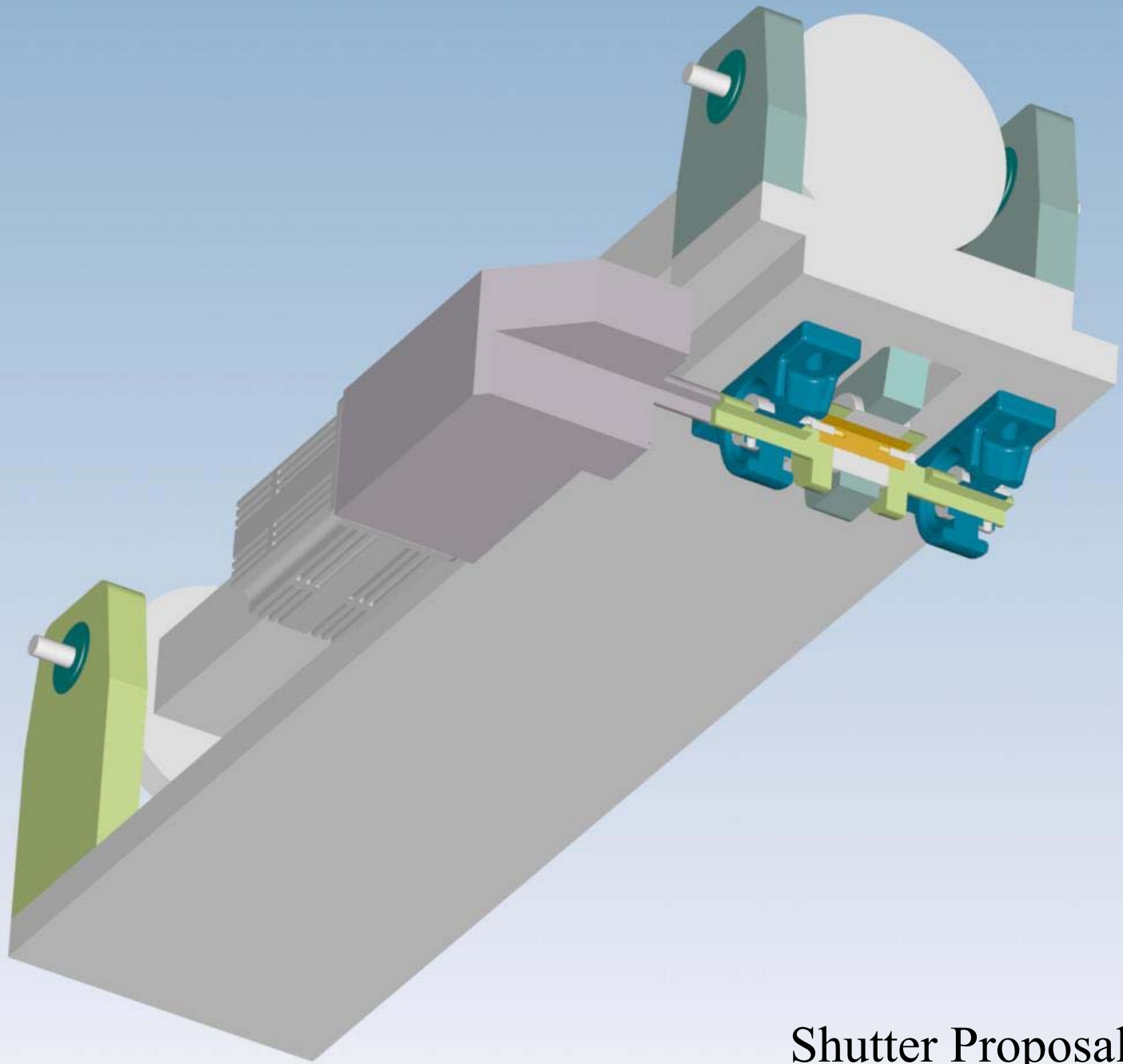
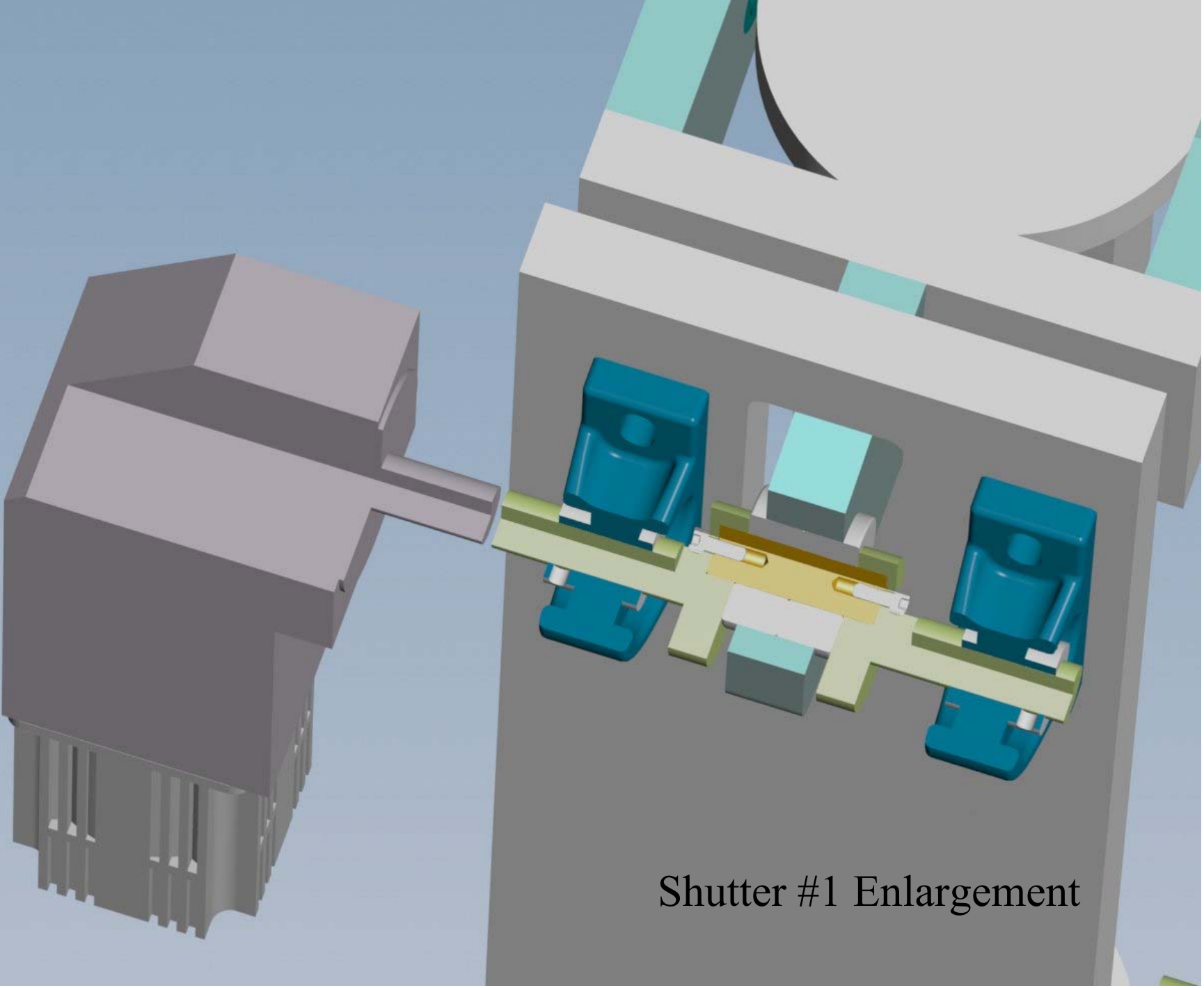
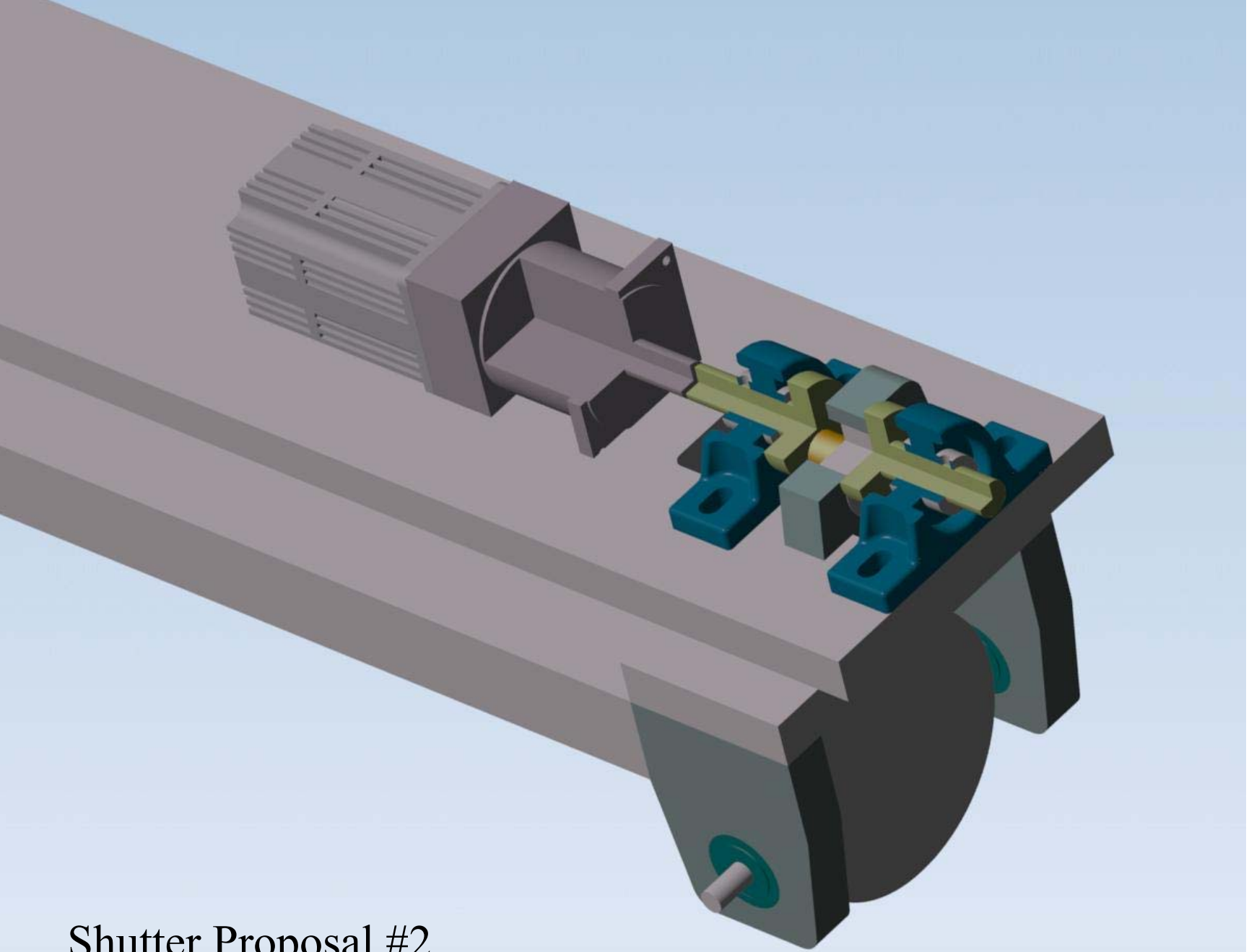


