



MANUAL

Contents

Encoder motor ECM Series

Encoder ECM	2
DSM702-24V-90P-ECM	4
DSM702H-24V-90P-ECM (Hollow disc flange option)	5
DSM702S-24V-90P-ECM (Solid shaft option)	6
DSM702-24V-120P-ECM	7
DSM702H-24V-120P-ECM (Hollow disc flange option)	8
DSM702S-24V-120P-ECM (Solid shaft option)	9

ECM series encoders make an impression with their robust design and high signal quality.

ECM encoder is a 360° angle sensor that provides contactless high-resolution angular position data based on magnetic Circular Vertical Hall technology. The 3-channel encoder with differential signals guarantees interference-free function even under the highest loads.

A variety of smart EC motors and high resolution encoders can be combined to form a high precision control system.

Smart EC motors can be configured and ordered online. Fast, easy and online : www.dnj.co.kr (dnj@dnj.co.kr)

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Digital Quadrature Encoder integrated in the Smart EC Motor

ECM series encoders make an impression with their robust design and high signal quality.

ECM encoder is a 360° angle sensor that provides contactless high-resolution angular position data based on magnetic Circular Vertical Hall technology.

Multiple output formats supported for ease of system integration

- ABZ output provides high resolution, low latency, and PWM for initial position
- Output resolution on ABZ are selectable

The 3-channel encoder with differential signals guarantees interference-free function even under the highest loads.

A variety of smart EC motors and high resolution encoders can be combined to form a high precision control system.

Supports harsh operating conditions required for automotive and industrial applications, including direct connection to 12V battery

The resolution can be factory-set.

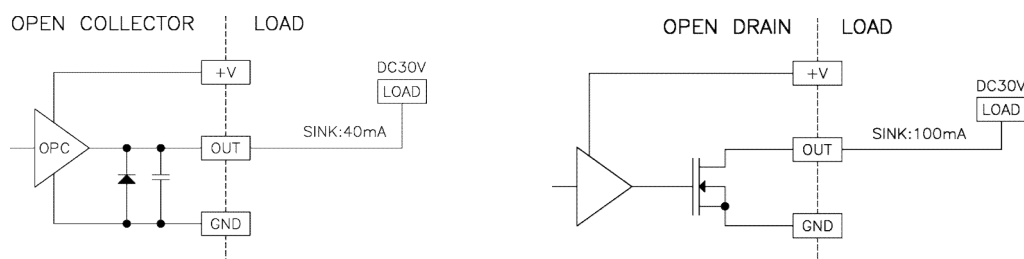
Features**Built in digital encoder ECM**

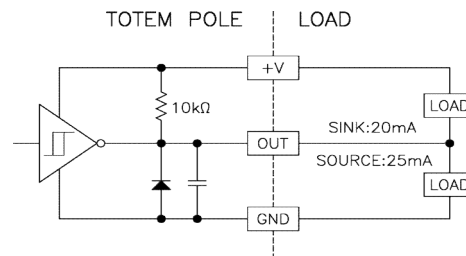
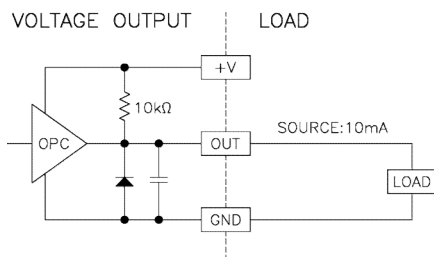
- Relative position signal suitable for positioning tasks
- Rotation direction recognition
- Speed information from number of pulses per time unit
- Incremental ABZ Quadrature Encoder interface with pulse per turn from 128~4096
- PWM Output 12-bit
- Open Collector, Totem Pole, Line Driver, Open Drain
- Wide input range 5~24Vdc
- Standard solution for many applications
- Customizing (absolute type)

ECM Type	Resolution	Output Phase	Output Type	Supply Voltage
MEI	07 08 09 10	2C 4C	OPC VOP TOP	05
MEI	07 08 09 10	2C 4C	OPD	24
MEI	07 08 09 10	6C	LDP	05
MEI	12	3C	OPD	24

