

Subject:	Release of SI-EtherCAT/Digitax HD M753 onboard EtherCAT firmware V01.07.01.06		
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SUMMARY

A new version of firmware for the SI-EtherCAT option module and the Digitax HD M753 onboard EtherCAT has been released. This Technical Notification details the changes between firmware V01.03.05.02 and V01.07.01.06.

NOTE: This release of firmware introduces many improvements along with enhanced functionality. Please read this document carefully to understand if certain changes may affect existing applications.

Please see the appendix for details of intermediate firmware releases that are referenced in this document.

MORE INFORMATION

Improvements to Cyclic Sync Velocity (CSV) mode (0x301A)

The previous realisation of CSV mode was implemented by closing the position loop inside the drive using the integral of the velocity as a position reference. If a position error was accumulated, then potentially the motor could rotate for a commanded zero speed reference.

An improved CSV mode has been implemented using speed control within the drive

NOTE: Improved CSV mode is now the default. If users wish to utilise the older (legacy) CSV mode implementation, then object 0x301A:1 should be set to a value of 0.

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0x301A		Legacy Profile Selector			
Sub-index 0					
Access:	RO	Range:	1	Size: 1 Byte	Unit: N/A
Default:	1		Type:	Unsigned integer	
PDO Mappable:	No				
Description:	The number of the highest sub-index of this object				
Sub-index 1					
Access:	RW	Range:	0 to 1	Size: 1 Bytes	Unit: N/A
Default:	1		Type:	Unsigned integer	
PDO Mappable:	No				
Description:	Legacy profile selector. This specifies if the current or legacy profiles are used. Latest Profiles = 1 Legacy Profiles = 0				

See the section “*Compatibility mode (S.00.048)*” for details of an alternative method of selecting legacy CSV mode.

EtherCAT Slave Information (ESI) files

The ESI files for M751 and M753 drives have been updated in order to add support for Omron EtherCAT PLCs, and also to replace all reference to Unidrive with Digitax HD.

If the user has already installed ESI files within their master greater than or equal to V01.02.08.06, it is suggested the old “Control Techniques Unidrive M751.xml” and “Control Techniques Unidrive M753.xml” files are removed from their master.

ESI files for the Commander C200 and C300, H300, C300 and M754 drives are also provided.

Diagnostic counters parameters (S.09.040, S.09.041)

Parameter S.09.040 diagnostic parameter selector has been added for advanced diagnostics

S.09.040	Diagnostic Counter Selector		
Minimum	0	Maximum	8
Default	None	Units	Enumeration
Type	8 bit volatile	Update Rate	Read in background
Display Format	Enumeration	Decimal Places	0
Access	Read Only		

Value	Display String	Description
0	OFF	No diagnostic counter is displayed
1	Port A Inv Errs	Invalid frame initially detected from port A (includes RX errors)
2	Port B Inv Errs	Invalid frame initially detected from port B (includes RX errors)

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3	Port A Rx Errs	Physical layer RX Errors from port A (inside/outside frame): MII: Rx errors EBUS: Manchester-Violations
4	Port B Rx Errs	Physical layer RX Errors from port B (inside/outside frame): MII: Rx errors EBUS: Manchester-Violations
5	Port A Fwd Errs	Invalid frame from port A with marking from previous EtherCAT slave controller detected
6	Port B Fwd Errs	Invalid frame from port B with marking from previous EtherCAT slave controller detected
7	Port A LL Count	Link lost events in port A
8	Port B LL Count	Link lost events in port B

Parameter S.09.041 displays the value of the counter as selected in parameter S.09.040.

S.09.041	Diagnostic Counter Value		
Minimum	0	Maximum	0xFFFFFFFF
Default	None	Units	Bit Mask
Type	32 bit volatile	Update Rate	Written in background
Display Format	Value	Decimal Places	0
Access	Read Only		

Rollover error of actual position

An error existed that caused incorrect value of the actual position at rollover. This has now been rectified so that rollover of the encoder results in the correct actual position to be reported by various CiA402 objects.

Enable full resolution drive position feedback (0x3009)

The object 0x3009 has been added. This object allows the maximum encoder resolution (as visible in object 0x608F) to be used in the drive's position loop when the user has set scaling of non-unity

NOTE: Object 0x3009 is only relevant to **Cyclic Synchronous Position (CSP)** mode.

0x3009	Enhanced Loop Control		
Access: RW	Range: 0 to 1	Size: 1 byte	Unit N/A
Default: 0	Type: Unsigned		
PDO Mappable: No			
Description:	This object can be used to Change the behaviour of the closed loop control. 0 = default, standard behaviour 1 = Where possible use Master AMC scaling as opposed to Slave AMC scaling so maximum encoder resolution is used in the AMC closed loop		

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Extrapolation (0x6086)

The drive always needs to be supplied with updated values every 250µs, since PDOs may not always be exchanged at 250µs, interpolation is used by SI-EtherCAT/Digitax HD M753 to provide linear values calculated from the previous and currently supplied target value.

SI-EtherCAT/Digitax HD M753 can now also use extrapolation, this is used when a target value hasn't been supplied in the defined cyclic period caused by a PDO loss. In this case, linear extrapolation of the target value is performed from the last two valid target values until a valid target value is supplied.

NOTE: Extrapolation is only relevant to Cyclic Synchronous Position (CSP) mode.

