Sumitomo Drive Technologies

# smartris

# smartris Servo Drive


<Note>

- This product should be handled by only those who have been trained for the work. Please read this manual carefully before use.
- Deliver this manual to the customer who will actually use the product.
- This instruction manual should be carefully stored.

Sumitomo Heavy Industries, Ltd. Maintenance Manual No.DM1802E-1

# Introduction: Safety Precautions

- Carefully read this maintenance manual and all accompanying documents before use (installation, operation, maintenance, inspection, etc.). Please use this product after thoroughly understanding the machine, information about safety, and all precautions for correct operation.
  After reading, retain this manual for future reference.
- Pay close attention to the "DANGER" and "CAUTION" warnings regarding safety and proper use.

**DANGER** Improper handling may result in physical damage, serious personal injury and / or death.

**CAUTION** Improper handling may result in physical damage and/ or personal injury.

Matters described in CAUTION may lead to serious danger depending on the situation.
Be sure to observe important matters described herein.

## DANGER

- Transport, installation, wiring, operation, maintenance, and inspections should be performed by trained technicians; otherwise, electric shock, injury, fire, or damage to the equipment may result.
- When the unit is to be used for the personnel transport vehicle, install a safety protecting device on the elevator side to prevent it from falling; otherwise, personal injury or damage to the equipment due to falling of hoisting equipment.

# Introduction: How to Refer to the Maintenance Manual, Table of Contents

This is the maintenance manual for the smartris servo drive unit.
For handling of motor and gear units, see the smartris Gearmotor Maintenance Manual (No. DM1801E).

## Contents

# 1. Overview

## 1-1 Purpose of This Document

This document describes the safe installation and operation of this product.
Please read it before using, and follow all safety warnings and cautions herein to ensure safe handling of this product.
Keep this document in a location where you can use it at any time.

**⚠CAUTION**

- This document is a maintenance manual for qualified persons who will use this product.

Only qualified persons should transport, wire, install, and operate this motor.
The contents of this document are subject to change without notice as a result of product improvements, etc.

## 1-2 Safety Precautions

Follow the safety procedures described in this document to ensure safe operation.
When operating this product and its peripheral devices, It is required to protect its operators and the surrounding area.

**⚠CAUTION**

- It is necessary to confirm that all system switches are working properly and that there are no warning indicators.
- Before startup, check wiring and confirm that there is no damage to the drive unit.
- Applying voltages other than those specified or reversed cable connections may cause faults in the drive unit.
- Do not connect or disconnect cables while the power is on or during operation.
- Operators are responsible for performing safe installations in compliance with any applicable laws and standards.

Notes: 1. Thoroughly read this document before performing installation.

This product contains parts that are sensitive to static electricity; improper handling may result in faults.
To prevent electrostatic faults, avoid contact with highly insulating plastic films and synthetic fibers.
Place this product on a conductive material and ground it to discharge static electricity.
Keep covers and control panels closed to avoid worker injury and product faults.

**⚠DANGER**

- Never connect or disconnect drive unit wiring when the power is ON; otherwise, faults or electrocution due to arcing discharge may occur.
- High voltage is applied to cables even when the motor is stopped. Never remove any cables.
- When disconnecting power connections after turning the power off, wait at least one minute before touching the device, because capacitors and contacts will remain charged.
  We recommend using an instrument to measure voltage before touching the device.

**⚠DANGER**

- The drive unit surface can become dangerously hot.
- Note that the heat sink and cables can also reach high temperatures.

**⚠CAUTION**

The following are cautions for avoiding personal injury and faults in the product and other devices.

- Only apply DC power within the voltage specifications listed in this document.
- When connecting power cables to this product, isolate it from dangerous high-voltage lines and use insulation that complies with safety standards.
- Before operating this product, ensure it was installed according to the procedures in this manual.
- Confirm proper operation before using the Safe Torque Off function.
- If the device catches fire, never throw water directly on it to extinguish it.

**⚠CAUTION**

- This is information for confirmation to ensure normal operation and understanding of the product.

Safety checks must be performed for workers and devices according to the appropriate standards.

## 1-3 Warranty

This manual presents information that is guaranteed to prevent accidents due to faults or wiring tasks for this product.

Strictly adhere to the specifications described in this document and catalogs.

- Do not remove the cover from the main unit.
- Do not remove any warning labels.
- Modifications to the drive unit or its parts will void the warranty.

Also, faults due to failure to perform actions described in this Maintenance Manual will void the warranty.

See "11. Warranty" for details regarding the product warranty.

## 1-4 Power Source Specifications

Table 1-1 Power Source Specifications

| Item | Description |
|---|---|
| Power supply voltage | 48 Vdc (30 - 60 Vdc) |
| STO power supply voltage | 24 Vdc (20 - 28 Vdc) |

Note: Never connect power supplies with voltages exceeding specifications.
Supplying high voltage to the drive unit may result in faults in its internal parts.

## 1-5 Installation and Terminal Connections

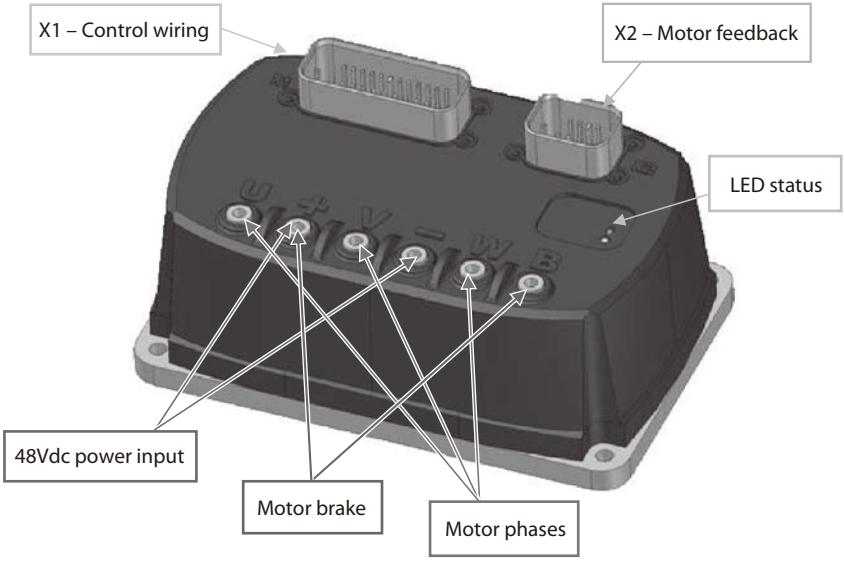



Fig. 1-1 Eternal Appearance of the smartris Servo Drive Unit

Table 1-2 Power Connections

| Pin No. | Signal | Description |
|---|---|---|
| + | +VBUS | Connection to +VBUS (+48 Vdc) |
| — | -VBUS | Connection to –VBUS |

Table 1-3 Motor Connections

| Pin No. | Signal | Description |
|---|---|---|
| U | phase U | Motor phase U |
| V | phase V | Motor phase V |
| W | phase W | Motor phase W |

Note: See "3-1 Power Cables" regarding recommended cables.
Terminal: M6 screw, 7 N • m tightening torque

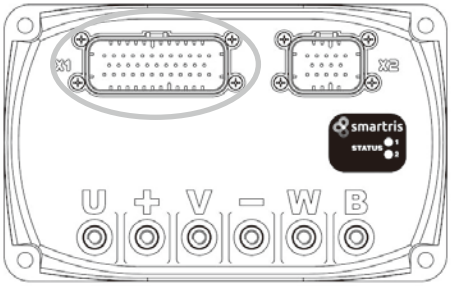
Table 1-4 Bake Connections

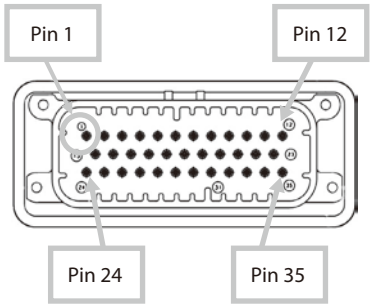
| Pin No. | Signal | Description |
|---|---|---|
| + | +VBUS | "Brake+" and +VBUS connection |
| B | BRAKE | "Brake" and B connection |

Note: Cable with 1 $mm^2$-AWG19 or higher is recommended

# 1. Overview

## ■ X1 Connector Connections (Control Signals)




Note: See "10. Cables (Optional)" regarding cables.

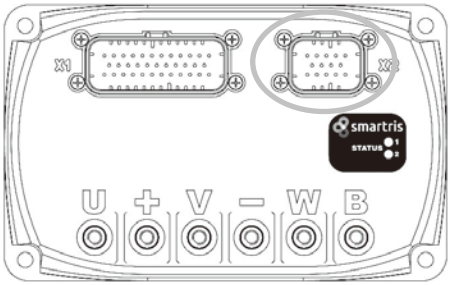
Table 1-5 X1 Connector Control Signals

| Pin No. | Signal | Description | Color |
|---|---|---|---|
| 1 | 0V24 | GND (control board power) | Black |
| 2 | COMMON | Digital input common | Pink |
| 3 | IN1 | Digital input 1 | White/pink |
| 4 | IN2 | Digital input 2 | Yellow/pink |
| 5 | IN3 | Digital input 3 | Pink/green |
| 6 | IN4 | Digital input 4 | Pink/brown |
| 7 | TX/485+ | TX232 signal/485+ signal | Gray/brown |
| 8 | RX/485 — | RX232 signal/485 – signal | Gray/green |
| 9 | 485_T | 120 Ω terminal resistor 485 (connected to 485+) | White/gray |
| 10 | GND_COM | GND (RS232 serial communication) | Gray |
| 11 | RET1 | Safety relay 1 (output) | White/red |
| 12 | STO1 | Safety relay STO1 (input) | Yellow/red |
| 13 | GND_REF | GND (analog command) | Brown/green |
| 14 | REF- | Analog input – | Brown |
| 15 | REF+ | Analog input + | Yellow |
| 16 | +10V | 10 Vdc output | Purple |
| 17 | OUTDAC | Analog output | White/yellow |
| 18 | GND_DAC | GND (analog output) | White/black |
| 19 | GND_CAN | GND (CAN) | Brown/black |
| 20 | CAN _T | 120 Ω terminal resistor CAN (connected to CAN H) | White/green |
| 21 | NC | - | - |
| 22 | COM_RET | Common (RET1/RET2: output) | Yellow/brown |
| 23 | STO2 | Safety relay STO2 (input) | Yellow/brown |
| 24 | 24/48V | Switching power | Red |
| 25 | V_OUT | Digital output common | Blue |
| 26 | OUT1 | Digital input 1: DRIVE OK | White/blue |
| 27 | OUT2 | Digital output 2: Open collector | Gray/blue |
| 28 | OUT3 | Digital output 3: Open collector | Green/blue |
| 29 | OUT4 | Digital output 4: Brake commands Note 1 | Yellow/blue |
| 30 | CAN_L | CAN_L connection | Green |
| 31 | CAN_H | CAN_H connection | White |
| 32/33 | NC | - | - |
| 34 | RET2 | Safety relay 2 (output) | Green/red |
| 35 | STO_COM | Common (STO1/STO2: input) | Yellow/black |

Notes: 1. Enabled when the brake is connected.

2. Digital input 24 V ± 20%, digital output 24 V ± 20%, impedance 3 kΩ, 7 mA

■ **X2 Connector Connections (for Feedback)**



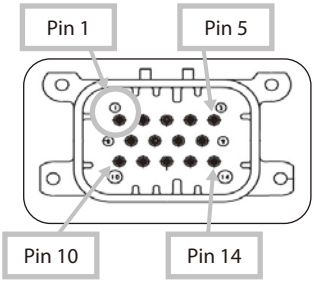




Table 1-6 X2 Connector, Feedback Signals

| Pin No. | Resolver | Absolute encoder |
|---|---|---|
| 1 | S2 (SIN+) | SIN |
| 6 | S4 (SIN-) | REFSIN |
| 2 | S1 (COS+) | COS |
| 7 | S3 (COS-) | REFCOS |
| 3 | R1 (REF+) | DATA+ |
| 8 | R2 (REF-) | DATA- |
| 10 | - | +8V |
| 11 | - | GND |
| 4 | - | - |
| 9 | - | - |
| 14 | - | - |
| 5 | SCH | SCH |
| 12 | NTC1a | NTC1a |
| 13 | NTC1b | NTC1b |

Note: See "10. Cables (Optional)" regarding cables.