Model information

ECM Type	MEI	Incremental type
Resolution	07	Cycles per Shaft Turn, 7 bit (Incremental 128 Steps / 2.81°)
	08	Cycles per Shaft Turn, 8 bit (Incremental 256 Steps / 1.40°)
CPR (Count per Revolution)	09	Cycles per Shaft Turn, 9 bit (Incremental 512 Steps / 0.70°)
	10	Cycles per Shaft Turn, 10 bit (Incremental 1024 Steps / 0.35°)
	12	Cycles per Shaft Turn, 12 bit (Incremental 4096 Steps / 0.0879°)
Output Phase	2C	2 channels dual quadrature A, B
	3C	3 channels dual quadrature A, B, with index Z
No. of channels	4C	4 channels dual quadrature A, B, with index Z and PWM output
	6C	3 channels A, B, Z and complementary output A $\bar$, B $\bar$, Z $\bar$
Output type		
Control interface output	OPC	NPN Open Collector output (max 30Vdc) Sink current per channel (max 30mA) External pull-up resistor 4.7k~10kΩ Voltage Output.
	VOP	Open collector output of the sensors with integrated pull-up resistor 4.7kΩ Supply voltage(Vin) = Ouput voltage(Vout) Source current : max 10mA
	TOP	Totem Pole output (Internally has two values, high or low) Schmitt trigger (74HC14) and TTL output (DC 5V) High : Source (max 25mA, min 3.5Vdc) Low : Sink (max 20mA, max 0.4Vdc)
	OPD	N channel Open Drain output VH : max 30Vdc VL : max DC 0.5Vdc Sink current : max 100mA
	LDP	Line Driver output, The 3-channel encoder with differential signals High : max -20mA, min 2.5Vdc Low : max 20mA, max 0.5Vdc Signal rise time : 100ns or less (CL=30pF, RL=1kΩ, 25°C) Signal fall time : 100ns or less (CL=30pF, RL=1kΩ, 25°C) Line Receiver Recommended IC : AM26LS32
Supply Voltage	05	Supply Voltage Vcc +5Vdc $\pm$ 10%
	24	Supply Voltage Vcc +7Vdc ~ +24Vdc

Block Diagram



Output Interface

Incremental AB

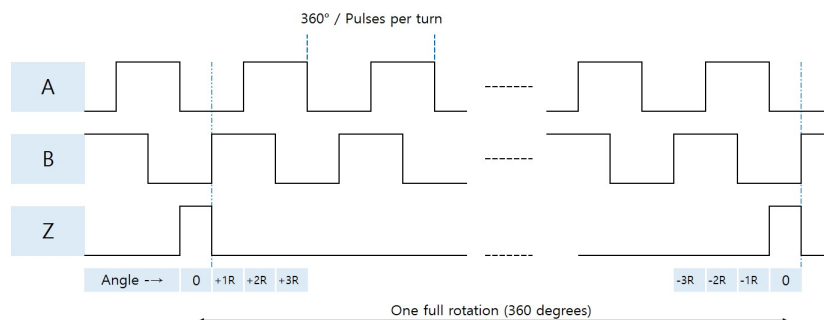
A/B Phase difference : $1/4T \pm 1/8T$

ECM Encoder AB output emulates a 10~12bit incremental encoder providing logic pulses in quadrature.

Signals A and B are quadrature signals, shifted by 90°, and signal Z is a reference mark. (index)

The A and B signals toggle with a 50% duty cycle (relative to angular distance, not necessarily time) at a frequency of 2^N cycles per revolution, giving a cycle resolution of $(360 / 2^N)$ degrees per cycle.

B is offset from A by 1/4 of the cycle period.



Index Z

Encoder Z signal is an index pulse that occurs once per revolution to mark the zero (0) angle position.

Under rotation, this allows the receiver to synchronize to a known mechanical/magnetic position, and then use the incremental A/B signals to keep track of the absolute position.

The width of the Z pulse is 1/4 of the quadrature signal period and it is synchronized with the A and B signals.

The index rising edge is aligned with the channel B falling edge.

PWM

The ECM encoder provides a pulse-width-modulated open-drain output, with the duty cycle (DC) proportional to measured angle. The PWM duty cycle is clamped at 5% and 95% for diagnostics purposes.

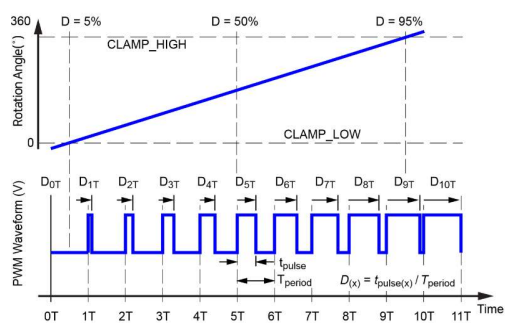
A 5% DC corresponds to 0°; a 95% DC corresponds to 360°.

Within each cycle, the output is high for the first 5% and low for the last 5% of the period.

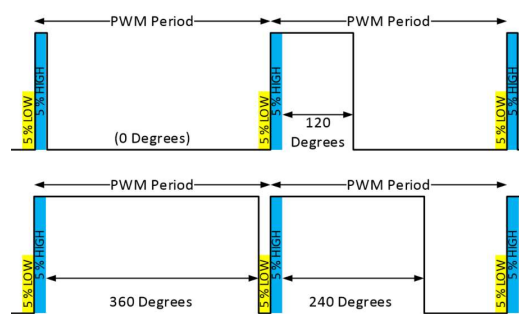
The middle 90% of the period is a linear interpolation of the angle as sampled the start of the PWM period.

