

Shannon Way,
Tewkesbury,
Gloucestershire. GL20 8ND
United Kingdom
Tel: +44 (0)1684 292 333
Fax: +44 (0)1684 297 929

187 Northpointe Blvd,
Suite 105
Freeport, PA 16229
United States of America
Tel: +1 724-540-5018
Fax: +1 724-540-5098

Tomson Centre
118 Zhang Yang Rd., B1701
Pudong New Area, Shanghai,
Postal code: 200122
CHINA
Tel/Fax: +86 21 587 97659

SCMC House
16/6 Vishal Nagar
Pimpale Nilakh, Wakad, Pune
PIN 411027
INDIA
Tel: +91 206 811 4902



Doc No.: AN-278

Version: 1.0

Date: 25 April 2012

Subject: EtherCAT Error codes – handling of

APPLICATION NOTE

1. Scope

This document considers the different errors and warnings which may occur when the MC464 is used with the P876 and EtherCAT servodrives or I/O. Only the low-level command line and BASIC program access to error management is discussed. Therefore some prior knowledge of Trio BASIC, the MC464 command line and CanOpen-over-EtherCAT is assumed of the reader.

In the future, the information here may be used by Trio Motion Technology as the basis for a high level user interface in Motion Perfect v 3.

2. Error types

Errors and warnings can come from a variety of sources. How they are handled will depend on the source and the channel over which the error arrives.

- MC464 configuration errors.
- EtherCAT slave controller errors.
- EtherCAT State Machine.
- CoE Control Word and Status Word from Drive.
- Drive Error reported over SDO channel.

3. MC464 configuration errors

There are 2 types of error which may appear in the MC464 display.

1. Uss. "ss" is the module slot number. This means that the P876 has a connection problem to the MC464. Or it may show this error when the EtherCAT cable is broken while the EtherCAT is in normal operation.
2. Css. "ss" is the module slot number. This means that the system encountered a configuration error when trying to initialise the axes. For example, if the EtherCAT wants to set up an axis that is already allocated to another module.

4. EtherCAT Slave Controller errors

The EtherCAT Slave Controller (ESC) of each remote drive can be interrogated through the command line or from a Trio BASIC program in the MC464. Use the ETHERCAT command to fetch values from the ESC of a remote node.

```
ETHERCAT($31, slot, slave address, ESC offset, ESC length, vr_index)
```

For example, to get the ESC state from the drive at node address 2 and print it to the terminal;

```
ETHERCAT($31, 0, 2, $130, 2, -1)
8
>>
```

Value	EtherCAT state
1	Initial
2	Pre-Operational
4	Safe-Operational
8	Operational

Table 1 - meaning of ESC state value

To get the ESC error code from the remote drive or IO node and put the value in VR(620);

```
ETHERCAT($31, 0, 2, $134, 2, 620)
PRINT HEX(VR(620)) ' V2.0186 and later
' or:
PRINT HEX(VR(621)+VR(622)*256) ' V2.0185 and before
```

Code	Description	Current state (or state change)	Resulting state
0x0000	No error	Any Current state	
0x0001	Unspecified error	Any	Any + E
0x0002	No memory	Any	Any + E
0x0011	Invalid requested state change	I→S, I→O, P→O O→B, S→B, P→B	Current state + E
0x0012	Unknown requested state	Any	Current state + E
0x0013	Bootstrap not supported	I→B	I + E
0x0014	No valid firmware	I→P	I + E
0x0015	Invalid mailbox configuration	I→B	I + E
0x0016	Invalid mailbox configuration	I→P	I + E
0x0017	Invalid sync manager configuration	P→S, S→O	Current state + E
0x0018	No valid inputs available	O, S, P→S	P + E
0x0019	No valid outputs	O, S→O	S + E
0x001A	Synchronization error	O, S→O	S + E
0x001B	Sync manager watchdog	O, S	S + E

