SMART EC LINEUP

MANUAL

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DSM EC drivers feature a compact structure of speed/positioning controllers, sensors and Smart EC motors.

Various operating modes allow an adaptable use in a wide range of drive systems.

Smart EC driver features extensive analog and digital I/O functionality and are being configured via RS485 interface using the graphical user interface "uSMART" for Windows PCs.

A wide range of operating modes allows flexible use in a variety of fields in drive systems, automation, and mechatronics.

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

No. 2104C V10. 2021 DNJWITH

Analog input type built in Speed Control Driver

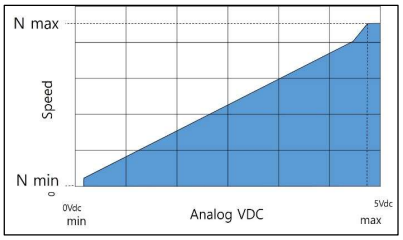
- DSM EC Drivers feature a compact structure of speed & positioning controllers, sensors and Smart EC motors.
- The use of existing DSM products with an adapted design results in robust, space-saving drive solution with high power density.
- EC drive solution is the key to production machinery with many years of maintenance-free operatio in a variety of applications.
- Speed set value (analog) : The value is defined by an analog voltage set(5Vdc) via external potentiometer(10kΩ).

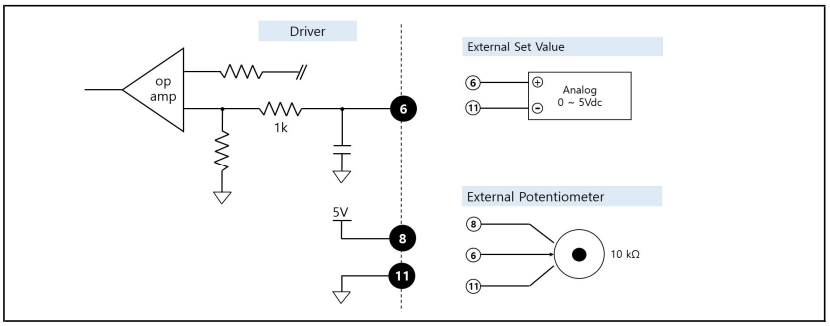
Interface

[24VDC] (red)
[PGND] (black)
[FGND] (green)

24VDC	24 [Vdc] ± 20%	Operating Voltage
PGND	Power Ground	DC Power Ground
FGND	Frame Ground	Frame Ground

[VR : Speed set] (white)
Speed set value : Analog 5Vdc

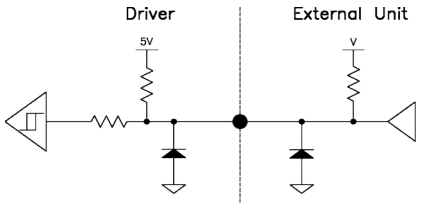




[BRAKE : Brake in] (orrange)

The motor shaft slows down in an uncontrolled fashion to a standstill by short-circuiting the motor windings.

High (1)	3.3 to 5 V or Input OPEN	Motor OFF (Brake function active)
Low (0)	0 to 0.8 V or Input to GND	Motor ON (Brake function not active)

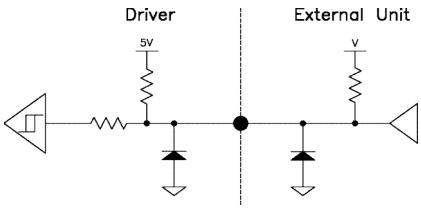


[CW/CCW : Direction in] (blue)

When the level changes, motors shaft slows down in an uncontrolled fashion to a standstill by short-circuiting the motor windings, andaccelerates in the opposite direction, until the nominal speed reaches again.

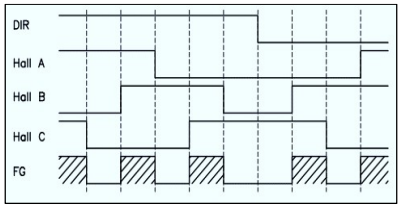
* Change CW/CCW input signal after motor had stopped completely.
If you change the CW/CCW signal during motor running, there is a danger of the damage of electronic parts inside motor.

High (1)	3.3 to 5 V or Input OPEN	Counter-clockwise rotation (CCW)
Low (0)	0 to 0.8 V or Input to GND	Clockwise rotation (CW)



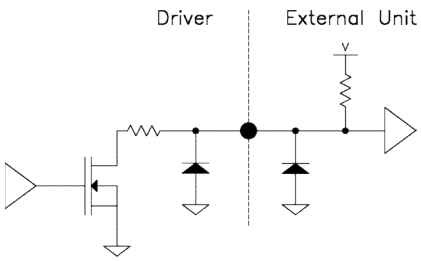
[FG : FG GEN out] (brown)

1FG puts into toggle-operation in which the logic reverses every time when excitation phase is switched by hall input.
* FG output pulse (DSM72) = **24 pulse / round**



Open Drain

VH : 5.5Vdc max
VL : 0.4Vdc max
Sink current : 2mA max



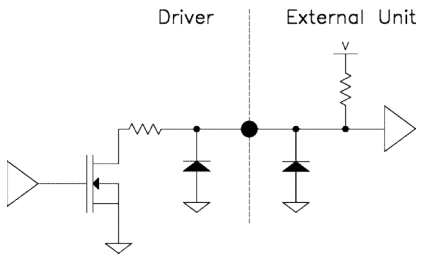
[ALARM : Alarm out] (gray)

Fault output
UVLO (undervoltage lockout)
TSD (thermal shutdown)
OCP (overcurrent protection)
LOCK (motor lock detection)

Fault reset
1. Turn on power again
2. Set logic of brake pin to brake ('H')
3. Switch logic of direction pin.

Open Drain

VH : 5.5Vdc max
VL : 0.4Vdc max
Sink current : 2mA max



You need to pull up for alarm terminal, so that the terminal is open-drain output.

Motor protection

* Fault output : Red LED (OCP, LOCK, TSD, UVLO)

* Fault reset 1. Turn on power again
2. Set logic of brake pin to brake ('H')
3. Switch logic of direction pin.

* Maximum permissive IC surface temperature 110 [℃]
* Maximum permissive FET temperature 110 [℃]

Parameters	Typ.	Description
PWM peak currnet limit (OCP)	10 [A]	This controls peak current flowing through the motor coil. After overcurrent is detected, output is OFF for certain time, and then auto-restarts.
Motor lock detection (LOCK)	t_L=2±1 [sec]	When the motor locks, the motor current automatically cuts off within the defined time. Can only be cleared by any one of the following actions. ① Power up again. ② Speed set value held high for t > t_L / 2
Thermal shutdown (TSD)	160±15 [℃]	(IC temperature/Design specification) When the driver IC and MOSFET reaches the defined temperature, the motor current automatically cuts off. Component reliability can't be ensured when motor is used in exceeded 150[℃]. There is no guarantee of proper operation when thermal shutdown motor is reused.
Undervoltage Lockout (UVLO)	8.5 [Vdc]	Driver protects when the power state reaches down to normally operable voltage value or less. Normal operation resumes when the VM undervoltage condition is removed.

Service life and product safety

1. Bearings and service life
- Service life is affected by maximum speed, residual imbalance and bearing load.
- Exceeding maximum torque can lead to excessive wear.
- Bearings designed for ones of thousands of hours (more than 5000[hrs], no load, rated, 20±5℃)
- Exposure of bearing to corrosive gas may cause corrosion, which may affect the motor's characteristics and durability

2. Locked motor
- No burning after locked rotor condition at rated voltage by using a specified drive circuit

3. Circuit Protect
- This motor does not have the protect circuit for surge voltage and wrong connection. So, don't apply surge voltage such as over rated voltage and wrong connection.
- You should connect a Schottky barrier diode betweene ach signal line to ground to prevent IC from damage.

Connection Interface

Pin No.	Wire color	SCA-01	Lead Wire
1	Red	24VDC	UL1061 AWG22
2	Black	PGND	
3	Green	FGND	
4	Blue	CW/CCW	UL1061 AWG28
5	Orange	BRAKE	
6	White	VR (SPEED IN)	
7	Black	V0 (GND)	
8	Red	V5 (5V OUT)	
9	Brown	FG	
10	Gray	ALARM	
11	Black	GND	

PWM input type built in Speed Control Driver

- DSM EC Drivers feature a compact structure of speed & positioning controllers, sensors and Smart EC motors.
- The use of existing DSM products with an adapted design results in robust, space-saving drive solution with high power density.
- EC drive solution is the key to production machinery with many years of maintenance-free operatio in a variety of applications.
- Speed set value (PWM) : The value is defined by fixed frequency and amplitude.

