ECM-XF

EtherCAT Master Chip
User Manual

NEXTW Technology CO., LTD.

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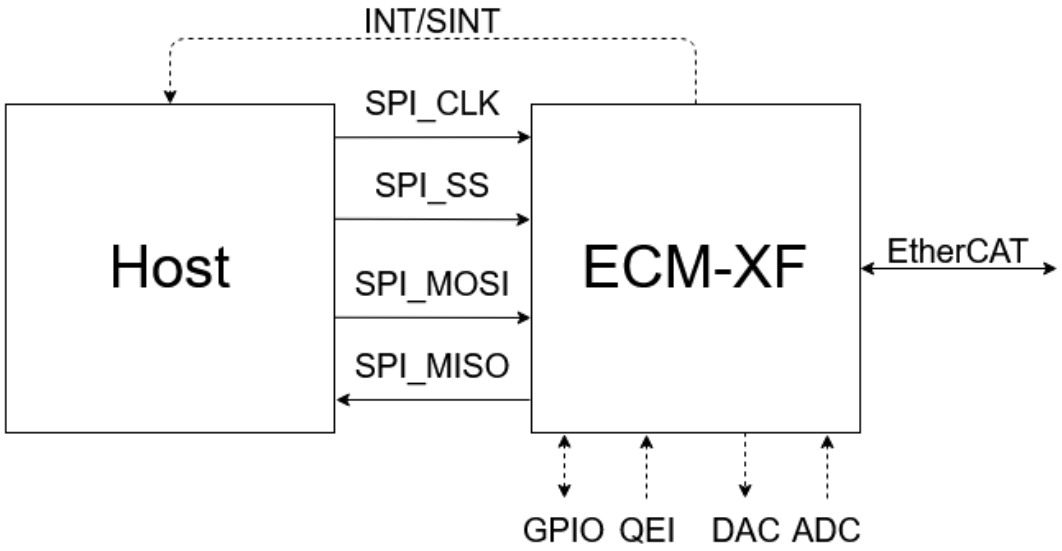
Ver.038

Introduction

ECM-XF is a cost effective EtherCAT Master chip connect with Control master by SPI interface. Provide users with minimum 125 us DC cycle time and 128 slaves. Support multiple surrounding IO, interrupt and application. Suitable for PLC controller, robot controller or multi-automation controller.

Support DC	Yes
Maximum Slaves	128
Minimum Cycle Time	125us
Mailbox Protocol	CoE/FoE
Surrounding IO	GPIO / QEI / ADC / DAC
Application function	CiA402 state machine control FIFO buffer

Interface



Pic. 1、ECM-XF interface connection

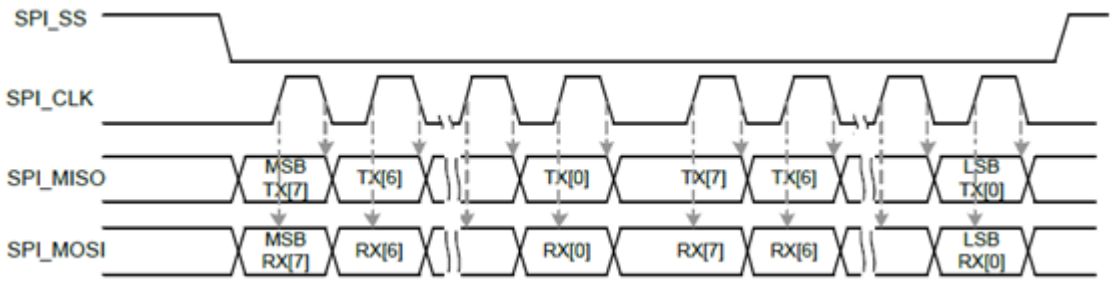
SPI Mode

Name	Pin Number	Meaning	Description
SPI_CLK	Pin 38	Signal Frequency	The minimum frequency generate and control by SPI Master to connect EtherCAT communication cycle.
SPI_MOSI	Pin 40	Master Out, Slave In	SPI Master data output, SPI Slave data input
SPI_MISO	Pin 39	Master In, Slave Out	SPI Master data input, SPI Slave data output
SPI_SS	Pin 37	SPI Slave Select	Option signal, control by master. The slave on ly react with master when the level in low.

<table>
<tr><td>Duplex Mode</td><td colspan="3">Full duplex</td></tr>
<tr><td>Transmission Rate</td><td colspan="3">96Mbps(max.)</td></tr>
<tr><td rowspan="3">Timing Mode</td><td colspan="3">SPI_CLK at low level when idling, upward edges receive data, downward edges transmit data</td></tr>
<tr><td>POL=0</td><td colspan="2">PHA=0</td></tr>
<tr><td>POL=0</td><td>TXNEG=1</td><td>RXNEG=0</td></tr>
</table>

SPI Mode Transmission

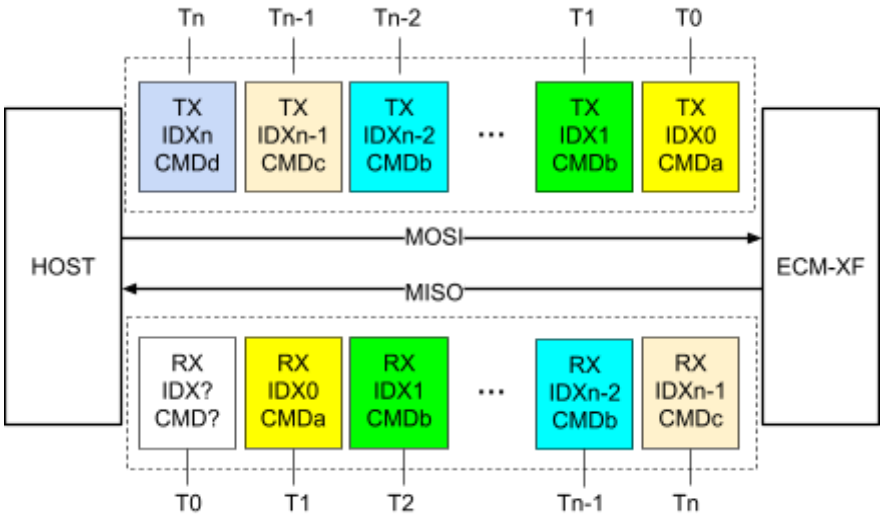
In ECM SPI Slave mode, SPI_CLK at low level when idling, upward edges receive data, downward edges transmit data, following MSB like picture shows below.



Pic. 2 SPI Timing

SPI Master generates clock to SPI slaves, transmitting data at the edges of high levels, receiving data at the edge of low levels. SPI transmission packs on Byte. Transmitting from the lowest address to the highest address. It means it starts at Byte 0, Byte 1, Byte 2 to the last Byte. But the SPI transmitting Byte is followed by MSB.

SPI Command Transmit and Receive

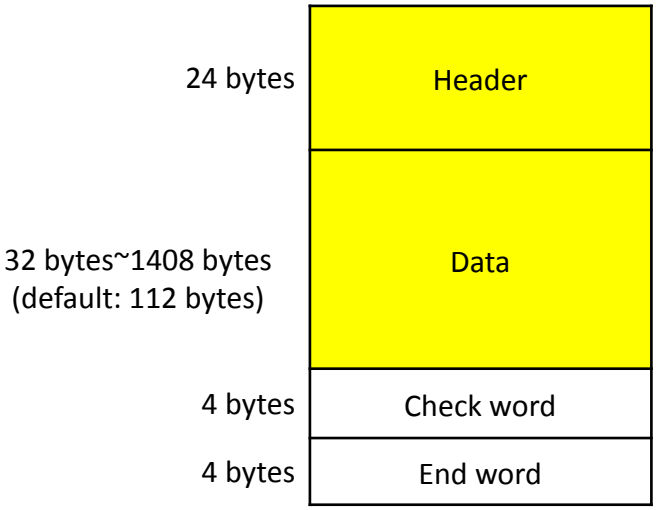


Pic 3. SPI full duplex data packet exchange

Warning
1. Master will receive the last data packet when transmitting the SPI command.
2. When ECM-XF enabled, the first return packet does not include the last respond packet.
3. If command packets are same at index code and command code, the commands will be treated as ECM_CMD_INFO_UPDATE_OP except the first one.

Packet Format

1. Command packet includes 4 parts: header, data, check word and end word.
2. Command header include commands, parameters, and system control, etc.
3. Return header include command return values, return data, error states and system state, etc.
4. Data section include PDO data or including data. The data size could be modified by application.
5. Check word has 4 different types for users as following: Fixed value ($0x12345678$), CRC-8, CRC-CCITT, CRC 32.
6. End word is a fixed value(0x56575859) for checking packet completeness
7. Data size is 32 bytes~1408 bytes, default is 112 bytes.