The angle is represented in 12-bit resolution and can never reach 360°.

The maximum duty cycle high period is : $\text{DutyCycleMax} (\%) = (4095 / 4096) \times 90 + 5$



PWM Outputs a Duty-Cycle Proportional To Sensed Angle



Pulse-Width Modulation (PWM) Examples

Pin Allocation

Connection Encoder Interface

UL1061 AWG28

(F.G : AWG22)

Pin No.	COLOR	MEI	MEI (LDP)	MEC	Comments
Pin 1	red	VCC	VCC	VCC	Supply power
Pin 2	black	GND	GND	GND	Ground
Pin 3	brown	ENC A	ENC A	ENC A	
Pin 4	blue	-	ENC nA	-	
Pin 5	gray	ENC B	ENC B	ENC B	
Pin 6	green	-	ENC nB	-	
Pin 7	yellow	ENC Z	ENC Z	ENC Z	
Pin 8	orange	-	ENC nZ	Tx / SSCK	
Pin 9	white	PWM	-	Rx / SSD	
Pin 10	black	F.G	F.G	F.G	Frame Ground



DSM EC MOTOR

Ø70 mm, 24VDC, brushless, 2600rpm, 90 Watt, Standard Hollow Shaft (front only), Encoder

- Brushless DC motor with high resolution encoder
- External diameter Ø70
- Incremental ABZ Quadrature Encoder output
- PWM output 12-bit
- Hall sensor (5~24Vdc, open-collector)
- High torque density
- Insulation class F
- Robust ball bearing system for long service life
- Customizing

Motor data		with Hall sensors		Part numbers			
Ratings				702-24V-90P	702-24V-120P		
1 Nominal Voltage	V			24	24		
2 Current	A			5.0	7.0		
3 Power	W			90	120		
4 Speed	RPM			2200	2900		
5 Torque	N.m			0.38	0.40		
Electrical characteristics							
1 Maximum Operating Voltage	V			30	30		
2 Maximum Output Power	W			154	204		
3 No Load Speed	RPM			2600	3600		
4 No Load Current	mA			600	800		
5 Stall Torque	N.m			1.74	1.75		
6 Torque Constant	mN.m/A			85	64		
7 Back EMF Constant	mV/RPM			8.88	6.42		
8 Terminal resistance phase to phase	Ω			0.50	0.30		
9 Terminal inductance phase to phase	mH			0.98	0.54		
10 Minimum Insulation resistance (dc 500V)	MΩ			10	10		
11 Noise (Rad.30[cm] DC24V, No load)	dB			0.0	0.0		
Specifications		Characteristic Curves					

Mechanical data (preload ball bearing)