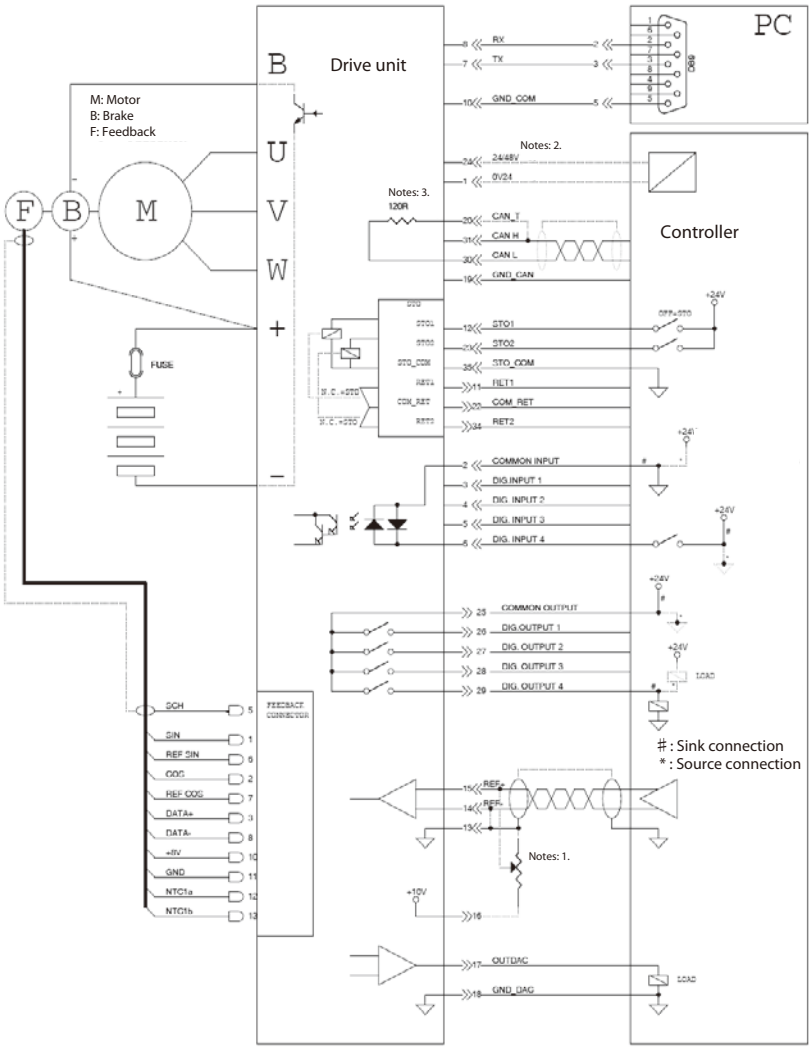
**⚠DANGER**

The following are precautions for avoiding injury and risk of death due to improper use.

■ Avoid ground loops in wiring for control devices.

- When connecting the PC, the encoder, switches, actuators, etc., to the control connector, never connect ground (pins 1, 10, 13, 18, 19) and battery negative (–) terminals.
  Never disconnect the battery negative (–) terminal while the battery positive (+) terminal is connected to the drive unit. Excess current flows from the ground pin, so disconnecting a wire or connector can result in damage or faults to controllers and peripherals.
- The controller connector grounds (pins 1, 10, 13, 18, 19) are connected to drive unit by internal negative (–) terminals.
- Be sure to connect battery negative (–) terminals in controller ground wiring.
- Do not use power ground cables for connectors and switches.
- Shield external I/O signals to prevent effects from main power.

## ■ Connection Example




Notes: 1. The potentiometer connections

2. Backup power supply for logic

3. CAN terminal connection: Pin 20 and Pin 31 (CAN H signal)

Fig. 1-2 Connection Example for Drive Unit and Controller

## 1-6 Ambient Conditions

This product must be installed in appropriate ambient conditions to ensure safe operation.
Faults due to modifications or inappropriate storage conditions will void the product warranty.
Keep the device covered for protection from dust, metal filings, water, oil, etc.

| Item | Details |
|---|---|
| Ambient temperature | -10 °C - 40 °C |
| IEC60068-2-2 | 40–55 °C: Requires motor capacity derating |
| Ambient humidity | ≤85% RH, no condensation |
| Altitude | Altitude: 1000 m max. |
| Protection class | IP54 |
| Contamination level | 2(EN 2, 61800, EN61800-5-1) |

**⚠CAUTION**

This product diffuses heat by heat dissipation and conduction.
The maximum allowable ambient temperature is 55 °C; this product cannot be used in environments with higher temperatures.

| Storage | Details |
|---|---|
| Storage temperature | -10 °C - 70 °C |
| Storage humidity | ≤90% RH, no condensation |

## 1-7 Certification

**(1) CE Compliance**

This product is certified for the conformance with the following EC Directives by Certification Bodies.
- EMC Directive (2014/30/EU)
- RoHS Directive (2011/65/EU)
- WEEE Directive (2012/19/UE)

**(2) Safety**

This product is compliant with the following EN safety standards:
- **EN 61800-5-1**: Adjustable speed electrical power drive systems - Part 5-1: Safety requirements – Electrical, thermal and energy.

**(3) EMC Requirements**

This product satisfies category requirements for emission and immunity conditions for "type-2 environments" (industrial environments).
- **EN 61800-3**: Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods.

**(4) Safety Conformity (STO)**

This product is equipped with two-channel Safe Torque Off (STO) input compliant with safety functions. (Optional)

This function halts PWM output and safely stops torque of the drive unit.

The circuit designs have been tested and certified by TÜV SÜD.

The STO safety function for circuit designs in this product are compliant with the following EN standards:

- **EN61508**: Functional safety of electrical/electronic/programmable electronic safety-related systems
- **EN61800-5-2** and category: Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
- **EN ISO 13849-1:2015**: Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design.

Subsystems include safety conditions with the following characteristics:

| EN 13849-1 | EN 61508 | PFHD [1/h] |
|---|---|---|
| PLe | SIL3 | - |

**(5) Ambient Conditions for Vibration and Shock**

The drive unit satisfies the following specifications:

- Vibration: DIN EN 60068-2-6:2008
- Vibration frequency range: 10–150 Hz
- Acceleration: 5G

## 1-8 Motor and Circuit Protection

There is no need for connecting a thermal relay for motor protection. Overload protection is possible with the $I^2t$ function (electronic thermal).

Protection function parameters are as follows:

- Nominal current
- Peak current
- Overload

Nominal current and peak current are motor characteristics. The overload time is the initial value due to the load and motor, but can be set programmatically.

Drive behavior after the overload time has elapsed can be set as follows:

- Occurrence of overload alarms
- Operation under peak nominal current

The motor's temperature sensor has a function for protecting the motor from overheating.

In that case, drive operation can be set as follows:

- Even with the sensor detecting temperatures above the threshold, continue operation until the motor overheat alarm.
- It is possible to read sensor temperature values and reduce the load or speed to lower the motor temperature.

## 1-9 Startup

EMC directives forbid startup before confirmation that this product was installed in compliance with EC Directive standards.
Also, standards for machinery directives (2006/42/EC) and EMC directives (2014/30/EU) prohibit application and operation of this product with incompatible mechanical systems.
Machine and system manufacturers must ensure EMC thresholds satisfying the requirements of EMC standards.

### (1) Proper Usage

This product can be applied to drive synchronous servo motors using permanent magnets (servo motors compatible with machine and system feedback systems).
This product is certified for use in industrial applications. Note that its use in residential areas requires additional EMC countermeasures.
The customer will need to prepare a risk analysis for the final product.

**⚠CAUTION**

- Customers planning use for nonindustrial applications must first obtain our approval.

### (2) Inappropriate Uses

This product is incompatible with motors other than synchronous servo motors. It also cannot be used in motors incompatible with feedback systems.
Note that installation in areas presenting the danger of flammable materials, flammable gases, dust, etc., can result in fire or explosion.
Do not install the drive unit or gearmotor of this product in such environments.

## 1-10 Location of Installation

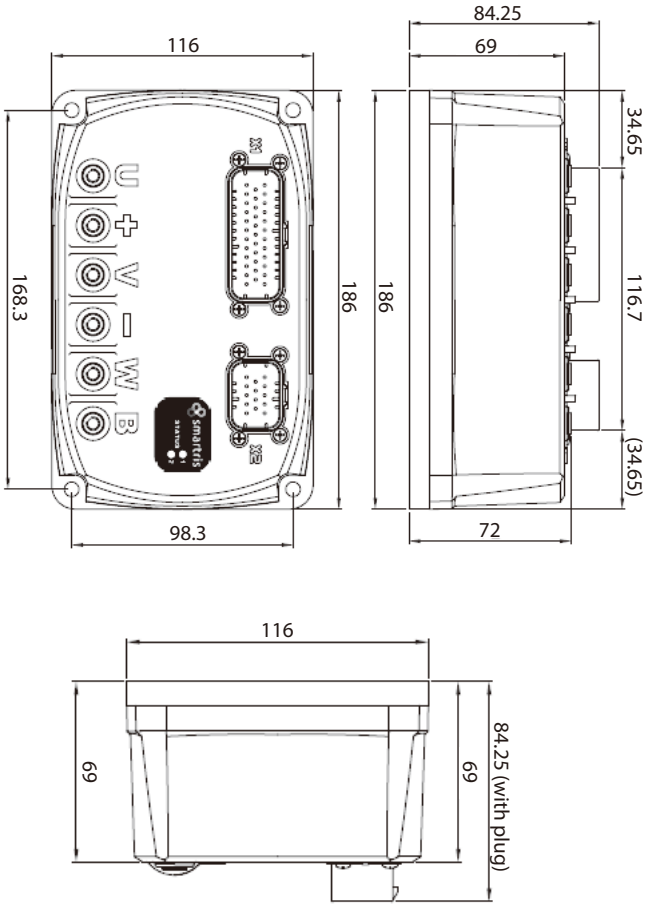
Install this Protection Standard IP54 product in a place where it can operate reliably.
It must be installed in a location conforming to IP54 class or higher protective structures.

## 1-11 Maintenance

Perform periodic maintenance and inspections to ensure that the drive unit is free of abnormal appearances, dust adhesion, and loose connectors or terminals.
Disassembling this product will void its warranty. When disassembling, safety functions corresponding to standards are not guaranteed.

# 2. Dimensions

## 2-1 Dimensions




Unit: mm Mass: 1.6kg

## 2-2 Installation

Safety Precautions

- Install the drive unit inside a control panel to prevent humidity, water droplets, and metal dust.
- Before installation, confirm that the drive unit is not damaged.
- Ensure sufficient ventilation within the control panel.
- Do not operate the drive unit if condensation generates.

## 2-3 Wiring Precautions

Safety Precautions

**⚠CAUTION**

- Ensure that the system is displaying no alarms to confirm safety.
- Before operation, check that the wiring with the drive unit is correct and theses cables have no damage.
  Before operation, confirm there are no problems with the drive unit and wiring.
- Non-specification voltages, reversed polarity of connections, improper wiring, etc., can result in drive unit faults or damage.
- Improper protection against excess power can result in damage to the drive unit or wiring.
- See "5. STO Safety Function (Optional)."

## 2-4 Power Adapters and Supplied Voltage

24V for STO logic and 48Vdc power supply must supply constant voltage.

**⚠CAUTION**

- Using power adapters that do not conform to SELV/PELV designs can produce dangerously high voltages that may result in injury or death.

48 Vdc power adapters must allow regeneration up to 60 Vdc during motor regeneration operation. Power adapters must be designed to accommodate the above regeneration operation.

# 3. Technical Data

## 3-1 Power Cables

The table below shows an example of cable size selection for wiring to the servo motor and power supply.

Table 3-1 Example of Power Cable Selection

| AGV load (kg) | Motor output (W) | Power source cable ($mm^2$) - AWG | Protective fuse (A) |
|---|---|---|---|
| 600 | 430 | 2.5 - AWG14 | 25 |
| 1000 | 600 | 4 - AWG12 | 50 |
| 1500 | 1000 | | |
| 1500 | 1000 | 6 - AWG10 | 100 |
| 2500 | 1500 | | |

Note: Power supply voltage is 48 Vdc (max. 60 Vdc)

Cables in the table are reference examples. Applicable to Lafert or similar servo motors.

■ This document is applicable to the following feedback.

- Resolver
- Absolute encoder

**⚠CAUTION**

- This product optionally includes a Safe Torque Off (STO) safety feature.
  Please confirm correct operation of circuits for this function before operation.
  See "5. STO Safety Function (Optional)" for details.