Pic 3. SPI packet format

Header

Command Header: Master to ECM-XF packet header

3	2	1	0	
Packet Start Word 0xA1A2A3A4				0x00
Parametric data 3	Parametric data 2	Parametric data 1	Parametric data 0	0x04
Index	Control Word	Reserved		0x08
Data Length		Command Parameter	**Command Code**	0x0c
Interrupt Clear				0x10
GPIO Output 1	GPIO Output 0	GPIO Interrupt Clear 1	GPIO Interrupt Clear 0	0x14

Pic 4 Command Header

Command Code relating

Interrupt relating

System or Hardware relating

Response Header: The header from ECM-XF to master

3	2	1	0	
Packet Start Word 0xA1A2A3A4				0x00
RxPDO waiting to transmit quantity	TxPDO waiting to receive quantity	WKC Error Count	CRC Error Count	0x04
Return Index	ECM Status	ECM Error Status	ECAT State	0x08
Data Length		Return Value	**Return Command Code**	0x0c
Interrupt Flag				0x10
GPIO Input 1	GPIO Input 0	GPIO Interrupt Flag 1	GPIO Interrupt Flag 0	0x14

Pic 5 Return Header

Header Column Explanation

Table 1. Header column in command packet

Command Header			
Location	Length	Name	Description
0x00	4	Packet Start Word	Fixed Value(0xA1A2A3A4)
0x04	1	Parametric Data 0	Transmit command parameter or data
0x05	1	Parametric Data 1	Transmit command parameter or data
0x06	1	Parametric Data 2	Transmit command parameter or data
0x07	1	Parametric Data 3	Transmit command parameter or data
0x08	2	Reserved	
0x0A	1	Control Word	Control or erase system interrupt event bit0: Valid header IO output column bit3: Erase FIFO error bit4: Erase SPI communication error bit5: Erase SPI CRC error bit6: Erase blocking command bit7: Erase non-blocking command
0x0B	1	Index	Identify main application
0x0C	1	Command Code	Refer to command table
0x0D	1	Command Parameter	command parameter
0x0E	2	Data Length	command parameter or data transmission

0x10	4	Interrupt Clear	Bit 31 : EtherCAT package interrupt clear Bit 29 : Encoder interrupt clear Bit 0-28, 30 : Reserve
0x14	1	GPIO Interrupt Clear 0	Clear GPIO low level interrupt flag
0x15	1	GPIO Interrupt Clear 1	Clear GPIO high level interrupt flag
0x16	1	GPIO output 0	GPIO low level output value
0x17	1	GPIO output 1	GPIO high level output value

Table 2. Header column in return packet

Return Header			
Location	Length	Name	Description
0x00	4	Packet Start Word	Fixed value(0xA1A2A3A4)
0x04	1	CRC Error Count	Number of CRC error count in SPI communication
0x05	1	WKC Error Count	Number of working count error in PDO communication
0x06	1	Number of TxPdoFIFO	Number of TxPDO which are not received in FIFO
0x07	1	Number of RxPdoFifo	Number of RxPDO which are not received in FIFO
0x08	1	ECAT state	0x00 : NONE(non initialize state) 0x01 : INIT(initialized state) 0x02 : PRE_OP(pre-operate state) 0x03 : BOOT(boot state) 0x04 : SAFE_OP(safe operate state) 0x08 : OPERATIONAL(operation state) 0x10 : ERROR(error state)
0x09	1	Error Status	bit0: Check the connect between RJ45 and ECM-XF PIN52 LINK(hardware)

			(1: Linked, 0: unlinked) bit1: Check the connect between RJ45 and PIN52 by software when operating Ecat_Init()(software) (1: Linked, 0: unlinked) bit2: Reserved bit3: blocking command return error bit5: FIFO error bit6: SPI CRC error bit7: blocking command busy ※Only a blocking command can be operated at the same period. If bit7 is high and continues to send another blocking command. The bit3 error will pop out. The non-blocking commands are okay to send when the blocking command is operating.
0x0A	1	ECM Status	bit1-bit0 : 0 : fixed value check 1: CRC8 check 2: CRC-CCITT check 3: CRC32 check bit2 : DC cycle time stable flag bit3 : ethernet initialized flag bit4 : ECAT PDO configured flag bit5 : return packet is NOP flag bit6 : FIFO enable flag bit7 : blocking time command busy flag
0x0B	1	Index	Return command header index
0x0C	1	Command Code	Return command header command code
0x0D	1	Command Return Value	Return value from return command
0x0E	2	Data length	command parameter or data valid length
0x10	4	Interrupt flag	Bit 31 : EtherCAT package interrupt flag Bit 29 : encoder interrupt flag Bit 0-28, 30 : Reserve
0x14	1	GPIO interrupt flag 0	GPIO low level interrupt flag
0x15	1	GPIO interrupt flag 1	GPIO high level interrupt flag
0x16	1	GPIO input 0	GPIO low level input value
0x17	1	GPIO input 1	GPIO high level input value

Command Code Table

Commands are divided into two types by response time.
1. NON-BLOCKING - Received commands and operate immediately and return parameters or values.
2. BLOCKING - Received commands and wait a period time to operate and return parameters or values.
3. ECM-XF can only operate a blocking command once. Check the blocking command busy flag of ECM state is zero before transmitting the next blocking command.
4. When blocking command operates, transmitting non-blocking command and other operations is allowed.
Please refer to Pic 6 Command and Return flowchart diagram

Table 3. Command Table

Blocking Command	Non-blocking Command
ECM_CMD_ECAT_INIT_OP ECM_CMD_ECAT_RECONFIG_OP ECM_CMD_ECAT_DCSYNC ECM_CMD_ECAT_PDO_CONFIG_SET ECM_CMD_ECAT_STATE_SET	ECM_CMD_INFO_UPDATE_OP ECM_CMD_FW_VERSION_GET ECM_CMD_ECAT_PDO_DATA_FIFO_OP ECM_CMD_ECAT_PDO_DATA_OP ECM_CMD_ECAT_STATE_GET ECM_CMD_ECAT_PDO_WC_GET ECM_CMD_ECAT_SLV_INFO_GET ECM_CMD_ECAT_SLV_CNT_GET ECM_CMD_FIFO_ENABLE ECM_CMD_FIFO_PACK_SIZE_GET ECM_CMD_SPI_PACK_SIZE_GET ECM_CMD_SPI_RECONFIG_OP ECM_CMD_CRC_ERR_CNT_CLR ECM_CMD_CRC_TYPE_SET ECM_CMD_402_CONFIG_SET ECM_CMD_402_STATE_SET ECM_CMD_402_STATE_GET ECM_CMD_402_CTL_SET ECM_CMD_402_CTL_GET
ECM_CMD_ECAT_PDO_CONFIG_REQ ECM_CMD_ECAT_SDO_REQ ECM_EEPROM_REQ	ECM_CMD_ECAT_PDO_CONFIG_GET ECM_CMD_ECAT_SDO_GET ECM_EEPROM_GET

Table 4. Command Description

ECM_CMD_INFO_UPDATE_OP	Refresh header data
ECM_CMD_ECAT_INIT_OP	Initialize EtherCAT network and slaves before EtherCAT application
ECM_CMD_ECAT_RECONFIG_OP	After configuring PDO, reconfiguring memory size for ECM-XF
ECM_CMD_ECAT_PDO_WC_GET	Read the slaves quantity of the PDO data contents outputs/inputs or working counter value.
ECM_CMD_ECAT_PDO_DATA_FIFO_OP	Access PDO data to FIFO
ECM_CMD_ECAT_PDO_DATA_OP	Access PDO data
ECM_CMD_ECAT_PDO_CONFIG_SET	Configure PDO slaves
ECM_CMD_ECAT_PDO_CONFIG_REQ	Request PDO configuration read. Use ECM_CMD_PDO_CONFIG_GET to return configuration.
ECM_CMD_ECAT_PDO_CONFIG_GET	Read PDO slave configuration.
ECM_CMD_ECAT_SDO_REQ	Request operating SDO write/read commands. Use ECM_CMD_ECAT_SDO_GET to read return data
ECM_CMD_ECAT_SDO_GET	Return ECM_CMD_ECAT_SDO_REQ data
ECM_CMD_ECAT_STATE_SET	Set EtherCAT state
ECM_CMD_ECAT_STATE_GET	Return EtherCAT state
ECM_CMD_ECAT_SLV_INFO_GET	Read slaves information
ECM_CMD_ECAT_SLV_CNT_GET	Read slave quantity
ECM_CMD_FIFO_ENABLE	Enable RxPDO output. ECM-XF enables

	RxPDO FIFO by default. Use this command can disable RxPDO FIFO manually and pre-save output.
ECM_CMD_FIFO_PACK_SIZE_GET	Read PDO data length, a PDO counts one in FIFO
ECM_CMD_SPI_PACK_SIZE_GET	Read SPI data packet length
ECM_CMD_SPI_RECONFIG_OP	Reset SPI data packet length
ECM_CMD_CRC_ERR_CNT_CLR	Erase CRC error counter
ECM_CMD_CRC_TYPE_SET	Set checking type
ECM_CMD_402_CONFIG_SET	Assign slaves control word and status word offset
ECM_CMD_402_STATE_SET	Switch 402 state of assigned slaves
ECM_CMD_402_STATE_GET	Read 402 state of assigned slaves
ECM_CMD_402_CTL_SET	Set control byte in ECM-XF internal 402 state
ECM_CMD_402_CTL_GET	Read control byte in ECM-XF internal 402 state
ECM_GPIO_CONFIG_SET (ECM_GpioSetMode)	Set GPIO mode
ECM_GPIO_CONFIG_SET (ECM_GpioEnableDebounce)	Enable/disable GPIO debounce
ECM_GPIO_CONFIG_SET (ECM_GpioSetDebounceClock)	Set debounce clock
ECM_GPIO_CONFIG_SET (ECM_GpioIntEnable)	Enable/Disable GPIO interrupt
ECM_GPIO_CONFIG_SET (ECM_GpioIntClear)	Clear GPIO interrupt flag
ECM_GPIO_FUNC_OP (ECM_GpioSetValue)	Set GPIO value
ECM_GPIO_FUNC_OP (ECM_GpioExtSetValue)	Set GPIO value (Extension function, only work for ver. 9 or later)
ECM_GPIO_FUNC_OP (ECM_GpioGetValue)	Get GPIO value

