



SYNTEC
TECHNOLOGY CO.,LTD.

EtherCAT Drive Application Manual.

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1 EtherCAT Communication Development Progress.

	De lta A 2 E	De lta A3 E/ B3 E	Pana sonic A5BE	Pana sonic A6BE	Servot ronics CDHD	Servot ronics DDHD Servot ronics CDHD2	Mitsu bishi MR- J4	Shih lin Elec tric SDP	INV T DA 20 0	Tsi no Dy na tro n	TQKT EC Synte c Step per	Oth er bra nds *Im por tin g ESI is req uir ed.
*Axis Control/ Alarm Existence	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
*Parameter Display/Read & Write	✓	✓	✓	✓			✓		✓		✓	
*Alarm Reading/ String Display	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Tuning Function												
*Absolute Encoder Initialization	✓	✓	✓	✓			✓					
*Absolute Home Setting	✓	✓	✓	✓			✓		✓			
*Show Servo Information	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Parameter Synchronization (Kp)												
*Parameter Initialization	✓	✓	✓	✓			✓		✓			
*Index Functions (Threading, Home Searching)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Backup & Restore	✓	✓	✓	✓			✓	✓	✓		✓	
*Spindle/Axis Load Ratio (R5141~, 5151~)	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
*Axis Torque Limit, Torque Arriving Signal (R5171~, R30)	✓	✓	✓	✓			✓					
VFF												
TFF												
G31 External signal latch												

1.1 Notification :

1. version 10.118.28I, 10.118.33 and below: Suggested max number of axis: 9
version 10.118.28J, 10.118.34 and above: Supported max number of axis: 16, please refer to Pr3203 Interpolation time interval.
2. Only supports position mode, not supporting speed mode.

1.2 New function supporting versions for all brands :

1. Spindle/Axis Load Ratio (R5141~, 5151~): 10.118.27 and above *Drive must support PdoMapping Object Dictionary: 0x6074.
2. Index Functions (Threading, Home Searching) *Drive must support PdoMapping Object Dictionary: 0x60B8, 0x60B9, 0x60BA.

1.3 New function supporting versions for each brand :

For new functions provided in versions 10.118.12L, 10.118.17 and above, please refer to the information below

[Delta A2E](#) Delta A3E/B3E Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 Mitsubishi MR-J4
 INVT DA200 Tsino Dynatron Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
Spindle/Axis Loading Ratio	10.118.19~10.118.26, shows the average load ratio
Axis Torque Limit	10.118.12L, 10.118.19 and above

Delta A2E [Delta A3E/B3E](#) Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 Mitsubishi MR-J4
 INVT DA200 Tsino Dynatron Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
All supported functions	10.118.28G, 10.118.33 and above *Only supports parameter/alarm that is compatible with Delta A2E.

Delta A2E Delta A3E/B3E [Panasonic A5BE/A6BE](#) Servotronics DDHD and CDHD2 Mitsubishi MR-J4
 INVT DA200 Tsino Dynatron Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
Spindle/Axis Loading Ratio	10.118.22B, 10.118.24~10.118.26, shows the overload ratio
Axis Torque Limit	10.118.12L, 10.118.19 and above

Delta A2E Delta A3E/B3E Panasonic A5BE/A6BE [Servotronics DDHD and CDHD2](#) Mitsubishi MR-J4
 INVT DA200 Tsino Dynatron Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
Axis Control/Alarm Existence	10.118.12R, 10.118.22 and above
Show Servo Information	10.118.12R, 10.118.22 and above
Index Functions (Threading, Home Searching)	10.118.12R, 10.118.22 and above
Spindle/Axis Load Ratio	10.118.12R, 10.118.22 and above
Alarm Reading/String Display	10.118.29Z, 10.118.40F, 10.118.43 and above

Delta A2E Delta A3E/B3E Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 [Mitsubishi MR-J4](#)
 INVT DA200 Tsino Dynatron Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
Absolute Encoder Initialization/Absolute Encoder Home Setting	10.118.12L, 10.118.20 and above
Parameter Initialization	10.118.12U, 10.118.22B, 10.118.24 and above
Spindle/Axis Load Ratio	10.118.12T, 10.118.22B, 10.118.24~10.118.26, shows effective load ratio
Axis Torque Limit	10.118.12T, 10.118.22B, 10.118.24 and above