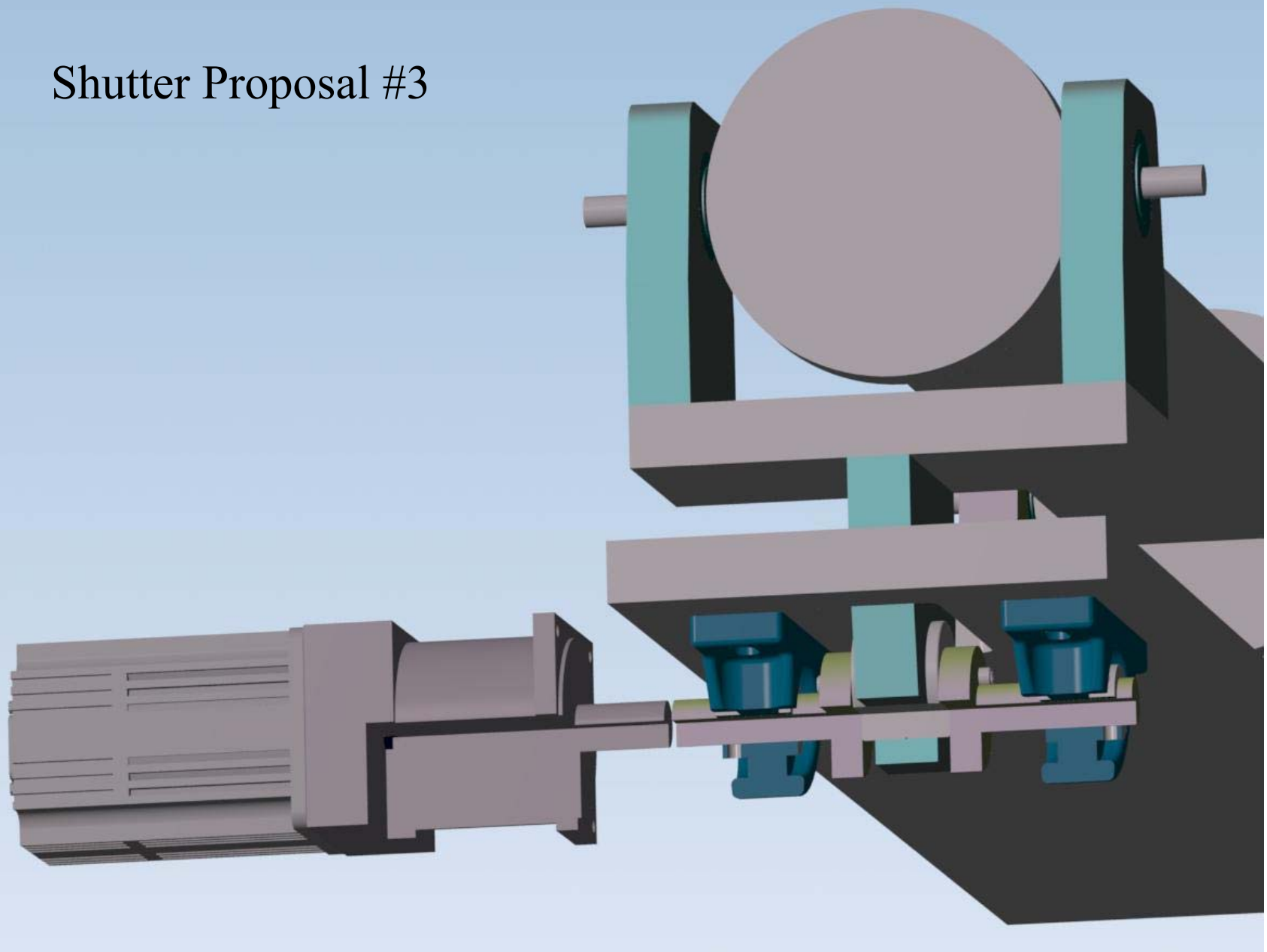
Shutter Proposal #1


Shutter #1 Enlargement



Shutter Proposal #2

Shutter Proposal #3



EPT E CATALOG - PART DETAIL

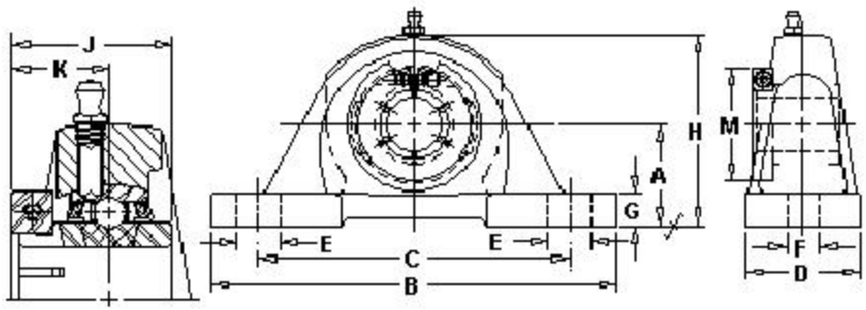
SealMaster NP-12T

Standard Duty - NP-T Series - Pillow Block - 2 Bolt - Skwezloc Lock - Felt Seal

Product Type:	Two Bolt Pillow Block
Product Line:	Gold Line
Shaft Size (In):	3/4
Rolling Element:	Ball
Locking Device:	Skwezloc
Seal Type:	Felt Seal
Duty Series:	Standard

MORE INFO.

