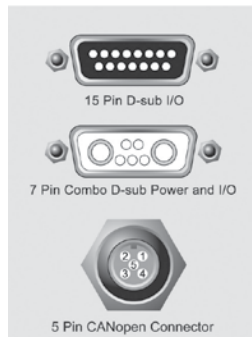
PIN	Isolated 24 VDC I/O Connector	Max. Load (Sourcing)	Notes	P4
1	I/O – 16 GP	150 mAmps	These I/O ports also support analog input	 <p>M12 12-PIN FEMALE END VIEW</p>
2	I/O – 17 GP	150 mAmps		
3	I/O – 18 GP	150 mAmps		
4	I/O – 19 GP	150 mAmps		
5	I/O – 20 GP	300 mAmps		
6	I/O – 21 GP	300 mAmps		
7	I/O – 22 GP	300 mAmps		
8	I/O – 23 GP	300 mAmps		
9	I/O – 24 GP	300 mAmps		
10	I/O – 25 GP	300 mAmps		
11	+24 Volts Input	18-32 VDC		
12	Ground-I/O (Not Common)		Isolated	



CAUTION: P2 DB-15 D-Sub Connector pins 14 and 15 are intended for use with DE series motors for control power only. Attempting to supply main servo-drive power to a non-DE motor through those pins will result in immediate damage to the electronics and void the warranty.

CAUTION: Connectors P3 and P4 must be finger tightened only! DO NOT use a tool. Doing so can cause overtightening of the connection, which may damage the connector and will void the warranty.

CANopen



CANopen Pinout:

- 1 Not Connected
- 2 Not Connected
- 3 CAN ground
- 4 CAN H
- 5 CAN L

Moog Animatics CANopen SmartMotor™

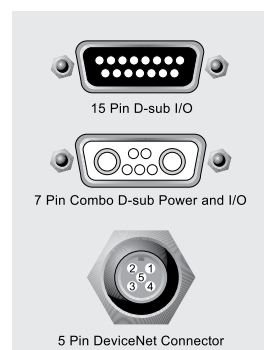
Features include:

- All basic motion commands available via CiA V4.02 specification
- Ability to read/write all SmartMotor variables
- Use of onboard I/O via CANopen gateway, SmartMotor program, or RS-232 commands
- Ability to run 1000 SmartMotor subroutines via CANopen
- Online diagnostics of the SmartMotor via SMI software and RS-232 connection
- Up to 127 nodes
- 250 microsecond interrupt-driven subroutine
- Baud rates: 20, 50, 125, 250, 500 Kbps, 1 Mbps; default 125 Kbps



NOTE: This option DOES NOT apply to all models, refer to website or factory.

DeviceNet™



DeviceNet Pinout:

- 1 Not Connected
- 2 +24V
- 3 Common
- 4 CAN H
- 5 CAN L



Moog Animatics DeviceNet SmartMotor™

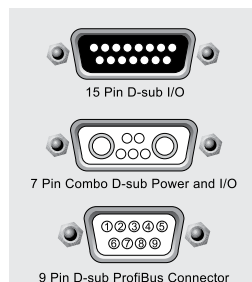
Features include:

- Polled I/O and Explicit Messages from your PLC to control all SmartMotor operation
- Read/Write control over all ODVA Position Controller parameters
- Use of onboard I/O via DeviceNet, SmartMotor program or RS-232 commands
- Ability to run 1000 SmartMotor subroutines via DeviceNet and read/write four 32-bit user variables
- Online diagnostics of the SmartMotors via SMI software and RS-232 connection
- Up to 64 DeviceNet nodes
- 250 microsecond interrupt-driven subroutine
- Baud rates: 125, 250, 500 Kbps, 1 Mbps; default 125 Kbps



NOTE: This option DOES NOT apply to all models, refer to website or factory.

PROFIBUS™



Profibus Pinout:

- | | |
|----------|---------|
| 1 NC | 6 +5V |
| 2 NC | 7 NC |
| 3 BUS-B | 8 BUS-A |
| 4 NC | 9 NC |
| 5 ground | |

Moog Animatics PROFIBUS SmartMotor™

Features include:

- Command/Response Codes for all Class 5 SmartMotor commands
- Use of onboard I/O via PROFIBUS, SmartMotor program, or RS-232 commands
- Ability to run 1000 SmartMotor subroutines via PROFIBUS
- Ability to read/write all SmartMotor variables
- Online diagnostics of the SmartMotor via SMI software and RS-232 connection
- Up to 127 PROFIBUS nodes
- 250 microsecond interrupt-driven subroutine
- Baud rates: default 1.5 Mbps
 - 9.6, 19.2, 31.25, 45.45, 93.75, 187.5, 500 Kbps, 1.5, 3, 6, 12 Mbps