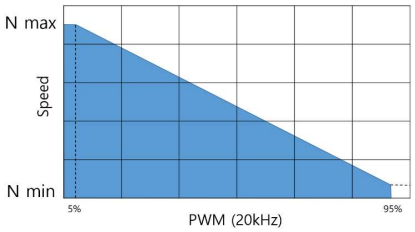
  The desired change is achieved by variation of the duty cycle of 5~95%.

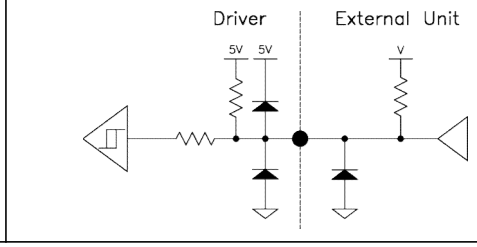
Interface

[24VDC] (red)
[PGND] (black)
[FGND] (green)

24VDC	24 [Vdc] ± 20%	Operating Voltage
PGND	Power Ground	DC power ground
FGND	Frame Ground	Frame Ground

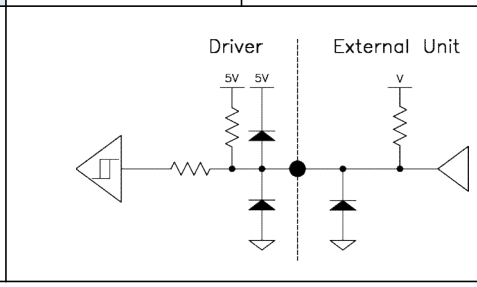
[PWM : SPEED set] (white)
Speed set value : PWM



Input voltage range	**High (1)**	3.3 to 5 V or Input OPEN	Motor OFF
	Low (0)	0 to 0.8 V or Input to GND	Motor ON
Frequency		PWM frequency range is 25kHz (between 20 ~ 30 [kHz])	
Set value input		Speed setting for speed control via PWM duty 5~95%	
Interface			

[BRAKE : BRAKE in] (orange)

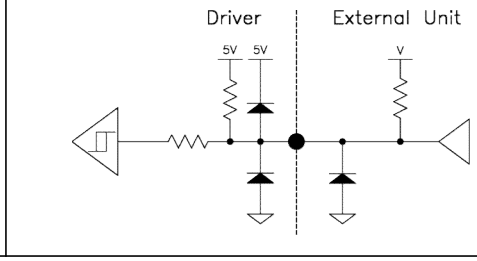
The motor shaft slows down in an uncontrolled fashion to a standstill by short-circuiting the motor windings.

Input voltage range	**High (1)**	3.3 to 5 V or Input OPEN	Motor OFF (Brake function active)
	Low (0)	0 to 0.8 V or Input to GND	Motor ON (Brake function not active)
Interface			

[CW/CCW : Direction in] (blue)

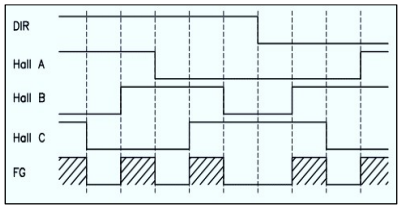
When the level changes, motors shaft slows down in an uncontrolled fashion to a standstill by short-circuiting the motor windings, and accelerates in the opposite direction, until the nominal speed reaches again.

* Change CW/CCW input signal after motor had stopped completely.
  If you change the CW/CCW signal during motor running, there is a danger of the damage of electronic parts inside motor.

Input voltage range	**High (1)**	3.3 to 5 V or Input OPEN	Counter-clockwise rotation (CCW)
	Low (0)	0 to 0.8 V or Input to GND	Clockwise rotation (CW)
Interface			

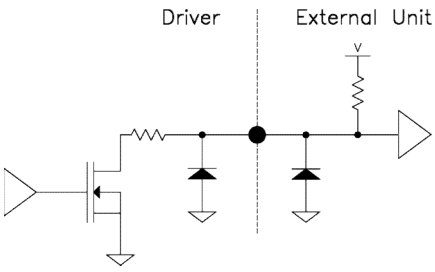
[FG : FG GEN out] (brown)

1FG puts into toggle-operation in which the logic reverses every time when excitation phase is switched by hall input.
* FG output pulse (DSM72) = **24 pulse / round**



Open Drain

VH : 5.5Vdc max
VL : 0.4Vdc max
Sink current : 2mA max



[ALARM : Alarm out] (gray)

Fault output

UVLO (undervoltage lockout)

TSD (thermal shutdown)

OCP (overcurrent protection)

LOCK (motor lock detection)

Fault reset

1. Turn on power again
2. Set logic of brake pin to brake ('H')
3. Switch logic of direction pin.

Open Drain

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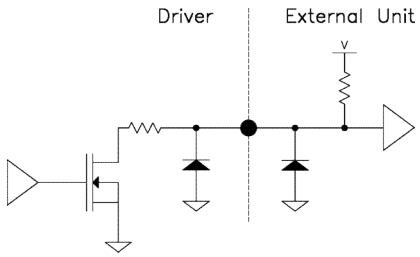
VL : 0.4Vdc max
Sink current : 2mA max



You need to pull up for alarm terminal, so that the terminal is open-drain output.

Control sequence timing chart

Motor protection

* Maximum permissive IC surface temperature 110 [℃]
* Maximum permissive FET temperature 110 [℃]

Parameters	Typ.	Description
PWM peak currnet limit (OCP)	10 [A]	This controls peak current flowing through the motor coil. After overcurrent is detected, output is OFF for certain time, and then auto-restarts.
Motor lock detection (LOCK)	t_L=2±1 [sec]	When the motor locks, the motor current automatically cuts off within the defined time. Can only be cleared by any one of the following actions. ① Power up again. ② Speed set value held high for t > t_L / 2
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Service life and product safety

1. Bearings and service life
   - Service life is affected by maximum speed, residual imbalance and bearing load.
   - Exceeding maximum torque can lead to excessive wear.
   - Bearings designed for ones of thousands of hours (more than 5000[hrs], no load, rated, 20±5℃)
   - Exposure of bearing to corrosive gas may cause corrosion, which may affect the motor's characteristics and durability
2. Locked motor
   - No burning after locked rotor condition at rated voltage by using a specified drive circuit
3. Circuit Protect
   - This motor does not have the protect circuit for surge voltage and wrong connection. So, don't apply surge voltage such as over rated voltage and wrong connection.
   - You should connect a Schottky barrier diode betweene ach signal line to ground to prevent IC from damage.

Connection Interface

Pin No.	Wire color	SCP-01	Lead Wire
1	Red	24VDC	UL1061 AWG22
2	Black	PGND	
3	Green	FGND	
4	Blue	CW/CCW	UL1061 AWG28
5	Orange	BRAKE	
6	White	PWM	
7	Black	GND	
8	Brown	FG	
9	Gray	ALARM	

PWM input type built in Speed Control Driver (with Incremental Encoder)

- DSM EC Drivers feature a compact structure of speed & positioning controllers, sensors and Smart EC motors.
- The use of existing DSM products with an adapted design results in robust, space-saving drive solution with high power density.
- EC drive solution is the key to production machinery with many years of maintenance-free operatio in a variety of applications.
- Speed set value (PWM) : The value is defined by fixed frequency and amplitude.

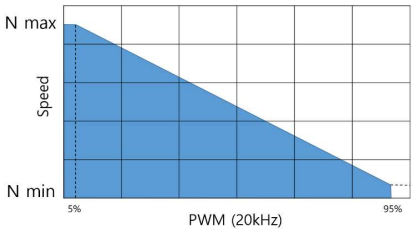
  The desired change is achieved by variation of the duty cycle of 5~95%.