Images may not be an exact representation of the product



Part No	Description	Shaft Dia. (In)	Insert No.	A	B	C (Min)
705372	NP-12T	3/4	2-012T	1 5/16	5	3 3/8
C (Max)	**D**	**E**	**F**	**G**	**H**	**J**
4 1/8	1 1/2	3/4	7/16	1/2	2 9/16	1 9/32
K	**M**	**Bolt Size**				
25/32	1 3/4	3/8				

EPT E CATALOG - PART DETAIL

McGILL

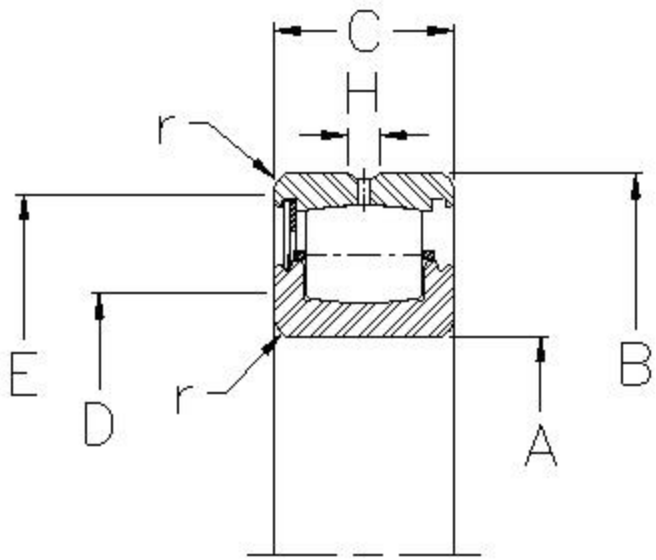
McGill SB 22204 W33 S

Spherical Roller Bearing; single row; standard seal; cylindrical bore

Bore Dia:	0.7874
Bore Dia (mm):	20
Bore Configuration:	Cylindrical
Series:	22200
Internal Clearance:	Standard
Seal Type:	Standard
Basic Dynamic Rating:	7,000

Images may not be an exact representation of the product

MORE INFO.



Part No	Description	A	A (mm)	B	B (mm)	C
0304005000	SB 22204 W33 S	0.7874	20	1.8504	47	0.709
C (mm)	**D**	**E**	**H**	**R**		
18	1	1 5/8	1/8	0.039		

EPT E CATALOG - PART DETAIL

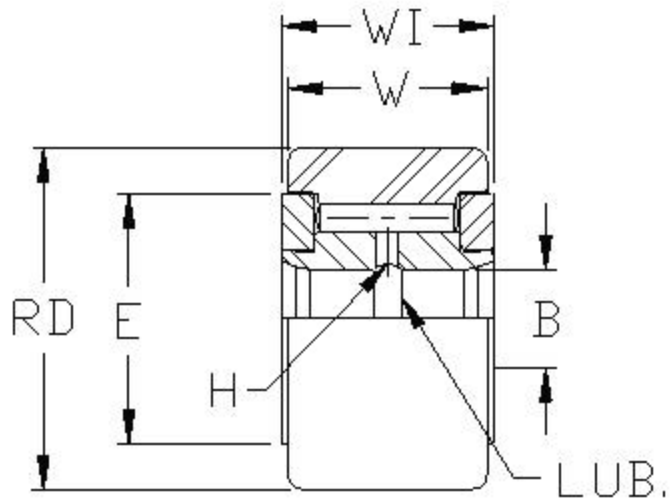
McGill CYR 3/4

Inch CAMROL (CYR), Cylindrical O.D., Unsealed, Needle Roller

Images may not be an exact representation of the product

Series:	Inch CAMROL (CYR)
Roller Dia. (Inch):	0.7500
O.D. Configuration:	Cylindrical
Sealing:	Unsealed
Rolling Element:	Needle Roller
Basic Dynamic Rating:	1660

MORE INFO.

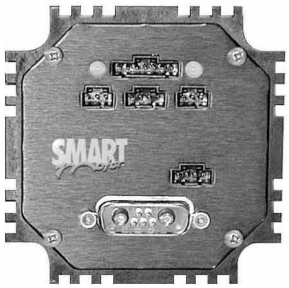


Part No	Description	RD	B	E	H	W
4060100000	CYR 3/4	0.7500	0.2500	39/64	3/32	0.500

W1	Min Boss Dia.
0.5625	1/2

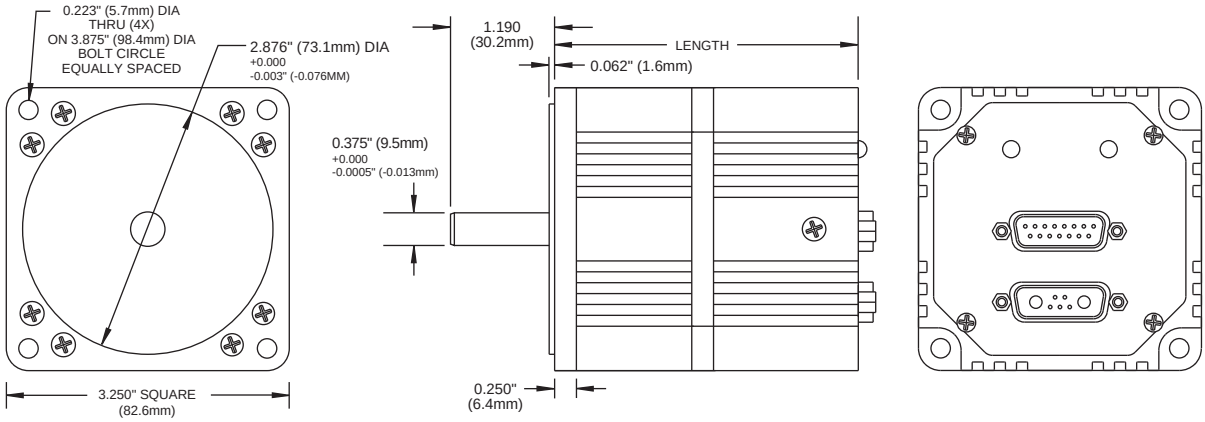
SM34D with D-sub I/O Connector

More robust construction,
provides better resistance to harsh environments,
and at no additional cost.
Recommended for new designs.



SM34 with Molex® I/O Connectors

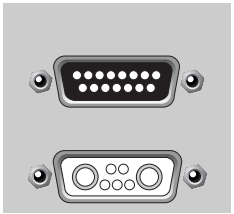
			SM3410	SM3420	SM3430	SM3440	SM3450
Peak Torque[2]	T_p	oz-in *(N-m)*	180 *1.27*	540 *3.81*	575 *4.06*	625 *4.41*	750 *5.30*
Continuous Torque[2]	T_c	oz-in *(N-m)*	45 *0.32*	100 *0.706*	155 *1.09*	210 *1.48*	250 *1.77*
Voltage Constant	K_v	V/kRPM	9.2	10.8	12.1	12.9	13.7
No Load Speed	S_{nl}	RPM	5,060	4,310	3,850	3,609	3,398
Torque Constant	K_t	oz-in/amp *(N-m/amp)*	12.5 *0.0883*	14.6 *0.103*	16.4 *0.116*	17.4 *0.123*	18.5 *0.131*
Rotor Inertia	J_m	oz-in-sec^2 *(kg.m^2)*	0.006 *4.2x10^{-5}*	0.013 *9.2x10^{-5}*	0.019 *1.3x10^{-4}*	0.025 *1.8x10^{-4}*	0.03 *2.1x10^{-4}*
Winding Resistance		Ohms	2.3	1.2	0.7	0.6	0.6
Weight	W_t	lbs *(kg)*	2.5 *1.1*	3.5 *1.6*	4.5 *2.0*	5.5 *2.5*	6.5 *2.9*
Number of Poles			4	4	4	4	4
Number of Slots			24	24	24	24	24
Length		inches *(mm)*	3.49 *88.6*	4.14 *105*	4.79 *122*	5.44 *138*	6.09 *155*
Width		inches *(mm)*	3.25 *82.6*	3.25 *82.6*	3.25 *82.6*	3.25 *82.6*	3.25 *82.6*
Nominal Continuous Power		hp *(kW)*	0.16 *0.12*	0.24 *0.18*	0.3 *0.22*	0.34 *0.26*	0.36 *0.27*
Default Thermal Limit		^{o}C	70	70	70	70	70
Encoder Resolution		post-quad counts/rev	4,000	4,000	4,000	4,000	4,000



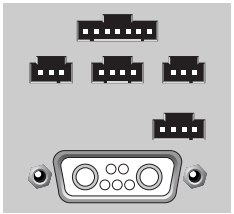
Notes

1. Any SmartMotor™ can be offered with custom windings to achieve higher speeds or greater torque and custom shaft lengths and diameters. Please consult factory.
2. All data derived under dynamometer testing using 48 VDC.
3. Connector kits and cable options found on pg. 33 and pg. 39.