ECM_GPIO_FUNC_OP (ECM_GpioExtGetValue)	Get GPIO value (Extension function, only work for ver. 9 or later)
ECM_GPIO_FUNC_OP (ECM_GpioGetIntFlag)	Get GPIO Interrupt flag
ECM_GPIO_FUNC_OP (ECM_GpioExtGetIntFlag)	Get GPIO Interrupt flag (Extension function, only work for ver. 9 or later)
ECM_QEI_FUNC_OP (ECM_EncOpen)	Open and set encoder mode
ECM_QEI_FUNC_OP (ECM_EncStart)	Start encoder counting
ECM_QEI_FUNC_OP (ECM_EncStop)	Stop encoder counting
ECM_QEI_FUNC_OP (ECM_EncGetCount)	Get encoder counter value
ECM_DAC_FUNC_OP (ECM_DacOpen)	Open DAC function
ECM_DAC_FUNC_OP (ECM_DacClose)	Close DAC function
ECM_DAC_FUNC_OP (ECM_DacSetDelayTime)	Set DAC delay time
ECM_DAC_FUNC_OP (ECM_DacSetData)	Set DAC data
ECM_DAC_FUNC_OP (ECM_DacStartConv)	Start DAC conversion
ECM_ADC_FUNC_OP (ECM_AdcOpen)	Open ADC function
ECM_ADC_FUNC_OP (ECM_AdcClose)	Close ADC function
ECM_ADC_FUNC_OP (ECM_AdcConfigSampleModule)	Configure ADC trigger source
ECM_ADC_FUNC_OP (ECM_AdcGetDataValidFlag)	Get ADC data valid flag
ECM_ADC_FUNC_OP	Start ADC conversion

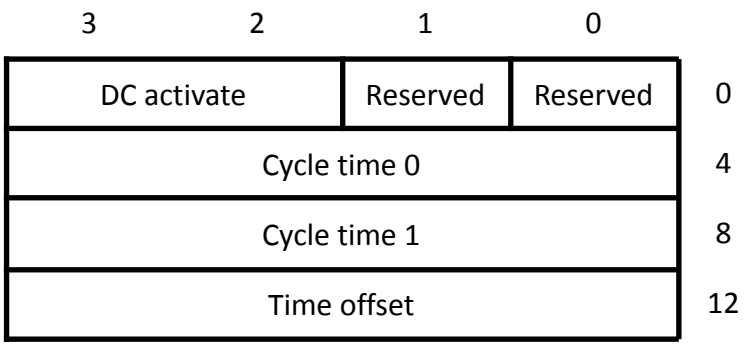
(ECM_AdcStartConv)	
ECM_ADC_FUNC_OP (ECM_AdcGetConvData)	Get ADC converted data
ECM_EEPROM_REQ	Request EEPROM write/read command. Use ECM_EEPROM_GET to return reading data.
ECM_EEPROM_GET	Read ECM_EEPROM_REQ data
ECM_CMD_ECAT_STATE_CHECK	Reflash and check slaves state
ECM_CMD_ECAT_DCSYNC	Set DC sync signal source, cycle time, and shift time
ECM_CMD_FIFO_CLR_OP	Clear FIFO
ECM_CMD_FIFO_SET_TX_CNT	Set Tx FIFO count
ECM_CMD_FIFO_GET_TX_CNT	Get Tx FIFO count
ECM_CMD_FIFO_SET_RX_CNT	Set Rx FIFO count
ECM_CMD_FIFO_GET_RX_CNT	Get Rx FIFO count
ECM_CMD_FW_VERSION_GET	Read firmware version
ECM_CMD_ECAT_STATE_UPDATE	Update ECAT state
ECM_CMD_ECAT_INT_SET_ENABLE	Set interrupt enable mask
ECM_CMD_ECAT_INT_GET_ENABLE	Get interrupt enable mask

Command Description

In this section, introducing commands and header relating columns and data content.
Please refer to pic 3 to pic 5.

1. Yellow background are command relating, according to command code parametric data
2. Index codes for identify return packet
3. When the command packets have the same index code, the commands will be treated as ECM_CMD_INFO_UPDATE_OP except the first one.

ECM_CMD_INFO_UPDATE_OP Refresh header data			
Command Packet			
Header	1	Command Code	0
	2	Index Code	Custom Defined
	3	Data Length	0

ECM_CMD_ECAT_INIT_OP Initialize EtherCAT network and slaves before EtherCAT application					
Command Packet					
Header	1	Command Code	1		
	2	Index Code	Custom Defined		
	3	Data Length	16		
Data Section	1				
		Location	Length	Name	Description
		0x00	1	Reserved	Fixed Value 0xFF
		0x01	1	Reserved	Fixed Value 0x81 FIFO disabled (default) Enable FIFO after OP state if needed

		0x02	2	DC activate	Reference AssignActivate in ESI
		0x04	4	Cycle Time 0	SYNC0 Cycle Time(ns)
		0x08	4	Cycle Time 1	SYNC1 Cycle Time(ns)
		0x12	4	Time Offset	Cycle Time Offset(ns)

ECM_CMD_ECAT_RECONFIG_OP After configuring PDO, reconfiguring memory size for ECM-XF			
Command Packet			
Header	1	Command Code	2
	2	Index Code	Custom Defined
	3	Data Length	0

ECM_CMD_ECAT_PDO_WC_GET Read the slaves quantity of the PDO data contents outputs/inputs or working counter value.			
Command Packet			
Header	1	Command Code	4
	2	Index	Custom Defined
	3	Data Length	0
	4	Command Parameter	1 : Input Slave Quantity 2 : Output Slave Quantity 3 : Working Counter Quantity
Return Packet			
Header	1	Command Code	4
	2	Index	Same as Command Packet Index
	3	Data Length	4
Data Section	1	Read return quantity value	

Working counter logical value = (input slave quantity)*1 + (output slave quantity)*2

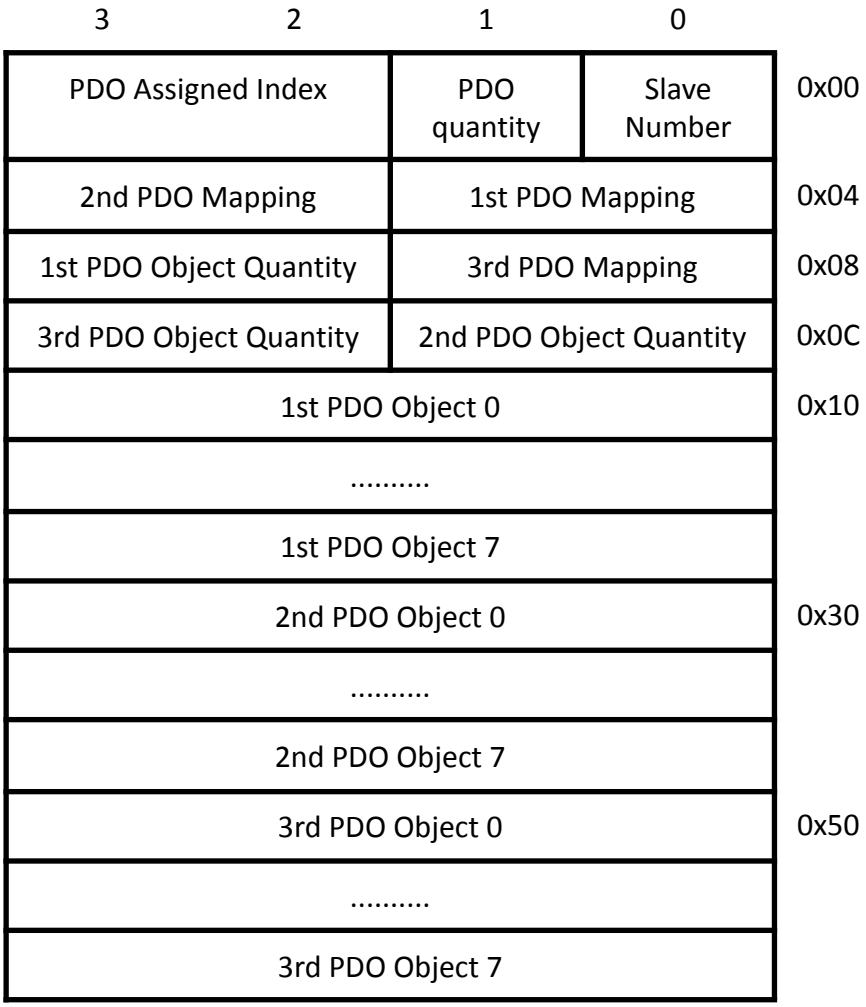
ECM_CMD_ECAT_PDO_DATA_FIFO_OP Access PDO data to FIFO			
Command Packet			
Header	1	Command Code	5
	2	Index Code	Custom Defined
	3	Data Length	RxPDO Length
	4	Command Parameter	PDO Data quantity
	5	Command Data 0	Write/Read Operation Code bit 0: Write operation bit 1: Read operation
Data Section	1	PDO Data	RxPDO Data
Return Packet			
Header	1	Command Code	5
	2	Index Code	Same as Command Packet Index
	3	Data Length	TxPDO Length
	4	Return Value	Write/Read Operation Code bit 0: Write operation bit 1: Read operation
Data Section	1	TxPDO Data	

ECM_CMD_ECAT_PDO_DATA_OP Access PDO data			
Command Packet			
Header	1	Command Code	6
	2	Index Code	Custom Defined
	3	Command Parameter	RxPDO Length

	4	Command Data 0	Write/Read Operation Code bit 0: Write operation bit 1: Read operation bit 2: 1 presents operation valid. If bit value is 0, force it operates write and read operation
Data Section	1	RxPDO Data	
Return Packet			
Header	1	Command Code	6
	2	Index Code	Same as Command Packet Index
	3	Data Length	TxPDO Length
	4	Return Value	Write/Read Operation Code bit 0: Write operation bit 1: Read operation bit 2: 1 presents operation valid. If bit value is 0, force it operates write and read operation
Data Section	1	TxPDO Data	

ECM_CMD_ECAT_PDO_CONFIG_SET Set PDO configuration ※This API only allows 3 PDO and 8 objects for each of them. If you need more please use SDO to set the configuration.			
Command Packet			
Header	1	Command Code	7
	2	Index	Custom Defined
	3	Data Length	112