Delta A2E Delta A3E/B3E Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 Mitsubishi MR-J4
[INVT DA200](#) Tsino Dynatron Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
Axis Control/Alarm Existence	10.118.12L, 10.118.19 and above
Other supported functions	10.118.12N, 10.118.20 and above

Delta A2E Delta A3E/B3E Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 Mitsubishi MR-J4
 INVT DA200 [Tsino Dynatron](#) Shihlin Electric SDP TQKTEC Syntec Stepper

Function	Supporting Versions
All supported functions	10.118.12R, 10.118.22 and above

Delta A2E Delta A3E/B3E Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 Mitsubishi MR-J4
 INVT DA200 Tsino Dynatron [Shihlin Electric SDP](#) TQKTEC Syntec Stepper

Function	Supporting Versions
All supported functions	10.118.28N, 10.118.37 and above

Delta A2E Delta A3E/B3E Panasonic A5BE/A6BE Servotronics DDHD and CDHD2 Mitsubishi MR-J4
 INVT DA200 Tsino Dynatron Shihlin Electric SDP [TQKTEC Syntec Stepper](#)

Function	Supporting Versions
All supported functions	10.118.40D, 10.118.42 and above



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2 EtherCAT Driver: ESI Import and Debug Mode Specification.

- [Introduction](#)
- [ESI Import Specification](#)
- [Enabling Debug Mode/Object Dictionary Reading&Writing Mode](#)
- [Debug Mode Specification](#)
 - [Register Number and Corresponding Content:](#)
- [Object Dictionary Reading&Writing Mode Specification](#)
 - [R Number and Corresponding Contents:](#)
 - [Read/Write Object Dictionary:](#)
 - [Operation Example of Reading/Writing Object Dictionary:](#)

2.1 Introduction

For controller versions 10.118.12S, 10.118.22A, 10.118.23 and later, users are able to import ESI files on their own. This function supports EtherCAT drives from each brand and please refer to [EtherCAT Driver: ESI File Specification](#). for ESI files specifications.

If controller is not able to connect to controller after imported ESI files, please enter Debug mode and provide the related information and ESI files to R&D personnel for troubleshooting.

This document includes :

1. ESI import specification.
2. Enable/Disable of "Debug mode" / "Object Dictionary Writing & Reading mode."
3. Debug mode specification.
4. Object Dictionary Reading & Writing mode specification.

2.2 ESI Import Specification

For controller versions 10.118.12S, 10.118.22A, 10.118.23 and later, users are able to import ESI files on their own, please refer to Import ESI.

The maximum number of imported files is 20, if there are over 20 files, alarm OP-082, ESI File Read Failed, will be triggered, please refer to Operation Alarm -OP

If alarm OP-082 is triggered, please delete the ESI files imported with SA, and then re-import the ESI files supporting EtherCAT drives, please refer to SA Manual.

2.3 Enabling Debug Mode/Object Dictionary Reading&Writing Mode

Debug mode/Object dictionary reading&writing mode will be enabled after installing this package :
[package_821AF785.zip](#)

Debug mode/Object dictionary reading&writing mode will be disabled after installing this package :
[package_D416183A.zip](#)

2.4 Debug Mode Specification

2.4.1 Register Number and Corresponding Content:

(default Rm is 20000) When Debug mode is enabled, the controller can only **serially connect at most 9 stations.**

Rm ~ Rm+1 record the common data of all stations. The data of each station is recorded in sequence from Rm+11.

Rm+11~ means Rm+11 to Rm+19, the data of 1st station is saved in Rm+11; the data of 2nd station is saved in Rm+12, and so on.