1 Max. axial load (dynamic)	kgf.cm	455	Refer to bellow T-I, T-N drawing
2 Max. force for press fits (static)	kgf.cm	600	

Thermal data

Temperature ratings

1 Max. permissible winding temp.	°C	+160
2 Max. permissible bearing temp.	°C	+110

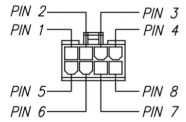
Ambient condition

1 Operation condition	°C	-10~50
2 Storage condition	°C	-10~60

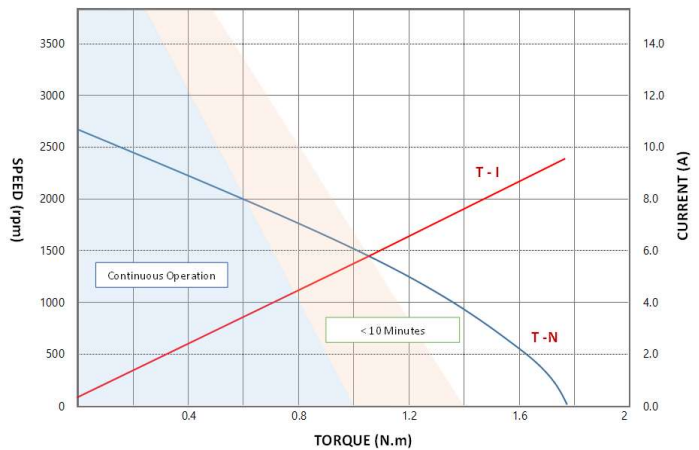
Other specifications

1 Number of pole pairs	pole	8
2 Number of phases	phase	3
3 Weight	gram	660

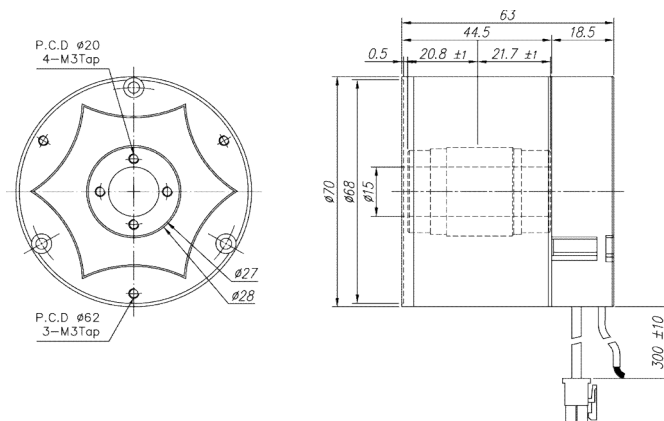
Pin Allocation		(Molex 5557-08R)	
1 black	GND	Motor	UL1061 AWG 22
2 blue	Motor winding W	Hall sensor	UL1061 AWG 26
3 green	Motor winding V		
4 yellow	Motor winding U		
5 red	Vhall 5 ... 24Vdc		
6 brown	Hall sensor C		
7 gray	Hall sensor B		
8 white	Hall sensor A		



702-24V-90P T-N-I curve



Dimensions in [mm]





DSM EC MOTOR

Ø70 mm, 24VDC, brushless, 2600rpm, 90 Watt, Hollow disc flange option (front only), Encoder

- Brushless DC motor with high resolution encoder
- External diameter Ø70
- Incremental ABZ Quadrature Encoder output
- PWM output 12-bit
- Hall sensor (5~24Vdc, open-collector)
- High torque density
- Insulation class F
- Robust ball bearing system for long service life
- Customizing

Motor data		Part numbers	
		702-24V-90P	702-24V-120P
1 Nominal Voltage	V	24	24
2 Current	A	5.0	7.0
3 Power	W	90	120
4 Speed	RPM	2200	2900
5 Torque	N.m	0.38	0.40

Electrical characteristics			
1 Maximum Operating Voltage	V	30	30
2 Maximum Output Power	W	154	204
3 No Load Speed	RPM	2600	3600
4 No Load Current	mA	600	800
5 Stall Torque	N.m	1.74	1.75
6 Torque Constant	mN.m/A	85	64
7 Back EMF Constant	mV/RPM	8.88	6.42
8 Terminal resistance phase to phase	Ω	0.50	0.30
9 Terminal inductance phase to phase	mH	0.98	0.54
10 Minimum Insulation resistance (dc 500V)	MΩ	10	10
11 Noise (Rad.30[cm] DC24V, No load)	dB	0.0	0.0

Specifications	Characteristic Curves
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Mechanical data (preload ball bearing)

1 Max. axial load (dynamic)	kgf.cm	455	Refer to bellow T-I, T-N drawing
2 Max. force for press fits (static)	kgf.cm	600	

Thermal data

Temperature ratings

1 Max. permissible winding temp.	°C	+160
2 Max. permissible bearing temp.	°C	+110

Ambient condition

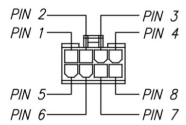
1 Operation condition	°C	-10~50
2 Storage condition	°C	-10~60

Other specifications

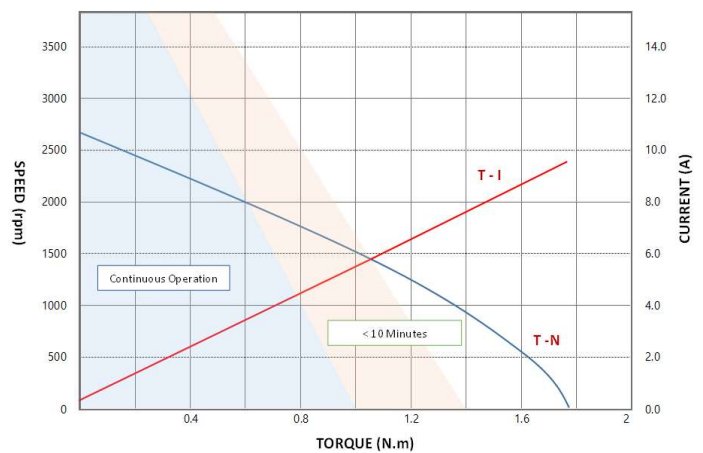
1 Number of pole pairs	pole	8
2 Number of phases	phase	3
3 Weight	gram	700