## 4-1 Analog Mode

This product can be operated with ±10 V speed commands.
Voltage inputs for speed commands are REF+ and REF–. (See Fig. 4-1 and Table 4-1 for X1 connector control signals.)
The servo motor speed can be changed to the maximum speed by following the voltage between REF+ and REF–.
Speed commands are proportional to input voltage from -10 V to +10 V.
+10 V: maximum speed during forward rotation; -10 V: maximum speed during reverse rotation

### ■ Speed Commands (For Servo motor Maximum Speed of 3000 r/min)

Input voltage = +10 V → +3000 r/min
= +5V → +1500 r/min
= -10V → -3000 r/min
= -5V → -1500 r/min

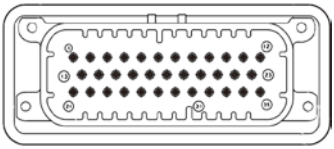


Fig. 4-1 X1 Connector

Table 4-1 X1 Connector Control Signals

| Pin No. | Signal | Description |
|---|---|---|
| 3 | IN1 | Digital input 1: RUN command Note |
| 4 | IN2 | Digital input 2: STOP command Note |
| 5 | IN3 | Digital input 3: Dynamic brake command (see "4.5 Motor Brake") |
| 6 | IN4 | Digital input 4 |
| 13 | GND | GND (analog input) |
| 14 | REF- | Analog input – |
| 15 | REF+ | Analog input + |
| 16 | +10V | 10 Vdc output |

Note: Setting IN1, IN2 to ON operates the servo motor.

# 4. Operation Mode Functions

Table 4-2 Analog Mode LED Display

| IN1 | IN2 | Drive State | Status 1<br>Green LED | Status 2<br>Yellow LED | LED Display |
|---|---|---|---|---|---|
| OFF | X | STAND-BY | "Blink" | OFF | 1 Blink, 50%<br>2 OFF |
| X | X | FAULT<br>See "8. Diagnostic" | "Blink"<br>Code [x] | "Blink"<br>Code [y] | 1 Code<br>2 8. Diagnostic, Table 8-2 |
| ON | ON | RUN | ON | OFF | 1 ON<br>2 OFF |
| ON | OFF | STOP | ON | ON | 1 ON<br>2 ON |
| X | X | Safety STO OFF See "5. STO Safety Function (Optional)." | OFF | "Blink" | 1 OFF<br>2 Blink, 50% |

IN3 is programmable input for dynamic brake (emergency stop).
Enabled/disabled for dynamic brake can be logically selected.

(1) IN3: ON → OFF Dynamic brake enabled
(2) IN3: OFF → ON Dynamic brake disabled

**(1) Monitoring**

Analog mode allows connection to the CAN interface and monitoring the following items that change during drive by CANOpen.

- Object 2002h: Drive status mode
- Object 2003h: Warning
- Object 2004h: Servo drive state
- Object 2030h: Drive unit temperature
- Object 2031h: Motor temperature
- Object 2032h: Heat sink temperature
- Object 2041h: Bus voltage
- Object 2050h: Torque current
- Object 2051h: Drive power
- Object 2052h: Motor power
- Object 2053h: Velocity filtered
- Object 3020h: Digital input
- Object 3022h: Analog input
- Object 4000h: Safety state

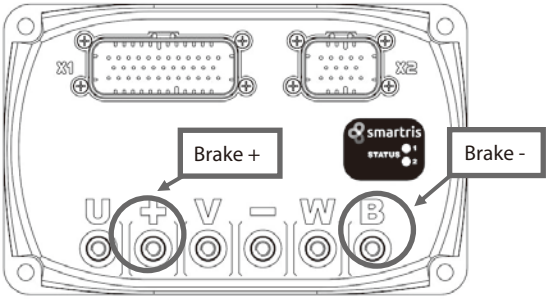
## 4-2 CANOpen Mode

The open network CANOpen (DS301-DS402) can be used with this product.
See "6. CANOpen communication" and the smartris CANOpen Communication User's Manual (No. DM1803E).

## 4-3 Motor Brake

Motor brake operates by being supplied power.
The DIG-OUT4 (digital output 4) signal operates the brake relay.
(The relay requires external power.)
Enabling this function requires setting the BIT_BRAKE customer flag (second flag from the top).
The brake can be set to automatic or manual.

- Automatic mode: Inputting the RUN/Enable operation command allows automatic brake release. Brake power (+24 V)
- Manual mode: The brake release command can be issued by CANOpen communication or a parameter.




### ■ Automatic Mode

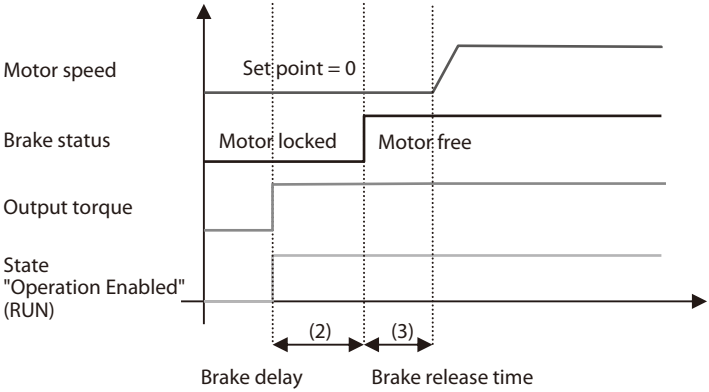



Fig. 4-2 Automatic Brake Operation

## ■ Manual Mode

In CANopen mode, set bit 1 of 60FEh (subindex 1).

- Set brake [60FEh (subindex 1), bit 0] = 1 for brake release.

### (1) Standby to Operation Phase (STBY → RUN)

In STBY, the brake is released and the motor is locked.
During the time set by Delay 1, the motor is in the stop status even if the RUN signal is input.
Even after the Delay 1 time elapses and the brake is released, the motor remains stopped for the time set by Delay 2.
After the Delay 2 time, RUN mode starts and the motor reaches the set speed.
Even when the motor is stopped, stall torque (retention torque) is generated.
Note: Brake delay time is the time from issuance of the brake release command to motor lock release.

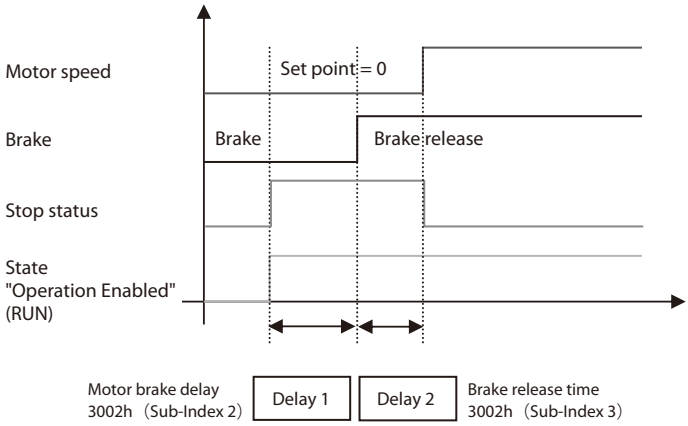



Fig. 4-3 Automatic Brake Delay Time

**(2) Phases from Operation to Standby (RUN → STBY)**

In the RUN state, the brake is released. When halting, stop operation differs according to whether dynamic brake is enabled, as shown in the figure below.

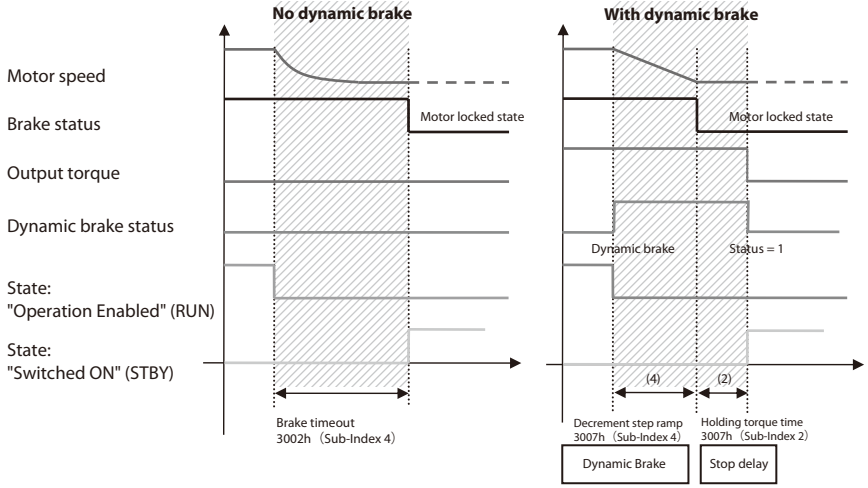



Fig. 4-4 Dynamic Brake

When the dynamic brake function is OFF, as in the first case in Fig. 4-4, the motor decelerates at the free run speed.

The brake locks the motor when the speed reaches zero, or when the deceleration time exceeds the set brake timeout time.

When the dynamic brake function is ON, deceleration occurs in the ramp time set in the dynamic brake parameters.

After ramp deceleration completes, the brake's locking the motor, and the motor's stopping with the delay time set in the dynamic brake parameters, the drive unit turns to be STBY mode.

## 4-4 Digital I/O

The following digital I/O are available.

- Digital input 4: **DIG-INx**
- Digital input 4: **DIG-OUTx**
- Safety digital input 2: **DIG- STO**

### (1) Digital Input

This is an analog mode for operating the motor by using two digital inputs.

- **DIG-IN1** = RUN (analog mode)
- **DIG-IN2** = STOP (analog mode)

Drive unit with the STO function can utilize STO safety.
When the drive unit is in the safety state, STO is enabled regardless of other functions.

In the case of a drive unit being out of order (fault), the drive unit transfers to the FAULT state.
When the "Enable CAN" flag is set, the state machine follows the controlword (6060h) and digital input is ignored.

**DIG-IN3** can be programmed as "**Enable Input Emergency**."
In this case, DIG-IN3 is used for transition from RUN to STANDBY in an emergency with dynamic brake.

This function is enabled through the following settings:
• CANOpen: Set object 0x3008h (Emergency Input Enable) subindex 1.

Logic for dynamic brake input (DIG-IN3) can be selected.
• CANOpen: Set object 0x3008h (Emergency Input Enable) subindex 2.

**DIG-IN4** resets the drive unit hardware.

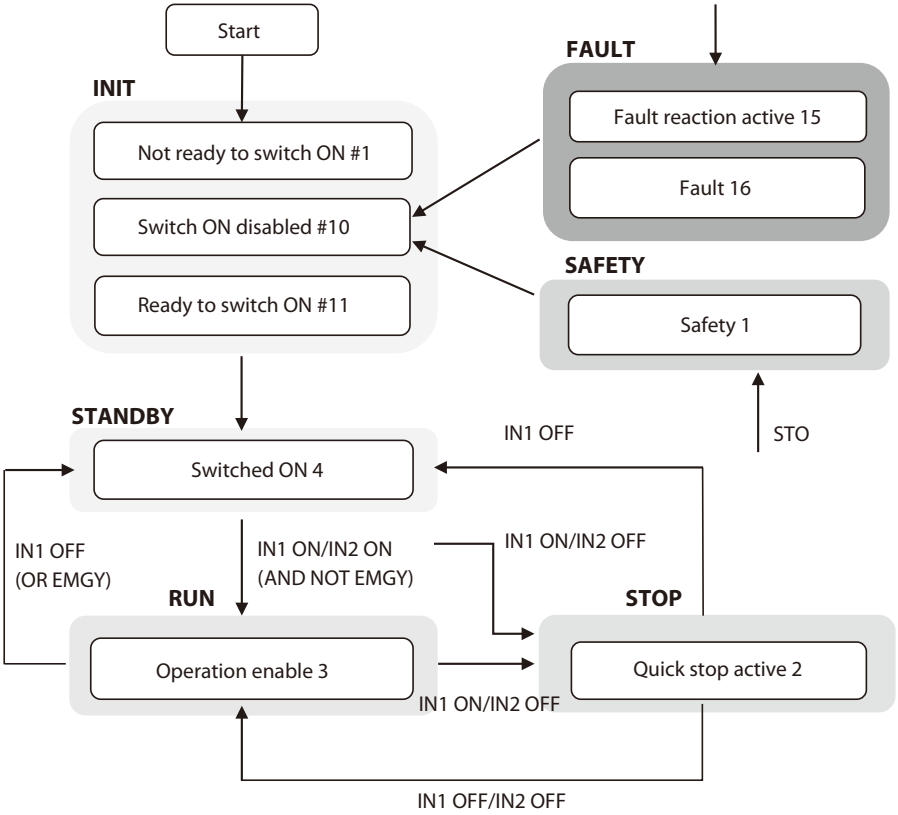



Fig. 4-5 Analog Mode State Machine

### (2) Digital Input, Safety STO

**DIG-STO**: STO input is shown in the following circuits.

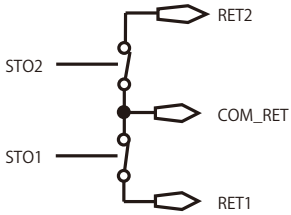



Fig. 4-6 STO Output Feedback Relay

If the application requires deceleration and stop (controlled deceleration and stop) before use of the STO function, first perform deceleration and stop operation, then activate the STO function after stop.

1. Drive deceleration and stop operation
2. In the case of stop state, disable the drive unit.
3. If there is a suspended load, mechanically lock the drive as well.
4. Activate the STO function.

**⚠CAUTION**

The drive unit cannot generate torque when the STO function operates, so load cannot be maintained.