R No.	Inspecting Item	Notes
Rm	Shows if it's currently in Debug mode	0 = Disabled, 1 = Enabled
Rm+1	CANopen initialization state of all stations	Value-State List 0 = FAIL 1 = RESET 2 = BOOTUP 3 = PRESETUP 4 = SETUP 5 = START 6 = FIRSTRUN 7 = RUN
Rm+11~	CANopen initialization state of each station	Value-State List 0 = FAIL 1 = RESET 2 = RESET_WAIT 3 = SETUP 4 = SETUP_WAIT 5 = CONFI 6 = CONFIG_WAIT 7 = CONFIG_CHECK 8 = START 9 = START_WAIT 10 = RUN 11 = SDO_SEND 12 = SDO_UPDATE

R No.	Inspecting Item	Notes
Rm+21~	Last object dictionary command Index in SDO when initializing each station	
Rm+31~	Last object dictionary command SubIdx in SDO when initializing each station	
Rm+41~	Communication state of each EtherCAT drive	<p>Value-State List</p> <ul style="list-style-type: none"> 0 = IDLE 1 = IDLE → Init 2 = INIT 3 = INIT → PreOp 4 = PreOp 5 = SyncMode(Init) 6 = SyncMode(Start) 7 = SyncMode(Wait) 8 = PreOp → SafeOp 9 = SafeOp 10 = SafOp → Op 11 = Op
Rm+51~	VendorID	
Rm+61~	ProductCode	
Rm+71~	SM0 start address	SyncManager0 setting, please refer to ESI
Rm+81~	SM1 start address	
Rm+91~	SM2 start address	
Rm+101~	SM3 start address	
Rm+111~	Whether the EtherCAT drive catch the corresponding ESI file	Normal: 0; No corresponding ESI file: 1
Rm+121~	AL Status Code	Error Code of EtherCAT State Machine. 0= No Error, if there're other error codes, please refer to EtherCAT manual on Beckoff official website.

R No.	Inspecting Item	Notes
Rm+131~	StatusWord	Please refer to EtherCAT manual on Beckoff official website.
Rm+141~	PowerDriverSystem state	<p>Value-State List</p> <ul style="list-style-type: none"> -1 = Fault 0 = NotReadyToSwitchOn 1 = SwitchOnDisabled 2 = ReadyToSwitchOn 3 = SwitchedOn 4 = OperationEnabled
Rm+151~	ControlWord	Please refer to EtherCAT manual on Beckoff official website.
Rm+161~	Whether data number in ESI file exceeds the limit and cause data reading error	<p>Value-State List</p> <ul style="list-style-type: none"> Bit 0 On: Number of ESI Device over 100. Bit 1 On: Number of Device DataType over 500. Bit 2 On: Number of Device DataType SubItem over 256. Bit 3 On: Number of Device Object over 4000. (*Note 1) Bit 4 On: Number of Device Sm over 4. Bit 5 On: Number of Device RxPdo over 8. Bit 6 On: Number of Device TxPdo over 8. <p>Note 1 : Inside controller, the single object of device will be separated into plural objects, thus Bit 3 might be On with number of ESI file Device Object under 4000.</p>

2.5 Object Dictionary Reading&Writing Mode Specification

2.5.1 R Number and Corresponding Contents:

(Rn default as 20200)

R No.	Inspecting Item	Read/Write	Notes
Rn	Shows the Reading&Writing state of object dictionary	Read Only	0 = Disabled; 1 = Enabled

R No.	Inspecting Item	Read/Write	Notes
Rn + 1	Reading/Writing Station ID	R/W	ID of 1st station = 1, and so on
Rn + 2	Sends reading/writing command (trigger)	R/W	1 = Sending command, turns back to 0 automatically after the command is sent
Rn + 3	Object dictionary reading/writing mode	R/W	0 = Read; 1 = Write; other value is forbidden
Rn + 4	Object Index	R/W	(Decimal)
Rn + 5	Object SubIdx	R/W	(Decimal)
Rn + 6	Reading/Writing value of data	R/W	(Decimal)
Rn + 7	Reading/Writing value of BitLen	R/W	(Decimal)
Rn + 8	Result display of reading/writing command	Read Only	Value might be 0~3, which stands for different results: before 10.118.12 / after 10.118.12 0: Command Processing / Reading&Writing error 1: Reading&Writing succeed / Reading&Writing succeed 2: The brand does not support this object dictionary command / Command Processing 3: Reading&Writing error / The brand does not support this object dictionary command

Possible reason for showing Reading&Writing error (Rn+8 = 3):

1. Station ID setting error. For Rn+1 station ID setting, the valid range is the connected drive station IDs.
2. Station ID communication failed.
3. Reading/Writing command mode setting error (Rn+3).
4. Running parameter reading&writing with the station server.
5. Object dictionary command reading/writing failed.