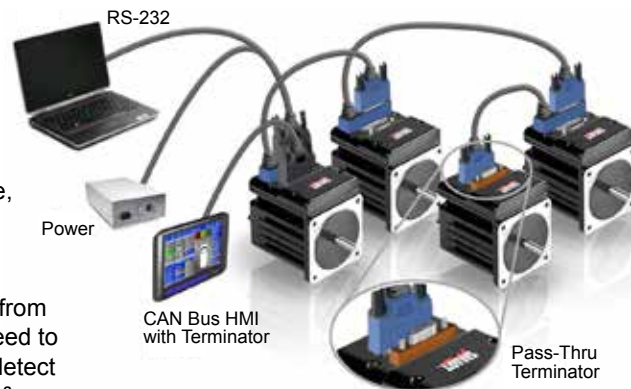


NOTE: PROFIBUS baud rates are achievable only with proper cable length and termination connectors. The minimum cable length when operating ≥ 1 Mbaud is 1 meter (3 feet). If the cable is too short, reflected impedance can cause loss of communications data packets and spurious node errors.

CAN Bus through 7W2 Connector (CDS7 Option)

Power, CAN Bus and RS-232 communications in a simple, single-cable solution.

Once again, Moog Animatics raises the bar in servo motor design, features and ease of use with the release of its new CDS (CAN over D-Sub) option – CDS7. It lets you create a CANopen network through either the DB-15 or the 7W2 D-Sub connector on top of the motor to make room for a brake and allowing it to be used in numerous vertical axis applications. When coupled with our new CDS7 Add-A-Motor™ cable, you can make a simple, single-cable, power and communications connection from motor to motor¹ — no other integrated motor manufacturer offers this capability.



Unlike competitive CANopen devices, CDS7 features RS-232 auto-detection from SMI™ for easy setup and CAN network addressing. With CDS7, there is no need to individually address each motor in the CAN network on startup — SMI™ can detect and auto-address every SmartMotor™ in the system with just one line of code.²

Additionally, the new CDS7 option provides:

- A foolproof Pass-Thru Terminator (shunt) easily installed on the DB-15 connector of the last motor
- A compact design that decreases the required space in the machine
- Full backward compatibility with the previous CDS option, allowing CDS7 motors to be used in new or old systems³

Finally, by adding CDS7 to your SmartMotor™, you gain access to these proprietary SmartMotor™ features:

- Combitronic™ technology for simplified motor-to-motor communications
- I/O Device CAN Bus Mastering for simple, economical and effective total machine control with just the SmartMotor™

The CDS7 option is fully compatible with all Class 5 D-style SmartMotors. Consult the factory for a complete list of compatible part numbers.

¹ Proper termination is required at both ends of the bus. For details, see the Class 5 SmartMotor™ installation and CANopen guides.

² Requires CDS7 SmartMotors and CDS7 Add-A-Motor cables or equivalent customer-supplied cables.

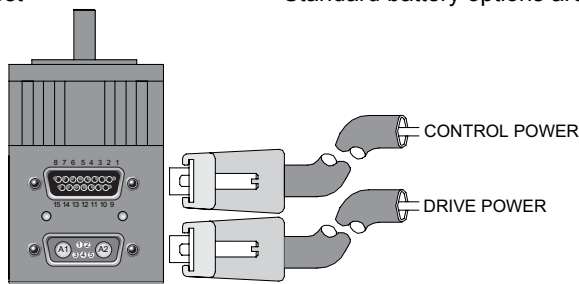
³ CDS7 Add-A-Motor cables are not compatible with the older –CDS motors. If a CDS7 motor is being used in an older CDS system, it must be wired like the other –CDS motors in that system. See the Class 5 SmartMotor™ installation and CANopen guides.

⚠ WARNING: Proper bus biasing and termination must be incorporated into system wiring to ensure quality communications over any industrial bus. Failure to do so could result in loss of communications. Please consult the associated bus standard organizations for details.

Recommended “DE” Option

The DE option allows the controller and drive-amplifier to be powered from separate 24-48 VDC power supplies.

- Controller can be powered from a standard 24 VDC supply
- Position will not be lost if drive power is lost
- No need to re-home
- Load surges will not cause power surge on controller
- Standard battery options are made simpler



Please see the *SmartMotor Installation & Startup Guide* for the schematic diagram and installation details.

NOTE:

- The same power supply may be used for control and drive power, but maximum protection is provided with separate power supplies.
- Only DE option SmartMotors can be wired in this manner. Attempting to power a non-DE motor in this way will damage the motor and void the warranty.
- To suppress back EMF, shunts should be placed between the E-stop switch and motor Drive Power input.
- All M-style SmartMotors are designed to always have separate drive and control power. As a result, no DE designation is available for those motors.