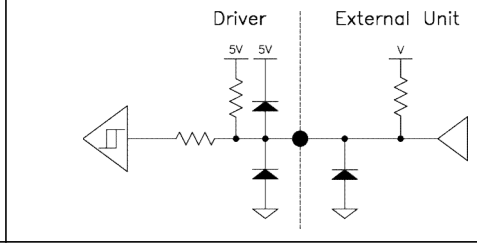
Interface

[24VDC] (red)
[PGND] (black)
[FGND] (green)

24VDC	24 [Vdc] ± 20%	Operating Voltage
PGND	Power Ground	DC power ground
FGND	Frame Ground	Frame Ground

[PWM : SPEED set] (white)
Speed set value : PWM



Input voltage range	**High (1)**	3.3 to 5 V or Input OPEN	Motor OFF
	Low (0)	0 to 0.8 V or Input to GND	Motor ON
Frequency		PWM frequency range is 25kHz (between 20 ~ 30 [kHz])	
Set value input		Speed setting for speed control via PWM duty 5~95%	
Interface			

[BRAKE : BRAKE in] (orange)

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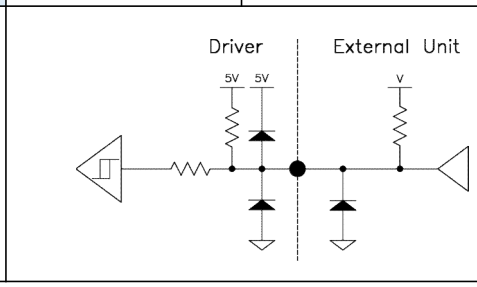
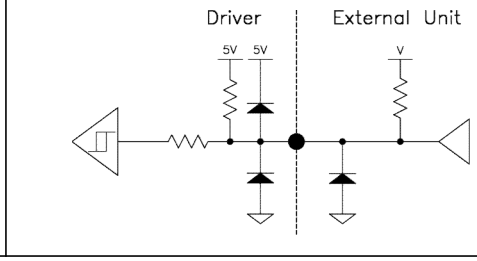
Input voltage range	**High (1)**	3.3 to 5 V or Input OPEN	Motor OFF (Brake function active)
	Low (0)	0 to 0.8 V or Input to GND	Motor ON (Brake function not active)
Interface			

[CW/CCW : Direction in] (blue)

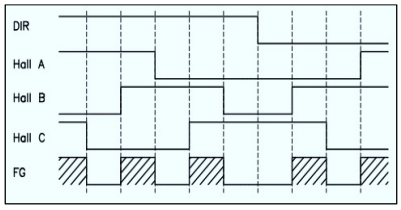
When the level changes, motors shaft slows down in an uncontrolled fashion to a standstill by short-circuiting the motor windings, and accelerates in the opposite direction, until the nominal speed reaches again.

* Change CW/CCW input signal after motor had stopped completely.
  If you change the CW/CCW signal during motor running, there is a danger of the damage of electronic parts inside motor.

Input voltage range	**High (1)**	3.3 to 5 V or Input OPEN	Counter-clockwise rotation (CCW)
	Low (0)	0 to 0.8 V or Input to GND	Clockwise rotation (CW)
Interface			

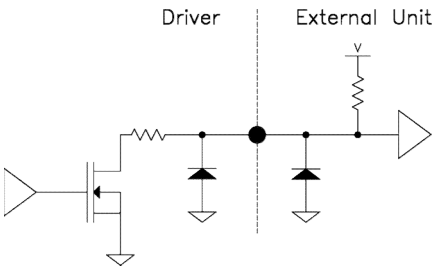
[FG : FG GEN out] (brown)

1FG puts into toggle-operation in which the logic reverses every time when excitation phase is switched by hall input.
* FG output pulse (DSM72) = **24 pulse / round**



Open Drain

VH : 5.5Vdc max
VL : 0.4Vdc max
Sink current : 2mA max



[ALARM : Alarm out] (gray)

Fault output

UVLO (undervoltage lockout)

TSD (thermal shutdown)

OCP (overcurrent protection)

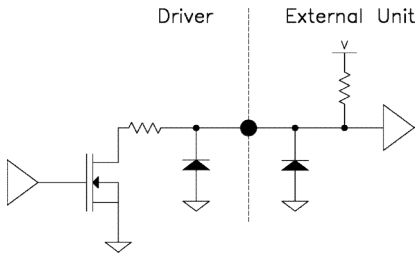
LOCK (motor lock detection)

Fault reset

1. Turn on power again
2. Set logic of brake pin to brake ('H')
3. Switch logic of direction pin.

Open Drain

VH : 5.5Vdc max
VL : 0.4Vdc max
Sink current : 2mA max



You need to pull up for alarm terminal, so that the terminal is open-drain output.

[Encoder out] (A: brown, B: gray, Z: yellow)

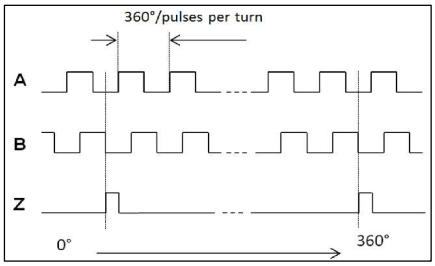
Incremental quadrature signals A, B

Reference mark(index) Z

Cycles per Shaft Turn

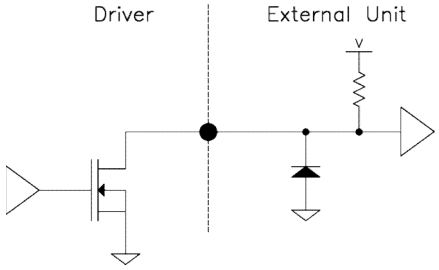
: 10 bit (1024 Steps)

Open drain output



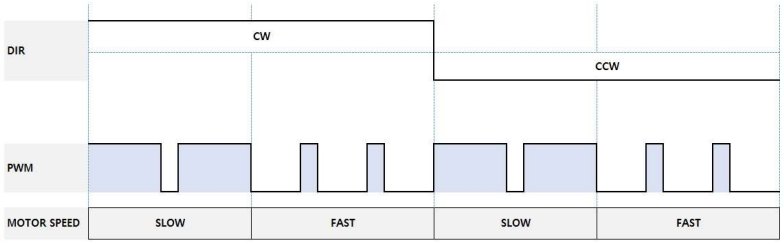
Open Drain

VH : 30Vdc max
VL : 0.5Vdc max
Sink current : 100mA max



You need to pull up for encoder terminal, so that the terminal is open-drain output.

Control sequence timing chart



Motor protection

Parameters	Typ.	Description
PWM peak currnet limit (OCP)	10 [A]	This controls peak current flowing through the motor coil. After overcurrent is detected, output is OFF for certain time, and then auto-restarts.
Motor lock detection (LOCK)	t_L=2±1 [sec]	When the motor locks, the motor current automatically cuts off within the defined time. Can only be cleared by any one of the following actions. ① Power up again. ② Speed set value held high for t > t_L / 2
Thermal shutdown (TSD)	160±15 [℃]	(IC temperature/Design specification) When the driver IC and MOSFET reaches the defined temperature, the motor current automatically cuts off. Component reliability can't be ensured when motor is used in exceeded 150[℃]. There is no guarantee of proper operation when thermal shutdown motor is reused.
Undervoltage Lockout (UVLO)	8.5 [Vdc]	Driver protects when the power state reaches down to normally operable voltage value or less. Normal operation resumes when the VM undervoltage condition is removed.

* Maximum permissive IC surface temperature 110 [℃]
* Maximum permissive FET temperature 110 [℃]

Service life and product safety

1. Bearings and service life
   - Service life is affected by maximum speed, residual imbalance and bearing load.
   - Exceeding maximum torque can lead to excessive wear.
   - Bearings designed for ones of thousands of hours (more than 5000[hrs], no load, rated, 20±5℃)
   - Exposure of bearing to corrosive gas may cause corrosion, which may affect the motor's characteristics and durability
2. Locked motor
   - No burning after locked rotor condition at rated voltage by using a specified drive circuit
3. Circuit Protect
   - This motor does not have the protect circuit for surge voltage and wrong connection. So, don't apply surge voltage such as over rated voltage and wrong connection.
   - You should connect a Schottky barrier diode betweene ach signal line to ground to prevent IC from damage.

Connection Interface

Pin No.	Wire color	SCP-02	Lead Wire
1	Red	24VDC	UL1061 AWG22
2	Black	PGND	
3	Green	FGND	
4	Blue	CW/CCW	UL1061 AWG28
5	Orange	BRAKE	
6	White	PWM	
7	Black	GND	
8	Brown	FG	
9	Gray	ALARM	
10	Brown	ENC_A	UL1061 AWG28 (tube)
11	Gray	ENC_B	
12	Yellow	ENC_Z	

RS485 type built in Speed Control Driver

- DSM EC Drivers feature a compact structure of speed & positioning controllers, sensors and Smart EC motors.
- The use of existing DSM products with an adapted design results in robust, space-saving drive solution with high power density.
- EC drive solution is the key to production machinery with many years of maintenance-free operatio in a variety of applications.
- Interface I/O protocol : RS485 (MODBUS RTU)

Interface

[24VDC] (red)
[PGND] (black)
[FGND] (green)

24VDC	24 [Vdc] ± 20%	Operating Voltage
PGND	Power Ground	DC power ground
FGND	Frame Ground	Frame Ground

[RS485] (D+ : orange, D- : white)
MODBUS RTU

Baudrate	115,200 bps
Data	8 bit
Parity bit	None
Stop bit	1
Flow control	None
Address No.	Current Direction : 0x0008 Current Speed : 0x007
Read	0x03 (Read holding resisters)
Write	0x06 (Write single resisters)

Motor protection

Parameters	Typ.	Description
Currnet limit (OCP)	10 [A]	
Motor lock detection (LOCK)	tL=2±1 [sec]	When the motor locks, the motor current automatically cuts off within the defined time.
Thermal shutdown (TSD)	160±15 [℃]	(IC temperature/Design specification) When the driver IC and MOSFET reaches the defined temperature, the motor current automatically cuts off. Component reliability can't be ensured when motor is used in exceeded 150[℃]. There is no guarantee of proper operation when thermal shutdown motor is reused.
Undervoltage Lockout (UVLO)	8.5 [Vdc]	Driver protects when the power state reaches down to normally operable voltage value or less. Normal operation resumes when the VM undervoltage condition is removed.