- When the STO function is operated during driving, the drive unit stops without control.
- If the drive unit has an STO function, it is necessary to confirm that all circuits for the drive unit are correct in addition to function settings for it.

#### ■ STO 2 Input Feedback

Feedback signals for each STO input can be monitored by two-channel relay output (RET1, RET2).
The status of STO commands can be monitored by output from each relay. (Safety functions can be completely monitored.)
The state of digital input can be read with CANOpen DSP402 (60FDh: Sub-Index 0)

### (3) Digital Output

**DIG-OUT1**: Indicates the drive state.

• 1 = Drive OK
• 0 = Drive fault

**DIG-OUT2**, **DIG-OUT3**: Can be used as general-purpose output.

**DIG-OUT4**: Indicates the brake status.

• 1 = Brake release, motor shaft free.
• 0 = Brake operation, motor lock

CANOpen DSP402: 0x60FE can can be read with the status of digital output.

Safety circuits include safety functions based on IEC 61800-5-2.
The STO module conforms to uncontrolled stop in "Stop category 0: IEC 60204-1," shutting off torque output.

## 5-1 STO (Safe Torque Off)

In the STO state, power for the motor to generate torque is not supplied.
The motor therefore cannot rotate.

Notes: 1. This safety function is compatible with uncontrolled stop.
2. Use this function when required to shut off output to prevent unexpected start-up.
3. In the presence of external influences (falling due to suspended load, etc.), it is necessary to use an additional measures (a mechanical brake, etc.) to prevent danger.

**(1) STO Connections**

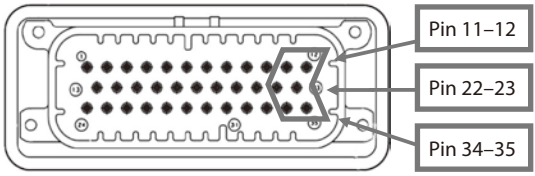



Table 5-1 I/O signals (AGV)

| Pin No. | Signal | Description |
|---|---|---|
| 11 | RET1 | Safety relay 1 (output) |
| 12 | STO1 | Safety relay STO1 (input) |
| 22 | COM_RET | Common (RET1/RET2: output) |
| 23 | STO2 | Safety relay STO2 (input) |
| 34 | RET2 | Safety relay 2 (output) |
| 35 | STO_COM | Common (STO1/STO2: input) |

## 5-2 Hardware Specifications

- STO input: STO1, STO2 (common: STO_COM)
- Relay output: RET1, RET2 (common: COM_RET)

Table 5-2 STO Input Specifications

| STO Input | Data |
|---|---|
| STO Inactive status (normal operation) input voltage | 20 - 28 Vdc |
| STO Active (SAFETY) input voltage | < 2.4 Vdc |
| Input current | 29 mA |
| Active response time (time from normal to STO operation) | 10 ms |
| RET1, RET2 connection specifications (rated voltage/current) | 30 V/0.5 A |

Table 5-3 I/O Relay Operation

| Input 1 | Input 2 | Output 1 | Output 2 | Output Status |
|---|---|---|---|---|
| STO1 | STO2 | RET1 | RET2 | Status |
| 0 V | 0 V | Closed | Closed | Safety |
| 24V | | Open | | |
| 0V | 24V | Closed | Open | |
| 24V | | Open | | Normal mode |

■ If either STO1 or STO2 is 0 V, safety mode (zero torque) operates.

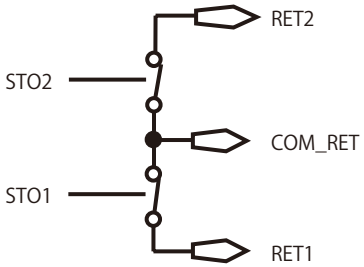



Fig. 5-1 STO Output Relay

## 5-3 Software Specifications

Safety procedure: RUN → STANDBY → SAFETY

Recovering from SAFETY to STANDBY mode requires setting STO and RUN to reactive.

The recovery procedure is as follows.

- In analog mode: SAFETY → STANDBY → RUN
- In CANOpen mode: SAFETY → SWITCH ON DISABLED
  → READY TO SWITCH ON → SWITCH ON
  → OPERATION ENABLED

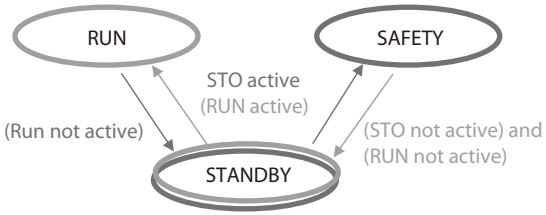



Fig. 5-2 STO State Machine

## 5-4 Safe Operation Sequence Procedure

If deceleration and stop (controlled deceleration and stopping) is required before using the STO function, first perform deceleration and stop operation, then operate the STO function.

1. Drive deceleration and stop operation.
2. In the case of stop state, disable the drive unit.
3. If there is a suspended load, mechanically lock the drive as well.
4. Activate the STO function.

**⚠CAUTION**

The drive unit cannot generate torque when the STO function operates, so load cannot be maintained.

- When the STO function is operated during driving, the drive unit stops without control.

## 5-5 Example of Schematic Application

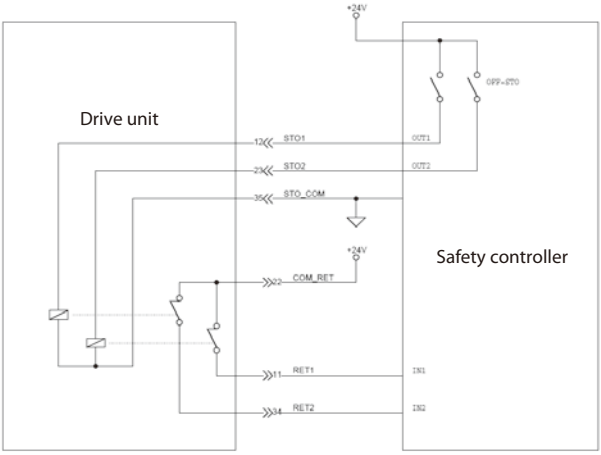



Fig. 5-3 STO Application Example

### ■ STO 2 Input Feedback

Feedback signals for each STO input can be monitored by two-channel relay output (RET1, RET2).
The status of STO commands can be monitored by output from each relay. (Safety functions can be completely monitored.)
The state of digital input can be read with CANOpen DSP402 (60FDh: Sub-Index 0)

## 5-6 Function Check

The STO function should be confirmed on first startup after system wiring or parts replacement.
Please confirm that STO circuits are functioning correctly every six months.

# 6. CANOpen Communication

## 6-1 CANOpen Network Topology

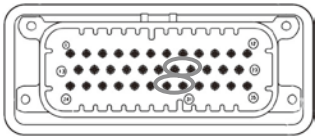


Table 6-1 CANOpen Signals (AGV)

| Pin No. | Signal | Description |
|---|---|---|
| 19 | GND_CAN | CANOpen GND |
| 20 | CAN_T | 120 Ω<br>(CANOpen terminating resistor) |
| 30 | CAN_L | CAN_L connection |
| 31 | CAN_H | CAN_H connection |

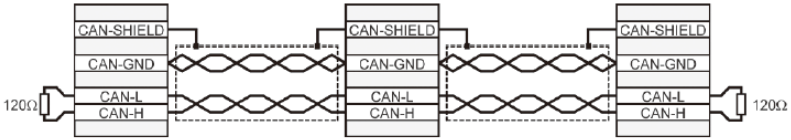



Fig. 6-1 CANOpen Wiring

Table 6-2 Status LEDs

| Drive State | CANOpen Status | Status 1<br>LED (Green) | Status 2<br>LED (Yellow) | LED Display |
|---|---|---|---|---|
| INIT | Not ready to switch ON<br>Switch ON disabled<br>Ready to switch ON | Alternately<br>"Blink" | Alternately<br>"Blink" | 1 Alternately blink<br>2 Alternately blink |
| STANDBY | Switched ON | "Blink" | OFF | 1 Blink<br>2 OFF |
| FAULT | Fault<br>Fault reaction fault | "Blink"<br>Code [x] | "Blink"<br>Code [y] | 1 See 8. Diagnostic<br>2 Table 8-2 |
| RUN | Operation enabled | ON | OFF | 1 ON<br>2 OFF |
| STOP | Quick Stop Active | ON | ON | 1 ON<br>2 ON |
| SAFETY | - | OFF | "Blink" | 1 OFF<br>2 Blink |

## 6-2 CANOpen Bitrate and Node ID

Compliance with CiA DS301 v4.02 and DSP402 v2.0 directives.

- CANOpen baudrate: 50K,125K, 250K, 500K, 800K, 1000K (initial setting: 1000Kb)
- Node ID (initial setting: 1)

## 6-3 CANOpen Overview

**Features**

- TPDO 7, RPDO 7, event timer, access unit 8 bits
- Heartbeat, node guarding
- Baudrate setting: 50K, 125K, 250K, 500K, 800K, 1000K (initial setting: 500K)
- Enable input (standby mode at L-level input, switch ON disabled).
- Node ID setting (default: ID1)
- Parameters are stored in nonvolatile memory (communication + manufacturer name + device profile)
- Load initial CANOpen parameter value from ROM by command.

Compliance with CiA DS301 v4.02 and DSP402 v2.0 directives.

See "CiA DS301 Standards" for additional information.

### ■ Reference Materials

- CANOpen User Manual

- CiA 301 (310_1v01010005_cor.pdf)
- CiA 402 (CiA® 402 Draft Standard Proposal.pdf)

**(1) Object 6040h: Controlword**

This object is used in CiA-402 FSA and CiA-402 modes and for control of manufacturer-specific entities. Controlword comprise the following bits.

| 15 – 11 | 10 | 9 | 8 | 7 | 6 – 5 – 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| ms | r | oms | h | fr | oms | eo | qs | ev | so |

MSB LSB

| | | |
|---|---|---|
| ms: manufacturer-specific | h: halt | qs: quick-stop |
| r: reserved | fr: fault reset | ev: enable voltage |
| oms: operation mode specific | eo: enable operation | so: switch ON |

| Command | Controlword Bits | | | | | Transition |
|---|---|---|---|---|---|---|
| | Bit 7 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
| Shutdown | 0 | X | 1 | 1 | 0 | 2, 6, 8 |
| Switch ON | 0 | 0 | 1 | 1 | 1 | 3 |
| Switch ON + operation enabled | 0 | 1 | 1 | 1 | 1 | 3 + 4 Note) |
| Voltage disabled | 0 | X | X | 0 | X | 7, 9, 10, 12 |
| Quick stop | 0 | X | 0 | 1 | X | 7, 10, 11 |
| Operation disabled | 0 | 0 | 1 | 1 | 1 | 5 |
| Operation enabled | 0 | 1 | 1 | 1 | 1 | 4, 16 |
| Fault reset | ↑ | X | X | X | X | 15 |

Note: After performing switch ON, operation automatically transfers to enabled. This transition interval requires 20 ms or more.

- Bits 9, 6, 5, 4: Operation mode specific
- Bit 8 (halt function): This is an operation mode specific function.
  At bit 1 commands are interrupted and drive unit execution halts at the defined option code. After canceling the stop function, the command operation continues.
- Bit 10 (reserved): Please set to 0.
- Bit 11 (manufacturer-specific, warning recognition): Setting to 1 clears the statusword warning bit.
- Bits 12, 13, 14, 15 (manufacturer-specific): Not used

**(2) Object 6041h: Statusword**

This object indicates the current FSA status. There are operation mode and manufacturer-specific bits.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ms | | oms | | ita | tr | rm | ms | w | sod | qs | ve | f | oe | so | rtso |

MSB LSB

| Bit | Description | M/O |
|---|---|---|
| 0 | Ready to switch ON | M |
| 1 | Switched ON | |
| 2 | Operation enabled | |
| 3 | Fault | |
| 4 | Voltage enabled | |
| 5 | Quick stop | |
| 6 | Switch ON disabled | |
| 7 | Warning | O |
| 8 | Manufacturer-specific | |
| 9 | Remote | M |
| 10 | Target reached | |
| 11 | Internal limit operation | |
| 12 - 13 | Operation mode specific | O |
| 14 - 15 | Manufacturer-specific | |

- Bit 4 (voltage enabled): 1 indicates that high voltage is supplied to the drive unit.
- Bit 5 (quick stop): 0 indicates that PDS is reacting on a quick stop request.
- Bit 7 (warning): 1 indicates that a warning status occurs.
  Note that warnings are not errors or faults (ex: temperature increase, job halt, etc.) The drive unit FSA status therefore does not change.
  Warning definitions can be read from the warning parameter object (2003h).
- Bit 10 (target reached): 1 indicates that the PDS reached its set value.
  The set value is operation mode specific, and defined in clauses corresponding to some of the profile specifications.
  Bit 10 is set to 1 when the operation mode changes.
  This bit changes on software updates of target value.
- Bit 11 (internal limit active): 1 indicates that the internal limit functions.
- Bits 12, 13: Operation mode specific (depends on profile set).
- Bit 14 (manufacturer specific: safety): 1 indicates that the drive unit is in safety mode.
- Bit 15 (manufacturer specific: fault): 1 indicates that the drive unit faults.