0x001C	Invalid Sync Manager Types	O, S, P→S	S + E P + E
0x001D	Invalid Output Configuration	O, S, P→S	S + E P + E
0x001E	Invalid Input Configuration	O, S, P→S	P + E
0x001F	Invalid Watchdog Configuration	O, S, P→S	P + E
0x0020	Slave needs cold start	Any	Current state + E
0x0021	Slave needs INIT	B, P, S, O	Current state + E
0x0022	Slave needs PREOP	S, O	S + E, O + E
0x0023	Slave needs SAFEOP	O	O + E
0x0024	Invalid input mapping	P→S	P + E
0x0025	Invalid output mapping	P→S	P + E
0x0026	Inconsistent settings	P→S	P + E
0x0027	Free-Run not supported	P→S	P + E
0x0028	Synchronization not supported	P→S	P + E
0x0029	Free-Run needs 3 buffer mode	P→S	P + E
0x002A	Background watchdog	S, O	P + E
0x002B	No valid inputs and outputs	O, S→O	S + E
0x002C	Fatal Sync error	O	S + E
0x002D	No Sync error	S→O	S + E
0x0030	Invalid DC SYNCH Configuration	O, S	S + E
0x0031	Invalid DC Latch Configuration	O, S	S + E
0x0032	PLL Error	O, S	S + E
0x0033	Invalid DC IO Error	O, S	S + E
0x0034	Invalid DC Timeout Error	O, S	S + E
0x0035	DC invalid Sync Cycle Time	P→S	P + E
0x0036	DC Sync0 Cycle Time	P→S	P + E
0x0037	DC Sync1 Cycle Time	P→S	P + E
0x0041	MBX_AOE	B, P, S, O	Current state + E
0x0042	MBX_EOE	B, P, S, O	Current state + E
0x0043	MBX_COE	B, P, S, O	Current state + E
0x0044	MBX_FOE	B, P, S, O	Current state + E
0x0045	MBX_SOE	B, P, S, O	Current state + E
0x004F	MBX_VOE	B, P, S, O	Current state + E
0x0050	EEPROM no access	Any	Any + E
0x0051	EEPROM error	Any	Any + E

0x0060	Slave restarted locally	Any	I
Other codes			
<0x8000	Reserved		
0x8000-0xFFFF	Vendor specific		

Table 2 - ESC Error codes

5. EtherCAT state machine

The EtherCAT connection has 5 different states.

1. Base State - no activity, everything uninitialised.
2. Initial State - Bus communication is being established and clock arbitration taking place.
3. Pre-Operational - Bus is active and parameterisation can occur via SDO.
4. Safe-Operational - Master all slaves communicate cyclically. PDOs are being exchanged.
Slaves cannot enable.
5. Operational - Fully cyclic operation. Slave devices can be enabled.

The EtherCAT state of the master (MC464) can be read with ETHERCAT command function 6.

```
ETHERCAT($06, 0, -1) ' print the EtherCAT state to the terminal
3
>>
```

```
ETHERCAT($06, 0, 600) ' Put EtherCAT state from slot 0 into VR(600)
```

Value	EtherCAT state
0	Initial
1	Pre-Operational
2	Safe-Operational
3	Operational

Table 3 - Value returned by ETHERCAT Func. 6

6. CoE control word and status word

The protocol used by the MC464 is CanOpen over EtherCAT. (CoE) The CoE control word is sent cyclically to each slave and the CoE status word is received from each drive cyclically. The values are available to both the Motion Perfect terminal and the BASIC programs as Axis Parameters.

```
DRIVE_CONTROLWORD
DRIVE_STATUS
```

For example:

```
BASE(2)
IF (DRIVE_STATUS AND $07) <> $07 THEN
  PRINT "Drive Axis 2 not enabled"
ENDIF
```

6.1. DRIVE_CONTROLWORD bit functions

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved					r	oms	h	fr	oms		hos	eo	qs	ev	so

- r = reserved
- oms = operation mode specific
- h = halt
- fr = fault reset
- hos = homing operation start
- eo = enable operation
- qs = quick stop
- ev = enable voltage
- so = switch on

Note: Exact functions depend upon the slave drive. See also the CiA DS402 specification.