* Maximum permissive IC surface temperature 110 [℃]
* Maximum permissive FET temperature 110 [℃]

Service life and product safety

1. Bearings and service life
   - Service life is affected by maximum speed, residual imbalance and bearing load.
   - Exceeding maximum torque can lead to excessive wear.
   - Bearings designed for ones of thousands of hours (more than 5000[hrs], no load, rated, 20±5℃)
   - Exposure of bearing to corrosive gas may cause corrosion, which may affect the motor's characteristics and durability
2. Locked motor
   - No burning after locked rotor condition at rated voltage by using a specified drive circuit
3. Circuit Protect
   - This motor does not have the protect circuit for surge voltage and wrong connection. So, don't apply surge voltage such as over rated voltage and wrong connection.

Connection Interface

Pin No.	Wire Color	SCR-401	Lead Wire
1	Red	24VDC	UL1061 AWG22
2	Black	PGND	
3	Green	FGND	
5	Green	RS485 D+	UL1061 AWG28
6	White	RS485 D-	
7	Black	SGND	

RS485 type built in positioning control driver

- DSM EC Drivers feature a compact structure of speed & positioning controllers, sensors and Smart EC motors.
- SPR drives are digital positioning controllers internally mounted on DSM EC motors with Hall signals.
- The use of existing DSM products with an adapted design results in robust, space-saving drive solution with high power density.
- EC drive solution is the key to production machinery with many years of maintenance-free operation in a variety of applications.
- Interface I/O protocol : RS485 (MODBUS RTU)

Interface

[24VDC] (red)
[PGND] (black)
[FGND] (green)

24VDC	24 [Vdc] ± 20%	Operating Voltage
PGND	Power Ground	DC power ground
FGND	Frame Ground	Frame Ground

[RS485] (D+ : orange, D- : white)
MODBUS RTU

Baudrate	115,200 bps
Data	8 bit
Parity bit	None
Stop bit	1
Flow control	None
Address No.	Current Direction : 0x0008 Current Speed : 0x007
Read	0x03 (Read holding resisters)
Write	0x06 (Write single resisters)

*** Positioning set value : Steps**

position error : about ±5 step

Step is the number of feedback Hall sensor signals (FG signals) of the smart EC motor.

[Step = Number of motor Poles x motor phase x reduction ratio]

ex) Brushless dc geared motor 4 pole, 3 phase, reduction ratio 50 : 1
4 (pole) * 3 (phase) * 50 (reduction) = 600 steps

Motor protection

* Maximum permissive IC surface temperature 110 [℃]
* Maximum permissive FET temperature 110 [℃]

Parameters	Typ.	Description
Currnet limit (OCP)	10 [A]	
Thermal shutdown (TSD)	160±15 [℃]	(IC temperature/Design specification) When the driver IC and MOSFET reaches the defined temperature, the motor current automatically cuts off. Component reliability can't be ensured when motor is used in exceeded 150[℃]. There is no guarantee of proper operation when thermal shutdown motor is reused.
Undervoltage Lockout (UVLO)	8.5 [Vdc]	Driver protects when the power state reaches down to normally operable voltage value or less. Normal operation resumes when the VM undervoltage condition is removed.

Service life and product safety

1. Bearings and service life
   - Service life is affected by maximum speed, residual imbalance and bearing load.
   - Exceeding maximum torque can lead to excessive wear.
   - Bearings designed for ones of thousands of hours (more than 5000[hrs], no load, rated, 20±5℃)
   - Exposure of bearing to corrosive gas may cause corrosion, which may affect the motor's characteristics and durability
2. Locked motor
   - No burning after locked rotor condition at rated voltage by using a specified drive circuit
3. Circuit Protect
   - This motor does not have the protect circuit for surge voltage and wrong connection.
     So, don't apply surge voltage such as over rated voltage and wrong connection.

Connection Interface

Pin No.	Wire Color	SPR-401	Lead Wire
1	Red	24VDC	UL1061 AWG22
2	Black	PGND	
3	Green	FGND	
4	Green	RS485 D+	UL1061 AWG28
5	White	RS485 D-	
6	Black	SGND	

RS485 type built in positioning control driver (with Incremental Encoder)

- DSM EC Drivers feature a compact structure of speed & positioning controllers, sensors and Smart EC motors.
- SPR drives are digital positioning controllers internally mounted on DSM EC motors with Hall signals.
- The use of existing DSM products with an adapted design results in robust, space-saving drive solution with high power density.
- EC drive solution is the key to production machinery with many years of maintenance-free operation in a variety of applications.
- Interface I/O protocol : RS485 (MODBUS RTU)

Interface

[24VDC] (red)
[PGND] (black)
[FGND] (green)

24VDC	24 [Vdc] ± 20%	Operating Voltage
PGND	Power Ground	DC power ground
FGND	Frame Ground	Frame Ground

[RS485] (D+ : orange, D- : white)
MODBUS RTU

Baudrate	115,200 bps
Data	8 bit
Parity bit	None
Stop bit	1
Flow control	None
Address No.	Current Direction : 0x0008 Current Speed : 0x007
Read	0x03 (Read holding resisters)
Write	0x06 (Write single resisters)

*** Positioning set value : Steps**

position error : about ±5 step

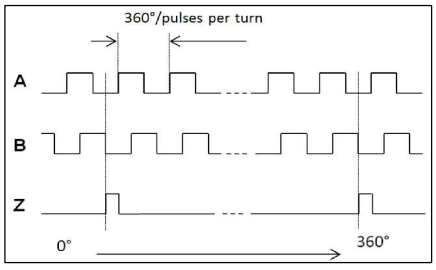
Step is the number of feedback Hall sensor signals (FG signals) of the smart EC motor.

[Step = Number of motor Poles x motor phase x reduction ratio]

ex) Brushless dc geared motor 4 pole, 3 phase, reduction ratio 50 : 1
4 (pole) * 3 (phase) * 50 (reduction) = 600 steps

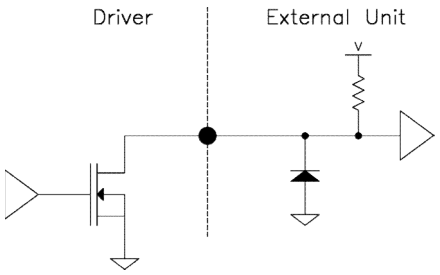
[Encoder out] (A: brown, B: gray, Z: yellow)

Incremental quadrature signals A, B
Reference mark(index) Z
Cycles per Shaft Turn
: 10 bit (1024 Steps)
Open drain output



Open Drain

VH : 30Vdc max
VL : 0.5Vdc max
Sink current : 100mA max



You need to pull up for encoder terminal, so that the terminal is open-drain output.

Motor protection

* Maximum permissive IC surface temperature 110 [℃]
* Maximum permissive FET temperature 110 [℃]

Parameters	Typ.	Description
Currnet limit (OCP)	10 [A]	
Thermal shutdown (TSD)	160±15 [℃]	(IC temperature/Design specification) When the driver IC and MOSFET reaches the defined temperature, the motor current automatically cuts off. Component reliability can't be ensured when motor is used in exceeded 150[℃]. There is no guarantee of proper operation when thermal shutdown motor is reused.
Undervoltage Lockout (UVLO)	8.5 [Vdc]	Driver protects when the power state reaches down to normally operable voltage value or less. Normal operation resumes when the VM undervoltage condition is removed.