**(3) Object 6060h: Mode of Operation**

This object can be used to set operation modes and
shows value for required operation modes. Actual PDS operation modes are reflected in the Modes_of_ operation_display object.

Bit definitions are as follows.

| Bit | Description | Access |
|---|---|---|
| 0 | No mode change/No mode assignment | rw |
| 1 | Profile position mode | |
| 2 | Velocity mode | |
| 3 | Profile velocity mode | |
| 4 | Torque profile mode | |
| 5 | Reserved | |
| 6 | Homing mode | |
| 7 | Interpolated position mode | |
| 8 | Cyclic synchronous position mode | |
| 9 | Cyclic synchronous velocity mode | |
| 10 | Cyclic synchronous torque mode | |
| - x | Manufacturer specifications | |

Usable operation modes

- Mode 3: Profile velocity mode
- Mode 1: Analog Mode

## ■ Profile Velocity Mode (3)

In profile velocity mode, profile movement is defined according to velocity and acceleration/deceleration commands.

Start velocity control profile:

(1) Writing object 6060h = By inputting 3, the drive unit moves to the operation mode of profile velocity mode.
(2) Operation enabled
(3) Set acceleration and deceleration in objects 6083/6084h, respectively.
(4) Operation starts when the target velocity is set in Object 60FFh.

To start operation, clear bit 8 in object 6040h.

The target velocity can be changed during operation. Operation stops when any of the following conditions are satisfied:

- The target velocity is set to zero.
- The Halt command is issued.
- An error occurs.

## ■ Control Composition in Profile Velocity Mode

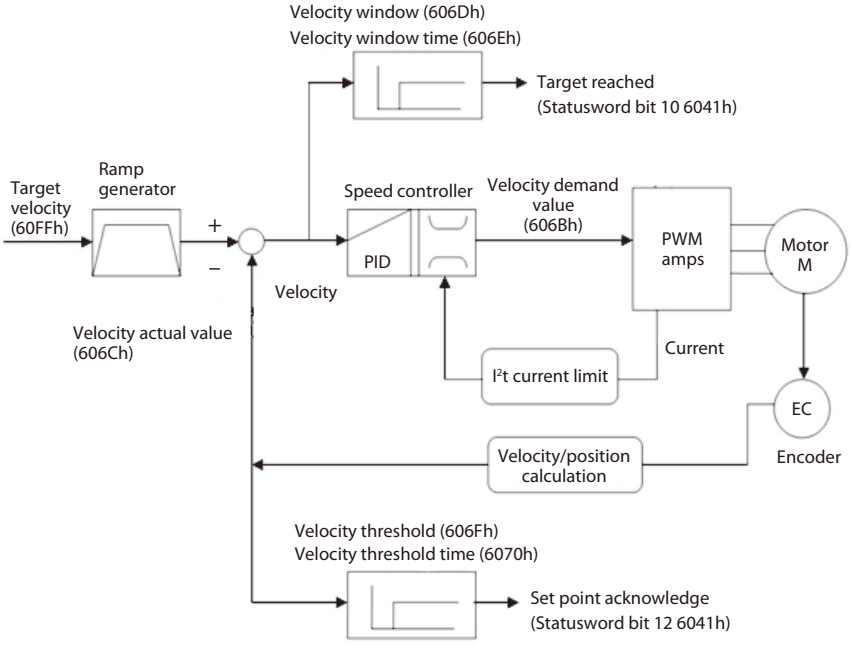



Fig. 6-2 Control Composition in Profile Velocity Mode

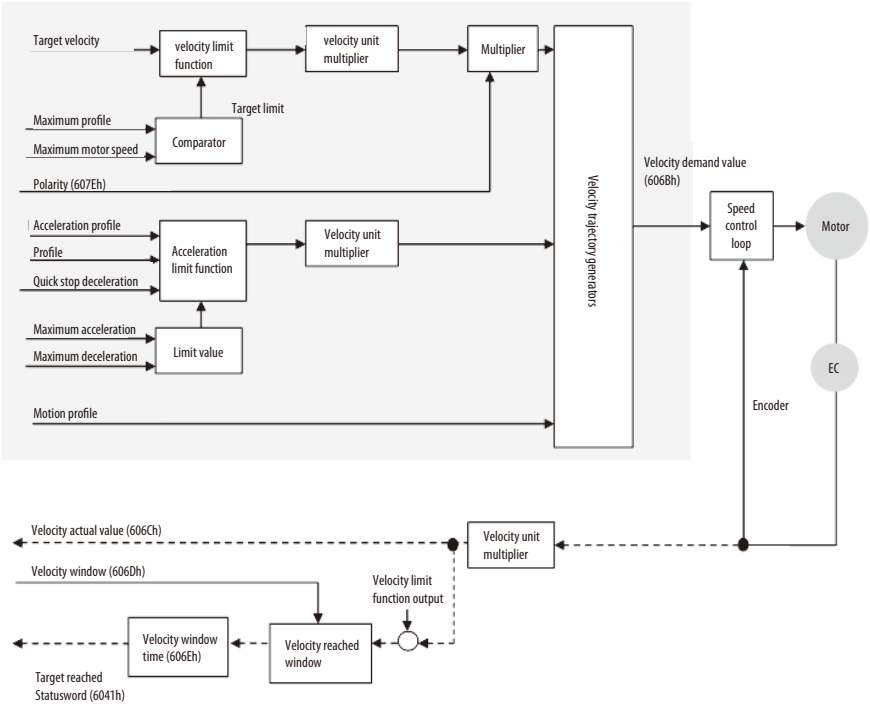



Fig. 6-3 Speed Control Composition

In this mode, the drive unit can follow the set speed.
Please set object 0x6060 (operation mode) to 3.
If the drive unit is in an "operation enabled" state, it is necessary to issue the Halt command, read object 0x6061, and confirm that Mode 3 is accepted.
If the drive unit is not in an "operation enabled" state, there is no need to issue the Halt command (simply set 0x6060 to 3).
If the drive unit is in an "operation enabled" state in profile velocity mode, drive the motor by following the speed setting defined by 0x60FF (rpm). The motor reaches the set value by the acceleration or deceleration defined in 0x6083–0x6084 (rpm/s).

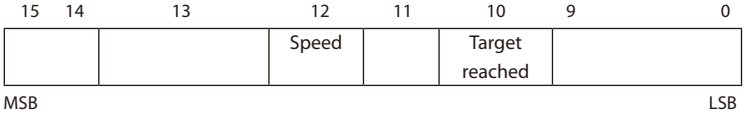
## ■ Controlword Bits (Profile Velocity Mode)

| 15 – 9 | 8 | 7 | 6 – 4 | 3 – 0 |
|---|---|---|---|---|
| | Halt | | Reserved | |

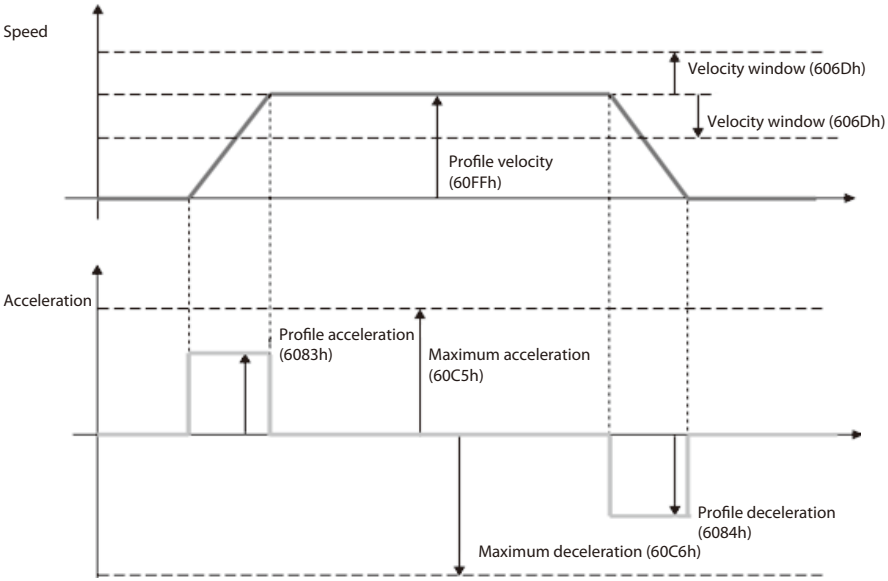
MSB LSB

| Name | Value | Description |
|---|---|---|
| Halt | 0 | Execute operation |
| | 1 | Stop axle |

■ **Statusword Bits (Profile Velocity Mode)**




| Name | Value | Description |
|---|---|---|
| Target reached | 0 | Halt = 0: Target speed not reached<br>Halt = 1: Decelerating |
| | 1 | Halt = 0: Target speed reached<br>Halt = 1: Speed zero reached |
| Speed | 0 | Non zero speed |
| | 1 | Zero speed |



### (4) Object 6061h: Mode of Operation Display

This object defines the actual operation mode.

Object description

| Index | Object Code | Data Type | Category |
|---|---|---|---|
| 6061h | VAR | Integer 8 | Mandatory |

Entry description

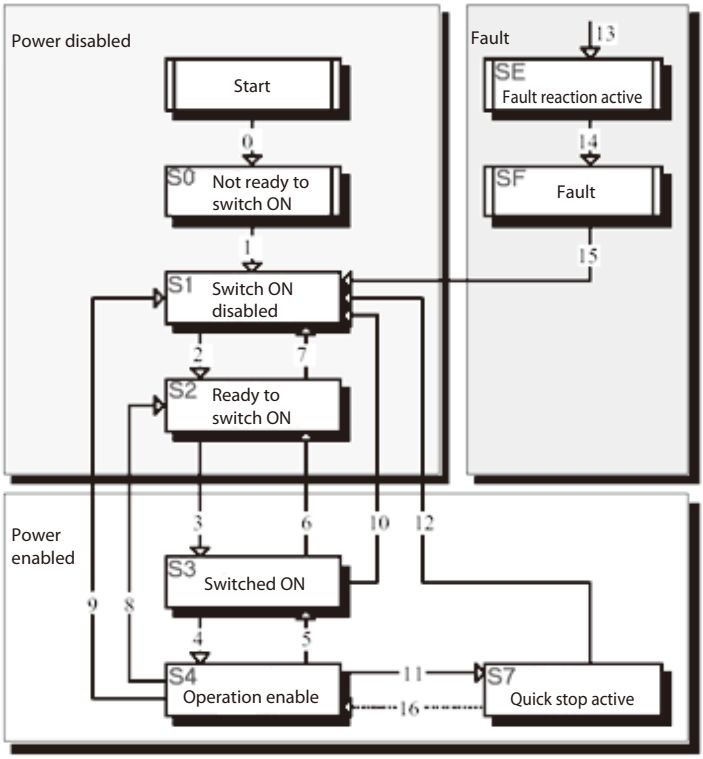
| Subindex | Access | PDO Mapping | Value Range | Default | Unit |
|---|---|---|---|---|---|
| 00h | ro | YES (default) | -128 - 10 | - | - |

Bit definitions are as follows.

| Bit | Description | Access |
|---|---|---|
| 0 | No mode change/No mode assignment | ro |
| 1 | Profile position mode | |
| 2 | Velocity mode | |
| 3 | Profile velocity mode | |
| 4 | Profile torque mode | |
| 5 | Reserved | |
| 6 | Homing mode | |
| 7 | Interpolated position mode | |
| 8 | Cyclic synchronous position mode | |
| 9 | Cyclic synchronous velocity mode | |
| 10 | Cyclic synchronous torque mode | |
| - x | Manufacturer specifications | |

## 6-4 DSP402 State Machine

For additional information, see definitions in "DSP402 v2.0."