0x6086		Motion Profile Type					
Access:	RW	Range:	-32768 to 32767	Size:	2 Bytes	Unit:	N/A
Default:	0			Type:	Signed integer		
PDO Mappable:	No						
Description:	Motion profile to perform (values less than zero are manufacture specific) -1 = Linear interpolation followed by linear extrapolation on data loss 0 = Linear interpolation terminated on data loss 1 = 32767 unused (treat same as value 0) (Note: these have defined & reserved values in CiA402 spec)						

Enhanced Link Detection (ELD)

The default configuration for Enhanced Link Detection (ELD) has been changed to off. This should have no adverse impact on the user's application. If required ELD can be set to on using a suitable tool such as TwinCAT's E²PROM configuration.

EtherCAT E²PROM recovery (S.00.034)

Parameter S.00.034 has been added and allows the user to default the E²PROM to factory values.

Quick stop deceleration object range

The ESI file defines the maximum value for the quick stop deceleration value to be 0x7FFFFFFF. If the value was set higher than this value, instead of clamping the value at the maximum, SI-EtherCAT/Digitax HD M753 incorrectly converted the value to a negative deceleration value, the result was that although ramping to a stop occurs, the time to do this ramp was very short. This has now been fixed.

Alarm Bits (S.09.039)

Parameter S.09.039 has been added, this shows the bit mask of active alarms. Bit 3 = PDO loss warning, Bit 5 = Drive Sync Lost. All other bits are reserved.

S.09.039	Alarm Bits		
Minimum	0	Maximum	0xFFFFFFFF
Default	None	Units	Bit Mask
Type	32 bit volatile	Update Rate	Written in background
Display Format	Bit Mask	Decimal Places	0
Access	Read Only		

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Absolute position now maintained when CiA402 shutdown occurs

Previously, whenever the AMC was de-activated as part of a CiA402 shutdown, the absolute position was reset. This was fine when the gear ratio was 1:1 or rollover had not occurred.

Now, whenever the AMC is reactivated an adjustment is made (via Pr 33.003) to adjust for the effects of previous rollover when gear-ratio is not 1:1.

The effects of this are:

- 0x6064 Absolute position maintains continuity no matter the number of rollovers, change of state or mode or the use of a non-unity gear ratio (except when reconfiguring the gear-ratio). This was not so previously.
- Value of Pr 33.003 is now updated when entering Operational Mode. Previously the EtherCAT interface assumed that Pr 33.003 always had default value of zero and was never updated.

Improvements to the sequencing when CiA402 shutdown occurs

The following sequencing improvements have been made when a CiA402 shutdown occurs

- Disabling the drive is now 40ms quicker
- The AMC in the drive is no longer deactivated, reactivated and deactivated again
- When disabled the EtherCAT interface no longer continuously refreshes the AMC master position reference with encoder actual position.

Rollover issue with gear ratio

Firmware V01.04.02.04 fixed an issue with Rollover when using a non-unity gear ratio and also moving between states of operational and shutdown.

Unfortunately, this did not work when setting special object 0x3009 to 1 (enabling of enhanced loop control). This release extends the previous fix to also work when enhanced loop control is enabled.

Window Filter Implemented (0x300A)

A window filter has been implemented in object 0x300A. This is intended for use in Cyclic Synchronous Position Mode to filter the quantisation noise on the master position reference. This can help reduce the noise on the speed feed-forward term in the position loop.

0x300A		Window Filter Size					
Access:	RW	Range:	0 to 4	Size:	1 Byte	Unit:	N/A
Default:	0			Type:	Unsigned integer		
PDO Mappable	No						
Description:	0 = Disable window filter 1 = Window filter size 2 x interpolation period 2 = Window Filter size 4 x interpolation period 3 = Window Filter size 8 x interpolation period 4 = Window Filter size 16 x interpolation period						

If the Window filter is enabled, the target position values are fed through a window filter, the output of that window filter is then the input to the interpolation. The window filter is executed at the rate of the EtherCAT cycle time; hence it operates before the interpolator.

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One of the side effects of the window filter is to add a delay in the feedback loop. Therefore, the following error, as seen by the PLC, will be increased by the length of the filter. The EtherCAT module does not hide this fact so it will impact on status word target reached flag which will no longer indicate target reached if the increase in following error exceeds the position window object setting (0x6067).

Interpolator Improvements

Improvements have been made to the interpolator to make it more linear and increase the resolution.

Network loss behaviour

The object 0x6007 has been added.

SI-EtherCAT and Digitax M753 onboard EtherCAT support the SM watchdog, by default the SM watchdog's value is set to 100 ms. The value for the SM watchdog may be configured by the user from their EtherCAT Master by writing to register 420h within SI-EtherCAT/Digitax M753 onboard EtherCAT.

If the SM watchdog expires it is an indication of complete loss of network for the watchdog period. If the slave is in the EtherCAT Operational state it will move to the SafeOp state and trigger the abort connection action as defined in object 0x6007.

0x6007	Abort connection option code			
Access: RW	Range -3 to +3	Size: 2 bytes	Unit N/A	
Default: 0	:		:	
PDO Mappable: TxPDO	Type: Integer			
Description:	Defines network loss behaviour			
n:	(-3) – Perform Quick stop ramp (0x605A) to a stop and then raise a trip (-2) – Disable voltage and raise a trip (-1) – Perform Fault reaction (0x605E) and then raise a trip 0 – No reaction 1 - Perform Fault reaction (0x605E) 2 - Disable voltage 3 - Perform Quick stop ramp (0x605A) to a stop			

The user may also configure the cyclic data loss behaviour object (0x3005).

Note: If a cyclic data loss event (0x3005) and a Network Loss event overlaps, then the Network loss event takes precedence.

0x6077 (Torque actual value)

In previous versions of the firmware, the Torque actual value object (0x6077) was derived from reference values as opposed to feedback values.