Service life and product safety

1. Bearings and service life
   - Service life is affected by maximum speed, residual imbalance and bearing load.
   - Exceeding maximum torque can lead to excessive wear.
   - Bearings designed for ones of thousands of hours (more than 5000[hrs], no load, rated, 20±5℃)
   - Exposure of bearing to corrosive gas may cause corrosion, which may affect the motor's characteristics and durability
2. Locked motor
   - No burning after locked rotor condition at rated voltage by using a specified drive circuit
3. Circuit Protect
   - This motor does not have the protect circuit for surge voltage and wrong connection.
     So, don't apply surge voltage such as over rated voltage and wrong connection.

Connection Interface

Pin No.	Wire Color	SPR-402	Lead Wire
1	Red	24VDC	UL1061 AWG22
2	Black	PGND	
3	Green	FGND	
4	Green	RS485 D+	UL1061 AWG28
5	White	RS485 D-	
6	Black	SGND	
7	Brown	ENC_A	UL1061 AWG28 (tube)
8	Gray	ENC_B	
9	Yellow	ENC_Z	

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 digitial encoder

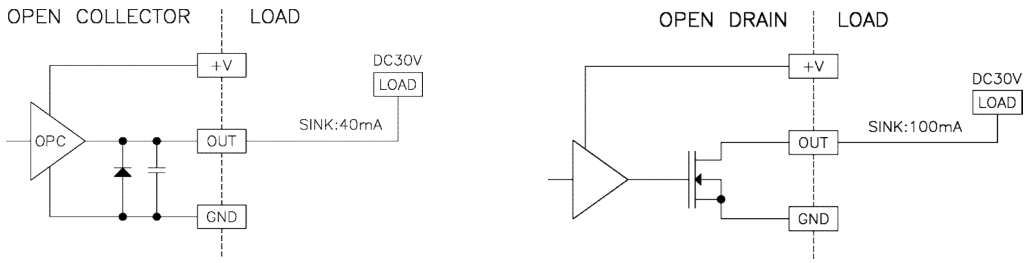
- Relative position signal suitable for positioning tasks
- Rotation direction recognition
- Speed information from number of pulses per time unit
- Incremental ABZ Quadrature Encoder interface with pulse per turn from 128~1024
- PWM Output 12-bit
- Open Collector, Totem Pole, Line Driver, Open Drain
- Wide input range 5~24Vdc
- Standard solution for many applications
- Customizing

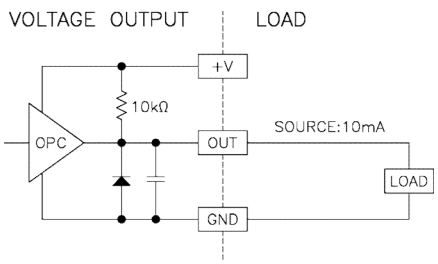
ECM Type	Resolution	Output Phase	Output Type	Supply Voltage
MEI	07 08 09 10	2C 4C	OPC VOP TOP	05
MEI	07 08 09 10	2C 4C	OPD	24
MEI	07 08 09 10	6C	LDP	05

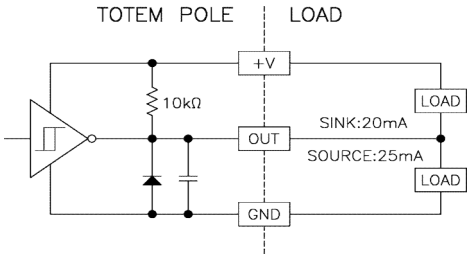
Model information

ECM Type	**MEI**	Incremental type
Resolution	**07**	Cycles per Shaft Turn, 7 bit (Incremental 128 Steps / 2.81°)
CPR (Count per Revolution)	**08**	Cycles per Shaft Turn, 8 bit (Incremental 256 Steps / 1.40°)
	09	Cycles per Shaft Turn, 9 bit (Incremental 512 Steps / 0.70°)
	10	Cycles per Shaft Turn, 10 bit (Incremental 1024 Steps / 0.35°)
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 \ , B \ , Z \
Output type	**OPC**	NPN Open Collector output (max 30Vdc)
Control interface output		Sink current per channel (max 30mA)
		External pull-up resistor 4.7k~10kΩ
	VOP	Voltage Output.
		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℃)
		Signal fall time : 100ns or less (CL=30pF, RL=1kΩ, 25℃)
		Line Receiver Recommanded IC : AM26LS32
Supply Voltage	**05**	Supply Voltage Vcc +5Vdc ± 10%
	24	Supply Voltage Vcc +7Vdc ~ +24Vdc

Block Diagram





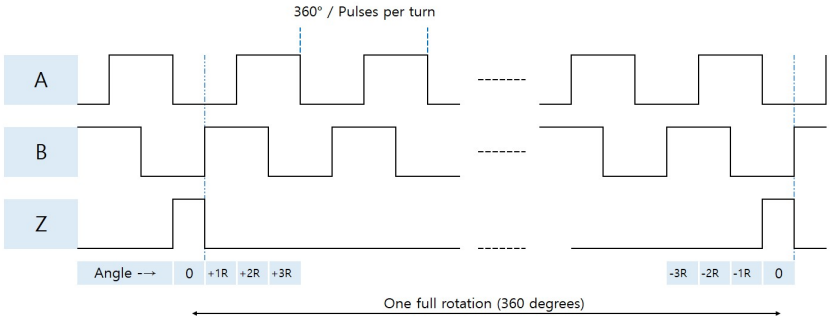


Output Interface

Incremental AB

A/B Phase difference : 1/4T±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.

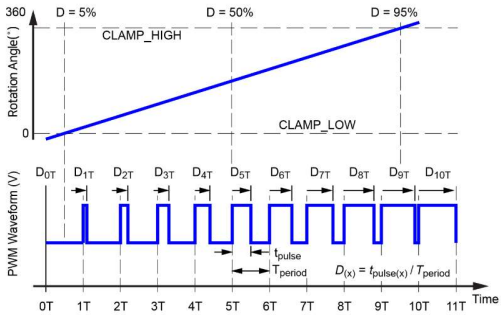


Index Z

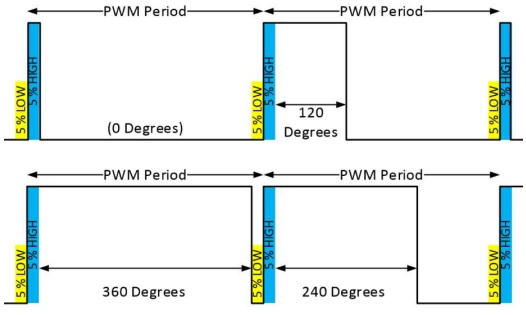
Encoder Z signal is an index pulse that occurs once per revolution to mark the zero (0) angle position.
Under rotation, this allows the receiver to synchronize to a known mechanical/magnetic position, and then se the incremental A/B signals to keep track of the absolute position.
The width of the Z pulse 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 : **DutyCycleMax (%) = (4095 / 4096) x 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.	Wire Color	MEI	MEI (LDP)	Lead Wire	Comments
1	Red	VCC	VCC	UL1061 AWG28	Supply power
2	Black	GND	GND		Ground
3	Brown	ENC A	ENC A		
4	Blue	-	ENC /A		
5	Gray	ENC B	ENC B		
6	Green	-	ENC /B		
7	Yellow	ENC Z	ENC Z		
8	Orange	-	ENC /Z		
9	White	PWM	-		
10	Black	F.G	F.G	AWG22	Frame Ground

1. This product applies MODBUS-RTU communication protocol
2. The device ID(default) is "0x64: 100" (Device ID can be changed)
3. Set the speed as 115,200bps, data as 8bit, Parity None, 1 Stop.
4. Reading registers : use 'Read Holding Registers' (Function Code 3),
   Writing register : use 'Write Single Register' (Function Code 6).
   (Other function codes are not supported.)
5. Table. 1 describes the registers and their functions.