6.2. DRIVE_STATUS bit functions

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

- ms = manufacturer-specific
- ha = homing attained
- oms = operation mode specific
- lla = internal limit active
- tr = target reached
- rm = remote
- w = warning
- sod = switch on disabled
- qs = quick stop
- ve = voltage enabled
- f = fault
- oe = operation enabled
- so = switched on
- rtso = ready to switch on

Note: Exact functions depend upon the slave drive. See also the CiA DS402 specification.

7. Drive Error reported over SDO channel

The commands CO_READ and CO_READ_AXIS can be used to obtain the values from CoE objects in the drive. There may be various objects, including manufacturer specific objects, which are there to give information about the error status of the drive.

The standard DS402 object for error status is 0x603F sub index 00. This is a 16 bit unsigned value which may be read in a BASIC program or from the Motion Perfect command line terminal.

Examples:

1. Get the value of 0x603F in a program and print it in Hexadecimal.

```
CO_READ_AXIS(2, $603F, $00, 6, 428)
PRINT #5, HEX(VR(428))
```

2. Print the value of 0x603F to the Motion Perfect command line.

```
CO_READ_AXIS(4, $603F, $00, 6, -1)
```

12592
>>

The actual error codes supported by a drive will depend on the drive manufacturer. The table below shows some of the typical error codes which may be returned by a drive. See the drive's handbook for a full list.

Error Code (Hex)	Meaning
0000	No Error
1000	Generic Error
2000	Current
2200	Internal current
2330	Earth leakage
3110	Mains overvoltage
3210	DC Bus overvoltage
3220	DC Bus undervoltage
4210	High motor temperature
4310	High drive temperature
9000	External error

8. Example program

This example reads some of the errors and reports them to the Motion Perfect terminal at channel #5.

```
' Check and report the errors over EtherCAT
ec_axis=0
ec_node=0
ec_slot=0

PRINT #5,"" ' print a blank line

' 1. Check slot configuration errors
IF (SYSTEM_ERROR AND $010000) <> 0 THEN
  PRINT #5,"Unit Lost"
ELSEIF (SYSTEM_ERROR AND $020000) <> 0 THEN
  PRINT #5,"Unit Terminator Lost"
ELSEIF (SYSTEM_ERROR AND $040000) <> 0 THEN
  PRINT #5,"Unit Station Lost"
ELSEIF (SYSTEM_ERROR AND $080000) <> 0 THEN
  PRINT #5,"Invalid Unit error"
ELSEIF (SYSTEM_ERROR AND $100000) <> 0 THEN
  PRINT #5,"Unit Station Error"
ELSE
  PRINT #5,"no unit errors"
ENDIF

' 2. Check Slave Controller Error
IF ETHERCAT($31, ec_slot, ec_node, $130, 2, 25)=TRUE THEN
  IF VR(25)=1 THEN
    PRINT #5,"ESC Initial State"
```

```
ELSEIF VR(25)=2 THEN
    PRINT #5,"ESC Pre-Operational State"
ELSEIF VR(25)=4 THEN
    PRINT #5,"ESC Safe-Operational State"
ELSEIF VR(25)=8 THEN
    PRINT #5,"ESC Operational State"
ENDIF
ELSE
    PRINT #5,"ESC read failed"
ENDIF

' Check ESC Error value
IF ETHERCAT($31, ec_slot, ec_node, $134, 2, 25)=TRUE THEN
    PRINT #5,"ESC Error code: ";HEX(VR(25))
ELSE
    PRINT #5,"ESC read failed"
ENDIF

' 3. Check master state
IF ETHERCAT($06, ec_slot, 25)=TRUE THEN
    PRINT #5,"MC464 EtherCAT state = ";VR(25)[0]
ELSE
    PRINT "Failed to read Master State"
ENDIF

' 4. Check control and status words
PRINT #5,"Control Word = ";HEX(DRIVE_CONTROLWORD AXIS(ec_axis))
PRINT #5,"Status Word = ";HEX(DRIVE_STATUS AXIS(ec_axis))

' 5. Check slave drive error word
CO_READ_AXIS(ec_axis, $603F, $00, 6, 25)
PRINT #5,"Drive Error Word = ";HEX(VR(25))
```

Note: Some details of the operation of this program requires the use of firmware V2.0186 or later.