For drives in a closed-loop (RFC-A/S) mode this value was derived from parameter 04.003 (Final Torque Reference). This has been changed so that if the customer sets a non-zero value in parameter 04.041 (Rated Torque) it is now derived from parameter 04.026 (Percentage Torque). No change has been made for drives operating in open-loop mode, and in this case the object remains to derive its value from parameter 04.026 (Percentage torque).

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0x6078 (Current actual value)

In previous versions of the firmware, the Current actual value object (0x6078) for drives in closed-loop modes was derived from reference values as opposed to feedback values.

With this release it is derived from parameter 04.001 (Current Magnitude) for all drive modes.

0x6075 (Motor rated current)

Previously on a Unidrive M200/M300/M400 or Commander C200/C300 drive the object 0x6075 (Motor Rated Current) was scaled incorrectly and resulted in the value returned that was ten times too small in magnitude. This has been corrected in this release of firmware.

The Motor rated current (0x6075) can now be written to by the user. The value of 0x6075 will be reflected in drive parameter 05.007, therefore altering either the parameter or object will update the other.

Performance improvements when SI-EtherCAT is in Pre-Op

When SI-EtherCAT was in Pre-Op both CoE and EoE experienced a reduction in performance, this has now been rectified.

Improvements to poor Master Shift Offset settings

When a non-optimal Shift Offset was applied for whatever reason in the EtherCAT Master, then SI-EtherCAT may have discarded new data. Changes have been made to make the system more robust, and now when this condition is encountered if possible, the newest data is processed, and the oldest data is discarded.

CiA402 status word (0x6041)

Changes have been made to bit 12 within the status word so it is now further compliant with CiA402. Bit 12 in the status word provides status information which is different for each profile mode. Previously it was only used in homing profile mode to report that the homing position had been reached.

In this version of firmware, changes have been made so that additionally when in Cyclic Synchronous and Interpolated profile modes bit 12 now indicates that the drive is following the commands, e.g. if in CSP, it indicates the drive is actively trying to reach the target position provided.

0x6041			Status word													
Access:		RW	Range:			0 to 65535		Size:		2 Bytes		Unit:			N/A	
Default:			N/A					Type:		unsigned integer						
PDO Mappable			TxPDO													
Description: This provides feedback about the current operating state of the drive.																
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ms			fl	ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rtso	

LEGEND: ms = manufacturer-specific; fl = following commands; oms = operation mode specific; ila = 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

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CiA402 control word (0x6040)

Changes have been made to bit 8 within the control word so it is now further compliant with CiA402. Bit 8 of the control word is defined by CiA402 to be halt only for VL velocity and homing modes. Previously the bit was also functional for the Cyclic Synchronous and Interpolated modes. In this version of the firmware bit 8 of the control word no longer functions in Cyclic Synchronous and Interpolated modes. See Compatibility mode below if older behaviour is deemed necessary.

0x6040				Control word													
Access:		RW		Range:				0 to 65535		Size:		2 bytes		Unit:		N/A	
Default:				N/A						Type:				Unsigned integer			
PDO Mappable:				RxPDO													
Description:				Provides the primary method of controlling the behaviour of the drive.													
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
Reserved				ila	r	oms	h	fr	oms		hos	eo	qs	ev	so		

LEGEND: ms = manufacturer-specific; 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

Compatibility mode (S.00.048)

The SI-EtherCAT module provides a parameter to enable non-compliant legacy features. The value is a bit mask of legacy features to enabled. In most cases the mask can remain as zero.

NOTE: Compatibility mode should only be used if it is strictly necessary to support Legacy PLC programs that use the non-compliant legacy features, its use is strongly discouraged in new PLC programs. The functionality of this bit mask may change in the future.

S.00.048	Compatibility Mode		
Minimum	0 (OFF)	Maximum	0x7FFFFFFF
Default	0 (OFF)	Units	None
Type	32 bit User Save	Update Rate	Read on reset
Display Format	32 bit	Decimal Places	N/A
Access	Read/Write		

Bit 0: Halt behaviour for control word (0x6040)

0 = Halt bit ignored in CSV, CSP, CST and IP profile modes.

1 = Halt bit in control word is actioned in the aforementioned modes.

Bit 1: Behaviour of the actual current object (0x6078)

In versions of the firmware prior to V01.06.02.04, the Current actual value object (0x6078) for drives in closed-loop (RFS-A/S) modes was derived from reference values as opposed to feedback values. With the release of V01.06.02.04 it was derived from parameter 04.001 (Current Magnitude) for all drive modes. This firmware (V01.07.00.26) adds a legacy option.

0 = Use method to calculate actual current as per firmware version 01.06.02.04 and greater.

1 = use the method that was used previous to firmware V01.06.02.4.

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Bit 2: CSV behaviour (0x301A)

Previous to firmware version V01.04.02.04, realisation of CSV mode was implemented by closing the position loop inside the drive using the integral of the velocity as a position reference. If a position error was accumulated, then potentially the motor could rotate for a commanded zero speed reference. An improved CSV mode was implemented in V01.04.02.04 using speed control within the drive.

Object 0x301A was provided in V01.04.02.04 if the legacy functionality prior to V01.04.02.04 was required. Additionally, in this firmware (V01.07.00.26) the user may now also set bit 2 of parameter S.00.048 to select the legacy mode. Setting of the object or parameter's bit should be exclusive.

0 = Use new CSV behaviour as per V01.04.02.04 and greater.

1 = use the method that was used previous to V01.04.02.04.

Sync manager 4 and 5 Synchronisation objects (0x1C34 & 0x1C35)

Objects 0x1C34 and 0x1C35 have been added for the low-priority non-deterministic Sync managers four and five.