D-sub Connector



Molex® Connectors

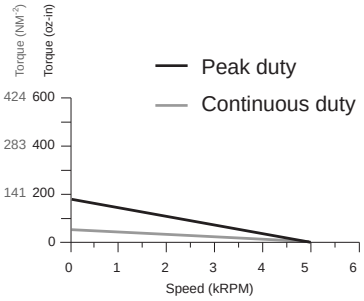


See pg.9 for details

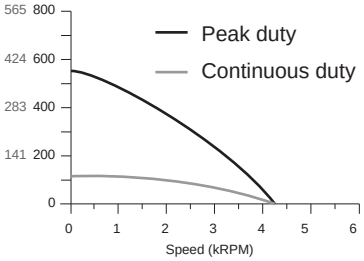
CE

SmartMotor™ servos have CE certification

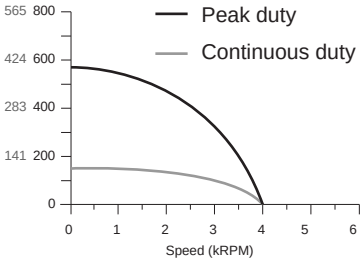
SMARTMOTOR™ SM3410D



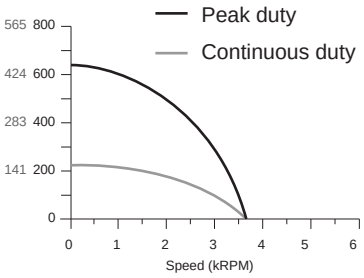
SMARTMOTOR™ SM3420D



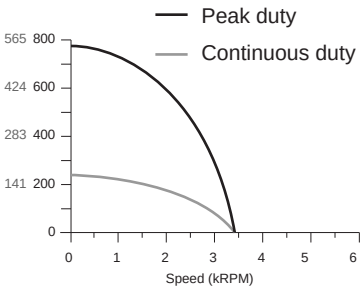
SMARTMOTOR™ SM3430D



SMARTMOTOR™ SM3440D



SMARTMOTOR™ SM3450D



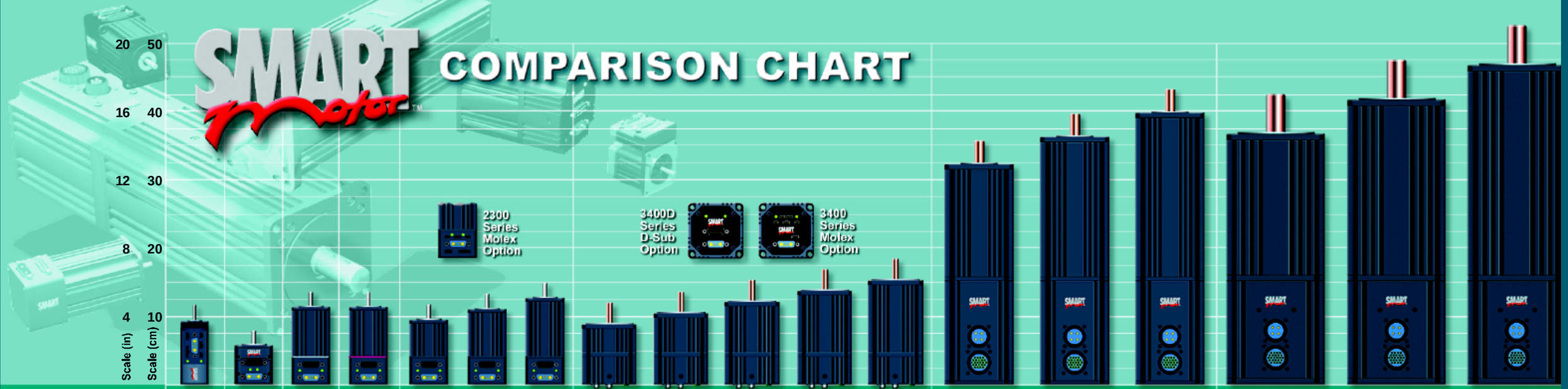
VRE Option:

Animatics Corporation has augmented its SmartMotor™ line with a special, ultrahigh resolution encoder option that operates at unprecedented speeds. Sizes 23 and 34 are available with the "VRE" option which stands for "**Variable Resolution Encoder**". The SmartMotor™ can be programmed to increase its resolution to as much as 256,000 counts per revolution. What is even more astounding is the speed at which the motor still operates.

The maximum resolution of 256,000 counts can be retained, even at speeds in excess of 5,000 rpm. Most high resolution encoder products are speed limited because the data cannot be transmitted back to the controller fast enough. With the SmartMotor™, since the controller and the motor are together, these data transfer problems go away, along with any concerns about signal integrity in electrically noisy, industrial environments because there simply are no cables.

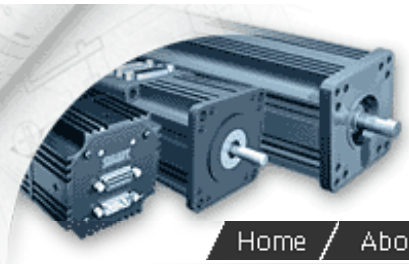
This technology creates new opportunities for machine builders. Systems can be built with very fast slew rates, but still allow motion to stop and position to sub-micron levels, such as one would do with Hard Disk Certification Equipment. The machine designer no longer needs to choose between high resolution and high speed.