2.5.2 Read/Write Object Dictionary:

Steps	Description	Operation Command
Step 0	Set the command to reading/writing	Rn + 1 Set the reading/writing station ID Rn + 3 Set reading/writing

Steps	Description	Operation Command
Step 1	Fill in the reading/writing object dictionary command	Modify common variable Rn + 4 = the read/ written Index (decimal) Rn + 5= SubIdx (decimal) For reading commands, only requires to fill in Index & SubIdx For writing commands, Data(Rn + 6) & BitLen(Rn + 7) are also required
Step 2	Send command (trigger)	Modify common variable Rn + 2 = 1
Step 3	Record the changes	Reading: record the changes of common variable Rn + 6~8 Writing: record the changes of common variable Rn + 8
Step 4	Send other commands	Repeat step 0~3

2.5.3 Operation Example of Reading/Writing Object Dictionary:

Take reading Delta A2E drive with 2nd station communication transmission rate (Index: 0x2301, SubIdx: 0x00) as example:

1. CncBase_Cus.ini enable Object Dictionary Reading&Writing mode (Enable = 1). StartRNo sets initial R number to 20200(default).
2. Set the reading station ID (R20201 = 2).
3. Set to "Reading" mode (R20203 = 0).
4. Fill in object dictionary Index (R20204 = 8961), 8961(decimal) = 0x2301(hexadecimal)
5. Fill in object dictionary SubIndex(R20205 = 0)
6. Sen command (R20202 = 1)
7. Record the reading/writing information. If reading/writing succeed, R20208 = 1(succeed), R20206 = 1027(default, might be different due to the settings, please refer to the Delta manual), R20207= 16 (data length)

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3 EthterCAT Driver: ESI File Specification.

- Introduction
- ESI File Specification
 - ESI File Structure
 - Necessary Specification
 - Required Specification
- Communication Error Check

3.1 Introduction

For controller versions 10.118.12S, 10.118.22A, 10.118.23 and later, users are able to import ESI files on their own to support EtherCAT drives from every brand.

Syntec controller initialize the EtherCAT drive according to ESI files, the communication might fail if the information in ESI file is incomplete or incorrect.

This document includes :