Table. 1

Div.	Reg. Index (HEX)	Reg. Name	Description	Read/Write
ID	0000	BD_ADD	ID display (Hex)	R
Control set input	0001	SET_SPEED_REMOTE	Motor Speed Input Register (PWM Duty) (0 ~ SET_MOTOR_MAX_RPM: Reg. [0x001F])	R/W
	0002	SET_CW_CCW_REMOTE	Rotation direction input register (0:CW / 1:CCW)	R/W
	0003	SET_ENABLE_REMOTE	ON/OFF input register (0:Stop / 1:Start)	R/W
	0004	SET_BRAKE_REMOTE	Brake input register (0:OFF / 1:ON)	R/W
	0005	SET_ACC_TIME_REMOTE	Acceleration Time Input Register(0:none / 500 ~ 5000 [msec])	R/W
	0006	SET_DEC_TIME_REMOTE	Deceleration time input register (0:none / 500 ~ 5000 [msec])	R/W
	0007~0008	[Reserved]	(Do not use, write protected)	-
Operation set value	0009	CUR_SPEED	Displays the motor speed (PWM Duty) (0 ~ SET_MOTOR_MAX_RPM: Reg. [0x001F])	R
	000A	CUR_CW_CCW	Rotation direction indicator (0:CW / 1:CCW)	R
Control set value	000B	SET_SPEED	Speed set value (PWM Duty) of set motor (0 ~ SET_MOTOR_MAX_RPM: Reg. [0x001E])	R
	000C	SET_CW_CCW	Rotation direction of the set motor (0:CW / 1:CCW)	R
	000D	SET_ENABLE	ON/OFF of the set motor(0:Stop / 1:Start)	R
	000E	SET_BRAKE	Brake of the set motor (0:OFF / 1:ON)	R
	000F	SET_ACC_TIME	Acceleration time of the set motor (0:none / 500 ~ 5000 [msec])	R
	0010	SET_DEC_TIME	Deceleration time of the set motor (0:none / 500 ~ 5000 [msec])	R
	0011~0018	[Reserved]	(Do not use, write protected)	-
Operation set value	0019	MOTOR_RPM	Rotational speed of motor (RPM)	R
	001A	MOTOR_CURRENT	Current of motor([A] * 100)	-
	001B	MOTOR_FAULT (*1)	Error status (0:Normal / 1:Fault)	-
Motor operation settings	001C	SET_CURRENT_LIM	Current limit setting (0 ~ 1000 : [A] * 100)	R/W
	001D	SET_LOCK_TIME	Lock time setting (0 ~ 5000 [msec], default: 3000)	R/W
	001E	SET_MOTOR_POL_NUM	Pole number setting	R/W
	001F	SET_MOTOR_MAX_RPM	Max rotation speed setting (Max. RPM)	R/W
	0020	SET_MOUNTING_DIR	Set the mounting direction of the motor (0:Left / 1:Right)	R/W
	0021	SET_GEAR_RATIO	Reduction ratio setting (Reduction ratio * 100)	R/W

(* 1) Fault reset
- -① Control set, Start & brake ON (SET_ENABLE_REMOTE: 1 & SET_BRAKE_REMOTE: 1)
- -② Control set, Stop (SET_ENABLE_REMOTE: 0)
- -③ Control set, Start (SET_ENABLE_REMOTE: 1)

1. This product applies MODBUS-RTU communication protocol
2. The device ID(default) is "0x64: 100" (Device ID can be changed)
3. Set the speed as 115,200bps, data as 8bit, Parity None, 1 Stop.
4. When reading registers, use 'Read Holding Registers' (Function Code 3),
   When writing to a register, use 'Write Single Register' (Function Code 6).
   However, for position value (Step) input, input POSITION (H) and POSITION (L) into two registers at the same time by using 'Write Multiple Registers' (Function Code 16).
   Function Code 16 is used only for position input and does not support other function codes.
5. Table. 1 describes the registers and their functions.

Table. 1

Div.	Reg. Index (HEX)	Reg. Name	Description	Read/Write
ID	0000	BD_ADD	ID display (Hex)	R
Operation set value	0001	CUR_SPEED	Displays the motor speed (PWM Duty) (0 ~ MOTOR_MAX_RPM: Reg. [0x001E])	R
	0002	CUR_POSITION (H) (*1)	MSB 2 bytes in position value (Step) of 4 bytes (4 bytes signed: -2,147,483,648 to + 2,147,483,647)	R
	0003	CUR_POSITION (L)	LSB 2 bytes in position value (Step) of 4 bytes (4 bytes signed: -2,147,483,648 to + 2,147,483,647)	R
	0004~0005	[Reserved]	(Do not use, write protected)	-
	0006	MOTOR_RPM	Rotational speed of motor (RPM)	R
	0007	MOTOR_CURRENT	Current of motor([A] * 100)	R
	0008	MOTOR_FAULT (*2)	Error status (0:Normal / 1:Fault)	R
Motor operation settings	0009	CURRENT_LIM	Current limit setting (0 ~ 1000 : [A] * 100)	R/W
	000A	LOCK_TIME	Lock time setting (0 ~ 5000 [msec], default: 3000)	R/W
	000B	CLUTCH	Clutch setting (0: OFF / 1: ON)	R/W
	000C	MOTOR_MOUNTING_DIR	Set the mounting direction of the motor (0:Left / 1:Right)	R/W
	000D	MOTOR_POL_NUM	Pole number setting	R/W
	000E	MOTOR_MAX_RPM	Max rotation speed setting (Max. RPM)	R/W
	000F	REDUCER_RATIO	Reduction ratio setting (Reduction ratio * 100)	R/W
Control set value	0010	SET_SPEED	Speed set value (PWM Duty) of set motor (0 ~ MOTOR_MAX_RPM: Reg. [0x000E])	R
	0011	SET_POSITION (H)	MSB 2 bytes in 4-byte position value (Step) of the set motor (4 bytes signed: -2,147,483,648 to + 2,147,483,647)	R
	0012	SET_POSITION (L)	LSB 2 bytes in 4-byte position value (Step) of the set motor (4 bytes signed: -2,147,483,648 to + 2,147,483,647)	R
	0013~0014	[Reserved]	(Do not use, write protected)	-
	0015	SET_RESET	Reset (0:Low / 1:High)	R
	0016	SET_BRAKE	Brake of the set motor (0:OFF / 1:ON)	R
	0017~001F	[Reserved]	(Do not use, write protected)	-
Control set input	0020	REMOTE_SPEED	Motor Speed Input Register (PWM Duty) (0 ~ MOTOR_MAX_RPM: Reg. [0x000E])	R/W
	0021	REMOTE_POSITION (H)	Input register MSB 2 bytes in 4 byte position value (Step) (4 bytes signed: -2,147,483,648 to + 2,147,483,647)	R/W
	0022	REMOTE_POSITION (L)	Input register LSB 2 bytes in 4 byte position value (Step) (4 bytes signed: -2,147,483,648 to +2,147,483,647)	R/W
	0023~0024	[Reserved]	(Do not use, write protected)	-
	0025	REMOTE_RESET	Reset input register (0: Low / 1: High)	R/W
	0026	REMOTE_BRAKE	Brake input register (0:OFF / 1:ON)	R/W
	0027~003F	[Reserved]	(Do not use, write protected)	-
0 Position	0040	SET_ORIGIN	Zero Positioning Input Register (The position where '1' is input is set to '0'.)	R/W

(*1) Step is the number of FG (Hall Sensor Signal) feedback signals of the motor.

- Motor pole number 4, reduction ratio 1/50 is 600 Step. (1 rotation angle (360°) of geared motor output)

  4 [poles] * 3 [phase] * 50 [reduction ratio] = 600: 0 to 599
  ex) If you enter Step 900, it rotates 540 degrees. (Based on output side)
  600 [1 rotation] + 300 [half rotation]

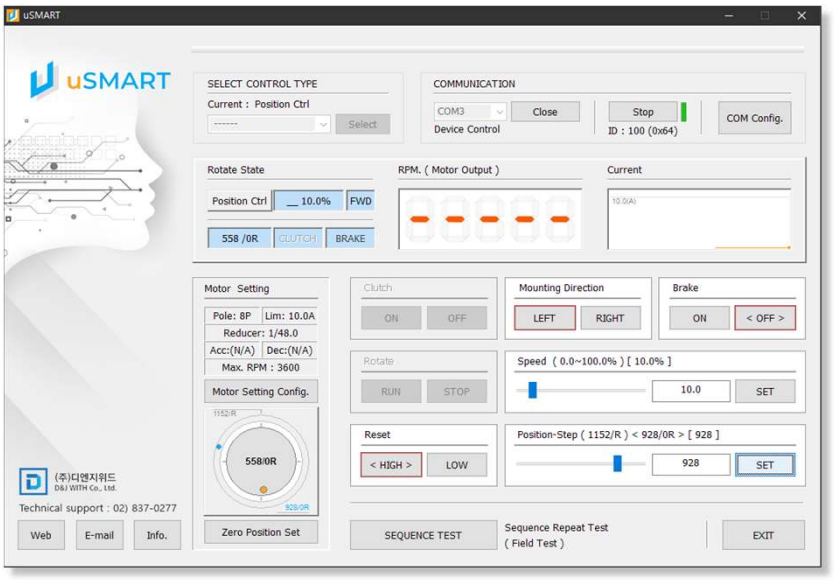
- Negative(-) input rotates in the opposite direction of positive(+) rotation to reach the target position.
  ex) Register write value at 900 input: [Reg. Hex 0021]: 0x0000 / [Reg. Hex 0022]: 0x0384

