

softMC Training – Module 6

Motion Bus



Contents

- Motion bus in reference to: EtherCAT and CANopen
- Motion bus connections:
 - Cable connections
 - Drive mapping
 - IO module mapping
- Software module
 - Motion Bus libraries and Motion Bus setup programs
 - I/O modules can be connected to the motion bus (may require additional libraries)
- Cyclic Synchronous Position Mode (default)
- Troubleshooting

Cable Connections



MC:EtherCAT → CDHD:C5 and CDHD:C6 → CDHD:C5 and CDHD:C6 → CDHD:C5 ...

EtherCAT Slave Communication States

INIT

- Drive power up. Cable not connected.

PREOP

- EtherCAT cable connected. Yellow LED turned on.

SAFEOP

- Communication with MC established.
Both LEDs blinking fast.

OP

- Cycle-time set. PDOs mapped. System is running.

EtherCAT Operation Modes (CiA 402)

- Set by user in Object 6060h

(1) Profile Position Mode

(3) Profile Velocity Mode

(4) Profile Torque Mode

(6) Homing Mode

(7) Interpolated Position Mode

(8) Cyclic Synchronous Position Mode

(9) Cyclic Synchronous Velocity Mode

(10) Cyclic Synchronous Torque Mode

SDO and PDO

- **SDOs** (Service Data Objects)
 - Used for direct access devices
- **PDOs** (Process Data Objects)
 - Cyclic data transferred every motion bus sample
- Position resolution (MC-Basic global variable)
 - **Pos_Units[*]** array of integers defining the number of units per motor revolution (pitch for linear motors).
This array is assigned by EC_SETUP.PRG with values retrieved from CDHD.
- **Basic EtherCAT interface functions:**
 - **EC_SDO_WRITE**
 - **EC_SDO_READ**
 - **EC_SDO_READ_DOUBLE**
 - **EC_SDO_WRITE_DOUBLE**
 - **EC_SDO_READ_STRING**
 - **EC_PDO_READ**
 - **EC_PDO_WRITE**

SDO and PDO

- **SDOs (Service Data Objects)**
 - Acyclic (on demand) reading/writing data objects in the drive.
 - Data is explicitly checked on write and ACKed or NAKed.
 - Optional retry if data lost.

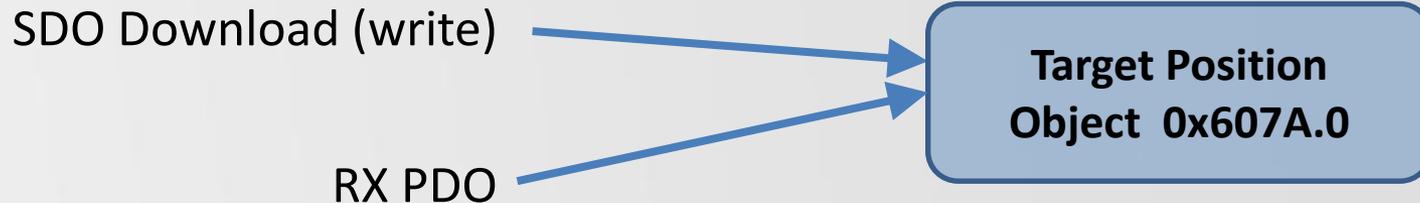
- **PDOs (Process Data Objects)**
 - Cyclic exchange of predefined number of objects.
 - Cyclic data transferred every motion bus sample.
 - No explicit handshake.
 - Incorrect data – drive either ignores or issues general error
 - No retry. Drive or motion controller handles (extrapolates) missing data.