0x1C34		Sync Manager 4 Synchronisation		
Sub-index 0				
Access:	RO	Range:	4	Size: 1 Byte
Default:	4	Type:		Unsigned
PDO Mappable:	No			
Description:	The highest sub-index supported.			
Sub-index 1				
Access:	RO	Range:	0	Size: 2 bytes
Default:	0	Type:		Unsigned
PDO Mappable:	No			
Description:	Synchronisation Type. The following values are supported: 0 = Free Running (all drives)			
Sub-index 2 – not supported				
Sub-index 3 – not supported				
Sub-index 4				
Access:	RO	Range:	1	Size: 2 bytes
Default:	0x0001	Type:		Unsigned
PDO Mappable:	No			
Description:	Synchronisation types supported. A bit-mask. For drives that support DC SYNC0 it will be free-run, SM sync and SYNC0. For drives that don't support DC Sync0 then only free run and SM-Sync			

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0x1C35		Sync Manager 5 Synchronisation					
Sub-index 0							
Access:	RO	Range:	4	Size:	1 Byte	Unit	N/A
				:			
Default:	4		Type:	Unsigned			
PDO Mappable:	No						
Description:	The highest sub-index supported.						
Sub-index 1							
Access:	R	Range:	0	Size:	2 bytes	Unit	N/A
				:			
Default:	0		Type:	Unsigned			
PDO Mappable:	No						
Description:	Synchronisation Type. The following values are supported: 0 = Free Running (all drives)						
Sub-index 2 – not supported							
Sub-index 3 – not supported							
Sub-index 4							
Access:	RO	Range:	1	Size:	2 bytes	Unit	N/A
				:			
Default:	0x0001		Type:	Unsigned			
PDO Mappable:	No						
Description:	Synchronisation types supported. A bit-mask. For drives that support DC SYNC0 it will be free-run, SM sync and SYNC0. For drives that don't support DC Sync0 then only free run and SM-Sync						

Improvements relating to inter-option mappings

Various improvements have been added for the handling of inter-option mappings. Previously under certain conditions it may have been possible for the module to experience HF.5 trips as a result of inter-option mappings, this has now been fixed. See the “*Known issues section*” in this document for details of SI-Applications Plus/Compact and MCi200/210.

Support for future products

SI-EtherCAT adds future support for new Control Techniques' hardware.

NOTE: The following parameters, features and objects have been added and may be visible to the user, but currently have no user utility.

Pr S.00.047 Black Channel Enable.
 Pr S.01.005 FSoE messages per Second.
 Pr S.01.006 Black Channel Status.
 Pr S.09.042 Cyclic Data Out Jitter Counter.

0x1609 RxPDO 10, not for general use.
 0x1A09 TxPDO 10, not for general use.
 0xF030 Configured Module Ident List (for ESI “module” support).
 0xF050 Detected Module Ident List (for ESI “module” support).
 0xF980 FSoE Slave Address.

Objects 0x6632, 0x6640, 0xE600, 0xE601, 0xE602, 0xE700, 0xE701, 0xE702, 0xE800 and 0xE901 are included in the ESI file but do not exist for the user without future hardware.

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Sync manager 5 & 6 have been extended to support up to 2 PDOs with the restriction that only one can be a non-Safety PDO and the other a Safety PDO.

Quick stop reaction time improved for Cyclic Synchronous Position (CSP) mode

Quick stop reaction time is much improved for CSP profile mode. The speed of reaction to a Quick Stop command depends on several factors:

- The profile Mode. Currently only Quick Stop in CSP has a very fast reaction, in other profile modes it is the time to perform one background loop of the CiA402 state machine (40 ms).
- The State of the fault reaction object the fault reaction ramps are pre-configured in the drive's AMC, and a change of ramp requirement takes time to configure), this is shown in table 1.

CSP Quick Stop reaction time		Fault Reaction Option code (0x605E)		
		0	1	2
Quick Stop Option Code (0x605A)	0	Within a network cycle	Within a network cycle	Within a network cycle
	1	Within a network cycle	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)
	2	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)	Within a network cycle
	5	Within a network cycle	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)
	6	Within a network cycle	4 ms (if slow down ramp is different to quick stop ramp)	Within a network cycle

Table 1. Quick stop reaction time for CSP mode.

Value	Definition
0	Disable drive function, motor is free to rotate
1	Slow down on slow down ramp
2	Slow down on quick stop ramp

Table 2. Fault reaction option code (0x605E).

Value	Definition
0	Disable drive function
1	Slow down on slow down ramp and transit into Switch on disabled
2	Slow down on quick stop ramp and transit into Switch on disabled
5	Slow down on slow down ramp and stay in Quick stop active
6	Slow down on quick stop ramp and stay in Quick stop active

Table 3. Quick stop option code (0x605A).

Table 2 and 3 respectively show the values and their definitions for the Fault reaction option code and the Quick stop option code.

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NOTE: Once a Quick stop reaction starts, it will complete before a fault reaction is applied (if the fault was not due to a drive trip), i.e. the Quick stop ramp will not change to the fault reaction ramp part way through the ramping.

SI-EtherCAT now reports the drive serial number (0x1018:4)

Previously the EtherCAT slave serial number (SI-EtherCAT option module or onboard M753 EtherCAT interface) was reported in sub-index four of the Identity object (0x1018) and represented the lower 32-bits of the serial number.

This has now been changed to represent the lower 32-bits of the host drive's or the Digitax HD M753's serial number.

The SI-EtherCAT option module's or onboard M753 EtherCAT interface's serial number is available to the user in parameters S.00.004 and S.00.005, representing the least significant 32-bits and most significant 32-bits of the serial number respectively.

Error reporting when state machine enters the fault state (0x1001, 0x603F)

Changes have been made so that now the Error register (0x1001) and the Error code (0x603F) objects report errors for all cases when the CiA402 state machine enters the fault state, regardless of if the drive trips.