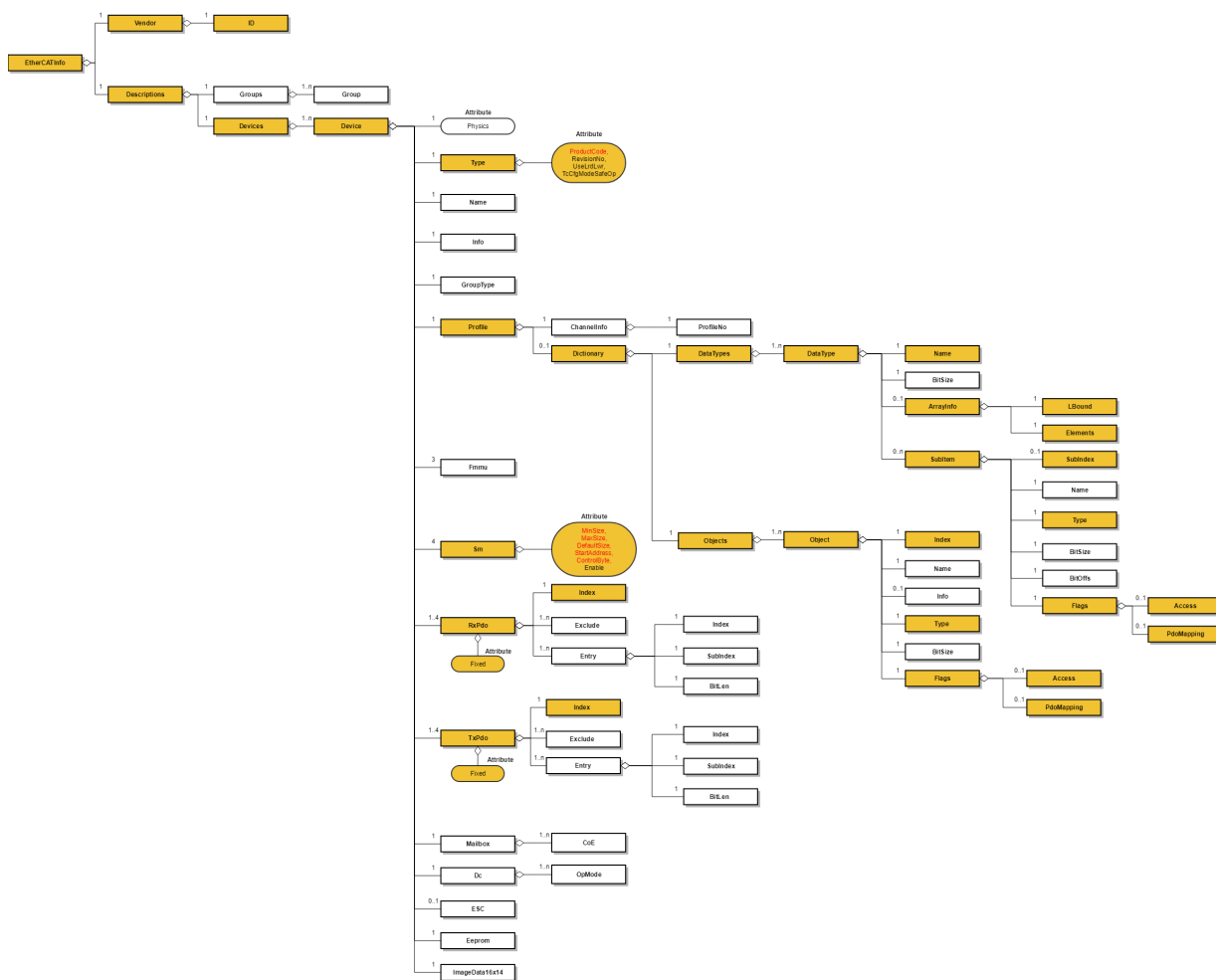
1. ESI file specification
2. Troubleshooting for communication error

3.2 ESI File Specification

3.2.1 ESI File Structure

Below shows the structure of an ESI file, the information not read by Syntec controllers is not listed, please check if the format of imported ESI file is correct first.

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The black text in yellow square is Element information which will be read; the red text in yellow circle is Attribute information which will be read. For TxPdo(1..4), it means there could be 1 to 4 TxPdo information and at least 1 information. The communication might fail if there is no such information included in the ESI file.

*For some information, if they are not included in the ESI file then default value is applied. Therefore, communication is not influenced by information 100 percent.

1. If there is no Dictionary information (i.e., Panasonic), all reading/writing authorities of object dictionary is set to rw(Read&Write).
2. If there is no Access information, default is rw(Read&Write).
3. If there is no PdoMapping information, default is rt(Rx&Tx).
4. If RxPdo, TxPdo has no Fixed information, default is False.

3.2.2 Necessary Specification

The communication would fail if the ESI file doesn't meet the specifications below:

1. The ESI file must include Id and ProductCode information

Step	Check Information	Explanation	Example
3	DataType of Index	For first SubItem of the DataType, its Access should be rw Note: This step can be skipped if the Access is defined as rw by Object in step 2.	<pre> <DataType> <Name>DT160X</Name> <BitSize>272</BitSize> <SubItem> <SubIdx>0</SubIdx> <Name>Number of Objects</Name> <Type>USINT</Type> <BitSize>8</BitSize> <BitOffs>0</BitOffs> <Flags> <Access>rw</Access> </Flags> </SubItem> </pre>