Typical Default PDO Mapping of CDHD

TXPDO		Size in bits	Mapping in Motion Controller
0x6041:00	Status Word	16	axis.dstat
0x6061:00	Modes of Operation Display	8	
0x6077:00	Torque Actual Value	16	
0x6064:00	Position Actual Value	32	axis.cfb
0x606c:00	Velocity Actual Value	32	
0x6078:00	Current Actual Value	16	axis.ctfb
0x6074:00	Torque Demand Value	16	axis.ctdcommand
0x20f2:00	Analog Input 1	16	
0x20f9:00	Analog Input 2	16	
0x60fd:00	Digital inputs	32	sys.din
0x20b6:00	Manuf_Spec_Machine_HW_Position_External_Command	32/	
0x60f4:00	Following Error Actual Value	32	
RXPDO			
0x6040:00	Control Word	16	axis.dcon
0x6060:00	Modes of Operation	8	
0x607a:00	Target Position	32	axis.ccmd
0x6081:00	Profile Velocity	32	axis.vcmd(*)
0x60ff:00	Target Velocity	32	axis.vcmd(*)
0x60b1:00	Velocity Offset	32	
0x60b2:00	Torque Offset	16	
0x6071:00	Target Torque	16	axis.ctcmd
0x60fe:01	Digital Output	32	sys.dout

SDO and PDO

- The same variable (object) in the node (drive) can be accessed over SDO and PDO at the same time.
- Both SDO and PDO access the same variable in the drive.



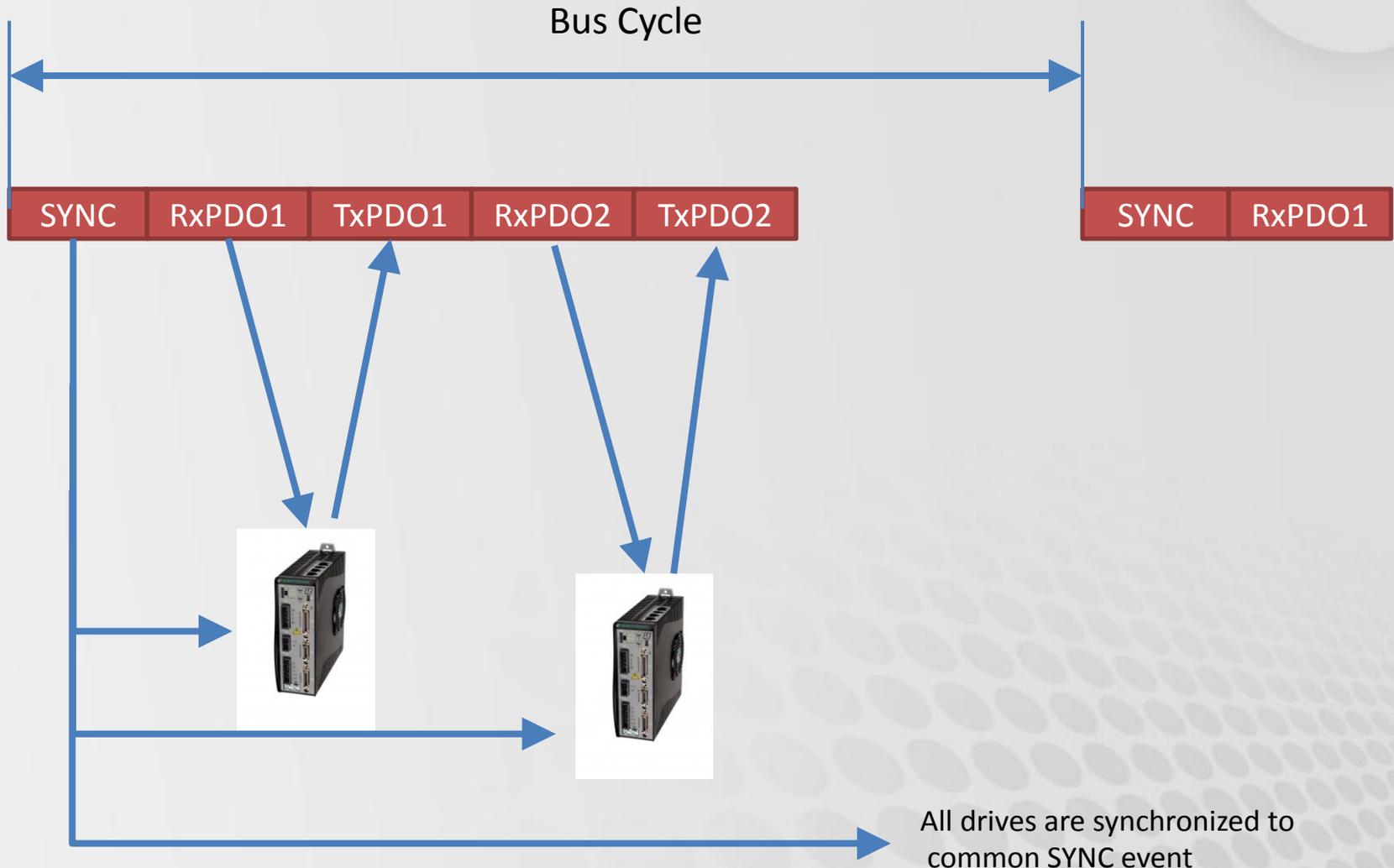
- **Important Note:**
Writing data over both SDO and PDO can lead to inconsistent behavior, since data is constantly being overwritten by PDO

