

DEXMART CANopen 說明

REV: 1.0

DATE: 23 Dec 2022

NO: UM-01-S0606

 創盟產品(Dexmart Drive) CANopen 通訊說明

OD列表: <https://docs.google.com/spreadsheets/d/1zoZQ9bN4h2NlkqqKRroGasjJInnI6tD-/edit#gid=715019616>

 支援產品系列: DEV、BVP

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- DEV OD
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- DEV CAN ID

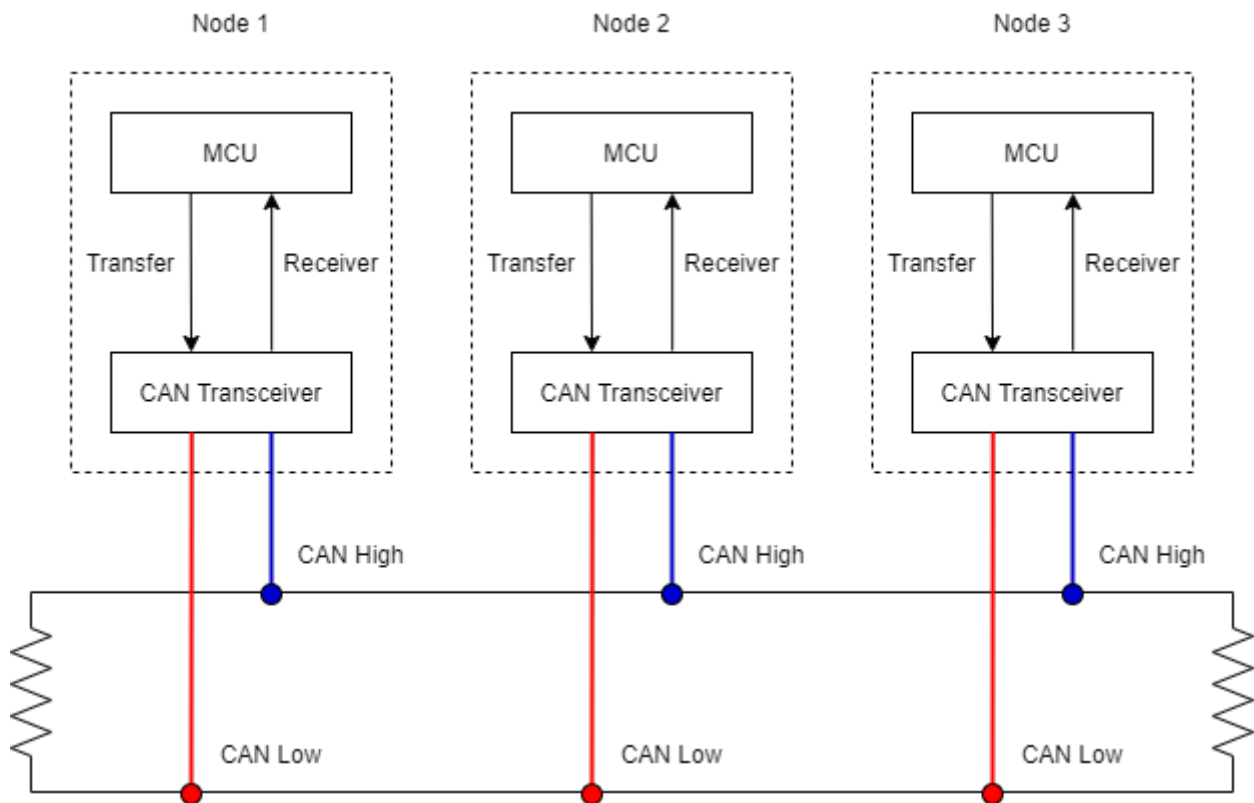
REV HISTORY

REV	DATE	REMARK
1.0	23 Dec 2022	初版發布。

CAN BUS簡介

詳細內容請參考：[成大資工 Wiki - CAN](#)

CAN Bus的硬體線路如下：



CAN Bus的封包格式如下

Base CAN data frame format

S O F	Arbitration field					Control field					Data field					CRC field							
	(base) ID					R	I	r0	DLC				Byte 0	Byte 1	...	Byte 6	Byte 7	Sequence					Delimit er
	Bit 28	Bit 27	...	Bit 19	Bit 18	T	D		Bit 3	Bit 2	Bit 1	Bit 0						Bit 14	Bit 13	...	Bit 1	Bit 0	
						R	E																