4. Below are the necessary object dictionary information, please check if they're all supported

Function	Supporting List	Example																												
PdoMapping	<p>TPdoMapping of TxPdo have to be t or rt</p> <p>PdoMapping of Pxpdo have to be r or rt, Access have to be rw</p> <table border="1"> <thead> <tr> <th colspan="2">TxPdo</th> <th colspan="2">RxPdo</th> </tr> </thead> <tbody> <tr> <td>0x6041</td> <td>status word</td> <td>0x6040</td> <td>control word</td> </tr> <tr> <td>0x6061</td> <td>operation mode display</td> <td>0x6060</td> <td>mode of operation</td> </tr> <tr> <td>0x6064</td> <td>real position</td> <td>0x6071</td> <td>target torque</td> </tr> <tr> <td>0x60F4</td> <td>position error</td> <td>0x607A</td> <td>target position</td> </tr> <tr> <td>0x60B9</td> <td>touch probe status</td> <td>0x60B8</td> <td>touch probe mode</td> </tr> <tr> <td>0x60BA</td> <td>touch probe position</td> <td></td> <td></td> </tr> </tbody> </table>	TxPdo		RxPdo		0x6041	status word	0x6040	control word	0x6061	operation mode display	0x6060	mode of operation	0x6064	real position	0x6071	target torque	0x60F4	position error	0x607A	target position	0x60B9	touch probe status	0x60B8	touch probe mode	0x60BA	touch probe position			<pre> <Object> <Index>#x6040</Index> <Name>Controlword</Name> <Type>UINT</Type> <BitSize>16</BitSize> <Info> <DefaultValue>#x0000</DefaultValue> </Info> <Flags> <Access>rw</Access> <SubMappings>PdoMapping <Backup>0</Backup> <Setting>0</Setting> </Flags> </Object> </pre>
TxPdo		RxPdo																												
0x6041	status word	0x6040	control word																											
0x6061	operation mode display	0x6060	mode of operation																											
0x6064	real position	0x6071	target torque																											
0x60F4	position error	0x607A	target position																											
0x60B9	touch probe status	0x60B8	touch probe mode																											
0x60BA	touch probe position																													

3.2.3 Required Specification

The communication might fail if the ESI file doesn't meet the specification below:

1. Physics should be "YY" or "YY." Y means the entity layer is MII (Media Independent Interface), and "YY" means Port0 & Port1 are both MII (Port is the COM port. Port3 & Port4 are not applied, there is nothing after YY).
 Note: Currently, Syntec controller only supports 2 ports(0 & 1), thus Port2 & Port3 must be skipped or blank.

Element Name	Explanation	Example
Physics	Entity Layer	<pre><Device> -----> <Physics>YY</Physics></pre>

- ProfileNo have to be "402", represents the communication protocol is CiA-402 (CANopen device profile for drives and motion control).

Element Name	Explanation	Example
ProfileNo	Communication protocol of CANopen motion control	<pre><Profile> -----> <ProfileNo>402</ProfileNo></pre>

- Fmmu has to include Outputs and Inputs.

Element Name	Explanation	Example
Fmmu	Fieldbus memory management unit	<pre><Fmmu>Outputs</Fmmu> <Fmmu>Inputs</Fmmu></pre>

- AssignActivate of Dc(Distributed Clock) should support synchronous mode (DC-synchronous). Under synchronous mode, the value of AssignActivate is #x300 in hexadecimal. Thus AssignActivate should be providing #x300 (#x300 or #x0300).

Element Name	Explanation	Example
AssignActivate	Distributed clock supporting mode	<pre><Dc> -----> <OpMode> -----> <Name>DC</Name> -----> <Desc>DC-Synchronous</Desc> -----> <AssignActivate>#x300</AssignActivate> -----> <CyclicTimeSync> <CyclicTimeSync>=1#</CyclicTimeSync> -----> <ShiftTimeSync></ShiftTimeSync> -----> </OpMode> -----> <OpMode> -----> <Name>Free Run</Name> -----> <Desc>Free Run</Desc> -----> <AssignActivate>#0</AssignActivate> -----> </OpMode> -----> </Dc></pre>

3.3 Communication Error Check

- State recognition of improper axis control
For controller improper axis control, it might be that the controller failed to control the motor with command in ready state, or the controller failed to enter ready state.

Controller State	Alarm	Possible Reason
Ready	No Alarm	Drive parameter setting error
Not Ready	No Alarm	Communication failure or drive parameter setting error
Not Ready	Alarm Triggered	Communication failure, drive parameter setting error or controller parameter setting error

Note 1: For settings of EtherCAT drive parameter and controller parameter, please refer to [EtherCAT Drive Application Manual](#).

Note 2: Possible alarms for communication error: OP-001, OP-009, OP-053, OP-056, OP-080, MOT-057...

- Please refer to [EtherCAT Driver: ESI Import and Debug Mode Specification](#).



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