Data Section | 1



Location	Length	Name	Description
0x00	1	Slave Number	0~127
0x01	1	PDO Quantity	0~127
0x02	2	PDO Assigned Index	TxPDO/RxPDO Assigned Index
0x04	2	1st PDO Mapping	The 1st PDO Mapping Index
0x06	2	2nd PDO Mapping	The 2nd PDO Mapping Index
0x08	2	3rd PDO	The 3rd PDO Mapping Index

				Mapping	
		0x0A	2	1st PDO Object Quantity	The 1st PDO Object Quantity
		0x0C	2	2nd PDO Object Quantity	The 2nd PDO Object Quantity
		0x0E	2	3rd PDO Object Quantity	The 3rd PDO Object Quantity
		0x10	4	The 1st PDO Object 0 3 2 1 0 Index | Sub-index | Length(bits)	
		...		The 1st PDO Object N(N=1~7)	
		0x30	4	The 2nd PDO Object 0	
		...		The 2nd PDO Object N(N=1~7)	
		0x50	4	The 3rd PDO Object 0	
		...		The 3rd PDO Object N(N=1~7)	

ECM_CMD_ECAT_PDO_CONFIG_REQ Request execute PDO configuration reading Use ECM_CMD_ECAT_PDO_CONFIG_GET to get configuration			
Command Packet			
Header	1	Command Code	8
	2	Index	Custom Defined
	3	Data Length	4
Data Section	1	3 2 1 0 PDO Assigned Index | Reserved | Slave | 0x00	

				Number

Location	Length	Name	Description
0x00	1	Slave Number	0~127
0x01	1	Reserved	
0x02	2	PDO Assigned Index	TxPDO/RxPDO Assigned Index

ECM_CMD_ECAT_PDO_CONFIG_GET Read slave PDO configuration			
Command Packet			
Header	1	Command Code	9
	2	Index	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	9
	2	Index	Same as Command Packet Index
	3	Data Length	112

Data Section — 1

3	2	1	0	
PDO Assigned Index		PDO Quantity	Slave Number	0x00
2nd PDO Mapping		1st PDO Mapping		0x04
1st PDO Object Quantity		3rd PDO Mapping		0x08
3rd PDO Object Quantity		2nd PDO Object Quantity		0x0C
1st PDO Object 0				0x10

.....	
1st PDO Object 7	
2nd PDO Object 0	0x30
.....	
2nd PDO Object 7	
3rd PDO Object 0	0x50
.....	
3rd PDO Object 7	

Location	Length	Name	Description
0x00	1	Slave Number	0~127
0x01	1	PDO Quantity	0~127
0x02	2	PDO Assigned Index	TxPDO/PxPDO Assigned Index
0x04	2	1st PDO Mapping	The 1st PDO Mapping Index
0x06	2	2nd PDO Mapping	The 2nd PDO Mapping Index
0x08	2	3rd PDO Mapping	The 3rd PDO Mapping Index
0x0A	2	1st PDO Object Quantity	The 1st PDO Object Quantity
0x0C	2	2nd PDO Object Quantity	The 2nd PDO Object Quantity
0x0E	2	3rd PDO Object Quantity	The 3rd PDO Object Quantity

		0x10	4	The 1st PDO Object 0 3 2 1 0 Index | Sub-index | Length (bits)
		...		The 1st PDO Object N(N=1~7)
		0x30	4	The 2nd PDO Object 0
		...		The 2nd PDO Object N(N=1~7)
		0x50	4	The 3rd PDO Object 0
		...		The 3rd PDO Object N(N=1~7)

ECM_CMD_ECAT_SDO_REQ
Request SDO write/read command.
Use ECM_CMD_ECAT_SDO_GET to read return data.

Command Packet

Header	1	Command Code	10
	2	Index Code	Custom Defined
	3	Data Length	Read Operation : 12
			Write Operation : 12+ Valid command data

Data Section 1

3 2 1 0

Index Code		Slave Number	Operation Code	0
Data Length		Reserved	Sub-index Code	4
Operation Timeout				8
Data				12

Location	Length	Name	Description

		0x00	1	Operation Code	0:Write Operation 1:Read Operation
		0x01	1	Slave Number	0~127
		0x02	2	Index	CoE Object Index
		0x04	1	Sub-index	CoE Object Sub-index
		0x05	1	Reserved	
		0x06	2	Data Length	Valid Write Operation, Valid Command Length
		0x08	4	Timeout	SDO Maximum Timeout(μs)
		0x12	256	Data	Valid Write Operation

ECM_CMD_ECAT_SDO_GET Read the result from ECM_CMD_ECAT_SDO_REQ			
Command Packet			
Header	1	Return Code	11
	2	Index Code	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	11
	2	Index Code	Same as Command Packet Index
	3	Data Length	Valid Data Length
Data Section	1	Last ECM_CMD_ECAT_SDO_REQ Read Data	

ECM_CMD_ECAT_STATE_SET Set EtherCAT state			
Command Packet			
Header	1	Command Code	12

	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	Slave Number 0xFF: All slaves
	5	Command Data 0	EtherCAT State

ECM_CMD_ECAT_STATE_GET Return EtherCAT state			
Command Packet			
Header	1	Command Code	13
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	Slave Number 0xFF: All slaves
Return Packet			
Header	1	Command Code	13
	2	Index Code	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	EtherCAT State

ECM_CMD_ECAT_SLV_INFO_GET Read Slave Information			
Command Packet			
Header	1	Command Code	15
	2	Index	Custom Defined
	3	Data Length	0
	4	Command Parameter	Slave Number (The 1st one would be 0)

	5	Command Data 0	Slave Information Code 0 : Manufacturer Code 1 : Manufacturer Product Number 2 : Version Number 3 : Product Name 4 : Configuration Location 5 : Location Alias 6 : State 7 : AL state 8 : Output Data Length 9 : Input Data Length
Return Packet			
Header	1	Command Code	15
	2	Index	Same as Command Packet Index
	3	Data Length	Slave Information Data Length
Data Section	1	Slave Information	

ECM_CMD_ECAT_SLV_CNT_GET Read slave quantity			
Command Packet			
Header	1	Command Code	16
	2	Index Code	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	16
	2	Index Code	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	Slave quantity

ECM_CMD_FIFO_ENABLE Enable RxPDO output. ECM-XF enables RxPDO FIFO by default. Use this command can disable RxPDO FIFO manually and pre-save output.			
Command Packet			
Header	1	Command Code	18
	2	Index	Custom Defined
	3	Data Length	0
	4	Command Parameter	0 : Disable 1 : Enable

ECM_CMD_FIFO_PACK_SIZE_GET Read PDO data length, a PDO counts 1 in FIFO.			
Command Packet			
Header	1	Command Code	19
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	0 : Read RxPDO Data Length 1 : Read TxPDO Data Length
Return Packet			
Header	1	Command Code	19
	2	Index	Same as Command Packet Index
	3	Data Length	2
Data Section	1	PDO Data Length	

ECM_CMD_SPI_PACK_SIZE_GET Read SPI data packet length			
Command Packet			
Header	1	Command Code	20

	2	Index Code	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	20
	2	Index Code	Same as Command Packet Index
	3	Data Length	2
Data Section	1		SPI data length

ECM_CMD_SPI_RECONFIG_OP Reset SPI data packet length			
Command Packet			
Header	1	Command Code	23
	2	Index Code	Custom Defined
	3	Data Length	SPI packet data length(32 ~ 1408)
Return Packet			
Header	1	Command Code	23
	2	Index Code	Same as Command Packet Index
	3	Data Length	0

ECM_CMD_CRC_ERR_CNT_CLR Erase CRC error check count			
Command Packet			
Header	1	Command Code	24
	2	Index	Custom Defined
	3	Data Length	0
Return Packet			

Header	1	Command Code	24
	2	Index	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	Erase the number of CRC error counting

ECM_CMD_CRC_TYPE_SET Set checking type			
Command Code			
Header	1	Command Code	25
	2	Index	Custom Defined
	3	Data Length	0
	4	Data Parameter	0 : Fixed Value Check: $0x12345678$ 1 : CRC-8: $X^8 + X^2 + X + 1$(Poly = 0x07) Init = 0x00, RefIn = False, RefOut = False, XorOut = 0x00 2 : CRC-CCITT-FALSE: $X^{16} + X^{12} + X^5 + 1$(Poly = 0x1021) Init = 0xFFFF, RefIn = False, RefOut = False, XorOut = 0x0000 3 : CRC-32: $X^{32} + X^{26} + X^{23} + X^{22} + X^{16} + X^{12} + X^{11} + X^{10} + X^8 + X^7 + X^5 + X^4 + X^2 + X + 1$ Init = 0xFFFFFFFF, RefIn = True, RefOut = True, XorOut = 0xFFFFFFFF

ECM_CMD_402_CONFIG_SET Assign slave control word and status word offset			
Command Packet			
Header	1	Command Code	26
	2	Index	Custom Defined
	3	Data Length	0

	4	Command Parameter	Motor Number(The 1st one would be 0)
	5	Command Data 0	Control Word Offset(Byte)
	6	Command Data 1	Status Word Offset(Byte)
	7	Command Data 2	Set control bytes of ECM-XF internal 402 state bit3 : Erase slave state error bit4 : Enable state machine bit7 : Enable automatic erasing slave state machine error Enable this function will control the axis control word automatically to achieve 402 state machine switching, fault reset ,etc. bit3 with 1 presents single fault reset, bit 4 with 1 presents enable, and bit 7 with 1 present automatic continuing fault reset
	8	Command Data 3	Slave Number (The 1st one would be 0)

ECM_CMD_402_STATE_SET Switch assigned slave 402 state			
Command Packet			
Header	1	Command Code	27
	2	Index	Custom Defined
	3	Data Length	0
	4	Parameter	Motor Number(The 1st one would be 0)
	5	Parametric Data	402 State NOT READY TO SWITCH ON 0x00 SWITCHED ON DISABLED 0x40 READY TO SWITCH ON 0x21 SWITCHED ON 0x23 OPERATION ENABLED 0x27 QUICK STOP ACTIVE 0x07 FAULT REACTION ACTIVE 0x0F FAULT 0x08