SMART Motor™ COMPARISON CHART



		1720	2315D	2337D	2337DT	2320D	2330D	2340D	3410D	3420D	3430D	3440D	3450D	4210T	4210F	4220T	4220F	4230T	4230F	5610T	5610F	5620T	5620F	5630T	5630F
Continuous Torque	in-lb	2.188	1.750	2.188	3.69	2.375	3.125	3.438	2.813	6.250	9.688	13.125	15.625	13.000	10.63	20.125	15.00	26.750	19.69	28.500	22.50	46.813	38.75	65.625	51.25
	oz-in	35	28	35	59	38	50	55	45	100	155	210	250	208	170	322	240	428	315	456	360	749	620	1,050	820
	N-m	0.247	0.198	0.247	0.42	0.268	0.353	0.388	0.318	0.706	1.095	1.483	1.765	1.469	1.20	2.274	1.69	3.022	2.22	3.22	2.54	5.29	4.38	7.415	5.79
Peak Torque	in-lb	5.625	3.125	6.875	12.50	5.625	7.813	7.813	11.250	33.750	35.938	39.063	46.875	132.000	52.50	99.00	40.00	132.00	52.50	241.88	95.00	405.88	163.75	565.75	226.25
	oz-in	90	50	110	200	90	125	125	180	540	575	625	750	2,112	840	1,584	640	2,112	840	3,870	1,520	6,494	2,620	9,052	3,620
	N-m	0.636	0.353	0.777	1.41	0.636	0.883	0.883	1.271	3.813	4.060	4.413	5.296	14.914	5.93	11.19	4.52	14.91	5.93	27.33	10.73	45.858	18.50	63.921	25.56
Torque Constant	oz-in/Amp	7.57	4.17	5.60	14.80	8.92	12.60	13.90	12.50	14.60	16.40	17.40	18.50	172.80	86.40	129.60	65.60	172.80	86.40	94.40	46.40	158.40	80.00	220.80	110.40
	Nm/Amp	0.05	0.03	0.04	0.10	0.06	0.09	0.10	0.09	0.10	0.12	0.12	0.13	1.22	0.61	0.92	0.46	1.22	0.61	0.67	0.33	1.12	0.56	1.56	0.78
Nominal Continuous	hp	0.15	0.18	0.18	0.183	0.19	0.20	0.22	0.16	0.24	0.30	0.34	0.36	0.44	0.78	0.92	1.29	0.91	1.00	1.81	0.79	1.78	2.02	2.60	0.74
Power	KW	0.11	0.13	0.13	0.14	0.14	0.15	0.16	0.12	0.18	0.22	0.25	0.27	0.33	0.58	0.69	0.96	0.68	0.75	1.35	0.59	1.33	1.51	1.94	0.55
Top Speed	rpm	8,700	10,786	8,630	3,800	7,820	5,590	5,310	5,060	4,310	3,850	3,609	3,398	2,225	4,470	2,950	5,950	2,200	4,470	4,075	8,170	2,425	4,840	1,743	3,500
Voltage Constant	V/krpm	5.50	4.45	5.62	10.95	6.60	9.32	10.26	9.20	10.80	12.10	12.90	13.70	128.00	64.00	96.00	48.00	128.00	64.00	70.00	35.00	117.00	59.00	164.00	82.00
Winding Resistance	ohms	1.8	1.0	0.6	0.9	1.1	1.2	1.0	2.3	1.2	0.9	0.6	0.6	10.0	2.9	3.2	0.9	3.7	1.1	0.9	0.3	1.2	0.4	1.5	0.4
Encoder Resolution	counts/Rev	2,000	2,000	2,000	2,000	2,000	2,000	2,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Rotor Inertia	oz-in-sec^2	0.00026	0.00099	0.00190	0.00190	0.00184	0.00273	0.00362	0.0060	0.0130	0.0190	0.0250	0.0300	0.029	0.029	0.042	0.042	0.054	0.054	0.110	0.110	0.180	0.180	0.240	0.240
	10^{-5} kg-m^2	0.18	0.70	1.34	1.34	1.30	1.93	2.56	4.24	9.19	13.43	17.67	21.20	20.50	20.50	29.68	29.68	38.16	38.16	77.74	77.74	127.21	127.21	169.61	169.61
Poles		4	8	8	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Slots		15	12	12	12	15	15	15	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Shaft Diameter	inches	0.1965	0.250	0.250	0.250	0.250	0.250	0.250	0.375	0.375	0.375	0.375	0.375	0.625	0.625	0.625	0.625	0.625	0.625	1.125	1.125	1.125	1.125	1.125	1.125
	cm	0.499	0.635	0.635	0.635	0.635	0.635	0.635	0.953	0.953	0.953	0.953	0.953	1.588	1.588	1.588	1.588	1.588	1.588	2.858	2.858	2.858	2.858	2.858	2.858
Weight	lbs	1.21	1.00	2.10	2.16	1.74	2.27	2.79	2.50	3.50	4.50	5.50	6.50	22.00	22.00	27.00	27.00	32.00	32.00	36.00	36.00	46.00	46.00	56.00	56.00
	kg	0.55	0.45	0.95	0.98	0.79	1.03	1.27	1.13	1.59	2.04	2.49	2.95	9.98	9.98	12.25	12.25	14.51	14.51	16.33	16.33	20.87	20.87	25.40	25.40
Length	inches	3.70	2.30	4.54	4.54	3.82	4.47	5.13	3.49	4.14	4.79	5.44	6.09	13.30	13.30	14.80	14.80	16.30	16.30	14.50	14.50	16.50	16.50	18.50	18.50
	cm	9.40	5.84	11.53	11.53	9.70	11.35	13.03	8.86	10.52	12.17	13.82	15.47	33.78	33.78	37.59	37.59	41.40	41.40	36.83	36.83	41.91	41.91	46.99	46.99
Width	inches	1.65	2.25	2.25	2.25	2.25	2.25	2.25	3.25	3.25	3.25	3.25	3.25	4.25	4.25	4.25	4.25	4.25	4.25	5.75	5.75	5.75	5.75	5.75	5.75
	cm	4.19	5.72	5.72	5.72	5.72	5.72	5.72	8.26	8.26	8.26	8.26	8.26	10.80	10.80	10.80	10.80	10.80	10.80	14.61	14.61	14.61	14.61	14.61	14.61
Encoder Index Output		◆												◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Encoder Follow/Gearing		◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Infinite Ratio Camming		◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Removable Memory		◆																							
Non Volatile Data Memory		◆	option	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆						
AniLink Port With RS-485		◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆												
AniLink with Separate RS-485														◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
DC Input to 48V		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆												
AC Input to 208V 3 Phase														◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Standard Military Connector														◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
CE Mark		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆												
Optional Built-in Brake		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆												

Animatics Corporation • 3050 Tasman Dr., Santa Clara, CA 95054, USA Tel: 408-748.8721 • Fax: 408-748.8725 • www.animatics.com



Tech Support

FAQ's

Addressing

How is motor addressing handled on the SmartMotor™?
How can a command be sent to a specific motor or group of motors?

Every motor has an address register: upon power up or reset, the value of this register is zero. The value stored in this register can be changed by a SADDR# command arriving from the host or from a command executed from within a stored user program. Valid addresses range from 0 to 120.

The SmartMotor scans incoming RS-232 communications for high order ASCII bytes (values between 128 - 249). When such a byte is received, the SmartMotor™ evaluates <byte> - 128 to get the address number. If the address number is 0 or equal to the value of the motor address register, subsequent commands are accepted. If neither condition is true, all commands are ignored until an appropriate high order ASCII byte is received.

Also available are motor unique states of SLEEP and WAKE. In the SLEEP state, all commands are ignored until a properly addressed WAKE command arrives. This allows global addressing techniques to be directed at specific sub-sets of motors in an application.

TOP

Braking

Does the SmartMotor™ have braking capability?
The SM1720, SM23XX, and SM34XX can be ordered with the - BRK option. The SM1720 powers and controls the brake built onto the backside of the motor. Both the SM23XX and the SM34XX have the brake mounted on the front of the motor where the user must supply +24V and an I/O to control the brake. The SM23XX rear-mounted brake will soon be available.

Can the SmartMotor™ do dynamic braking?
The SmartMotor™ is a full four quadrant servo design: it can brake dynamically up to the momentary torque/speed

limitations of the system.

Communication

What are the maximum recommended distance between SmartMotor™ and the computer/controller for communication through RS232, RS485, Anilink, and I/O connector?
This question is difficult to answer because so many factors are involved. In most instances, we quote 30 feet (10 meters) for RS-232, 1000 meters for RS-485, 10 feet (3 metres) for Anilink, and 3 feet for I/O connector. The maximum theoretical distance for Anilink is 100 feet, maximum practical distance 100 feet. (The 10PWR105 allows the addition of multiple motors to the network but does not increase separation.)

My screen is outputting junk on my screen while in monitor status, what's wrong?
There could be a print statement in your program. Make sure that ECHO is off. There is a chance that the memory module is corrupt.

What makes the SmartMotor™ more capable than other products in handling multi-axis, co-ordinated motion?
Communication speed and the ability to modify trajectories in less than 3 milli-seconds is key to smooth control of multi axis control. Enhanced Baud rate (up to 33.6kBaud) allows fast communication. Abbreviated command sets and efficient, abbreviated addressing minimizes the data load.

What is the communications rate through the RS-232?
The SmartMotor™ is designed for RS-232 communications at the following user select-able baud rates:
38,400 / 19,200 / 9,600 - Default / 4,800 / 2,400

Will the SmartMotor™ operate with Labview commands?
Labview uses RS232 as a driver so the interface is compatible. A customer will need to write code strings in ASCII 2 to convert RS232 to SmartMotor™ compatible commands.

I have a system based on DEVICENET;
how can the SmartMotor™ be used with such a system?
Background: DEVICENET is a low-cost controller area network (CAN) protocol, high speed communications link for industrial devices developed in the early 1980's by Allen Bradley. Many designers choose DEVICENET for its interchangeability (many vendors and products available), low cost, advanced diagnostics, and its compatibility with distributed power networks.
The current SmartMotor™ is based on the RS-232 communications protocol. RS-485 can be implemented using the Animatics RS485 communications adapter. The RS-485 adapter converts / arbitrates the RS-485 signals on the host side to the RS-232 signal structure required by the SmartMotor™.
A similar converter could be manufactured for DEVICENET. Should a user with sufficient volume want DEVICENET capability, we could produce a motor with the appropriate hardware and firmware support for plug-in operation.

What host communication relationships will the SmartMotor™ support?
The following common communications relationships are supported by the SmartMotor™:
Host / Slave
Host / Interactive
Host / Independent
Stand-Alone

In a Host / Slave relationship, the PC host transmits commands over the RS-232 one at a time for immediate execution by the SmartMotor™. In this relationship, the host assumes all of the timing functions for the application. It is also clear that certain SmartMotor commands don't work in this relationship, for example the WHILE command.
In Host / Interactive relationships, the host program and the SmartMotor™ program interact. There are two basic sub-categories of this relationship.

In one, the host interacts with a running program through RS-232 messaging or I/O level signaling. The SmartMotor™ may or may not be sending messages back to the host by similar methods.