In earlier versions of firmware, object 0x603F may have shown incorrect error values after the motor stopped. This has now been resolved.

Previously when SI-EtherCAT was used on Commander C200/C300 and Unidrive M400, then some error values mapped to object 0x603F were incorrect. This has now been corrected.

See appendix for a list of error codes associated with 0x603F, and the values for object 0x1001.

Error code object (0x603F)

Nine new error codes have been added to 0x603F, see appendix for details.

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Error history object (0x1003) has been added

0x1003 Error History			
Sub-index 0			
Access: RW	Rang e: 0 -10	Size: 1 Byte	Unit: N/A
Default: 0		Type: Unsigned integer	
PDO Mappable: No			
Description: The number of the last sub-index in this object. A value of zero can be written to sub-index 0 to clear the array of last errors			
Sub-index 1 to N			
Access: RO	Rang e: 0 – 0xFFFFFFFF FF	Size: 4 Bytes	Unit: See notes
Default: N/A		Type: Unsigned Integer	
PDO Mappable: No			
Description: This will contain an element of the error history. Index 1 is the latest error and index n is the oldest. A maximum of 10 error codes is kept with the oldest deleted when a new error occurs.			

Each entry is a 32 bit value where the most significant 16 bits is the age of the error and the least 16 bits is the error code as defined in Error code object (0x603F). See appendix for a list of error codes associated with 0x603F.

The age is expressed in seconds therefore the maximum age shown will be 0xFFFF i.e. approx. 18 hours. Due to the internal clock only having a resolution of approximately 49 days, after 49 days the age value will become invalid. It is suggested that the error list is downloaded regularly and cleared by writing a zero to sub-index zero. The history is volatile and therefore is cleared after a power cycle event or a reset.

Changes to Cyclic data loss for Commander C200/C300 and Unidrive M200/M300/M400

Previously on the C200, C300, M200, M300 & M400 drive products, when a network or master issue caused loss of cyclic data, an extended period was required before a PDO Loss message was displayed (or the action defined in object 0x3005 was initiated). This has now been changed, and a PDO Loss will be detected more promptly.

Improvements to the Cyclic data loss behaviour object (0x3005)

Improvements have been made to the PDO loss mechanism which is controlled by the Cyclic data loss behaviour object (0x3005).

Various fixes have been implemented to improve the fault reaction in Cyclic Synchronous Position mode.

The following issues have also been resolved in this release:

- Previously when object 0x3005's timeout was set to zero and the fault reaction was disabled immediately, it did not disable immediately.
- Setting a timeout greater than zero for object 0x3005 resulted in an indeterministic reaction time to PDO Loss.
- The PDO loss count in object 0x3005:2 gave misleading and non-useful information.

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- If the loss counter reached the threshold but did not increment further, then object 0x3005's action value was not respected.
- When object 0x3005's loss action was set to 0 or 1, and the CiA402 profiles were disabled then no action would be initiated on loss of cyclic data.
- Object 0x3005's loss mechanism did not restart after a fault had been cleared. (It now rearms after a configurable delay set in the new sub-index 4 of object 0x3005, see below)
- Six new counters, sub-indexes 3, 4, 5, 6, 7 and 8 have been added to 0x3005 to give further diagnostic capability to the user. These counters may be reset by the user.

When the drive profiles have been disabled by setting Pr S.0.33 to ON, then Cyclic Data loss actions 0 & 1 will still raise a warning and trip respectively, but the motor will not be stopped as it is not under the control of EtherCAT.

Table 4 shows the number of lost PDOs before the motor will be placed into the stopping state (0x3005:2 values 0 or 1) for each network cycle time.

		0x3005:1 Timeout value						
		0	1	2	3	4	5	6
Network Cycle Period	250us	1	8-11	12-15	16-19	20-23	24-27	28-31
	500us	1	4-5	6-7	8-9	10-11	12-13	14-15
	1ms	1	2-3	3-4	4-5	5-6	6-7	7-8
	2ms	1	1	1-2	2	2-3	3	3-4
	4ms	1	1	1	1	1	1	2

Table 4. Lost PDOs before stop.

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0x3005				Cyclic Data loss behaviour			
Sub-index 0							
Access: RO		Range: 8		Size: 1 byte		Unit: N/A	
Default: 8				Type: Unsigned integer			
PDO Mappable: No							
Description: The number of the last sub-index in this object.							
Sub-index 1 – Time out							
Access: RW		Range: 0 to 65535		Size: 2 bytes		Unit: ms	
Default: 0				Type: Unsigned integer			
PDO Mappable: No							
Description: The length of the loss validation period approximately in milliseconds, the exact period checked depends not only on the timeout but the cyclic period set by the master. Further details below the table							
Sub-index 2 – Cyclic Data Loss Action							
Access: RW		Range: 0 to 4		Size: 1 byte		Unit: N/A	
Default: 0				Type: Unsigned integer			
PDO Mappable: No							
Description: Cyclic Data Loss Action; the value will select an action as follows: 0: Raise a warning and initiate a motor stop according to the Fault reaction option code. 1: Raise a warning and initiate a motor stop according to the Fault reaction option code. When the motor has reached zero speed raise the cyclic data loss trip. 2: Raise the cyclic data loss trip and disabled the drive invertor. 3. Only raise a warning of PDO loss. [Note: For CSP mode a PDO loss will mean SI-EtherCAT will hold the motor at the current position (if extrapolation is disabled), this could be incorrectly interpreted, by the user, as a motor stop, if it was previously moving] 4. Ignore the cyclic loss completely (i.e. disabled cyclic loss detection). [Note: For CSP mode a PDO loss will mean SI-EtherCAT will hold the motor at the current position (if extrapolation is disabled), this could be incorrectly interpreted, by the user, as a motor stop, if it was previously moving]							
Sub-index 3 – CiA402 Cyclic Data Missed Count							
Access: RO		Range: 0 to 65535		Size: 2 bytes		Unit: N/A	
Default: N/A				Type: Unsigned Integer			
PDO Mappable: No							
Description: A count of the number of times the PDO data arrived late for the CiA402 motion profiles to use that data. For example, in CSP, the motion profile code is expecting a new updated target position a certain defined time after the Sync0 event. If this fails, this counter is incremented. The counter can be reset by writing a zero to this sub-index.							