(*2) Fault reset
-① Reset High & Brake ON (REMOTE_RESET: 1 & REMOTE_BRAKE: 1)
-② Reset Low (REMOTE_RESET: 0)
-③ Reset High (REMOTE_RESET: 1)

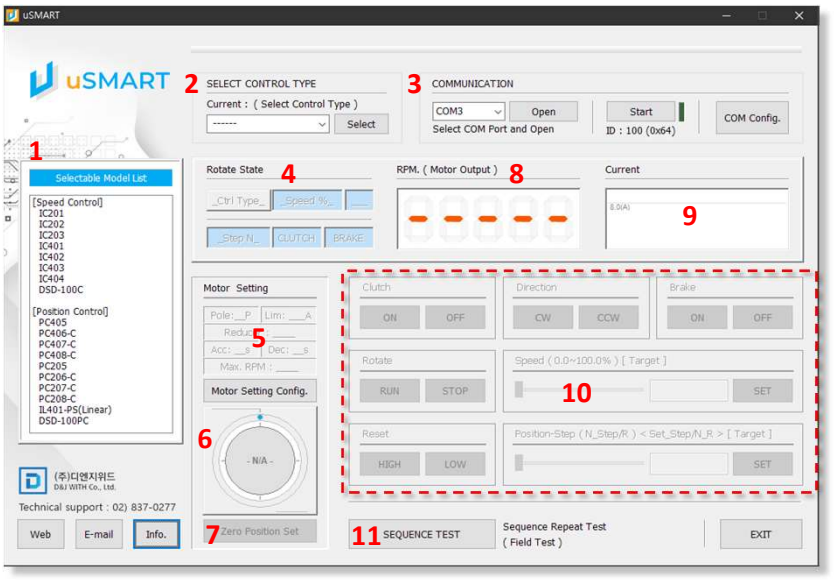
The Smart EC drivers are features extensive analog and digital I/O functionality and are being configured via RS485 interface using the graphical user interface "uSMART" for Windows PCs.

Installation Program : uSMART
Language : English
Operating System : Window 10, Windiw 8, Window 7
Communication interface : Serial (use USB to serial converter)

Program – Layout



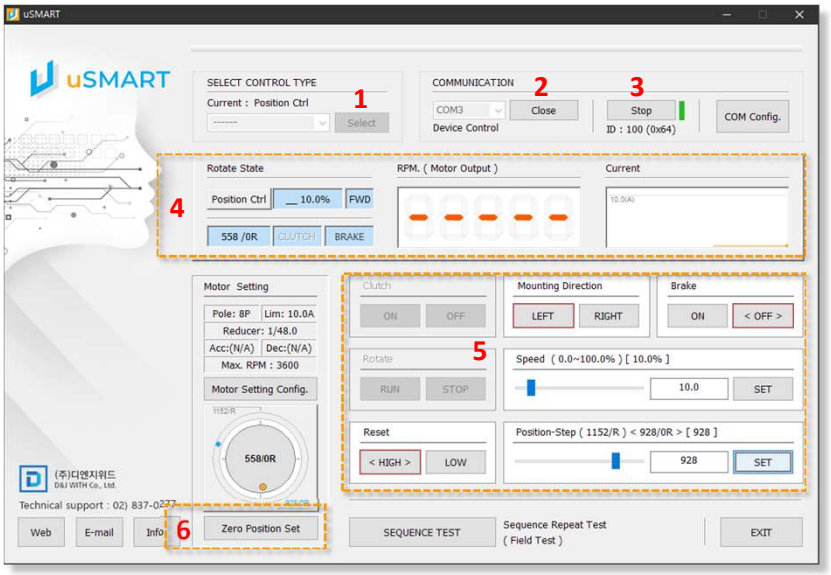
Program – Component



1	[Info]	Displays model information of the motor that can be controlled.
2	[Select control type]	Select the control mode of the motor. You can check the model information of the product in [Info.]. The control items for the selected mode are activatec
3	[Communication]	Set the COM(serial) port for communication.
	[Start]	Start communication with the motor.
	[Com Config]	Set the device ID, COM Port Baudrate
4	[Rotate State]	The control status of the connected motor is displayed.
5	[Motor Setting]	The set value of the motor is displayed. (Number of poles, current limit, reduction ratio, acceleration / deceleration time, maximum rotation speed)
	[Motor Setting Config]	Change motor settings.
6	[Jog & shuttle]	The position control angle of the motor can be set directly.
7	[Zero Position Set]	Zero position value of positioning control motor can be set. You can change the current position to the zero position.
8	[RPM]	Displays the rotation speed of the motor.
9	[Current]	The current of the motor is displayed.
10	[Control set value]	Set the control value of the motor. The input button is activated according to the selected mode. The selected control item is indicated by a red border.
11	[Sequence test]	The motor can be operated repeatedly with the set value.

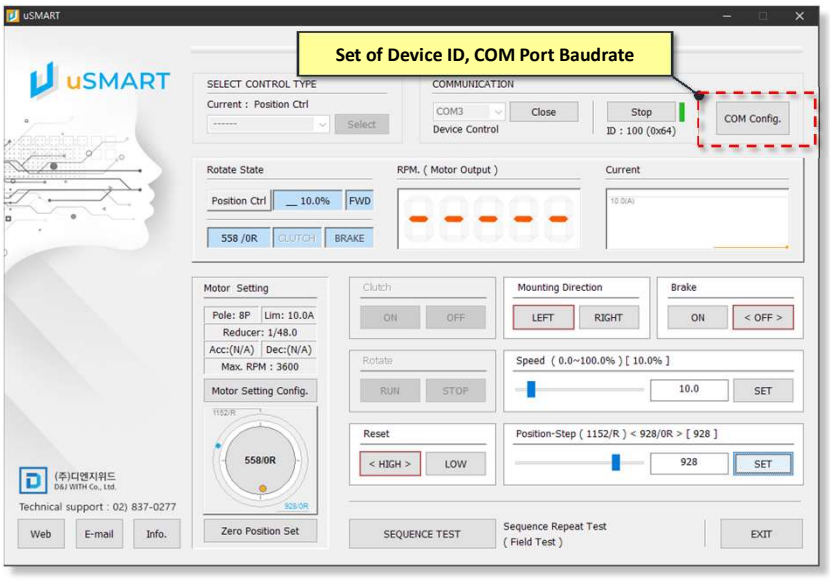
Program – Usage

Basic use of the control program



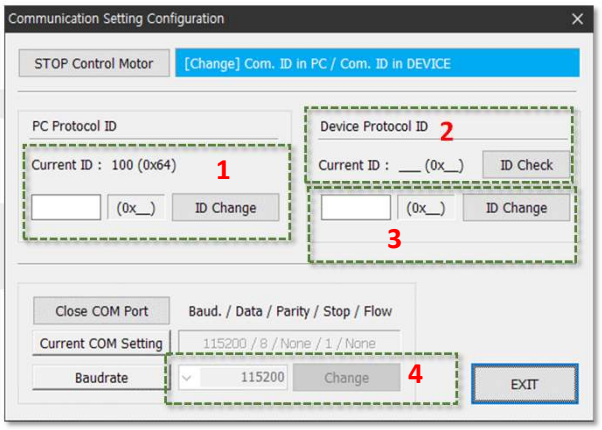
1	[Select]	Select the control mode.
2	[Open / Close]	Open COM Port (Serial)
3	[Start / Stop]	Start communication with motor
4	[Monitoring]	Check connected motor status, rotation speed, current graph
5	[Control Setting]	Input setting value to control the motor Input button activated (depends on selection mode) The selected control item is indicated by a red border on the button
6	[Zero Position Set]	home position return Set the zero position value of the control motor. Change current position to zero position.

Program – Setting



Program – Setting
/ COM Config.