ECM_CMD_402_STATE_GET Read assigned slave 402 state

Command Packet			
Header	1	Command Code	28
	2	Index	Custom Defined
	3	Data Length	0
	4	Command Parameter	Motor Number(The 1st one would be 0)
Return Packet			
Header	1	Command Code	28
	2	Index	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	Slave current 402 State

ECM_CMD_402_CTL_SET Set control bytes of ECM-XF internal 402 state			
Command Packet			
Header	1	Command Code	29
	2	Index	Custom Defined
	3	Data Length	0
	4	Command Parameter	Motor Number(The 1st one would be 0)
	5	Parametric Data 0	bit3 : Erase slave state error bit4 : Enable state machine bit7 : Enable automatic erasing slave state machine error

ECM_CMD_402_CTL_GET Read control bytes of ECM-XF internal 402 state			
Command Packet			
Header	1	Command Code	30

	2	Index	Custom Defined
	3	Data Length	0
	4	Command Parameter	Motor Number(The 1st one would be 0)
Return Packet			
Header	1	Command Code	30
	2	Index	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	Set value of 402 state machine

ECM_GPIO_CONFIG_SET(ECM_GpioSetMode) Set GPIO mode			
Command Packet			
Header	1	Command Code	31
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	0
	5	Command Data 0	Bit n: 1 for setting GPIO mode of GPIOn (n =0 to 7)
	6	Command Data 1	Bit n: 1 for setting GPIO mode of GPIOn+8 (n =0 to 7)
	7	Command Data 2	GPIO mode definition 0x0: Input Mode 0x1: Output Mode 0x2: Open-Drain Mode 0x3: Quasi-bidirectional Mode
	8	Command Data 3	GPIO pull select definition 0x0: Pull Select Disable Mode 0x1: Pull-up Mode 0x2: Pull-down Mode

ECM_GPIO_CONFIG_SET(ECM_GpioSetMode) Set GPIO mode (GPIO Extension function, only work for ver. 9 or later)			
Command Packet			
Header	1	Command Code	31
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	8
	5	Command Data 0	Bit n: 1 for setting GPIO mode of GPIOn+16 (n = 0 to 3)
	6	Command Data 1	Reserved, set 0.
	7	Command Data 2	GPIO mode definition 0x0: Input Mode 0x1: Output Mode 0x2: Open-Drain Mode 0x3: Quasi-bidirectional Mode
	8	Command Data 3	GPIO pull select definition 0x0: Pull Select Disable Mode 0x1: Pull-up Mode 0x2: Pull-down Mode

ECM_GPIO_CONFIG_SET(ECM_GpioEnableDebounce) Enable/disable GPIO debounce			
Command Packet			
Header	1	Command Code	31
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	2
	5	Command Data 0	Bit n: 1 for enable GPIO debounce of GPIOn, 0 for disable debounce of GPIOn.

			(n =0 to 7)
	6	Command Data 1	Bit n: 1 for enable GPIO debounce of GPIOn+8, 0 for disable debounce of GPIOn+8. (n =0 to 7)
	7	Command Data 2	IO direction 0: disable 1: enable
	8	Command Data 3	Reserved

ECM_GPIO_CONFIG_SET(ECM_GpioEnableDebounce) Enable GPIO debounce (GPIO Extension function, only work for ver. 9 or later)			
Command Packet			
Header	1	Command Code	31
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	9
	5	Command Data 0	Bit n: 1 for enable GPIO debounce of GPIOn+16; 0 for disable debounce of GPIOn+16. (n =0 to 3)
	6	Command Data 1	Reserved, set 0.
	7	Command Data 2	IO direction 0: disable 1: enable
	8	Command Data 3	Reserved

ECM_GPIO_CONFIG_SET(ECM_GpioSetDebounceClock) Set debounce clock			
Command Packet			
Header	1	Command	31

		Code	
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	3
	5	Command Data 0	Bit 0 to 3: Debounce clock cycle. The valid value is 0 to 15. Bit 4: Clock source 0: 192M 1: 10K The sampling cycle is 2^(Debounce clock cycle)*(clock period)

ECM_GPIO_CONFIG_SET(ECM_GpioIntEnable) Enable/Disable GPIO interrupt			
Command Packet			
Header	1	Command Code	31
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	1
	5	Command Data 0	Channels From 0 to 20
	6	Command Data 1	Interrupt type 0x0: Disable Interrupt 0x1: Interrupt enable by Rising Edge or Falling Edge 0x2: Interrupt enable by Input Falling Edge 0x3: Interrupt enable by Input Rising Edge

ECM_GPIO_CONFIG_SET(ECM_GpioIntClear) Clear GPIO interrupt flag			
Command Packet			
Header	1	Command Code	31

	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	4
	5	Command Data 0	Bit n: clear GPIOn interrupt flag (n =0 to 7)
	6	Command Data 1	Bit n: clear GPIOn+8 interrupt flag (n =0 to 7)

ECM_GPIO_CONFIG_SET(ECM_GpioIntClear) Clear GPIO interrupt flag (GPIO Extension function, only work for ver. 9 or later)			
Command Packet			
Header	1	Command Code	31
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	6
	5	Command Data 0	Bit n: clear GPIOn interrupt flag (n =0 to 7)
	6	Command Data 1	Bit n: clear GPIOn+8 interrupt flag (n =0 to 7)
	7	Command Data 2	Bit n: clear GPIOn+16 interrupt flag (n =0 to 3)

ECM_GPIO_FUNC_OP(ECM_GpioSetValue) Set GPIO value			
Command Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	0

	4	Command Parameter	0
	5	Command Data 0	Bit n: 1 for setting GPIOn to high, 0 for setting GPIOn to low. (n =0 to 7)
	6	Command Data 1	Bit n: 1 for setting GPIOn+8 to high, 0 for setting GPIOn+8 to low. (n =0 to 7)

ECM_GPIO_FUNC_OP(ECM_GpioExtSetValue) Set GPIO value (Extension function, only work for ver. 9 or later)			
Command Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	2
	5	Command Data 0	Bit n: 1 for setting GPIOn to high, 0 for setting GPIOn to low. (n =0 to 7)
	6	Command Data 1	Bit n: 1 for setting GPIOn+8 to high, 0 for setting GPIOn+8 to low. (n =0 to 7)
	7	Command Data 2	Bit n: 1 for setting GPIOn+16 to high, 0 for setting GPIOn+16 to low. (n =0 to 3)

ECM_GPIO_FUNC_OP(ECM_GpioGetValue) Get GPIO value			
Command Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined

	3	Data Length	0
	4	Command Parameter	1
Return Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	2
Data Section			Bit n: 1 if GPIOn is in input mode and the input is high; 0 if GPIOn is in input mode and the input is low. (n =0 to 15)

ECM_GPIO_FUNC_OP(ECM_GpioExtGetValue) Get GPIO value (Extension function, only work for ver. 9 or later)			
Command Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	3
Return Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	4
Data Section			Bit n: 1 if GPIOn is in input mode and the input is high; 0 if GPIOn is in input mode and the input is low. (n =0 to 19)

ECM_GPIO_FUNC_OP(ECM_GpioGetIntFlag) Get GPIO Interrupt flag

Command Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	5
Return Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	2
Data Section			Bit n: GPIOn interrupt flag (n = 0 to 15)

ECM_GPIO_FUNC_OP(ECM_GpioExtGetIntFlag) Get GPIO Interrupt flag (Extension function, only work for ver. 9 or later)			
Command Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	7
Return Packet			
Header	1	Command Code	32
	2	Index Code	Custom Defined
	3	Data Length	4
Data Section			Bit n: GPIOn interrupt flag (n = 0 to 19)

ECM_QEI_FUNC_OP(ECM_EncOpen) Open and set encoder mode			
Command Packet			
Header	1	Command Code	33
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	4
Data Section			Mode 0x000: X4 free-counting Mode 0x100: X2 free-counting Mode 0x200: X4 compare-counting Mode 0x300: X2 compare-counting Mode

ECM_QEI_FUNC_OP(ECM_EncStart) Start encoder counting			
Command Packet			
Header	1	Command Code	33
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	5

ECM_QEI_FUNC_OP(ECM_EncStop) Stop encoder counting			
Command Packet			
Header	1	Command Code	33
	2	Index Code	Custom Defined
	3	Data Length	0

	4	Command Parameter	6

ECM_QEI_FUNC_OP(ECM_EncGetCount) Get encoder counter value			
Command Packet			
Header	1	Command Code	33
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	21
Return Packet			
Header	1	Command Code	33
	2	Index Code	Custom Defined
	3	Data Length	4
Data Section			Encoder data

ECM_DAC_FUNC_OP(ECM_DacOpen) Open DAC function			
Command Packet			
Header	1	Command Code	34
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	20
Data Section	5	Data	Mode 0x0000: Use ECM_DacSetData() function to trigger DAC output. 0x0010: Use ECM_DacStartConv() function to trigger DAC output. 0x0030: DAC is triggered if DAC_ST pin is low.

			0x1030: DAC is triggered if DAC_ST pin is high. 0x2030: DAC is triggered if DAC_ST pin detect a rising edge. 0x3030: DAC is triggered if DAC_ST pin detect a falling edge.

ECM_DAC_FUNC_OP(ECM_DacClose) Close DAC function			
Command Packet			
Header	1	Command Code	34
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	21

ECM_DAC_FUNC_OP(ECM_DacSetDelayTime) Set DAC delay time			
Command Packet			
Header	1	Command Code	34
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	22
Data Section		Data	Basically the range of this value is from 0 to 1023.(unit: 1/96 us) Consider that DAC needs at least 8us from 0x000 to 0xFFF, DAC delay time is recommended to be greater than 768.