Extended CAN data frame format

S O F	Arbitration field										Control field					Data field					CRC field									
	(base) ID					S R R	I D E	(extended) ID					R T R	r1	r0	DLC				Byte 0	Byte 1	...	Byte 6	Byte 7	Sequence					Delimiter
	Bit 28	Bit 27	...	Bit 19	Bit 18			Bit 17	Bit 16	...	Bit 1	Bit 0				Bit 3	Bit 2	Bit 1	Bit 0						Bit 14	Bit 13	...	Bit 1	Bit 0	

簡化如下：

ID + RTR + DLC + Data

項目	說明	備註
ID	ID	NA
RTR	優先判斷與資料接收與否的識別，RTR=dominant(0)，表資料要傳出，RTR=recessive(1)，表要接收資料。	NA
DLC	資料長度：0 ~ 8	NA
Data	資料 0 ~ 8 Byte(s)	NA

Pre-defined CAN-IDs

CAN bus本身在封包上就已經包含了ID的設計

而在CAN Open中，利用不同的CAN-ID來代表不同的通訊Object (SDO · PDO · SYNC · EMCY...等)

底下為 **Pre-defined CAN-IDs**：

CAN-ID	Specification	Object	DEXMART驅動器是否支援
000h	CiA301	NMT 網路管理命令	Yes
001h	CiA304	Global failsafe command全局故障安全命令	No
071h~076h	CiA302-2	Flying master動態主站	No
07Fh	CiA302-6	Indicate active interface標示活動接口	No
080h	CiA301	Sync 同步報文	Yes
081h~0FFh (080h+Node ID)	CiA301	Emergency 緊急報文	Yes
100h	CiA301	Time stamp時間戳報文	No
101h~180h	CiA301	Safety-relevant data objects安全相關數據對象	No
181h~1FFh (180h+Node ID)	CiA301	TPDO1	Yes
201h~27Fh (200h+Node ID)	CiA301	RPDO1	Yes
281h~2FFh (280h+Node ID)	CiA301	TPDO2	Yes
301h~37Fh (300h+Node ID)	CiA301	RPDO2	Yes
381h~3FFh (380h+Node ID)	CiA301	TPDO3	Yes
401h~47Fh (400h+Node ID)	CiA301	RPDO3	Yes
481h~4FFh (480h+Node ID)	CiA301	TPDO4	Yes
501h~57Fh (500h+Node ID)	CiA301	RPDO4	Yes
581h~5FFh (580h+Node ID)	CiA301	Default SDO server-to-client	Yes
601h~67Fh (600h+Node ID)	CiA301	Default SDO client-to-server	Yes
701h~77Fh (700h + Node ID)	CiA301	NMT error control	Yes

SDO (Service Data Object) 通訊

- SDO Basic
- 一、SDO Download (主站將資料寫入從站)
- 二、SDO Upload (主站讀取從站的資料)
 - 2.1 SDO Upload initiate
 - 2.2 SDO Upload segment
- 三、Abort SDO transfer protocol (中斷SDO傳輸)

SDO Basic

SDO 主要用於CANOPEN主站對從站的參數配置，其通訊格式為一問一答形式。

	主站通訊封包	從站通訊封包
ID	600h + Node-ID	580h + Node-ID
DLC	8	8
Data	資料 (不足的補0)	資料 (不足的補0)

一、SDO Download (主站將資料寫入從站)

SDO Download包含SDO Download initiate跟SDO Download segment

 Dexmart Drive 目前僅支援SDO Download initiate

SDO Download initiate · 其通訊格式如下：

ID	RTR	DLC	Data					
600h + Node-ID	0	8	0					1~3
			7~5	4	3~2	1	0	m
			ccs = 1	x	n	e = 1	s = 1	d

從站回應格式如下：

ID	RTR	DLC	Data			
580h + Node-ID	0	8	0		1~3	4~7
			7~5	4~0	m	Reserved
			scs = 3	x		

ccs : Client command specified (1 : Initiate download request)

scs : Server command specified (3 : Initiate download response)

n : 只有 e = 1 而且 s = 1 才有意義，否則 n = 0。若此欄位有意義，則n代表d欄位內沒有資料的Byte數。

e : Transfer type · 目前僅支援 e = 1

0 : Normal transfer

1 : Expedited transfer

s : Size indicator · 目前僅支援 s = 1

0 : 封包內沒有資料大小的資訊

1 : 封包內有資料大小的資訊

m : Multiplexer (多功器) · 前兩個Byte為Index (Byte 1 為Index_L · Byte 2 為 Index_H) · 最後一個Byte為Sub-Index

d : Data (其中Byte4為Least Significant Byte · Byte7為Most Significant Byte)