Pin Allocation	(Molex 5557-08R)
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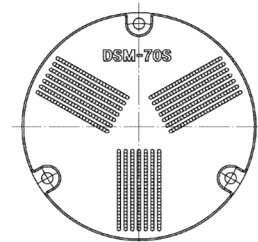
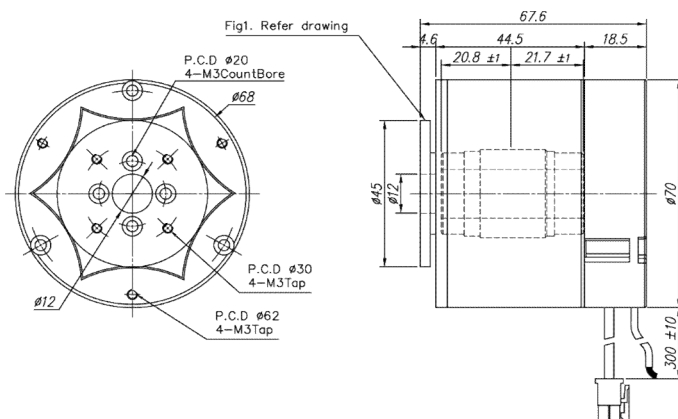
1 black	GND	Motor	UL1061 AWG 22
2 blue	Motor winding W	Hall sensor	UL1061 AWG 26
3 green	Motor winding V		
4 yellow	Motor winding U		
5 red	Vhall 5 ... 24Vdc		
6 brown	Hall sensor C		
7 gray	Hall sensor B		
8 white	Hall sensor A		



702-24V-90P T-N-I curve



Dimensions in [mm]





DSM EC MOTOR

Ø70 mm, 24VDC, brushless, 2600rpm, 90 Watt, Solid shaft option, Encoder

- Brushless DC motor with high resolution encoder
- External diameter Ø70
- Incremental ABZ Quadrature Encoder output
- PWM output 12-bit
- Hall sensor (5~24Vdc, open-collector)
- High torque density
- Insulation class F
- Robust ball bearing system for long service life
- Customizing

Motor data		with Hall sensors		Part numbers			
Ratings				702-24V-90P	702-24V-120P		
1 Nominal Voltage	V			24	24		
2 Current	A			5.0	7.0		
3 Power	W			90	120		
4 Speed	RPM			2200	2900		
5 Torque	N.m			0.38	0.40		

Electrical characteristics							
1 Maximum Operating Voltage	V			30	30		
2 Maximum Output Power	W			154	204		
3 No Load Speed	RPM			2600	3600		
4 No Load Current	mA			600	800		
5 Stall Torque	N.m			1.74	1.75		
6 Torque Constant	mN.m/A			85	64		
7 Back EMF Constant	mV/RPM			8.88	6.42		
8 Terminal resistance phase to phase	Ω			0.50	0.30		
9 Terminal inductance phase to phase	mH			0.98	0.54		
10 Minimum Insulation resistance (dc 500V)	MΩ			10	10		
11 Noise (Rad.30[cm] DC24V, No load)	dB			0.0	0.0		

Specifications	Characteristic Curves
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Mechanical data (preload ball bearing)

1 Max. axial load (dynamic)	kgf.cm	455	Refer to bellow T-I, T-N drawing
2 Max. force for press fits (static)	kgf.cm	600	

Thermal data

Temperature ratings

1 Max. permissible winding temp.	°C	+160
2 Max. permissible bearing temp.	°C	+110

Ambient condition

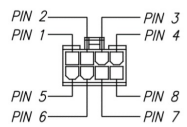
1 Operation condition	°C	-10~50
2 Storage condition	°C	-10~60

Other specifications

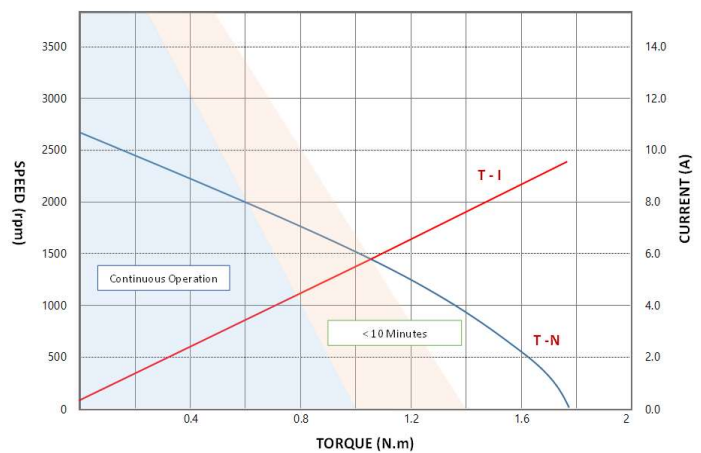
1 Number of pole pairs	pole	8
2 Number of phases	phase	3
3 Weight	gram	715