ECM_DAC_FUNC_OP(ECM_DacSetData) Set DAC data			
Command Packet			
Header	1	Command Code	34
	2	Index Code	Custom Defined

	3	Data Length	4
	4	Command Parameter	11
Data Section		Data	Data value: 0 ~ 4095 corresponding to 0 ~ 3.3V

ECM_DAC_FUNC_OP(ECM_DacStartConv) Start DAC conversion			
Command Packet			
Header	1	Command Code	34
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	0

ECM_ADC_FUNC_OP(ECM_AdcOpen) Open ADC function			
Command Packet			
Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	40
Data Section		Data	0x000: single-end mode 0x100: differential mode

ECM_ADC_FUNC_OP(ECM_AdcClose) Close ADC function			
Command Packet			
Header	1	Command Code	35

	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	41

ECM_ADC_FUNC_OP(ECM_AdcConfigSampleModule) Configure ADC trigger source			
Command Packet			
Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	12
	4	Command Parameter	42
Data Section		Data	3 2 1 0 Reserved, set 0 — 0x0 0: software trigger — 0x4 Reserved, set 0 — 0x8

ECM_ADC_FUNC_OP(ECM_AdcGetDataValidFlag) Get ADC data valid flag			
Command Packet			
Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	17
Data Section		Data	Reserved, set 0x1000.

Return Packet			
Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	4
Data Section			Valid flag. The convert data is valid if and only if the valid flag is non-zero.

ECM_ADC_FUNC_OP(ECM_AdcStartConv) Start ADC conversion			
Command Packet			
Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	12
Data Section			Reserved, set 0x1000.

ECM_ADC_FUNC_OP(ECM_AdcGetConvData) Get ADC converted data			
Command Packet			
Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	4
	4	Command Parameter	15
Data Section			Reserved, set 12.
Return Packet			

Header	1	Command Code	35
	2	Index Code	Custom Defined
	3	Data Length	4
Data Section			Convert data. 0 ~ 4095 corresponding to 0 ~ 3.3V

ECM_EEPROM_REQ
Request execute EEPROM write/read order
Use ECM_EEPROM_GET to read return data from ECM_EEPROM_REQ

Command Packet

Header	1	Command Code	38
	2	Index	Custom Defined
	3	Data Length	12

Data Section 1

3	2	1	0	
Slave Number		Operation Code		0
Write Data		Write/Read Location		4
Timeout				8

Location	Length	Name	Description
0x00	2	Operation Code	0 : Read 1 : Write
0x02	2	Slave Number	0~127
0x04	2	Write/Read Location	EEPROM Location
0x06	2	Write Data	Valid Write Operation
0x08	4	Timeout	Maximum Timeout(μs)

ECM_EEPROM_GET Read result from ECM_EEPROM_REQ command			
Command Packet			
Header	1	Command Code	39
	2	Index	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	39
	2	Index	Same as Command Packet Index
	3	Data Length	Valid Data Section Length
	4	Return Value	Operation Error Code
Data Section	1	Get ECM_EEPROM_REQ data back	

ECM_CMD_ECAT_STATE_CHECK Reflash and check slave state			
Command Packet			
Header	1	Command Code	41
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	Slave Number 0xFF: All slaves
	5	Command Data 0	EtherCAT State

ECM_CMD_ECAT_DCSYNC Set DC sync signal source, cycle time, and shift time			
Command Packet			
Header	1	Command	50

		Code	
	2	Index Code	Custom Defined
	3	Data Length	16
	4	Command Parameter	3 2 1 0 DC activate code / Reserved / Slave Number — 0 SYNC0 — 4 8 12
Return Packet			
Header	1	Command Code	50
	2	Index Code	Same as Command Packet Index
	3	Data Length	0

ECM_CMD_FIFO_CLR_OP Clear FIFO			
Command Packet			
Header	1	Command Code	51
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	0: Clear both TxFIFO and RxFIFO 1: Clear TxFIFO only 2: Clear RxFIFO only

ECM_CMD_FIFO_SET_TX_CNT Set Tx FIFO count
Command Packet

Header	1	Command Code	52
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	Tx FIFO count

ECM_CMD_FIFO_GET_TX_CNT Get Tx FIFO count			
Command Packet			
Header	1	Command Code	53
	2	Index Code	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	53
	2	Index	Custom Defined
	3	Data Length	0
	4	Return	Tx FIFO count

ECM_CMD_FIFO_SET_RX_CNT Set Rx FIFO count			
Command Packet			
Header	1	Command Code	54
	2	Index Code	Custom Defined
	3	Data Length	0
	4	Command Parameter	Rx FIFO count

ECM_CMD_FIFO_GET_RX_CNT Get Tx FIFO count			
Command Packet			
Header	1	Command Code	55
	2	Index Code	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	55
	2	Index	Custom Defined
	3	Data Length	0
	4	Return	Rx FIFO count

ECM_CMD_FW_VERSION_GET Read firmware version			
Command Packet			
Header	1	Command Code	56
	2	Index	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	56
	2	Index	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	Firmware Version

ECM_CMD_ECAT_STATE_UPDATE Update ECAT state
Command Code

Header	1	Command Code	57
	2	Index	Custom Defined
	3	Data Length	0

ECM_CMD_ECAT_INT_SET_ENABLE Set interrupt enable mask			
Command Code			
Header	1	Command Code	58
	2	Index	Custom Defined
	3	Data Length	6
	4	Data Parameter	u8INTActiveHigh : INT0/INT1 interrupt signal polar BIT0 : INT0 signal polar (0 for Active low, others vice versa) BIT1 : INT1 signal polar (0 for Active low, others vice versa)
Data Section	1		

3 2 1 0

u32CompIntEnable			0
	u8PeripIntEnable	u8GpioIntEnable	4

u32CompIntEnable : Complex interrupt
BIT31 : EtherCAT package receive
BIT25 : RxFIFO Low threshold
BIT24 : TxFIFO High threshold
BIT23 : CRC error
BIT22 : EtherCAT working counter error

u8GpioIntEnable : GPIO0~7 input interrupt
BIT0 : GPIO00 INT
BIT1 : GPIO01 INT
BIT2 : GPIO02 INT
BIT3 : GPIO03 INT
BIT4 : GPIO04 INT
BIT5 : GPIO05 INT
BIT6 : GPIO06 INT

		BIT7 : GPIO07 INT u8PeripIntEnable : GPIO8~11 & QEI interrupt BIT0 : GPIO08 INT BIT1 : GPIO09 INT BIT2 : GPIO10 INT BIT3 : GPIO11 INT BIT4 : QEI index INT BIT5 : QEI compare INT BIT6 : QEI Over/Under flow INT BIT7 : QEI direction change INT

ECM_CMD_ECAT_INT_GET_ENABLE Get interrupt enable mask			
Command Packet			
Header	1	Command Code	59
	2	Index	Custom Defined
	3	Data Length	6
Return Packet			
Header	1	Command Code	59
	2	Index	Same as Command Packet Index
	3	Data Length	6
	4	Return Value	u8INTActiveHigh : INT0/INT1 interrupt signal polar BIT0 : INT0 signal polar (0 for Active low, others vice versa) BIT1 : INT1 signal polar (0 for Active low, others vice versa)
Data Section	1		

3	2	1	0	
u32CompIntEnable				0
		u8PeripIntEnable	u8GpioIntEnable	4

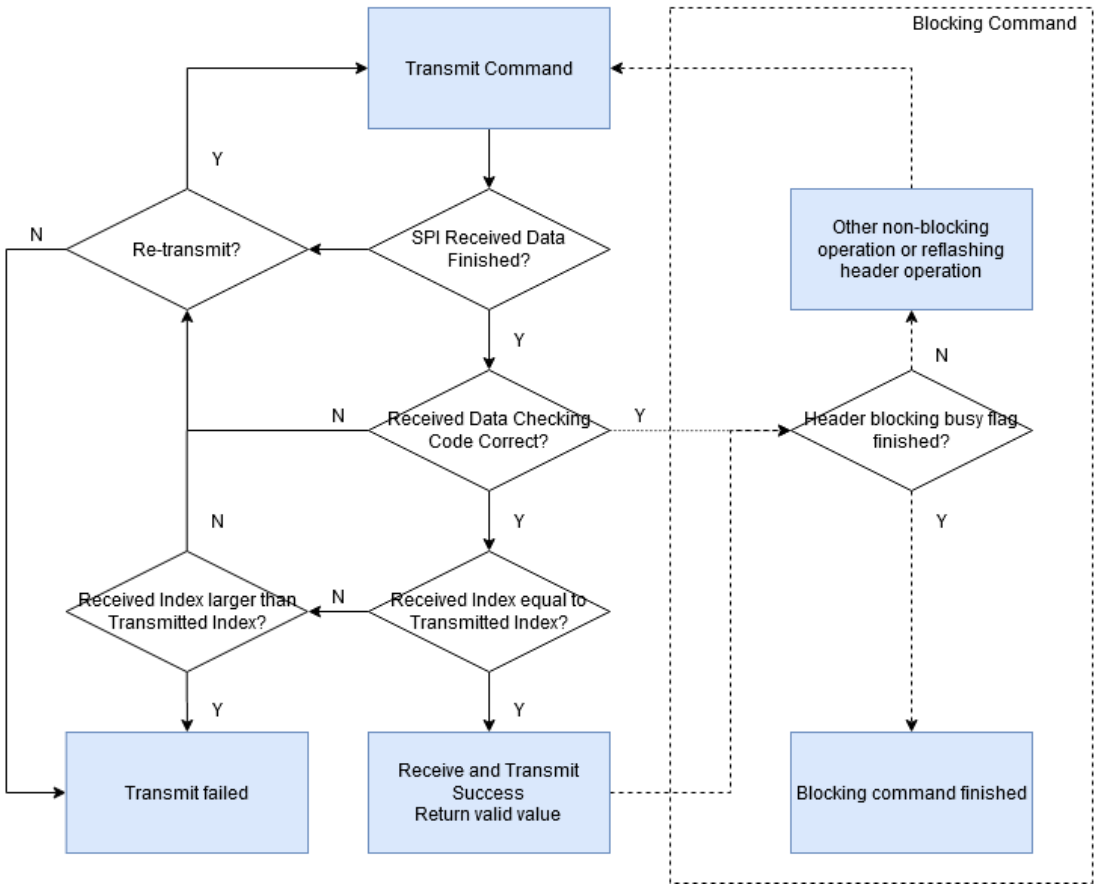
		u32CompIntEnable : Complex interrupt BIT31 : EtherCAT package receive BIT25 : RxFIFO Low threshold BIT24 : TxFIFO High threshold BIT23 : CRC error BIT22 : EtherCAT working counter error u8GpioIntEnable : GPIO0~7 input interrupt BIT0 : GPIO00 INT BIT1 : GPIO01 INT BIT2 : GPIO02 INT BIT3 : GPIO03 INT BIT4 : GPIO04 INT BIT5 : GPIO05 INT BIT6 : GPIO06 INT BIT7 : GPIO07 INT u8PeripIntEnable : GPIO8~11 & QEI interrupt BIT0 : GPIO08 INT BIT1 : GPIO09 INT BIT2 : GPIO10 INT BIT3 : GPIO11 INT BIT4 : QEI index INT BIT5 : QEI compare INT BIT6 : QEI Over/Under flow INT BIT7 : QEI direction change INT