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Sub-index 4 – Pdo Loss re-arm delay			
Access: RW	Range: 1 to 65535	Size: 2 bytes	Unit: Seconds
Default: N/A		Type: Unsigned Integer	
PDO Mappable: No			
Description: The delay after a PDO loss action has been completed and the PDO loss mechanism is re-armed. Note: the delay starts from the point at which the trip is cleared (if a trip was raised). The PDO Loss function is always armed when moving from SafeOp to Op states.			

Sub-index 5 – Max Weighted Internal SM event missed counter			
Access: RW	Range: 0 to 4	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer	
PDO Mappable: No			
Description: The maximum value seen for the weighted “internal” SM event missed counter as defined in ETG1020 and used by object 0x10F1 to determine when to exit OP state due to excess network errors. This counter only operates when DC Sync is active. The maximum can be reset by writing a zero to this sub-index.			

Sub-index 6 – PDO Jitter Counter			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Unsigned Integer	
PDO Mappable: No			
Description: This is a count of the number of times PDO data arrived earlier than expected. i.e. before the previous PDO data has been processed. The counter can be reset by writing a zero to this sub-index.			

Sub-index 7 – Max PDO loss duration			
Access: RW	Range: 0 to 4	Size: 2 bytes	Unit: N/A
Default: 0		Type: Unsigned integer	
PDO Mappable: No			
Description: The maximum PDO loss duration seen so far, when this value exceeds 0x3005:01 then the action in 0x3005:2 will be performed. The maximum can be reset by writing a zero to this sub-index..			

Sub-index 8 – Too many PDO counter			
Access: RO	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: N/A		Type: Unsigned Integer	
PDO Mappable: No			
Description: A count of the number of times two PDOs were seen in a single Cycle. This counter only operates when DC Sync is active			

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Error Settings object (0x10F1) has been added

0x10F1		Error Settings					
Sub-index 0							
Access:	RO	Range:	2	Size:	1 Byte	Unit	N/A
				:			
Default:	2			Type:	Unsigned integer		
PDO Mappable:	No						
Description:	The number of the last sub-index in this object.						
Sub-index 1							
Access:	RO	Range:	2	Size:	4 Bytes	Unit	N/A
				:			
Default:	0x00000002			Type:	Unsigned Integer		
PDO Mappable:	No						
Description:	The Local Error Reaction. This is always value '2' i.e. Manufacturer specific.						
Sub-index 2							
Access:	RO	Range:	0 - 65535	Size:	2 Bytes	Unit	N/A
				:			
Default:	0			Type:	Unsigned integer		
PDO Mappable:	No						
Description:	This is the Sync Error Counter limit. It is compared against the Weighed "internal" SM missed counter as defined in ETG1020. A value of zero disables this check. When the threshold is reached the Slave state is changed from Op to SafeOP and a AL status code raised to indicate the error.						

This is only available when DC sync is enabled. To be compliant to ETG1020, a weighted internal SM event missed counter is maintained. When in the operational state and DC Sync enabled, it is expected that the network events will alternate between a Sync0 event and a PDO event. If a PDO event is not seen between two sync0 events this is a "miss" as opposed to a "hit". For each "miss" the weighed counter is incremented by 3. For each "hit" the counter is decremented by 1. Object 0x1C32:11 will count the number of missed events. Object 0x3005:4 shows the maximum weighed counter seen so far and object 0x10F1:3 defines a threshold at which an error is flagged.

When the threshold is exceeded the following actions are performed:

- The sync error flag in object 0x1C32:32 is set true.
- The CiA402 state machine is informed to perform an immediate Fault reaction on the missed PDO event if running in a cyclic synchronous profile mode (i.e. CSP).
- The EtherCAT state machine is set to the SafeOP Error state.
- The action defined in object 0x6007 is performed, but object 0x605E will take precedence if the state machine is already in fault reaction.

Exceptions to the described action are:

- The CiA402 state machine may have already detected an error and has started the fault reaction and hence object 0x605E take precedence.

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- The loss detection mechanism 0x3005 may have already detected an error and has started the fault reaction and hence object 0x3005 take precedence.
- The SM watchdog may have expired and already applied object 0x6007 action.
- The Standard Sync0 watchdog may have already detected an error and already applied object 0x6007 action.

Manufacturer's objects 0x1008, 0x1009 and 0x100A

The following new objects have been added.

0x1008	Manufacturer Device Name			
Access:	RO	Range:	String	Size: Up to 40 bytes
Default:	"SI-EtherCAT"		Type:	String
PDO Mappable:	No			
Description:	A string of characters that represents the name of the Comms Module (either SI-EtherCAT or FF-EtherCAT). If a Safety Module is also fitted to the drive and FSoE enabled, the device name becomes "SI-EtherCAT with FSoE".			

0x1009	Manufacturer Hardware Version			
Access:	RO	Range:	String	Size: Up to 40 bytes
Default:	Depends		Type:	String
PDO Mappable:	No			
Description:	A string of characters that represents the hardware version of the comms module. This will also include the Safety Module if FSoE is enabled.			