SDO Read/Write

- **?EC_SDO_READ**(*<slave address>*, *<SDO index>*, *<SDO sub-index>*)
 - *<slave address>* drive address (1,2,3, ...)
 - *<SDO index>* object index (0x6073,)
 - *<SDO sub-index>* sub-index (0,1,2,)

- call **EC_SDO_WRITE**(*<slave address>*, *<SDO index>*, *<SDO sub-index>*, *<SDO size in bits>*, *<new value>*)
 - *<slave address>* drive address (1,2,3, ...)
 - *<SDO index>* object index (0x6073,)
 - *<SDO sub-index>* sub-index (0,1,2,)
 - *<SDO size>* bit size (8,16,32,64,)

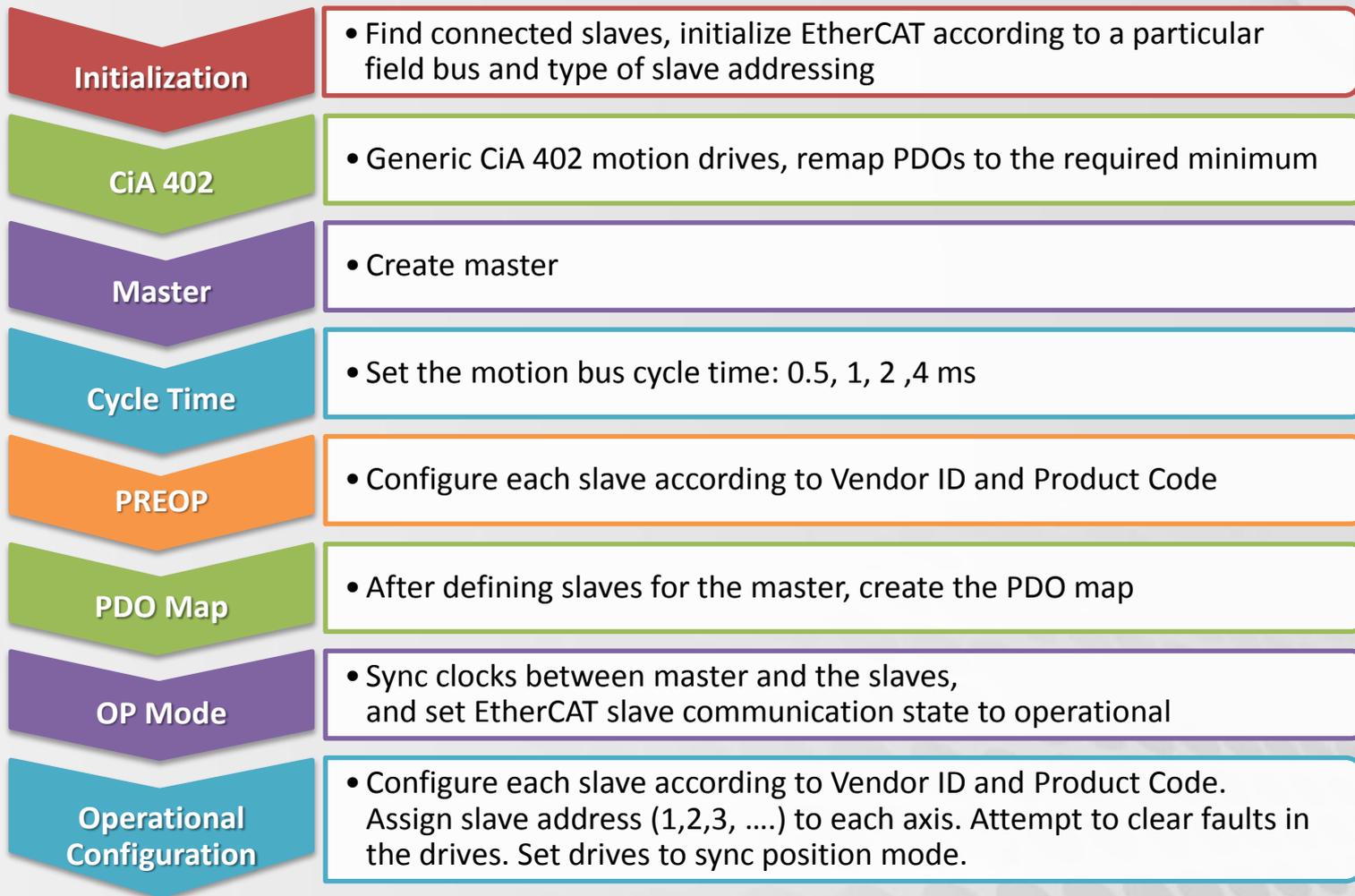
EtherCAT Bus Cycle Traffic (Simplified)