Pin Allocation	(Molex 5557-08R)
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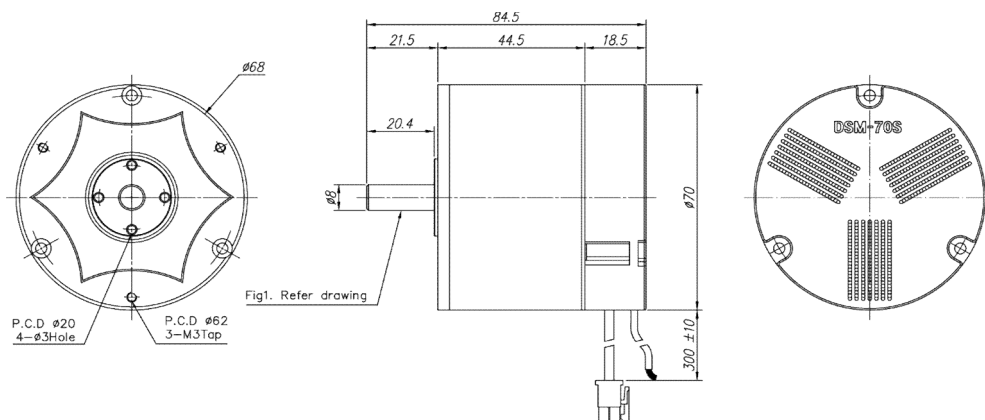
1 black	GND	Motor	UL1061 AWG 22
2 blue	Motor winding W	Hall sensor	UL1061 AWG 26
3 green	Motor winding V		
4 yellow	Motor winding U		
5 red	Vhall 5 ... 24Vdc		
6 brown	Hall sensor C		
7 gray	Hall sensor B		
8 white	Hall sensor A		



702-24V-90P T-N-I curve



Dimensions in [mm]





DSM EC MOTOR

Ø70 mm, 24VDC, Brushless, 3600rpm, 120 Watt, Standard Hollow Shaft (front only), Encoder

- Brushless DC motor with high resolution encoder
- External diameter Ø70
- Incremental ABZ Quadrature Encoder output
- PWM output 12-bit
- Hall sensor (5~24Vdc, open-collector)
- High torque density
- Insulation class F
- Robust ball bearing system for long service life
- Customizing

Motor data		with Hall sensors		Part numbers			
Ratings				702-24V-90P	702-24V-120P		
1 Nominal Voltage	V			24	24		
2 Current	A			5.0	7.0		
3 Power	W			90	120		
4 Speed	RPM			2200	2900		
5 Torque	N.m			0.38	0.40		

Electrical characteristics							
1 Maximum Operating Voltage	V			30	30		
2 Maximum Output Power	W			154	204		
3 No Load Speed	RPM			2600	3600		
4 No Load Current	mA			600	800		
5 Stall Torque	N.m			1.74	1.75		
6 Torque Constant	mN.m/A			85	64		
7 Back EMF Constant	mV/RPM			8.88	6.42		
8 Terminal resistance phase to phase	Ω			0.50	0.30		
9 Terminal inductance phase to phase	mH			0.98	0.54		
10 Minimum Insulation resistance (dc 500V)	MΩ			10	10		
11 Noise (Rad.30[cm] DC24V, No load)	dB			0.0	0.0		

Specifications	Characteristic Curves
----------------	-----------------------

Mechanical data (preload ball bearing)

1 Max. axial load (dynamic)	kgf.cm	455	Refer to bellow T-I, T-N drawing
2 Max. force for press fits (static)	kgf.cm	600	

Thermal data

Temperature ratings

1 Max. permissible winding temp.	°C	+160
2 Max. permissible bearing temp.	°C	+110

Ambient condition

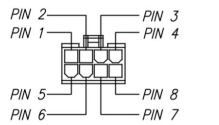
1 Operation condition	°C	-10~50
2 Storage condition	°C	-10~60

Other specifications

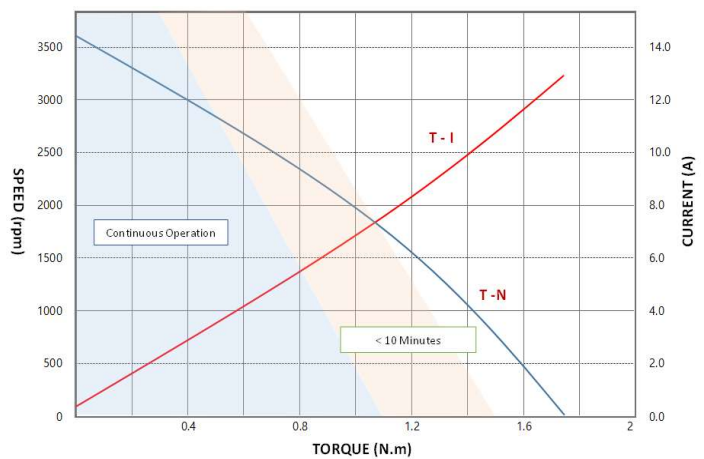
1 Number of pole pairs	pole	8
2 Number of phases	phase	3
3 Weight	gram	650