In another, the host sends preparatory (program configuration) data to the SmartMotor™, then issues a RUN command. The SmartMotor™ executes its independent program, which may or may not include messaging and host signaling. Upon program termination, the SmartMotor™ simply waits for further host instruction. This special category of host / slave relationships is called Host / Independent relationships: Entire programs are downloaded from the host to the SmartMotor™. RUN may be initiated by either the host or by external hardware input. One main feature of this type of relationship is the relative autonomy of the individual motors: here the motors may signal the host at appropriate times, but in general, host intervention is not expected.

TOP

Critical product features to the Host / Interactive relationship are:
The priority of host communications over the execution stored program code: This allows the SmartMotor™ to stop execution of stored code in an orderly manner, and begin execution of incoming serial code as soon as the one byte serial buffer is filled. Execution of the stored program resumes as soon one of the two following conditions is met:
1. A valid command is executed
2. An incoming command is determined to be invalid and is dumped.

The non-interrupt-ability of the busy/search (code scan) state of the SmartMotor™. A busy/searching state occurs whenever the SmartMotor™ is searching for an address in memory at which it can resume code execution. This address search occurs during the negative evaluation of an IF statement. It also occurs during a WHILE statement during a period after the last executable command of the LOOP block and the execution of the WHILE's argument expression.
The relative freedom of action provided by the SmartMotor's change-on-the-fly capability. Operational modes and trajectories can be changed on the fly.
While it is possible for a supervisory host to interrupt the execution a well-structured stored program, taking direct command of the application during critical periods, the relative independence of each SmartMotor™ relieves the host of the direct processing burden of each axes control, and reduces the required band-width of the serial communications channel.
In stand alone applications, the SmartMotor™ relies entirely on its EEPROM memory for user program storage. The SmartMotor can handle I/O from an outside source if desired, can communicate through RS-232 or other mechanisms. RS-232 communications retain their execution priority regardless of system design. Multi-axis stand alone applications which use one SmartMotor™ as a host platform have been implemented and are currently operating in the field.

What is the 8-N-1 ASCII protocol mentioned in the manual?
The SmartMotor™ uses an asynchronous serial interface often described as a "three wire implementation of RS-232." Asynchronous communications require a stable environment: if any bit of a transmission is lost, there is a high probability that the remainder of any transmitted message will be misunderstood. It is therefore necessary to carefully define the structure of the transmission. A serial bit is a defined period of time, and the state of the bit can either be a 1 or a 0, depending on the voltage state of the transmit line during the duration of the serial bit.
When the RS-232 is in the idle state (waiting to transmit a message) it rests in the high (on) state. When a character is to be transmitted the TxD line is brought low for a carefully defined period of time, the time period of the start bit is a function of the BAUD rate. This low state is called the start bit.
Immediately following the start bit are a number of data bits. The SmartMotor™ must use 8 data bits, and this is the meaning of the "8" in the string "8-N-1."

TOP

Following the data bits in the is an optional parity bit. The parity bit used in some transmission schemes to check the validity of received characters on a byte-by-byte basis. Since this is an optional process which slows down communications, it is not implemented in the SmartMotor™. The "N" in "8-N-1" stands for no parity bit. Following the optional parity bit is a bit called the stop bit. On ancient teletypes and other old machinery, a delay was required to ensure that the received character could be handled before the next character arrived. For this reason a stop bit was added at the end of every transmitted character. Depending on the delay needed, either one, one-and-a-half or two stop bits are added. The SmartMotor™ uses the minimum required period, 1 stop bit (8-N-1).
Following the above description, the SmartMotor™ uses 10 bit data structure to transmit an eight bit ASCII character. The SmartMotor™ requires a maximum of one signal change to transmit one bit, and since the baud rate is defined as the number of signal changes per second, this means that the data transmission rate is (BAUDRATE) /10 = characters

per second.

Baud Rate Transmission Rate,
Characters per Second
2400 240
4800 480
9600 960
19800 1980
38400 3840

Encoder

How do I get encoder outputs A, A, B, and B?
Use the chip DS26LS31 that converts the encoder A and B signals to differentials. The output signal from the encoder goes through a 74LS04 chip.

What kind of encoder is used with the motor?
The SmartMotor™ uses an Hewlett Packard HEDS incremental encoder which can read position to an accuracy of 2000 counts per revolution for the SM1720 and SM23XX and 4000 counts per revolution for the SM34XX and above. A variable resolution encoder is also available that provides up to 256,000 counts per revolution.

What does dual encoder capability mean?
Dual encoder capability means that the SmartMotor™ can accept and read an A-B signal from an external encoder. This capability allows the user program running on the SmartMotor™ to follow and react to an independent axis.

Can an external encoder input information to the motor to govern position?
External encoder data can be input through the I/O channels A and B while the SmartMotor™ is in the following or camming mode. The CTR command keeps track of external encoder position.

In case of a power shut down, can the encoder continue to read position?
Yes, as long as +5V is tied to any +5V pin, the SmartMotor™ will maintain and update its position register. The minimum required current to power the encoder and controller is 90mA per motor.

What is the encoder index mark?
Our quadrature encoders feature two physical tracks, which generate three signals. One track generates two of the signals, A and B. These signals are phased in quadrature and carry both position and direction information.
The second track generates the third signal; this signal changes state only once per revolution, and defines a unique point in the rotation. The mark on the second track which generates the state change is called the index mark. The index signal is often used to define a home position when used in conjunction with an external switch wired to one of the I/O. See the I and RI commands for details about how the SmartMotor™ handles its index signal in software.

Can the SmartMotor™ handle an absolute encoder?
The SmartMotor™ can handle either an internal or external absolute encoder. Most commercially available absolute encoders have both quadrature / index exporting incremental encoder data, and an 8, 12 or 16 bit bus handling the absolute position data. The SmartMotor can use either its internal encoder channel or its external encoder capability to accept the incremental signal, while using one or more DIO card to handle the absolute data.
For more details, please consult your factory applications engineer.

Hardware

How much current does the SmartMotor™ electronics consume?

The electronics consume about 70 to 90 mA. The motor can also supply approximately 150 mA which may be used to drive limit switches and/or user I/O's.

What is a 'skewed rotor' design?
The rotor is the component of the SmartMotor™ that rotates inside the stator coil. The rotor is surrounded by a permanent magnetic. Electric currents in the stator coil create a changing magnetic field. This magnetic field reacts with the magnet field around the rotor and causes the rotor to turn. The stator contains a number of coils. In a simple design of motor, the rotor will rotate in such a way that its magnet tries to stay in alignment with the field generated in the stator coils. At slower speeds, the rotor turns in small steps or jerks, not with a smooth uniform motion. This effect is known as torque ripple.

By building the rotor with a twist, or making a skewed rotor design, the permanent magnet is twisted around the rotor shaft. This causes a corresponding twisting of the magnetic field. The field is now distributed, or spread, over a number of the stator coils. Such a blurring of the magnetic field means that the rotor does not tend to line up with stator coils. The result is a much smoother rotation and considerable reduction in torque ripple.

During startup, how long does it take to power up the motor?
It takes about 40-60ms for the motor to power up from 0 to 5 volts. It takes 100 ms for the hardware to reset, and _ second to complete a software reset.

What is backlash?
Backlash is defined as the amount of freeplay between the motor shaft and the load. It is determined by measuring the amount of angular movement on the shaft which produces no movement on the load across a variety of conditions.

TOP

Limit Switch

I see there are two limit switch inputs. How are home switches typically implemented? Using one of the limits? How do you recommend implementing abort/emergency kill switches?
You can use the limit switches to trigger the motor to execute its 'home' subroutine. Similarly, one of the limit switches can be set up as a 'kill' or safety switch. By setting a software command to read the status of this switch, the motor will execute a stop in response to a change of state of the switch. I think that, typically, if the state goes to '0', or ground, you can get a fail-safe kill switch arrangement.

How can I stop the shaft without powering down the controller using a limit switch?
There are two function states controlling the behavior of the SmartMotor during limit switch activation. F=0 allows the shaft to run free upon a limit switch hit. F=1 is equivalent to issuing an X command upon a limit switch hit.
Neither command causes the controller to power down: there is no loss of position data or program execution upon such an event.