ECM_CMD_FIFO_INIT Initialize FIFO. Construct FIFO memory with FIFO count and PDO data size first.			
Command Packet			
Header	1	Command Code	66
	2	Index	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	66
	2	Index	Same as Command Packet Index
	3	Data Length	0

ECM_CMD_ECAT_WKC_CONTI_ERR_MAX_GET Get EtherCAT working counter error maximum value.			
Command Packet			
Header	1	Command Code	131
	2	Index	Custom Defined
	3	Data Length	0
Return Packet			
Header	1	Command Code	131
	2	Index	Same as Command Packet Index
	3	Data Length	0
	4	Return Value	working counter error maximum value value 255 means infinite

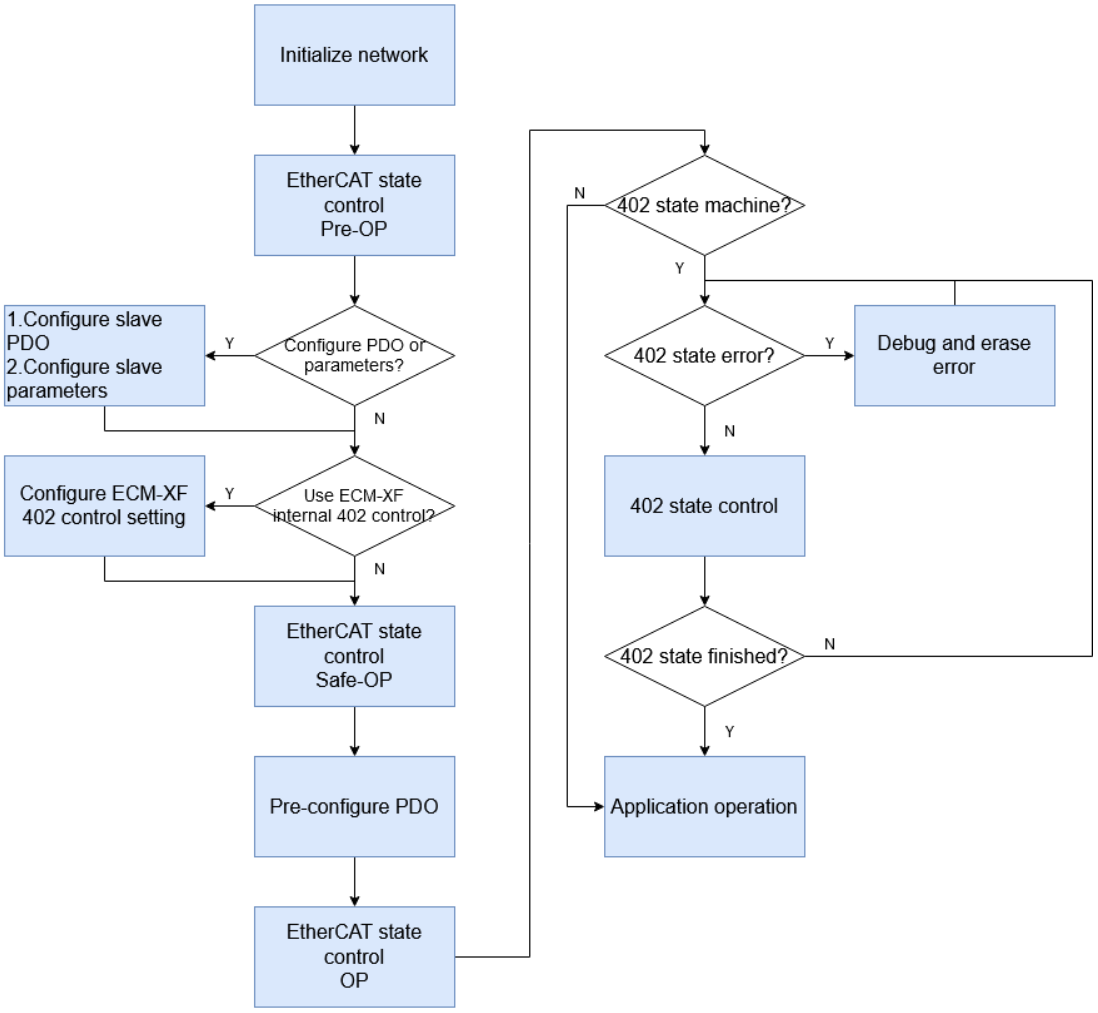
ECM_CMD_ECAT_WKC_CONTI_ERR_MAX_SET Set EtherCAT working counter error maximum value. When the value is larger than the setting, PDO data exchange would be terminated and the flag of Error status bit3/bit5 would turn into 0.			
Command Packet			
Header	1	Command Code	132
	2	Index	Custom Defined
	3	Data Length	0
	4	Parameter	working counter error maximum value default 255(255 means infinite), value range 1~254

ECM-XF Command and Return Access Diagram



Pic 6 Command and Return access diagram

ECM-XF EtherCAT Network Initialization and Slave Configuration



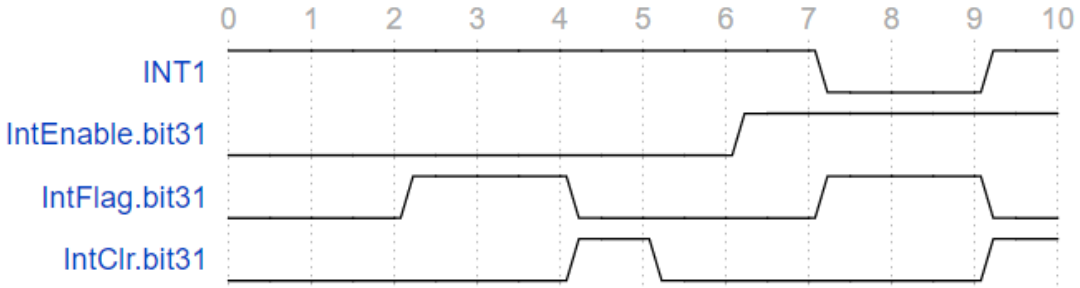
Pic 7. EtherCAT network initialization and configuration diagram

State	Relative Commands	Description
Initialize Network	ECM_CMD_ECAT_INIT_OP	Set DC Mode and Cycle Time
ECAT State Control	ECM_CMD_ECAT_STATE_SET ECM_CMD_ECAT_STATE_GET	Switch to EtherCAT State
Configure slave PDO	ECM_CMD_ECAT_PDO_CONFIG_SET ECM_CMD_ECAT_PDO_CONFIG_REQ ECM_CMD_ECAT_PDO_CONFIG_GET ECM_CMD_ECAT_RECONFIG_OP	Assign or configure PDO
Configure slave parameters	ECM_CMD_ECAT_SDO_REQ ECM_CMD_ECAT_SDO_GET	Use SDO to configure parameters like: control mode, torque limit, etc.
Configure 402 State	ECM_CMD_402_CONFIG_SET	Enable internal 402 control Configure erasing error
402 State Control	ECM_CMD_402_STATE_SET ECM_CMD_402_STATE_GET	Switch 402 state
Preconfigure PDO	ECM_CMD_FIFO_PACK_SIZE_GET ECM_CMD_ECAT_PDO_WC_GET ECM_CMD_ECAT_PDO_DATA_OP	Get PDO Data Size Get PDO communication WKC value Read TxPDO input Initialize RxPDO output
Application Operation	ECM_CMD_ECAT_PDO_DATA_FIFO_OP ECM_CMD_ECAT_SDO_REQ ECM_CMD_ECAT_SDO_GET	PDO data exchange by FIFO Use SDO write/read