The actual status can be read from the statusword. (standard code: defined in CiA DSP402).

| State | N° | Description |
|---|---|---|
| Not ready to switch ON | S0 | Performing self-test during drive unit initialization.<br>Brake output status. Drive unit function is disabled.<br>An internal state, where communication is possible only at the end of this state.<br>Users cannot acquire or monitor this state. |
| Switch ON disabled | S1 | Drive unit initialization completed. Drive unit parameter setup is completed.<br>Drive unit parameters are modifiable. Drive unit function is disabled.<br>Note: Errors are not displayed in this state.<br>Application-side state transition processing is required. |

| State | N° | Description |
|---|---|---|
| Ready to switch ON | S2 | Drive unit parameters are modifiable.<br>Drive unit function is disabled. |
| Switched ON | S3 | Power amp is standby.<br>Drive unit parameters are modifiable. Drive unit function is disabled. |
| Operation enabled | S4 | No faults are detected. Drive unit functions are enabled and power is supplied to the motor.<br>Drive unit parameters are modifiable.<br>The brake is automatically released at the timing set by brake parameters. |
| Quick stop active | S7 | Drive unit parameters are modifiable. Activating the quick-stop function.<br>Drive unit functions are enabled and power is supplied to the motor.<br>The motor is stopped or is stopping by the quick stop active.<br>Motor deceleration is completed and the drive unit is stopping.<br>If the quick stop active code (object 0X605A) is 0, the state of the drive is switch ON disabled. |
| Fault reaction active | SE | Drive unit parameters is modifiable. Drive unit fault occurred.<br>Performing fault reaction. Drive unit function is disabled.<br>Users cannot acquire this status. This status automatically transfers to the fault status. |
| Fault | SF | Drive unit parameters are modifiable.<br>Drive unit fault occurred. Drive unit function is disabled. |

## 6-5 CANOpen Run Sequence

(1) Power switch ON
(2) Verify LED status 1, 2 initial state (INIT mode)
(3) Configure profile velocity: 0x6060 → 0x03
(4) **Ready to switch ON** setting: Controlword write 0x6040 → 0x06
(5) **Switched ON** setting: Controlword write 0x6040 → 0x07
(6) Verify whether smartris drive state is switched ON: Statusword read 0x6041 → 0x23
(7) **Operation enabled** setting: Controlword write 0x6040 → 0x0F
(8) Verify whether LED status is enabled
Verify whether smartris drive state is enabled: Statusword read 0x6041 → 0x27
Verify brake release.
(9) Read speed command set value 0x60FF → 0x03e8 (Ex: set 1000 r/min)
(10) If motor revolutions are confirmed, verify motor speed (after acceleration is complete):
Read 0x606C → 0x03e8 (Ex: 1000 r/min)

Note: The motor immediately stops upon issuance of the STO safety command ( **SAFETY** ).
Commands being executed are immediately halted upon issuance of a stop command ( **STOP** ).
Commands being executed are immediately halted when a fault ( **FAULT** ; see 8. Diagnostic Table 8-2) occurs.

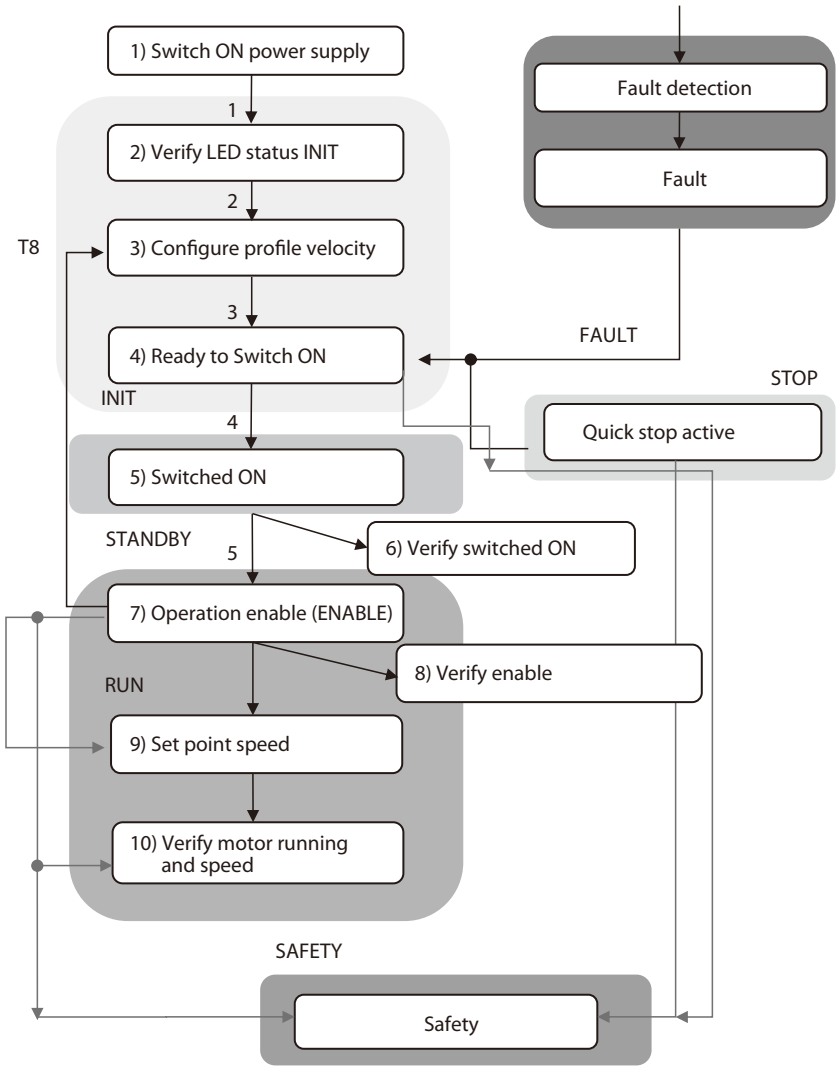



Fig. 6-4 CANOpen Run Sequence

## 6-6 Speed Polarity

Speed set value can be inverted by a CANOpen mode (either clockwise or counterclockwise).
This object affects the signs on "Position_demand_value" and "Velocity_demand_value."

Object description

| Index | EDS Name | Object Code | Data Type | Category |
|---|---|---|---|---|
| 607Eh | Polarity | VAR | Unsigned 8 | Mandatory |

Entry description

| Subindex | C Name | Descrip-tion | Access | PDO Mapping | Value Range | Default |
|---|---|---|---|---|---|---|
| 0 | p402 polarity | Polarity | rw | None | 0 - 192 | 00h |

Bit

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Positional polarity | Speed polarity | Reserved region (0) | | | | | |
| MSB | | | | | | | LSB |

The following value definitions are valid:

- Bit value = 0: +1 times the required value
- Bit value = 1: -1 times the required value

## 6-7 Store and Restore

The CiA CANOpen protocol specifications define objects that store and restore parameters.

- Object 1010h: Store parameter
- Object 1011h: Restore parameter

In order to save all parameters, the master writes in the SDO 1010h index the value "save" to one of the subentries of the object.
By this processing, corresponding parameter is written in nonvolatile memory.
Parameters are automatically loaded into the object dictionary after an NMT reset node or NMT reset communication.

The following objects are modified by writing to object 1010h:2h (communication parameters) and saved in EEPROM:

- 1000h: Device type
- 1001h: Error register
- 1002h: Manufacturer-specific status register
- 1003h: Predefined error field (history list)
- 1005h: COB-ID Sync
- 100Ch: Guard time
- 100Dh: Lifetime factor
- 1014h: COB-ID EMCY
- 1017h: Producer heartbeat time

- 1018h: Identity Object
- 1029h: Error behavior
- 1400h: RxPD01 parameter
- 1401h: RxPD02 parameter
- 1402h: RxPD03 parameter
- 1403h: RxPD04 parameter
- 1600h: RxPD01 mapping
- 1601h: RxPD02 mapping
- 1602h: RxPD03 mapping
- 1603h: RxPD04 mapping
- 1800h: TxPD01 parameter
- 1801h: TxPD02 parameter
- 1802h: TxPD03 parameter
- 1803h: TxPD04 parameter
- 1A00h: TxPD01 mapping
- 1A01h: TxPD02 mapping
- 1A02h: TxPD03 mapping
- 1A03h: TxPD04 mapping

The following objects are modified by writing to object 1010h:3h (application parameters) and saved in EEPROM:

- 6073h: Peak current
- 607Eh: Polarity Note
- 607Fh: Maximum profile velocity
- 6080h: Maximum motor speed
- 6083h: Acceleration profile Note
- 6084h: Deceleration profile Note
- 6096H: Velocity factor
- 6097h: Acceleration factor
- 60C5h: Maximum acceleration
- 60C6h: Maximum deceleration

The following objects are modified by writing to object 1010h:4h (manufacturer settings parameters) and saved in EEPROM:

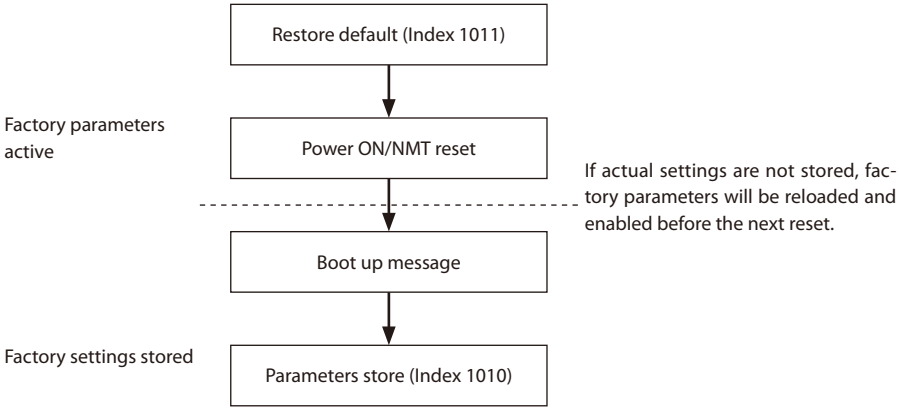
- 2000h: ID Node
- 2001h: Baudrate
- 3002h: Brake parameters Note
- 3007h: : Dynamic Brake parameters Note
- 3200h: PID current Note
- 3201h: PID velocity Note
- 3202h: PID positioner Note
- 3203h: PID decoupling Note

Note: Parameters modifiable in real time that will be lost if the drive unit is shut off.

All parameters can be stored in EEPROM. Modification requests are not accepted until a power reset or until the CANOpen "RESET COMM (NMT)" message is sent to the drive unit.
Manufacturer setting parameters are stored in a protected EEPROM called "Golden Image."
You can use the restore parameter 0x1011 to return EEPROM parameters to factory parameters.

In order to avoid the restoring of default parameters by mistake, the master sends the SDO 1011h and writes the signature "load" to one of sub-index.

■ **Function Mode for Restoring Factory Parameters:**



# 7. Measurement Unit Conversion

Parameters are used in various applications.
To more easily set parameters in different applications, you can use the measurement unit conversion module to convert user parameters into units used within the drive unit.

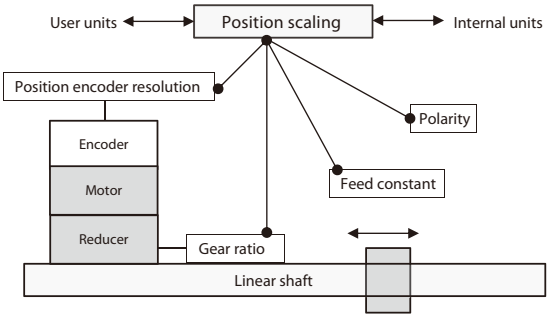



Fig. 7-1 Factor Groups

Factor group objects convert internal position value, speed value, and acceleration/deceleration value into user-defined units.
Internal position value are entered as increments and depend on the resolution of the feedback used.
User-defined units depend on the encoder resolution and the mounted linear moving device (the linear shaft).

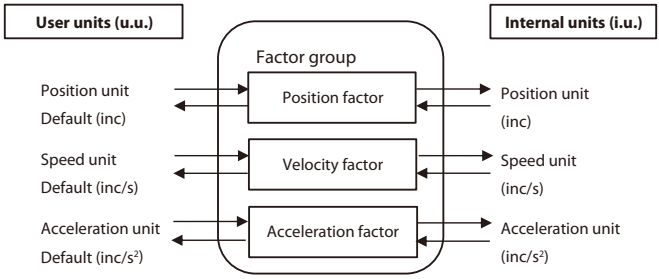



Fig. 7-2 Factor Group Units

All parameters are recorded by using internal units.
Parameters can be converted using factor-group values on a per-user basis.

Default is as follows.

| Object | Name | User Units | Description |
|---|---|---|---|
| Length | Position unit | Inc | Increment/gear ratio |
| Speed | Speed unit | Inc/s | Increment/s |
| Acceleration | Acceleration unit | $Inc/s^2$ | Increment/s/s |

Factors defined in factor groups set relations between internal units (increments) and physical units.
User units are defined as [uu] and internal units are defined as [iu].

## 7-1 Conversion Parameters for Measurement Unit

The factor is the result calculated from numerator and denominator parameters.

| Index | Name | Object Code | Data Type | Attribute | Remarks |
|---|---|---|---|---|---|
| 608Fh | Encoder resolution (position) | ARRAY | Unsigned 32 | rw | Unused |
| 6090h | Encoder resolution (velocity) | | | | |
| 6091h | Gear ratio | | | | |
| 6092h | Feed constant | | | | |
| 6096h | Velocity factor | | | | Used |
| 6097h | Acceleration factor | | | | |

### ■ Object 6096h: Velocity Factor

This object can be used to match velocity units with user-defined velocity units.