I am using normally closed induction proximity switches.
Can I stop the motor when the limit input sees a +5V signal?
Use the limit switches as digital inputs by using the program below and ground the limit input with a 500 ohm pull down resistor.

```
WHILE 1 'infinite loop
a=UDI 'set variable a equal to the left limit input signal
IF a==1 'if a +5V signal is sensed
S 'stop
ENDIF 'end if statement
LOOP 'loop back to while statement
```

How do your limit switches work?
When a limit switch is asserted (dragged to ground), the limit switch inputs interrupt the SmartMotor™ processor, causing motion to cease. Depending on the state of the F= command, the SmartMotor™ will either free the motor shaft, or command the current trajectory to come to rest and servo in place at a position determined by the current acceleration rate (A=).

If my ball screw application runs into a hardstop, what will happen?
If the SmartMotor is operating in position or velocity mode, when the axis run into a hardstop, the current position error will begin to rise. As the PID filter senses a rise in the current position error, and as the error is sustained over time, the PWM command will grow, resulting in more output torque. The output torque will continue to grow until the effective current maximum, set by the AMPS command, is reached. Once this limit is achieved, torque will remain constant until the current position error exceeds the error limit (E=), at which time the motor off flag will be set, and the drive will shut down (sending output torque to zero). The controller will continue to run following a position error event. Error handling routines based on the Bo (motor off) bit can be implemented in the stored user program.

Miscellaneous

How is the SmartMotor™ in terms of electrical noise and EMI?
SmartMotors™ are fully enclosed and are constructed with a minimum of internal inter connects. There are no internal wires, we use header pins to connect between stacked circuit boards. The result is an electrically quiet motor. We have a CE rating and meet the stringent requirements of the German TUV standard. (We been tested and passed by TUV, but we are waiting for our certificate before we can officially use their designation.)

Does the SmartMotor™ have a cleanroom rating?
Animatics has not submitted the SmartMotor™ for cleanroom compliance testing with any outside testing agency: We therefor can not make any specific claims about clean room category compliance.
However, since the SmartMotor™ is based on a brushless DC servo motor and a low-noise emission PWM amplifier, the SmartMotor™ is generally suitable for clean room service in all categories. In fact, the bulk of our current sales go to OEM companies manufacturing semiconductor handling and processing equipment; the end-use of almost all of our production is in the high-category clean rooms of semiconductor fabs, world-wide.
The cost of machine footprint is extremely important in cleanroom applications; the "all-in-one" integrated construction of the SmartMotor™ is widely considered a critical advantage by many clean room equipment designers. Several of our customers are manufacturing machines which would not be practical if they had to provide footprint for separate controllers, amplifiers, and feedback devices, not to mention the cabling required to integrate these separate devices. To extend this idea, an article in December '97 edition of Control Engineering sighted Animatics as the only manufacturer of such an integrated servo motion control package.

Is there any way of escaping a tight loop in the program?
Yes, press "Ctrl + F1", which activates a factory test mode. Then press F11 and follow the instructions.

What is the PWM switching frequency in the motor?
Depending on the motor, (SM42XX and SM56XX) 16kHz, (SM1720, SM23XX, and SM34XX Ver. 3.4) 25kHz, and (SM1720, SM23XX, SM34XX Ver. 4.0 and above) 33kHz.

Is the SmartMotor explosion proof?
The current SmartMotor™ design is not explosion proof. An explosion proof version of the motor is technically possible, consult an Animatics Applications Engineer for details.

What is the maximum number of revolutions that the SmartMotor™ can count?
The SM23XX can count 1,073,741 revolutions in each direction.
(+/-31 bits or 2,147,483,648 counts / 2000 counts/ revolution = 1,073,741 revolutions)

In the brochure, what does IP65 protection stand for?
The numbers 6 and 5 characterize the degree of protection. The motor is dust tight and protected against water jets.

Peripherals

What is the "AniLink Network"? -- As mentioned in the SmartMotor™ brochure:
The AniLink Network is a network management system for the Smart Motor peripherals. The AniLink network allows the SmartMotor™ to control up to sixteen daisy-chained external devices (eight of the DIO-family, and eight of the AIO-family). These devices extend the system functionality of the SmartMotor controller.

What network protocol are you using for the Anilink network?
What speed does it run at?
The Anilink Network does not run on a protocol, the system is specific to Animatics motors and peripherals. The network is designed for transmission over short distances (inches) across circuit boards. The simple system does not require expensive chip sets to communicate between devices. Devices read data byte by byte according to the clock cycles in the processors.

What is the EEPROM?
The EEPROM (electronically erasable programmable read only memory) is used in the SmartMotor™ to store user programs. A unique feature of an EEPROM is its ability to permanently store data. This allows the memory module on the SM to be removed, and a new program inserted, even with the SmartMotor™ under power. The EEPROM can store up to 8 KB of program data, programs are stored in ASCII. A 32 KB chip will soon be available

What are the options for networking SmartMotors?

Daisy-Chain
You can daisy-chain up to 128 SmartMotors™ using a single RS-232 port. Motor addressing is accomplished by command in the initialization segment of the stored user program. Commands are passed from the host to the first motor over the RS-232, then are repeated from on motor to the next until they arrive back at the host.

Multi-Drop
Using the optional RS485 converter, you can build a star configuration network with all motors in parallel. The RS-485 communication protocol is less susceptible to common mode noise than RS-232.

AniLink
Every SmartMotor™ is equipped with an integrated network manager, allowing each to master its own subsidiary network of AniLink peripherals, including LCD displays, digital and analog I/O modules, push wheel input devices, control pendants, and other peripheral devices. AniLink peripherals are available from Animatics as well as other manufactures.

What is a PLC?
A PLC (Programmable Logic Controller) is a type of general-purpose control computer. The SmartMotor™ can act as a slave to a PLC, with communications derived through a serial port (RS-232 or RS-485) or through I/O. SmartMotors are currently being used in PLC based systems using hardware by Allen Bradley (Slick 50, Slick 504), Siemeins, and Z-World.

Can I use the SM as a PLC? What changes are required?
You can use the SmartMotor™ as a PLC in many applications. A PLC is a Programmable Logic Controller is a rugged industrial computer generally used for machine or process control. In the United States, most PLC's are programmed in a language called ladder logic.
The SmartMotor has three on board, user definable I/O. Additional I/O can be added by connecting AniLink peripheral boards such as DIO-100 digital I/O card, or the AIO-100 analog I/O card. New +24 VDC opto-isolated Micro Adapter cards, which connect to the I/O, Anilink, or limit ports, are now available. Since the SmartMotor™ does not use ladder logic, care must be taken to understand the implications of command timing, and addressed host communication interruptions of the stored user program when considering such a system.

In what applications is the I/O connector necessary?
I/O connector is used in almost all applications where the SmartMotor™ is expected to interact directly with its application or environment.
Common uses for the I/O connector are:
Program Start Button
Program Stop Button
Emergency Stop Button
I/O signaling from application
Encoder following signal transmission

Step-and-Direction signal transmission
Monitoring of SmartMotor™ position by external device

Does the SmartMotor™ have any method to store data to non-volatile memory without use of a dedicated host?
The SmartMotor can store data using the RD-350 SRAM drive. This product allows the user to read or store up to 1 million 32 bit integers on a non-volatile battery-backed SRAM card.

Power Supply

What is the maximum input voltage for a SmartMotor running off a DC power supply?
The voltage input for the SmartMotor™ ranges from 20VDC to 48V DC maximum. Any voltage above 48 VDC will reduce the life of the SmartMotor™ and possibly damage it, especially if the application allows the motor to be back driven.
(In this mode, the load is driving the motor, which acts as a generator, and induces a voltage in the stator windings).

Will one power supply drive three motors?
It is necessary to match the power supply to the combined peak and rms power demand of all three motors. Power supplies are generally sized according to the procedure for sizing multiple motors. Account for IR losses in the supply and saturation.

What is the cable length limit between a power supply and SmartMotor™?
The limit is dependent on wire resistance, which limits the current and voltage to the motor. These resistive losses affect both acceleration and steady state velocity. There are minor acceleration issues and cases where the motor will not reach torque or speed. The length depends on the application. For more information, contact the applications engineer.

What kind of power supply do you recommend for the SmartMotor™?
Unregulated supplies are preferred over regulated power supplies for durability in high-demand motion control applications.

Can multiple SmartMotor™ operate from a single DC power supply?
Many SmartMotors™ can operate from a single power supply if the combined power demand (both peak and RMS) of all the motors does not exceed the capacity of the supply. The normal rules for sizing power supplies apply to sizing for multiple motors, be sure to account for line drops and demand saturation. In applications with multiple power supplies, remember that all power supplies must share a common ground configured to avoid ground loops and supporting the communications circuitry.