Pin Allocation	(Molex 5557-08R)
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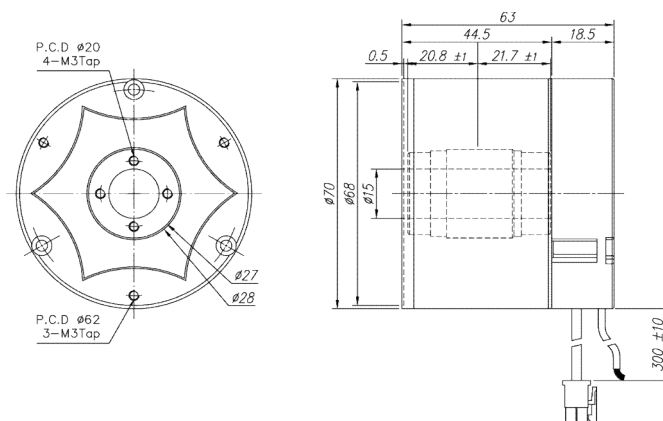
1 black	GND	Motor	UL1061 AWG 22
2 blue	Motor winding W	Hall sensor	UL1061 AWG 26
3 green	Motor winding V		
4 yellow	Motor winding U		
5 red	Vhall 5 ... 24Vdc		
6 brown	Hall sensor C		
7 gray	Hall sensor B		
8 white	Hall sensor A		



702-24V-120P T-N-I curve



Dimensions in [mm]





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Ø70 mm, 24VDC, Brushless, 3600rpm, 120 Watt, Hollow disc flange option (front only), Encoder

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- External diameter Ø70
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- PWM output 12-bit
- Hall sensor (5~24Vdc, open-collector)
- High torque density
- Insulation class F
- Robust ball bearing system for long service life
- Customizing

Motor data		Part numbers	
with Hall sensors		702-24V-90P	702-24V-120P
Ratings			
1 Nominal Voltage	V	24	24
2 Current	A	5.0	7.0
3 Power	W	90	120
4 Speed	RPM	2200	2900
5 Torque	N.m	0.38	0.40

Electrical characteristics			
1 Maximum Operating Voltage	V	30	30
2 Maximum Output Power	W	154	204
3 No Load Speed	RPM	2600	3600
4 No Load Current	mA	600	800
5 Stall Torque	N.m	1.74	1.75
6 Torque Constant	mN.m/A	85	64
7 Back EMF Constant	mV/RPM	8.88	6.42
8 Terminal resistance phase to phase	Ω	0.50	0.30
9 Terminal inductance phase to phase	mH	0.98	0.54
10 Minimum Insulation resistance (dc 500V)	MΩ	10	10
11 Noise (Rad.30[cm] DC24V, No load)	dB	0.0	0.0

Specifications	Characteristic Curves
-----------------------	------------------------------

Mechanical data (preload ball bearing)

1 Max. axial load (dynamic)	kgf.cm	455	Refer to bellow T-I, T-N drawing
2 Max. force for press fits (static)	kgf.cm	600	

Thermal data

Temperature ratings

1 Max. permissible winding temp.	°C	+160
2 Max. permissible bearing temp.	°C	+110

Ambient condition

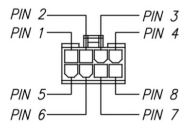
1 Operation condition	°C	-10~50
2 Storage condition	°C	-10~60

Other specifications

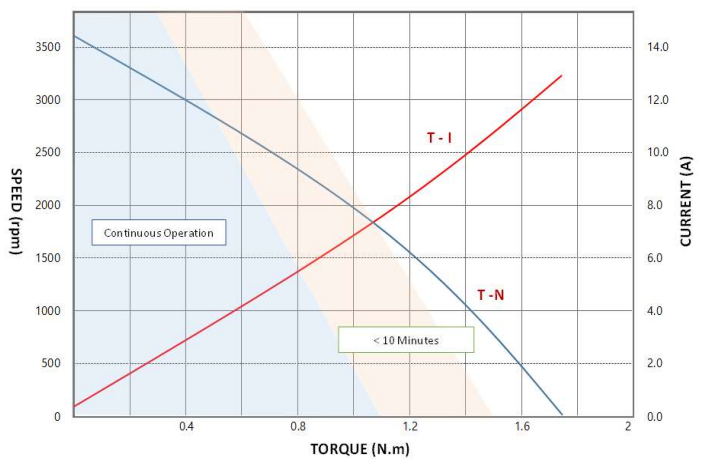
1 Number of pole pairs	pole	8
2 Number of phases	phase	3
3 Weight	gram	690