Object description:

| Index | EDS Name | Object Code | Data Type | Category |
|---|---|---|---|---|
| 6096h | Velocity factor | ARRAY | Unsigned 32 | Mandatory |

Entry description:

| Subindex | Description | Access | PDO Mapping | Data Type | Default |
|---|---|---|---|---|---|
| 0 | Highest subindex | ro | None | Unsigned 32 | 2 |
| 1 | Numerator | rw | | | 1 |
| 2 | Denominator | rw | | | 1 |

Velocity factor numerators and denominators are input separately.

Velocity factor = (numerator / denominator)

Default for user units [inc/s] is 1 for both numerator and denominator.

Velocity [iu] = velocity [uu] × (60 / resolution) × (numerator / denominator)

Resolution is one rotation of the encoder, or a measurement segment at a 1 in/mm linear scale, or the number of units.

e.g.: Velocity settings are defined as revolutions/min (rpm).

Velocity [inc/s] = velocity [rpm] × (60 / resolution) × (numerator / denominator)

If the encoder resolution is $2^{13}$ bits = 16,384, the numerator is 16,384 and the denominator is 60.

Factor groups are used for the following objects:

- 60FFh: Target velocity
- 606Dh: Velocity window
- 606Fh: Velocity threshold

# 7. Measurement Unit Conversion

## ■ Object 6097h: Acceleration Factor

This object can be used to match acceleration units with user-defined acceleration units.

Object description

| Index | EDS Name | Object Code | Data Type | Category |
|---|---|---|---|---|
| 6097h | Acceleration factor | Array | Unsigned 32 | Mandatory |

Entry description

| Subindex | Description | Access | PDO Mapping | Value Range | Default |
|---|---|---|---|---|---|
| 0 | Highest subindex | ro | None | Unsigned 32 | 2 |
| 1 | Numerator | rw | | | 1 |
| 2 | Denominator | rw | | | 1 |

Acceleration factor numerators and denominators are input separately.

Acceleration factor = (numerator / denominator)

Default for user units [inc/$s^2$] is 1 for both numerator and denominator.

Acceleration [iu] = velocity [uu] × (60 / resolution) × (numerator / denominator)

Resolution is one rotation of the encoder, or a measurement segment at a 1 in/mm linear scale, or the number of units.

e.g.: Acceleration settings are defined as revolutions/min (rpm).

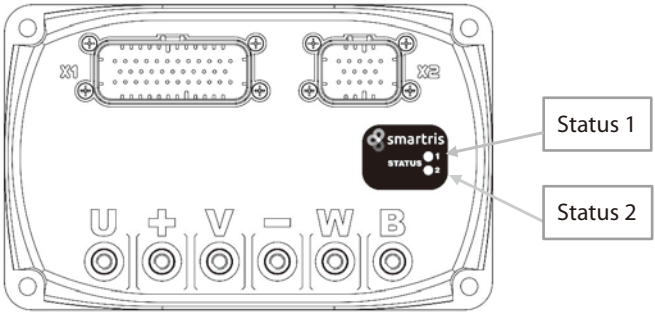
Acceleration [inc/$s^2$] = acceleration [rpm/s] × (60 / resolution) × (numerator / denominator)

If the encoder resolution is $2^{13}$ bits = 16,384, the numerator is 16,384 and the denominator is 60.

Factor groups are used for the following objects:

- 6083h: Profile acceleration
- 6084h: Profile deceleration
- 60C5h: Maximum acceleration
- 60C6h: Maximum deceleration

## 8-1 Diagnostic




• LEDs 1 and 2 on the right side of the main unit show the drive status; the green LED shows status 1, and the yellow LED shows status 2

Table 8-1 Status LEDs

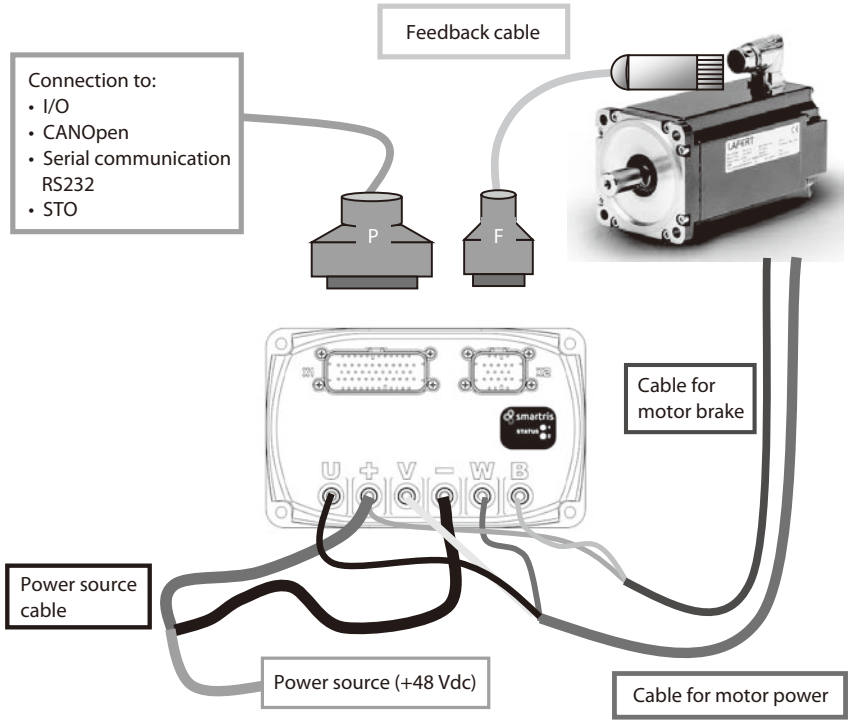
| Drive State | CANOpen Status | Status 1 LED (Green) | Status 2 LED (Yellow) | LED Display |
|---|---|---|---|---|
| INIT | Not ready to switch ON<br>Switch ON disabled<br>Ready to switch ON | Alternately "Blink" | Alternately "Blink" | 1 Alternately blink<br>2 Alternately blink |
| STANDBY | Switched ON | "Blink" | OFF | 1 Blink 50%<br>2 OFF |
| FAULT | Fault<br>Fault reaction fault | "Blink"<br>Code [x] | "Blink"<br>Code [y] | 1 See Fig. 8-2<br>2 |
| RUN | Operation enabled | ON | OFF | 1 ON<br>2 OFF |
| STOP | Quick stop active | ON | ON | 1 ON<br>2 ON |
| SAFETY | - | OFF | "Blink" | 1 OFF<br>2 Blink |

# 8. Diagnostic

Table 8-2 List of Alarms

| Category | Alarm | Status 1 LED (Green) Code [x] | Status 2 LED (Yellow) Code [y] | Alarm Description |
|---|---|---|---|---|
| A Temperature | Motor over temperature | 1 | 10 | Motor temperature exceeds the temperature setting. Operation is impossible due to high motor temperature. |
| | Heat sink over temperature | | 1 | Heat sink temperature exceeds the temperature setting. Operation is impossible due to high heat sink temperature. |
| | Heat sink temperature out of range | | 3 | Heat sink temperature is beyond range of the temperature sensor. Temperature sensor malfunction |
| | PCB over temperature | | 5 | PCB temperature exceeds the temperature setting. Operation is impossible due to high PCB temperature. |
| | PCB temperature out of range | | 6 | PCB temperature is beyond range of the temperature sensor. Temperature sensor malfunction |
| B Feedback | Resolver | 2 | 10 | Check resolver connector and wiring |
| | Resolver initialization | | 4 | Resolver initialization error |
| | Absolute encoder | | 6 | Absolute encoder fault |
| | Hall sensor | | 7 | Hall sensor fault |
| | Hall sensor gap | | 8 | |
| C Current | Current sensor offset | 3 | 10 | Current sensor offset is out of range |
| | Overcurrent | | 1 | Motor overcurrent Check motor wiring for shorts |
| D Voltage | Undervoltage | 4 | 1 | DC bus voltage is below set value Check +/– power terminal voltages |
| | Overvoltage | | 2 | DC bus voltage exceeds set value Check +/– power terminal voltages |
| E Functionality | Speed fault | 5 | 10 | Large error between commanded speed and actual speed |
| | Overload protection ($I^2T$) | | 2 | Motor overload protection ($I^2T$) |
| | Hardware | | 3 | Hardware fault |
| F Communication | EEPROM | 6 | 1 | Erroneous parameter stored in EEPROM |
| | CanOpen | | 2 | CanOpen communication fault |
| | Absolute fault | | 3 | Internal communication fault |
| | Parameter initialization | | 4 | Parameter initialization fault |
| | Profile | | 5 | Profile setting fault |
| G, H, L Programming | Program fault | 7 | × | Program code fault |
| | | 8 | | |
| | | 9 | | |

## 9-1 Connections Diagram




Note: Also see "1-5. Installation and Terminal Connections" regarding cable wiring.
The figure above is a block diagram for easier understanding of wiring.

Table 9-1 Power Connections

| Pin No. | Signal Name | Description | Color (Example) |
|---|---|---|---|
| + | +VBUS | Connection to +VBUS (+48 Vdc) | Red |
| — | -VBUS | Connection to –VBUS | Black |

Table 9-2 Motor Connections

| Pin No. | Signal Name | Description | Color (Example) |
|---|---|---|---|
| U | phase U | Motor phase U | Black |
| V | phase V | Motor phase V | White |
| W | phase W | Motor phase W | Red |

Table 9-3 Brake Connections

| Pin No. | Signal Name | Description | Color (Example) |
|---|---|---|---|
| + | +VBUS | Connection to "Brake +" and +VBUS | Orange |
| B | BRAKE | Connection to "Brake –" and B | Gray |

## 9-2 Nameplate and Codes

### ■ Nameplate

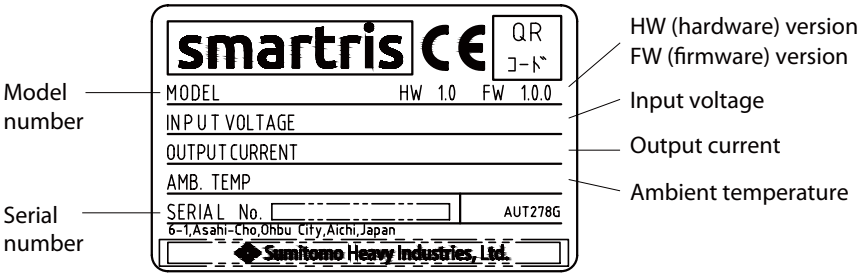



Fig. 9-1 Nameplate of smartris

### ■ Nomenclature

**AG110 D4 — 1A5 0 0**

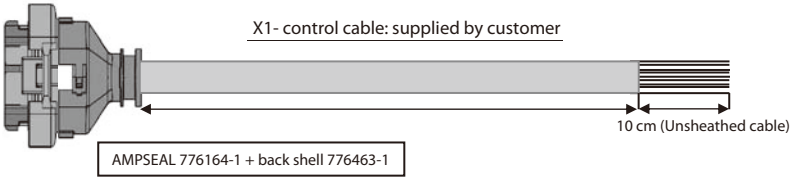
| Series Name |
|---|
| AG110 (ECO-S, ECO-M, PRO-M) |
| AG120 (PRO-L) |

| Drive Unit Capacity | |
|---|---|
| A60 | 600W (ECO-S) |
| 1A5 | 1500W (ECO-M, PRO-M) |
| 2A0 | 2000W (PRO-L) |

| Safety Function | |
|---|---|
| 0 | STO (Safe Torque Off) Unavailable |
| 1 | STO (Safe Torque Off) Available |

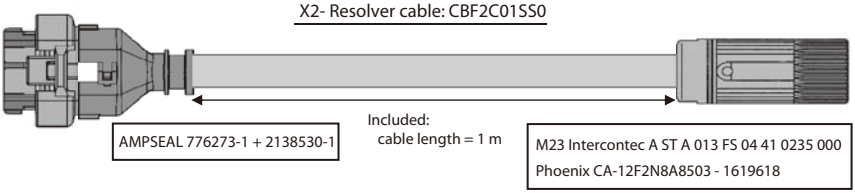
| Power Capacity | |
|---|---|
| D4 | DC48V |

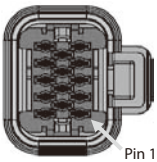
| Feedback | |
|---|---|
| 0 | Resolver |
| K | Absolute Encoder<br>Absolute Encoder (safety compatible) |




| Pin No. | Color (example) | Pin No. | Color (example) | Pin No. | Color (example) |
|---|---|---|---|---|---|
| 1 | Black | 13 | Brown–green | 25 | Blue |
| 2 | Pink | 14 | Brown | 26 | White–blue |
| 3 | White–pink | 15 | Yellow | 27 | Gray–blue |
| 4 | Yellow–pink | 16 | Purple | 28 | Green–blue |
| 5 | Pink–green | 17 | White–yellow | 29 | Yellow–blue |
| 6 | Pink–brown | 18 | White–black | 30 | Green |
| 7 | Gray–brown | 19 | Brown–black | 31 | White |
| 8 | Gray–green | 20 | White–green | 32 | NC Note |
| 9 | White–gray | 21 | NC Note | 33 | |
| 10 | Gray | 22 | Brown–red | 34 | Green–red |
| 11 | White–red | 23 | Yellow–brown | 35 | Yellow–black |
| 12 | Yellow–red | 24 | Red | Shield | External sheath |