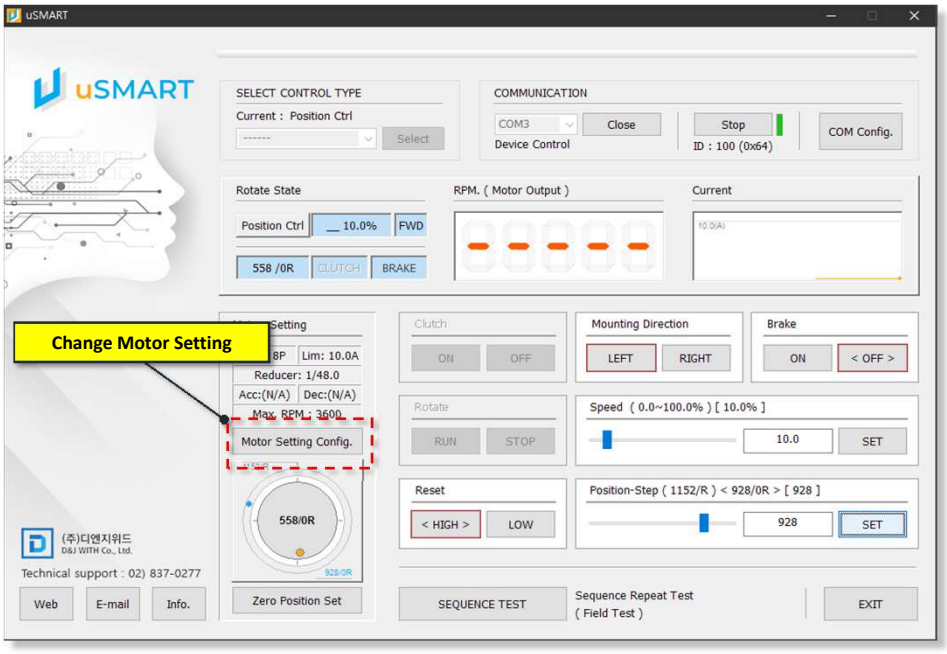
1	Communication ID set in the PC program. 1) Enter ID to change 2) "ID Change" button
2	Check the device ID of the connected motor
3	Change device ID. 1) Enter ID to change 2) "ID Change" button
4	Change communication speed 1) Select speed to change 2) "Change" button



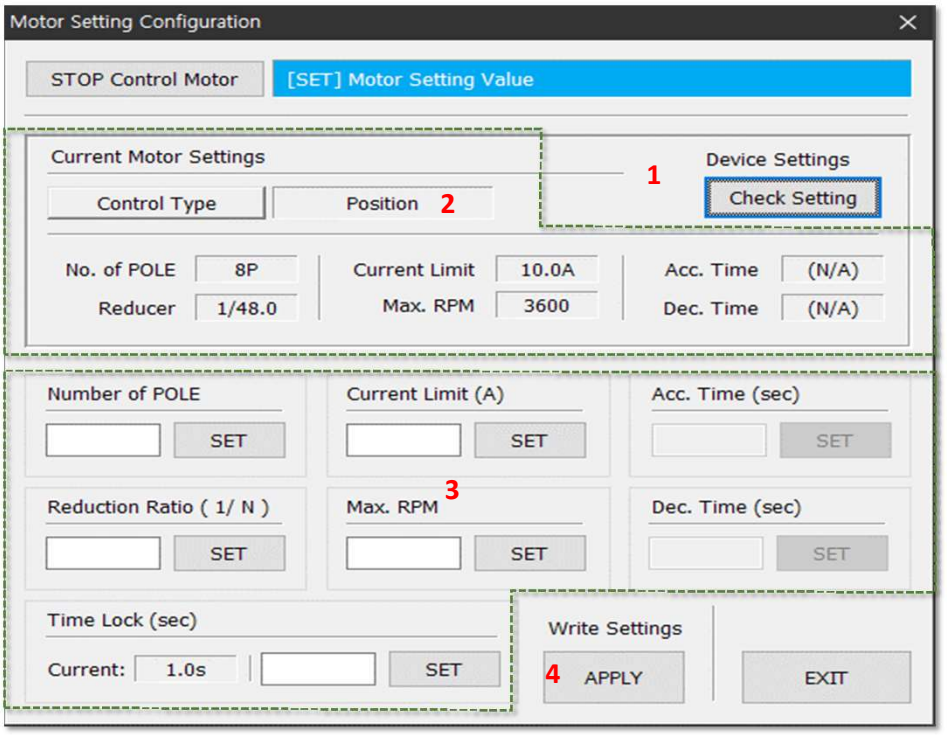
Caution

1	ID can be changed while communication is connected.
2	It cannot be changed while the motor is running.
3	Baudrate can be changed only when the port is "Close".

Program – Setting



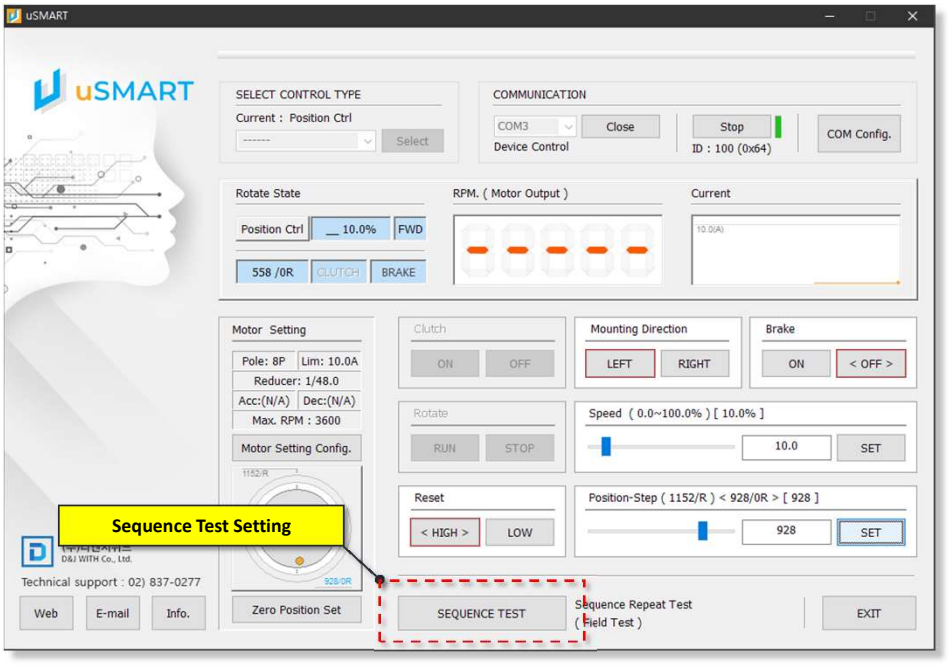
Program – Setting
/ Motor setting config.



1 Check default setting of connected motor
2 Display of control settings
3 Control settings
4 Apply settings

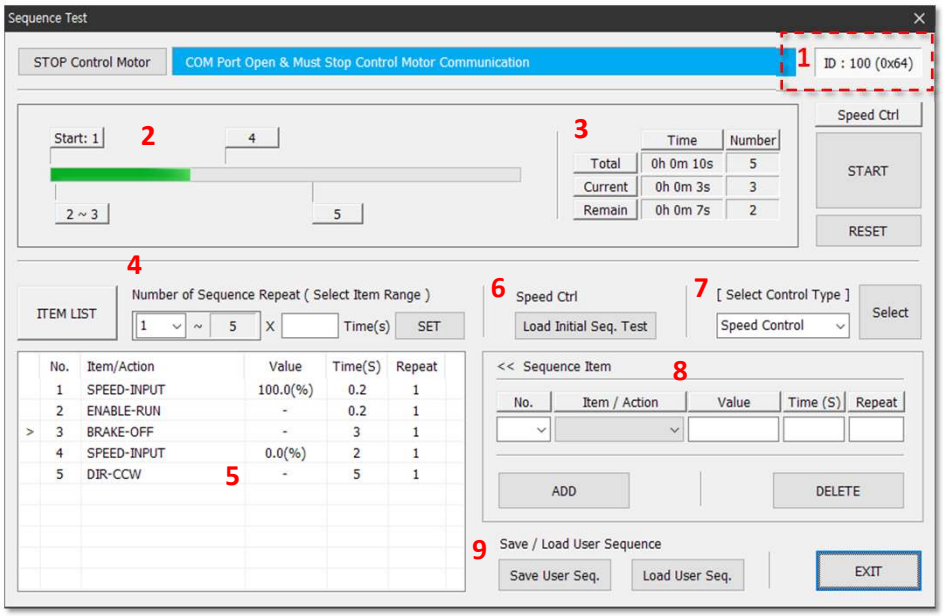
Caution
1 The set value can be changed only when communication is connected.
2 It cannot be changed while the motor is running.

Program – Setting



Program – Setting

/ Sequence Test Setting



1 Display the set communication ID
2 Display the set test item order and progress
3 Display setting time and test repeat count
4 Set the number of test repetitions
5 Sequential display of test setting items
6 Load default settings
7 Control mode selection
8 Test Item Settings
  1) Run / Time / Repeat: Setting
    "Add" Button : Add Item
  2) Sequential Selection
    "Delete" Button : Delete Item
9 Save the setting items
  Load saved setting items

Caution
1 Sequence test item can be changed only when communication is connected.
2 It cannot be changed while the motor is running.