Startup

- Libraries (Global)
 - **ETHERCAT.LIB** – main ECAT library, interface between MC-BASIC and C
 - **EC_USER.LIB** – user specific ECAT interface
 - **EC_CDHD.LIB** – specific CDHD drive library
 - **EC_IOMOD.LIB** – specific ECX-DIO8 2.0 IO module
 - **EC_AI8ME.LIB** – specific AXL_AI_8_ME IO module
 - **CPX_FB38.LIB** – specific CPX-FB38 IO module
 - **EC_HCNC.LIB** – specific HCNC HIO-1065 IO module
- Code
 - Some segments in **CONFIG.PRG** – load ETHERCAT.LIB
 - **EC_START.PRG** – loads libraries and starts the EC_SETUP
 - **EC_SETUP.PRG** – sets up the EtherCAT
- Complete list at: <http://softmc.servotronix.com/wiki/Category:EtherCAT:Functions>

EC_SETUP.PRG



IO Setup

- Default CDHD assignment (performed in EC_SETUP.PRG)
 - 1st Drive

```
sys.din[100] ... sys.din[111]
sys.dout[100] ... sys.dout[106]
```
 - 2nd Drive

```
sys.din[200] ... sys.din[211]
sys.dout[200] ... sys.dout[206]
```
 - 3rd Drive

```
sys.din[300] ... sys.din[311]
sys.dout[300] ... sys.dout[306]
```

Troubleshooting

- ?EC_SLAVES

Address	Mode	Type	Vendor ID	Product Code
0:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
1:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
2:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
3:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
4:00	OP	AXL F BK EC Axioline EtherCAT Bus Coupler	0x84	0x290783
5:00	PREOP	CDHD EtherCAT Drive (CoE)	0x2e1	
6:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	
7:00	OP	CPX-FB38 EtherCAT Bus Node	0x1d	0x26

- ?EC_MASTER

MAC	0:18:7D:37:07:C3
Status	attached
Slaves	8
Phase Operation	
Link	UP
Tx Frames	5185788
Rx Frames	5155354
Lost Frames	30434
Tx Bytes	1656144179
Tx Errors	0
Tx Frame Rate [1/s]	2000
Tx Rate [Kbytes/s]	1146
Tx Loss Rate [1/s]	0
Frame Loss Rate 0.00 [%]	
Ref Clock 0	

Servotronix Wiki Articles

- http://softmc.servotronix.com/wiki/Category:EtherCAT:EC_SETUP
- <http://softmc.servotronix.com/wiki/EtherCAT:DIGITAL-IOS>

- http://softmc.servotronix.com/wiki/EtherCAT:CDHD_CONFIGURE
- http://softmc.servotronix.com/wiki/EtherCAT:EC_INSTALL_STX_CDHD

END