0x100A	Manufacturer Software Version			
Access:	RO	Range:	String	Size: Up to 40 bytes
Default:	Depends		Type:	String
PDO Mappable:	No			
Description:	A string of characters that represents the software version of the Comms module. This will also include the Safety Module if FSoE is enabled.			

Revision number within ESI file

The Revision Number in the ESI file has been decoupled from the EtherCAT Firmware Version number. This is to follow ETG guidance and help better support future products such as the MiS2x0 family of safety modules that will support FSoE.

More correctly the revision number in the ESI file defines the revision number for the interface definition to the "drive", which is made up of drive, SI-EtherCAT, MiS2x0, keypad, etc

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The master checks the revision number in the ESI file with object 0x1018:3 in the Object dictionary. Object 0x1018:3 is implemented in SI-EtherCAT and so it's not completely decoupled, therefore we will continue to release the ESI files and SI-EtherCAT software as a package.

New objects 0x100A has been added (again as recommended by ETG). This is a string of 40 characters, it contains both the firmware version of the SI-EtherCAT and Safety Module. (See section "Manufacturer's objects 0x1008, 0x1009 and 0x100A").

The revision number scheme chosen for the ESI file starts at 0x02000001. This is so that this number is greater than the previous version for backwards compatibility reasons.

Clearing of trips

Previously after the user cleared a trip via the drive's keypad, then the motor may move. Changes have been implemented so now if the trip is cleared via the drive's keypad or via Control Techniques' PC tool Connect then the drive is always disabled and remains in the fault state until the user's program commands.

KNOWN ISSUES

Mapping non-mappable objects

If the user attempts to map non-cyclically mappable objects to a PDO, then an abort code is not returned, and the behaviour is indeterminate. In certain conditions an HF trip may be encountered.

The ESI file prescribes if an object can be mapped to either rx PDOs, tx PDOs, both rx and tx or none. Some development environments filter the available PDOs based upon the ESI files. Where applicable the objects' tables have been revised in this document to include the field "*PDO Mappable*".

Resetting SI-Applications Plus/ Compact or MCi200/210

Resetting the SI-Applications module or MCi module when inter-option mappings exist between the module and SI-EtherCAT/Digitax HD M753 EtherCAT, and if the EtherCAT network is operating causes the mappings to stop working.

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APPENDIX

Previous restricted firmware releases

The following incremental versions of firmware were previously released to a restricted base.

Version	Notes
V01.04.01.08 (PT181102)	Improvements to CSV mode (0x301A), ESI file change for Omron PLCs & Commander, Diagnostic counters (S.09.040, S.09.041), Rollover error actual position error corrected, Enable full resolution drive position feedback (0x3009) added, Extrapolation (0x6086) added, changes to ELD, E ² PROM recovery (S.00.034), Quick stop deceleration object range error fixed, Alarm bits (S09.039) added.
V01.04.02.04 (PT181104)	Absolute position now maintained when CiA402 shutdown occurs, improvements to sequencing when CiA402 shutdown occurs.
V01.04.03.04 (PT181105)	Rollover issue with non-unity gear ratio and 0x3009 fixed.
V01.04.04.04 (PT190203)	Window filter (0x300A) added, interpolator improvements.
V01.05.01.04 (PT190805)	Network loss behaviour added (0x6007)
V01.06.02.04 (T200302)	Changes to 0x6077, changes to 0x6078, changes to 0x6075
V01.07.00.26 (T201101)	SI-EtherCAT serial number (0x1018:4) - <i>deprecated in V01.07.01.06</i> , performance improvements in Pre-Op, improvements to poor shift offsets, changes to PDO loss detection for Commander drives, changes to status word, changes to control word, compatibility mode (S.00.048), Sync manager 4 & 5 objects added, improvements to inter-option mappings, support for future products (FSoE).
V01.07.01.06 (T201204_R1))	Quick stop reaction time improvements, now reports drive's serial number (0x108:4), Error reporting improvements (0x1001, 0x603F), Error code 0x603F extended, Error history object 0x1003 added, improvements to cyclic data loss (0x3005), error settings object 0x10F1 added, manufacturers objects 0x1008, 0x1009 and 0x100A added, clearing of trips behaviour changed, motor rated current object 0x6075 change

Error code object (0x603F)

0x603F	Error code		
Access: RO	Rang 0 to e: 0xFFFF	Size: 2 Bytes	Unit: N/A
Default: 0	Type: Unsigned integer		
PDO Mappable: TxPDO			
Description:	A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in the Error code tables below.		

The following error codes are new:

Error Code
0x431F
0x8101
0x8102
0x8103
0x8104
0xFF02
0x8606
0x8607
0x8608

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The Error can be the result of three things

- Drive trip, table 4 shows error codes and associated drive trip.
- EtherCAT Module trip, table 5 tables show error codes and associated module trip.
- EtherCAT network error, table 6 shows error codes and associated network event.

(See next page).