Note: No connection



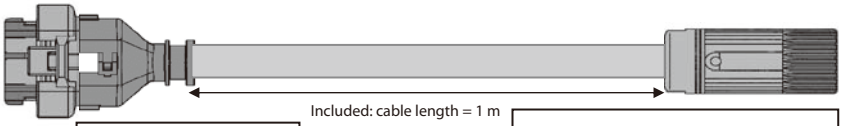

| 776273-1 (14 pins) | Signal | Color | M23 (12 pins) |
|---|---|---|---|
| 1 | S2 | White | 1 |
| 2 | S1 | Green | 2 |
| 7 | S3 | Yellow | 3 |
| - | NC | - | 4 |
| - | NC | - | 5 |
| 6 | S4 | Brown | 6 |
| 3 | R1 | Red | 7 |
| 5 | Shield | - | 8 |
| 12 | NTC1a | Pink | 9 |
| 13 | NTC1b | Gray | 10 |
| 8 | R2 | Blue | 11 |
| - | NC | - | 12 |

Connector pin topology

Note: Twisted pair (white–brown) (green–yellow) (gray–pink) (blue-red)

# 10. Cables (Optional)

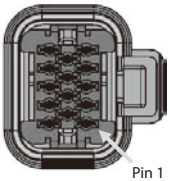
X2— Absolute encoder cable: CBF6C01SS0



Included: cable length = 1 m

AMPSEAL 776273-1 + 2138530-1

M23 Intercontec A ST A 013 FS 04 41 0235 000
Phoenix CA-12F2N8A8503 - 1619618




| 776273-1 (14 pins) | Name | Color | M23 (12 pins) |
|---|---|---|---|
| 1 | +SIN | Brown | 7 |
| 6 | REF SIN | Green | 3 |
| 2 | +COS | Blue | 8 |
| 7 | REF COS | Violet | 4 |
| 3 | DATA+ | Red | 5 |
| 8 | DATA- | Black | 6 |
| 10 | +V | Brown (0.5 $mm^2$) | 1 |
| 11 | GND | White (0.5 $mm^2$) | 2 |
| 12 | NTC1a | Pink | 9 |
| 13 | NTC1b | Gray | 10 |
| 5 | Shield | - | NC |
| 1 | +SIN | Brown | 7 |

Connector pin topology

Note: Twisted pair (green–brown) (blue–violet) (red–black) (gray–pink) (brown 0.5–white 0.5)

# 11. Warranty

The scope of warranty of our delivered products is limited only to what we manufactured.
Warranty (period and description)

| | |
|---|---|
| Period | The warranty period applies only to new products and represents 18 months after the shipment or 12 months after the actual operation, whichever is shorter. |
| Description | If the product failed within the warranty period, in the case where mounting is done properly, connection and maintenance & administration are followed according to the maintenance manual, and the product is properly run based on the specification on the catalog or under conditions agreed between us, we will repair or provide an alternative product at our discretion for free of charge, except the exclusions below.<br>However, as far as the product is connected with customers' other devices, we will not indemnify those expenses on dismounting from/mounting on the devices, etc. and other associated construction expenses, transportation expenses and opportunity loss and operation loss the customers suffered from, and other indirect damages. |
| Exclusion from the warranty | The following items will be excluded from the warranty:<br>1. A breakdown resulting from defects in the mounting of the product and connection with other devices, etc.<br>2. A breakdown resulting from insufficient maintenance & administration and improper handling of the product, including a case that the product is not stored according to our defined storage manual.<br>3. A breakdown resulting from operation which does not fall within our specification and other operation conditions and use status we hardly can know or a failure caused by the use of lubricant which we do not recommended.<br>4. A breakdown resulting from defects, special specification, etc of device prepared and connected by customer.<br>5. A breakdown resulting from modification or reconstruction of the product.<br>6. A secondary breakdown occurring in our product due to defects in sequence circuits.<br>7. A breakdown resulting from defects in parts supplied or specified by customers.<br>8. A breakdown caused by inevitable force including earthquake, fire, flood disaster, salt damage, gas damage, and lightning strike, etc.<br>9. Warranty of natural wear and tear, abrasion, and deterioration of consumable parts such as Aluminum electrolytic capacitor etc. under normal usage.<br>10. A breakdown caused for reasons not attributable to each of the above item. |

# 【MEMO】

# Worldwide Locations

**U.S.A**

**Sumitomo Machinery Corporation of America (SMA)**
4200 Holland Blvd. Chesapeake, VA 23323, U.S.A.
TEL (1)757-485-3355 FAX (1)757-485-7490

**Canada**

**SM Cyclo of Canada, Ltd. (SMC)**
1453 Cornwall Road, Oakville, Canada ON L6J 7T5
TEL (1)905-469-1050 FAX (1)905-469-1055

**Mexico**

**SM Cyclo de Mexico, S.A. de C.V. (SMME)**
Av. Desarrollo 541, Col. Finsa, Guadalupe,
Nuevo León, México, CP67132
TEL (52)81-8144-5130 FAX (52)81-8144-5130

**Brazil**

**Sumitomo Industrias Pesadas do Brasil Ltda. (SHIB)**
Rodovia do Acucar (SP-075) Km 26
Itu, Sao Paulo, Brasil
TEL (55)11-4886-1000 FAX (55)11-4886-1000

**Chile**

**SM-Cyclo de Chile Ltda. (SMCH)**
Camino Lo Echevers 550, Bodegas 5 y 6,
Quilicura, Región Metropolitana, Chile
TEL (56)2-892-7000 FAX (56)2-892-7001

**Argentina**

**SM-Cyclo de Argentina S.A. (SMAR)**
Ing Delpini 2230, B1615KGB Grand Bourg,
Malvinas Argentinas, Buenos Aires, Argentina
TEL (54)3327-45-4095 FAX (54)3327-45-4099

**Guatemala**

**SM Cyclo de Guatemala Ensambladora, Ltda. (SMGT)**
Parque Industrial Unisur, 0 Calle B 19-50 Zona 3,
Bodega D-1 Delta Bárcenas en Villa Nueva, Guatemala
TEL (502)6648-0500 FAX (502)6631-9171

**Colombia**

**SM Cyclo Colombia, S.A.S. (SMCO)**
Parque Industrial Celta, Km 7.0 Autopista Medellín,
Costado Occidental, Funza, Cundinamarca, Colombia
TEL (57)1-826-9766

**Peru**

**SM Cyclo de Perú, S.A.C (SMPE)**
Jr. Monte Rosa 255, Oficina 702, Lima,
Santiago de Surco, Perú
TEL (51)1-713-0342 FAX (51)1-715-0223

**Germany**

**Sumitomo (SHI) Cyclo Drive Germany GmbH (SCG)**
Cyclostraße 92, 85229 Markt Indersdorf, Germany
TEL (49)8136-66-0 FAX (49)8136-5771

**Austria**

**Sumitomo (SHI) Cyclo Drive Germany GmbH (SCG)**
**SCG Branch Austria Office**
Gruentalerstraße 30A, 4020 Linz, Austria
TEL (43)732-330958 FAX (43)732-331978

**Belgium**

**Hansen Industrial Transmissions NV (HIT)**
Leonardo da Vincilaan 1, Edegem, Belgium
TEL (32)34-50-12-11 FAX (32)34-50-12-20

**France**

**SM-Cyclo France SAS (SMFR)**
8 Avenue Christian Doppler, 77700 Serris, France
TEL (33)164171717 FAX (33)164171718

**Italy**

**SM-Cyclo Italy Srl (SMIT)**
Via dell' Artigianato 23, 20010 Cornaredo (MI), Italy
TEL (39)293-481101 FAX (39)293-481103

**Spain**

**SM-Cyclo Iberia, S.L.U. (SMIB)**
C/Gran Vía Nº 63 Bis, Planta 1, Departamento 1B
48011 Bilbao–Vizcaya, Spain
TEL (34)9448-05389 FAX (34)9448-01550

**United Kingdom**

**SM-Cyclo UK Ltd. (SMUK)**
Unit 29, Bergen Way, Sutton Fields Industrial Estate,
Kingston upon Hull, HU7 0YQ, East Yorkshire,
United Kingdom
TEL (44)1482-790340 FAX (44)1482-790321

**Turkey**

**SM Cyclo Turkey Güç Aktarım Sis. Tic. Ltd. Sti. (SMTR)**
Barbaros Mh. Çiğdem Sk. Ağaoğlu, Office Mrk. No:1 Kat:4 D.18
Ataşehir, İstanbul, Turkey
TEL (90)216-250-6069 FAX (90)216-250-5556

**India**

**Sumi-Cyclo Drive India Private Limited (SDI)**
Gat No. 186, Raisoni Industrial Park, Alandi Markal Road,
Fulgaon-Pune, Maharashtra, India
TEL (91)96-0774-5353

**China**

**Sumitomo (SHI) Cyclo Drive Shanghai, Ltd. (SCS)**
11F, SMEG Plaza, No. 1386 Hongqiao Road,
Changning District, Shanghai, China 200336
TEL (86)21-3462-7877 FAX (86)21-3462-7922

**Hong Kong**

**SM-Cyclo of Hong Kong Co., Ltd. (SMHK)**
Room 19, 28th Floor, Metropole Square, No.2 On
Yiu Street, Shatin, New Territories, Hong Kong
TEL (852)2460-1881 FAX (852)2460-1882

**Korea**

**Sumitomo (SHI) Cyclo Drive Korea, Ltd. (SCK)**
Room #913, Royal Bldg, Saemunan-ro 5 gil 19, Jongro-gu,
Seoul, Korea 03173
TEL (82)2-730-0151 FAX (82)2-730-0156

**Taiwan**

**Tatung SM-Cyclo Co., Ltd. (TSC)**
22 Chungshan N. Road 3rd., Sec. Taipei, Taiwan 104,
R.O.C.
TEL (886)2-2595-7275 FAX (886)2-2595-5594

**Singapore**

**Sumitomo (SHI) Cyclo Drive Asia Pacific Pte. Ltd. (SCA)**
15 Kwong Min Road, Singapore 628718
TEL (65)6591-7800 FAX (65)6863-4238

**Philippines**

**Sumitomo (SHI) Cyclo Drive Asia Pacific Pte. Ltd. Philippines Branch Office (SMPH)**
C4 & C5 Buildings Granville Industrial Complex, Carmona,
Cavite 4116, Philippines
TEL (63)2-584-4921 FAX (63)2-584-4922

**Vietnam**

**SM-Cyclo (Vietnam) Co., Ltd. (SMVN)**
Factory 2B, Lot K1-2-5, Road No. 2-3-5A,
Le Minh Xuan Industrial Park, Binh Chanh Dist.,
HCMC, Vietnam
TEL (84)8-3766-3709 FAX (84)8-3766-3710

**Malaysia**

**SM-Cyclo (Malaysia) Sdn. Bhd. (SMMA)**
No.7C, Jalan Anggerik Mokara 31/56, Kota Kemuning,
Seksyen 31, 40460 Shah Alam, Selangor Darul Ehsan,
Malaysia
TEL (60)3-5121-0455 FAX (60)3-5121-0578

**Indonesia**

**PT. SM-Cyclo Indonesia (SMID)**
Jalan Sungkai Blok F 25 No. 09 K, Delta Silicon III,
Lippo Cikarang, Bekasi 17530, Indonesia
TEL (62)21-2961-2100 FAX (62)21-2961-2211

**Thailand**

**SM-Cyclo (Thailand) Co., Ltd. (SMTH)**
195 Empire Tower, Unit 2103-4, 21st Floor, South
Sathorn Road, Yannawa, Sathorn, Bangkok 10120,
Thailand
TEL (66)2670-0998 FAX (66)2670-0999

**Australia**

**Sumitomo (SHI) Hansen Australia Pty. Ltd. (SHAU)**
181 Power St, Glendenning, NSW 2761, Australia
TEL (61)2-9208-3000 FAX (61)2-9208-3050

**Japan**

**Sumitomo Heavy Industries, Ltd. (SHI)**
ThinkPark Tower, 1-1 Osaki 2-chome, Shinagawa-ku,
Tokyo 141-6025, Japan
TEL (81)3-6737-2511 FAX (81)3-6866-5160



Sumitomo Heavy Industries, Ltd.

**Power Transmission & Controls Group**

Headquarter ThinkPark Tower, 1-1 Osaki 2-chome, Shinagawa-ku, Tokyo 141-6025, Japan

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