	ECM_CMD_INFO_UPDATE_OP	data Reflash state

ECM-XF Interrupts

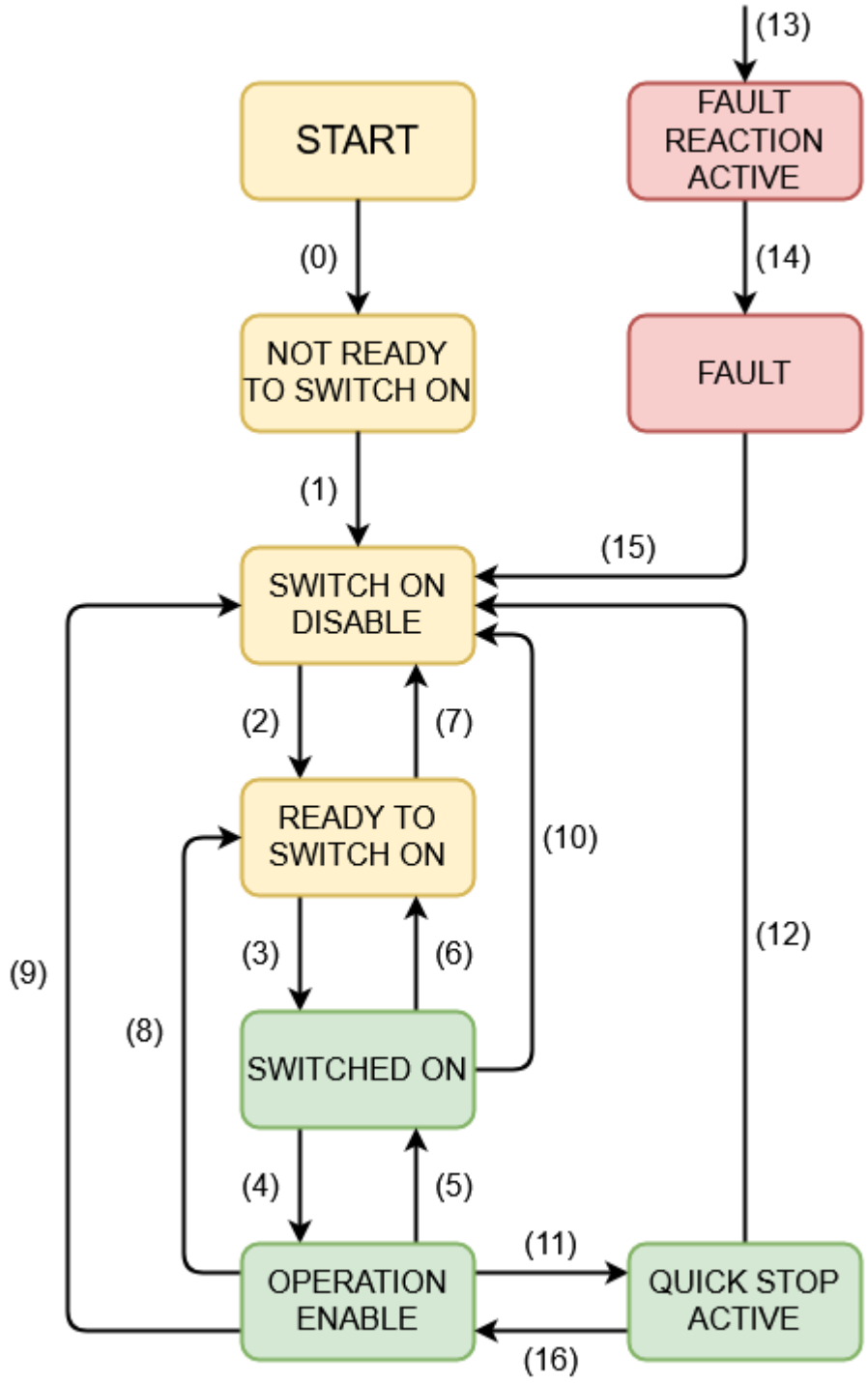
ECM-XF has two interrupt outputs. The INT0 pin is low if SPI is ready. Do not transmit/receive SPI if the INT0 pin is in high state.
INT1 is a general interrupt function pin. If an interrupt enable bit(with function ECM_CMD_ECAT_INT_SET_ENABLE) is set and an interrupt event occurs, the INT1 interrupt is active. Pic 8 shows a scenario where EtherCAT receives events that occur in t=2 and t=7; interrupt mode is low active.



Pic 8. An interrupt example.
INT1 is the hardware signal(ECM-XF PIN 7)
IntEnable is the function ECM_CMD_ECAT_INT_SET_ENABLE
IntFlag is the section of the return header(0x10~0x13)
IntClr is the section of the command header(0x10~0x13)

EtherCAT receive events occur in t=2 and t=7. The bit 31 of IntFlag is set in t=2 and t=7, and is reset if the bit 31 of IntClr is set by SPI master. INT1 is active only if both IntFlag and IntEnable are set. In this case, INT1 is active only in t=7.

Appendix 1. CiA 402 State Machine



Get CiA402 state from transmitting status word(0x0641:0)

Index	Sub	Name	Data Type	Access	PDO Mapping	Default Value
0x6041	00	Status	UINT	RO	Y	*(See

		Word				**below)**

Bit 0 to 3 and bit 5 to 6: for the current state of the drive

Command	bit 6	bit 5	bit 3	bit 2	bit 1	bit 0
Not ready to switch on	**0**	**0**	**0**	**0**	**0**	**0**
Switch on disabled	**1**	**0**	**0**	**0**	**0**	**0**
Ready to switch on	**0**	**1**	**0**	**0**	**0**	**1**
Switched on	**0**	**1**	**0**	**0**	**1**	**1**
Operation enabled	**0**	**1**	**0**	**1**	**1**	**1**
Quick stop active	**0**	**0**	**0**	**1**	**1**	**1**
Fault reaction active	**0**	**0**	**1**	**1**	**1**	**1**
Fault	**0**	**0**	**1**	**0**	**0**	**0**

The following table indicates which functionalities can be activated on every state. External brake can only applied if it is present, and high-level power applied is only selectable in controllers with an embedded contactor/switch for the power stage.

Function	Not Ready to Switch On	Switch On Disable	Ready to Switch On	Switch On	Operation Enabled	Quick Stop Active	Fault Reaction Active	Fault
Brake applied, if present	Yes	Yes	Yes	Yes	Yes/No(*)	Yes/No(*)	Yes/No(*)	Yes

Low-level power applied	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High-level power applied	Yes/No(**)	Yes/No(**)	Yes/No(**)	Yes	Yes	Yes	Yes	Yes/No(**)
Drive function enabled	No	No	No	No	Yes	Yes	Yes	No
Configuration allowed	Yes	Yes	Yes	Yes	No	No	No	Yes
Shunt control enabled	No	No	No	No	Yes	Yes	Yes	No

(*)In some states, brake could be activated and/or deactivated manually.
(**)In some controllers, high-level switch is not present and therefore high level power could not be deactivated.

Transition	Event	Action
0	Automatic transition after power-on or reset application.	Drive device self-test and/or self initialization is performed.
1	Automatic transition after initialization.	Communications are activated.
2	Shutdown command received from control device or local signal.	-

3	Switch on command received from control device and enable signal is activated (if available) or local signal.	The high-level power is switched on.
4	Enable operation command received from control device and enable signal is activated (if available) or local signal.	The drive function is enabled, Initial angle determination process is executed and all internal set-points cleared.
5	Disable operation command received from control device or enable signal is deactivated (if available) or local signal.	The drive function is disabled.
6	Shutdown command received from control device or enable signal is deactivated (if available) or local signal.	The high-level power is switched off.
7	Quick stop or disable voltage command received from control device or local signal.	-
8	Shutdown command received from control device or enable signal is deactivated (if available).	The drive function is disabled, and the high-level power is switched off.

9	Disable voltage command from control device or local signal.	The drive function is disabled, and the high-level power is switched off.
10	Disable voltage or quick stop command received from control device or local signal.	The high-level power is switched off.
11	Quick stop command received from control device or local signal.	The quick stop function is started.
12	Automatic transition when the quick stop function is completed or disable voltage command is received from control device (depending on 0x605A - Quick stop option code).	The drive function is disabled, and the high-level power is switched off.
13	Fault signal.	The configured fault reaction function is executed.
14	Automatic transition.	The drive function is disabled, and the high-level power is switched off.
15	Fault reset command received from control device or local signal.	A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the Fault state, the Fault reset bit in the control word is cleared by the control device.

16	Enable operation command from control device.	The drive function is enabled.

Caution:
※When drive function is disabled, no energy will be supplied to the motor. Target or set-point(torque, velocity, position) in that situation are not processed.
※High-level power is switched off only in systems with contractors or switches for this purpose.
※Enable signal will affect only if it is marked as available in the corresponding register. See Enable/Disable input for further information.

Update Log

Version	Update date (M/D/Y)	Description
022	10.14.2020	Update content copy from Chinese ver. 022
023	10.14.2020	Update interrupt
03	10.14.2020	Update ECM-XF ADC, DAC, GPIO, QEI, and FIFO clear function, resequence all function description
031	10.15.2020	Update set/get Rx/Tx FIFO count
032	01.18.2021	Update Error State(0x09) Update ECM_CMD_ECAT_PDO_CONFIG_SET Command Description
033	01.29.2021	Update ECM_CMD_402_CONFIG_SET ECM_CMD_402_STATE_SET ECM_CMD_402_STATE_GET ECM_CMD_402_CTL_SET ECM_CMD_402_CTL_GET
034	02.18.2021	SPI packet data length correction
035	03.11.2021	Correct unit on timeout, ECM_CMD_CRC_TYPE_SET Add ECM_CMD_ECAT_INIT_DC_OP, ECM_CMD_ECAT_STATE_UPDATE
036	07.09.2021	Add ECM_CMD_FIFO_INIT Modify ECM_CMD_ECAT_INIT_OP content Add DAC delay time content

037	07.29.2021	Add ECM_CMD_ECAT_INT_SET_ENABLE & ECM_CMD_ECAT_INT_GET_ENABLE descriptions Modify interrupt diagram explanation
038	08.04.2021	Add ECM_CMD_ECAT_WKC_CONTI_ERR_MAX_GET and ECM_CMD_ECAT_WKC_CONTI_ERR_MAX_SET
038	08.10.2021	Add ECM_CMD_402_CONFIG_SET internal 402 state machine description