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Error Code	Meaning	Corresponding Drive Trip Name. The Trip codes are not shown as some are different between Commander C200/C300/Unidrive M400 and M70x/M75x drives. Read the appropriate drive manual if the trip code value is required
0x0000	Error reset / No error	0 – None
0xFF01	Generic trip related error	<i>(Any trip code not elsewhere in table)</i>
0xFF02	Generic non-trip error	<i>Any error not elsewhere in this table or following tables that caused the CiA402 state machine into a FAULT state.</i>
0x2340	Current, device output side	OI_AC OUTPUT_PHASE_U OUTPUT_PHASE_V OUTPUT_PHASE_W
0x3130	Phase failure	PHASE_LOSS OUT_PHASE_LOSS PHASING_ERROR
0x2230	Short circuit/earth leakage (device internal)	PSU PSU_24V OI_SNUBBER
0x3210	DC link over-voltage	OVER_VOLTS
0x3230	Load error	LOW_LOAD
0x4310	Excess temperature drive	OHT_INVERTOR 101 – Oht Brake
0x4311	Excess temperature drive	OHT_POWER
0x4312	Excess temperature drive	OHT_CONTROL
0x4313	Excess temperature drive	THERMISTOR
0x4314	Excess temperature drive	OHT_DC_BUS
0x4315	Excess temperature drive	OHT_BRAKE
0x5112	"Supply low voltage" and "U2 = supply +24 V"	USER_24V
0x5200	Control device hardware	SLOT1_HF
0x5201	Control device hardware	SLOT1_NOT_FITTED
0x5202	Control device hardware	SLOT1_DIFFERENT
0x5203	Control device hardware	SLOT2_HF
0x5204	Control device hardware	SLOT2_NOT_FITTED
0x5205	Control device hardware	SLOT2_DIFFERENT
0x5206	Control device hardware	SLOT3_HF
0x5207	Control device hardware	SLOT3_NOT_FITTED
0x5208	Control device hardware	SLOT3_DIFFERENT
0x5209	Control device hardware	SLOT4_HF
0x520A	Control device hardware	SLOT4_NOT_FITTED
0x520B	Control device hardware	SLOT4_DIFFERENT
0x520C	Control device hardware	NO_POWER_BOARD
0x5400	Power section	CONFIGURATION POWER_DATA RATING_MISMATCH
0x5510	RAM	SUB_ARRAY_RAM_ALLOCATION
0x5530	Data Storage (Non-volatile data memory)	EEPROM_FAIL USER_SAVE POWER_DOWN_SAVE
0x5430	Input stages	RECTIFIER_SET_UP
0x5440	Contacts	SOFT_START
0x6010	Software reset (watchdog)	WATCHDOG
0x6320	Parameter Error	DESTINATION SLOT_APP_MENU_CRASH APP_MENU_CHANGED
0x7112	Brake Chopper (Over current brake chopper)	OI_BRAKE BRAKE_R_TOO_HOT HOT_RECT_BRAKE

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0x7113	Protective circuit break chopper	TH_BRAKE_RES
0x7120	Motor	AUTOTUNE_1 AUTOTUNE_2 AUTOTUNE_3
0x7122	Motor error or commutation malfunction	AUTOTUNE_4 AUTOTUNE_5 AUTOTUNE_6 MOTOR_TOO_HOT TH_SHORT_CIRCUIT RESISTANCE
0x7300	Sensor	AUTOTUNE_7 ENCODER_1 ENCODER_2 ENCODER_3 ENCODER_4 ENCODER_5 ENCODER_6 ENCODER_7 ENCODER_8 ENCODER_9 ENCODER_12 ENCODER_13 NAME_PLATE TEMP_FEEDBACK
0x7310	Speed	OVER_SPEED
0x7500	Communication	POWER_COMMS INTER_CONNECT
0x7600	Data storage (external)	CARD_SLOT
0x7601	Data storage (external)	CARD_PRODUCT
0x7603	Data storage (external)	CARD_USER_PROG
0x7604	Data storage (external)	CARD_BUSY
0x7605	Data storage (external)	CARD_DATA_EXISTS
0x7606	Data storage (external)	CARD_OPTION
0x7607	Data storage (external)	CARD_READ_ONLY
0x7608	Data storage (external)	CARD_ERROR
0x7609	Data storage (external)	CARD_NO_DATA
0x760A	Data storage (external)	CARD_FULL
0x760B	Data storage (external)	CARD_FILE_ERROR
0x760C	Data storage (external)	CARD_RATING
0x760D	Data storage (external)	CARD_FILE_DATA
0x760E	Data storage (external)	CARD_DERIVATIVE

Table 4. Error codes and associated drive trip

Each drive trip will correspond to only one error code (although one error code can represent multiple trip codes). The error code will be generated when a drive trip occurs.

Error Code	Meaning	Corresponding EtherCAT Comms Trip Name
0x0000	Error reset / No error	0 – None
0xFF01	Generic trip related error	(Any trip code not elsewhere in table)
0x431F	Excess temperature drive	OVER_TEMPERATURE
0x8101	Communications error	TO_ECAT_PDO
0x8102	Communications error	SYNC_TASK_ORUN
0x8103	Communications error	SYNC_PDO_STOP
0x8104	Communications error	PRECRIT_TASK_ORUN

Table 5. Error codes and their associated module trip.

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Each module trip will correspond to only one error code (although one error code can represent multiple trip codes). The error code will be generated when a drive trip occurs.

Error Code	Meaning	Corresponding EtherCAT Comms event
0x0000	Error reset / No error	0 – None
0xFF02	Generic non-trip error	<i>Any error not elsewhere in this table or following tables that caused the CiA402 state machine into a FAULT state.</i>
0x8606	Communications error	SM 2 loss count exceeds loss threshold causing CiA402 state machine to entering FAULT state
0x8607	Communications error	Network SM timeout causes state to change into SafeOp resulting in CiA402 state machine entering Fault state
0x8608	Communications error	User disabled profiles whilst profiles running

Table 6. Error codes and their associated network event.

Error register object (0x1001)

0x1001	Error register		
Access: RO	Range: 0 – 0xFF	Size: 1 Byte	Unit Bit Mask :
Default: 0	Type: Unsigned integer		
PDO Mappable: No			
Description:	A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits will be supported: 0: Generic error 1: Current 2: Voltage 3: Temperature 4: Communications		