Pin Allocation		(Molex 5557-08R)	
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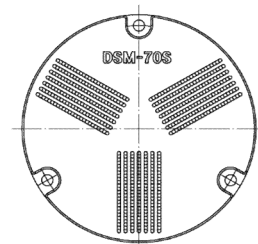
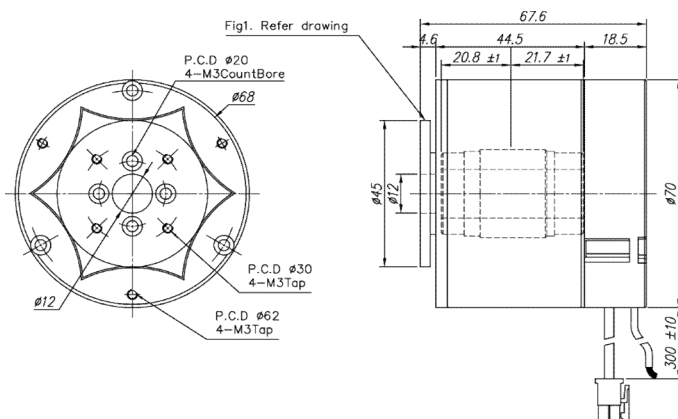
1 black	GND	Motor	UL1061 AWG 22
2 blue	Motor winding W	Hall sensor	UL1061 AWG 26
3 green	Motor winding V		
4 yellow	Motor winding U		
5 red	Vhall 5 ... 24Vdc		
6 brown	Hall sensor C		
7 gray	Hall sensor B		
8 white	Hall sensor A		



702-24V-120P T-N-I curve



Dimensions in [mm]





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Ø70 mm, 24VDC, Brushless, 3600rpm, 120 Watt, Solid shaft option (front only), Encoder

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- External diameter Ø70
- Incremental ABZ Quadrature Encoder output
- PWM output 12-bit
- Hall sensor (5~24Vdc, open-collector)
- High torque density
- Insulation class F
- Robust ball bearing system for long service life
- Customizing

Motor data		Part numbers	
with Hall sensors		702-24V-90P	702-24V-120P
Ratings			
1 Nominal Voltage	V	24	24
2 Current	A	5.0	7.0
3 Power	W	90	120
4 Speed	RPM	2200	2900
5 Torque	N.m	0.38	0.40

Electrical characteristics			
1 Maximum Operating Voltage	V	30	30
2 Maximum Output Power	W	154	204
3 No Load Speed	RPM	2600	3600
4 No Load Current	mA	600	800
5 Stall Torque	N.m	1.74	1.75
6 Torque Constant	mN.m/A	85	64
7 Back EMF Constant	mV/RPM	8.88	6.42
8 Terminal resistance phase to phase	Ω	0.50	0.30
9 Terminal inductance phase to phase	mH	0.98	0.54
10 Minimum Insulation resistance (dc 500V)	MΩ	10	10
11 Noise (Rad.30[cm] DC24V, No load)	dB	0.0	0.0

Specifications		Characteristic Curves	
Mechanical data (preload ball bearing)		Refer to bellow T-I, T-N drawing	
1 Max. axial load (dynamic)	kgf.cm	455	
2 Max. force for press fits (static)	kgf.cm	600	

Thermal data

Temperature ratings

- | | | |
|----------------------------------|----|------|
| 1 Max. permissible winding temp. | °C | +160 |
| 2 Max. permissible bearing temp. | °C | +110 |

Ambient condition

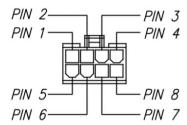
- | | | |
|-----------------------|----|--------|
| 1 Operation condition | °C | -10~50 |
| 2 Storage condition | °C | -10~60 |

Other specifications

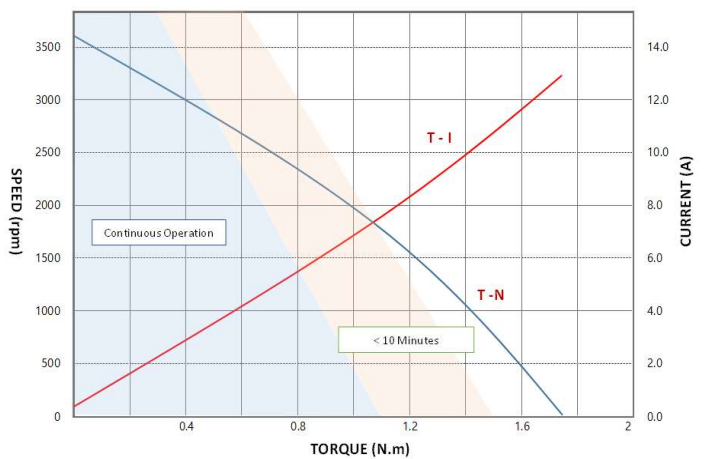
- | | | |
|------------------------|-------|-----|
| 1 Number of pole pairs | pole | 8 |
| 2 Number of phases | phase | 3 |
| 3 Weight | gram | 690 |

Pin Allocation (Molex 5557-08R)

- | | | | |
|----------|-------------------|-------------|---------------|
| 1 black | GND | Motor | UL1061 AWG 22 |
| 2 blue | Motor winding W | Hall sensor | UL1061 AWG 26 |
| 3 green | Motor winding V | | |
| 4 yellow | Motor winding U | | |
| 5 red | Vhall 5 ... 24Vdc | | |
| 6 brown | Hall sensor C | | |
| 7 gray | Hall sensor B | | |
| 8 white | Hall sensor A | | |



702-24V-120P T-N-I curve



Dimensions in [mm]