Reliability

What do the reliability studies look like for the SmartMotor™?
The SmartMotor™ MTBF has been calculated at over 100,000 hours using MILSPEC 17 methods. Motors are currently under long term test for verification. The SmartMotor™ is designed and manufactured for industrial environments where reliability and durability are critical. The SmartMotor's reliability is a function of:

1. Total system integration
2. Animatics' 9 years experience in design and mfg of servo motion control products
3. Extraordinary quality of components used

Is the MTBF value a theoretical or real achieved value ?
MTBF can be statistically calculated from the sum of the theoretical component lifetimes of the elements of the SmartMotor™, amplifier, controller etc. SEMI E10-96 is an industry standard that defines how to do this, as is the

method described in MIL-HDBK-217. However, we have also conducted accelerated aging tests to produce data that confirms our MTBF value.
In situations where high loads, or high temperatures are experienced, we recommend increasing the motor size. This allows the motor to perform at the required level without operating above the temperature range of the electronics. Of course, operating at a temperature comparable to the recommended temperature for the electronics increases the MTBF of the system.

Software

Can the SmartMotor™ implement an independent master-slave gear ratio?
The SmartMotor™ can implement fractional ratios between 0 and just under 256 (signed 7 bit number) using the MFR command. This means that the motor can be geared to follow a single encoder input to any positive or negative ratio between 255/1 to 1/255. Does the SmartMotor™ programming environment have arrays or tables? I need some means to store a large set of calibration values. The current SmartMotor™ does have this capability. It has the capability to hold overlaid arrays in bytes, words and longs (8,16, 32 bit numbers).

What kind of software do you use to control the SmartMotor™?
We supply a host terminal development system for the SmartMotor™ for Windows or DOS. This program acts as an RS-232 translator for host-to-slave interaction, and as an integrated development environment for the writing and testing stored user programs.

What host options are available for the SmartMotor™?
Can the SmartMotor™ receive commands from other software packages or devices other than a PC?
Since the SmartMotor™ receives commands in ASCII, any host which can transmit the appropriate ASCII strings can communicate with the SmartMotor™. A number of customers have used PC programs other than TERM as a host terminal program. LABWINDOWS and PROCOMM are commonly used, each program has unique advantages for particular applications.
Several customers have written their own host terminal programs on a variety of hardware platforms: PC, Mac, Next, Sun (Unix) and SGI (Unix) . The SmartMotor™ has also been integrated to accept ASCII commands from a variety of PLC's and bar code readers.

Can I download program comments and headers with my SmartMotor™ program?
Comments can be placed in you user source (.src) file using the (') character to the left of any comment. However, comments and headers represent illegal character strings within the SmartMotor processor, and should not be downloaded to the SmartMotor's memory.

Does the SmartMotor™ operate on fixed point or floating point math?
The SmartMotor™ processor is an integer machine. We can help you produce code allowing your operator to interface in standard decimal units for both input and output.

Speed

I have a SmartMotor™ servo, but I cannot reach anything near the maximum speed, even with no load on the motor?
Check the voltage supply! The motor needs a voltage supply equal to the desired speed multiplied by the voltage constant (rpm x Kv). If the supply voltage is too low, the motor will not attain its maximum theoretical speed. The maximum speed will be (supply voltage/Kv).

Temperature

What´s the maximum and minimum temperature for the SmartMotor™ electronics?
The maximum temperature is 70 degrees C. This is a standard industry temperature limit for CMOS components. Although almost half the components in the SmartMotor™ servo are rated above 70 degrees C (100 to 150 degrees C), microprocessors are very vulnerable to higher temperatures. Temperatures above 70 degrees C may reduce the reliability of circuit components and could corrupt data held in registers or in the processor.
The SmartMotor is limited to 70 degrees C by an electronic thermostat. This can be disabled to allow the system to run at higher temperatures, but system lifetime is reduced.

TOP

Timing

How fast are the Analog to Digital pins on the SmartMotor™ read and converted?
The acquisition time is 25 to 30 microseconds and the conversion time is about the same.

The literature mentions "4kHz 32-bit motion".
Does this mean a position update loop of 250usec (1/4kHz)?
Yes, a position update every 1/4000 seconds.

What is the best time resolution that you can get trying to synchronize motors over the network?
Your literature indicates that you can synchronize the motors via hardware (presumably the I/O port). Can you provide me details on how this is done? I am still curious about what performance can be attained over the network, so could you also ask your software people what the latency is when synchronizing motors via the network.

At its most basic, we can synchronize motors by hardware. In this mode, a motor will wait for a signal from a limit switch, another motor or external source before commencing a position change. This is perhaps the slowest method because movements are timed according to 'mechanical' events. Our network options are possible with series (RS232) or parallel (RS485) configurations. In RS232, each motor receives its commands preceded by that motor's unique address. A command for a specific motor must travel through the each motor that lies between the controller and the specific motor before it is 'seen' by the target. Each motor takes approximately 0.25 milliseconds to receive and re-transmit a command. The command for the target motor will be delayed according to the number of motors between it and the controller, and the number of other commands coming down the network. If the network may carry commands to and from other devices and the motor has to wait while this traffic passes before it can receive and read its instructions.

Response rate is a real differentiator of servomotors and an indicator of the capability of the on-board processors. In a worse case scenario long instructions and low baud rate, we take 5ms to read, receive and process an instruction. With typical faster baud rates and command lengths, the time can come down to 1 ms. Using RS485 mode, the motors are connected in parallel to the network and all motors read instructions simultaneously. A motor will ignore an instruction unless it is addressed to that specific motor.

How long does it take until a command is executed?
Depending on the PID tuning values, execution time is around 0.3 milliseconds. The time taken for RS-232 commands to pass along a set of SmartMotors in series is as follows:
The time for the SmartMotor controller to process a 14 character command, at 107 micro seconds per character is 1.5 ms.
The process time can be 1 to 6 servo cycles.
The servo rate is 4 kHz, 6 servo cycles in 1.5 ms.
Latency, the time for an incoming signal to be read, processed and retransmitted as an output to the next motor on the RS-232 is 2 to 3 ms.

How long does it take to transition out of Mode Follow to Position or Velocity Mode?
Transition time to Position and Velocity Mode is around 5.4 ms and 6.2 ms, respectively.

TOP

Torque

How long can a SmartMotor™ supply its peak torque?
The SmartMotor can supply peak torque until the heat generated from the maximum current in the stator winding raises the temperature of the electronics above 70 degrees C. This time will depend on the ambient temperature and way the application allows the motor to disperse heat. If a motor is fan cooled, in cold air, or bolted to a large metal surface (which aids cooling from heat conduction and radiation) the motor will sustain peak torque for longer periods. A general answer is that the motor could supply peak torque for 10 seconds every minute. If it runs longer, more heat is generated which raises the temperature of the microchip and electronics. Then the motor must run at a lower power output, or stop, until it has cooled.

How will the torque-speed curve change with a lower input voltage?
The downward slope of the curve will remain the same, just shifted to the left by the ratio of the input voltage and torque-speed curve voltage.

What do you mean by peak torque and continuous torque in your brochure?
Peak torque was measured using a dynamometer by attaching the SmartMotor™ face place to a 10" x 10" x _ " Al plate at room temperature. A pulley, attached to the shaft, connected to an adjustable brake and data was collected across a number of velocities.
The continuous ratings were the highest torque/speed SOAC readings found for continuous operation.
The published peak torque values will cause a SmartMotor™ starting from room temperature to shut down within 30 to 45 seconds. Normal de-rating techniques must be applied when considering any applications temperature and loading requirements. Note that the continuous operation specifications appear lower than those that would be calculated for a standard BLDC servomotor given our motors specifications and thermal capacitance. Thermal loading of system by the drive circuits account for these losses.

Is there a formula to relate torque speed characteristics when a SmartMotor™ is used with a power supply delivering less than 45V?
There is a complex relationship between the torque-speed curves and the applied voltage. You can predict the peak torque at a given speed by the formula:
Torque = Maximum current x Torque constant
Maximum current = the unit's current limit or max motor coil current, whichever is lower. For the SM17 and 23s, the unit current limit is 12.5A, while that for the SM34 is 40A. The RTC is 3A.
The max coil current is calculated as follows:
max coil current = (bus voltage - back EMF)
coil resistance
(where back EMF = motor voltage constant x RPM)
The continuous torque is a function of heat dissipation. Bus voltage has a negligible effect, as long as it is within the specified operating range.

TOP

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