在 e = 1 而且 s = 1 時，d為寫入的資料，資料長度 = 4 - n

x : 沒有使用 · 數值為0。

底下為 Data 0 寫入各種大小資料的整理

傳送 Data 0	描述	備註
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2Fh	寫1個Byte資料	是否成功寫入可以看回應封包的Data 0 寫入成功：Data 0 = 60h 寫入失敗：Data 0 = 80h (請參考 Abort SDO transfer protocol)
2Bh	寫2個Bytes資料	
27h	寫3個Bytes資料	
23h	寫4個Bytes資料	

ex：想要把 Node-ID = 1 的驅動器，參數 03-01 的EEP數值 (Index = 3003h · Sub-Index = 01h) 設定為 3000 (0BB8h)

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			2Bh	03h	30h	01h	B8	0B	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			60h	03h	30h	01h	00h	00h	00h	00h

二、SDO Upload (主站讀取從站的資料)

2.1 SDO Upload initiate

SDO Upload 包含 SDO Upload initiate 跟 SDO Upload segment。若讀取的資料長度在 4Bytes 以下，則僅需使用SDO Upload initiate即可；反之則需要使用 SDO Upload initiate跟SDO Upload segment。

SDO Upload initiate通訊格式如下：

ID	RTR	DLC	Data							
600h + Node-ID	0	8	0				1~3	4~7		
			7~5	4~0				m	Reserved	
			ccs = 2	x						

從站回應格式如下：

ID	RTR	DLC	Data							
580h + Node-ID	0	8	0				1~3	4~7		
			7~5	4	3~2	1	0	m	d	
			scs = 2	x	n	e	s			

ccs：Client command specified (2：Initiate upload request)

scs：Server command specified (2：Initiate upload response)

n：只有 e = 1 而且 s = 1 才有意義，否則 n = 0。若此欄位有意義，則n代表d欄位內沒有資料的Byte數。

e：Transfer type

0：Normal transfer

1：Expedited transfer

若 e = 1，則表示回傳的資料Byte數不超過 4Bytes (僅需使用SDO Upload initiate 即可完成資料回傳)

s：Size indicator

0：封包內沒有資料大小的資訊

1：封包內有資料大小的資訊

m：Multiplexer (多功器)，前兩個Byte為Index (Byte 1 為Index_L，Byte 2 為 Index_H)，最後一個Byte為Sub-Index

d：Data (其中Byte4為Least Significant Byte，Byte7為Most Significant Byte)

e = 0 · s = 0：d保留

e = 0 · s = 1：d包含回傳資料大小的資訊 (Byte數)

e = 1 · s = 1：d為回傳的資料，資料長度 = 4 - n

$e = 1 \cdot s = 0$: d為未標示資料長度的回傳資料

x : 沒有使用 · 數值為0 ·

P.S 是否成功讀取可以看回應封包的Data 0

回應 Data 0	描述	備註
4Fh	讀回1個Byte資料	正常回應
4Bh	讀回2個Bytes資料	
47h	讀回3個Bytes資料	
43h	讀回4個Bytes資料	
41h	資料長度超過4個Bytes · 後續需要SDO Upload segment 將資料讀回	
80h	資料讀取失敗	請參考 Abort SDO transfer protocol

ex : 讀取Dynamic Data 10 (Index = 3000h · Sub-Index = 0Ah) 的資訊

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			40h	00h	30h	0Ah	00h	00h	00h	00h

從站回應如下 :

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			48h	00h	30h	0Ah	6E	09h	00h	00h

Byte 0 = 4Bh · n = 2 · e = 1 · s = 1 ·

$e = 1 \cdot s = 1$ 表示d為回傳的資料 · 資料長度 = 4 - n = 2

回傳資料 = 096Eh = 2414

2.2 SDO Upload segment

當主站使用 SDO Upload initiate 讀取從站的資料時 · 若回傳的資料Byte數超過4Bytes · 則需要搭配SDO Upload segment 將資料讀回 ·

SDO Upload segment通訊格式如下 :

ID	RTR	DLC	Data			
600h + Node-ID	0	8	0			1~7
			7~5	4	3~0	Reversed
			ccs = 3	t	x	

從站回應格式如下 :

ID	RTR	DLC	Data							
580h + Node-ID	0	8	0				1~7			
			7~5	4	3~1	0	Seg-data			
			scs = 0	t	n	c				

ccs : Client command specified (3 : Upload segment request)

scs : Server command specified (0 : Upload segment response)

t : Toggle bit

兩兩Upload segment request 之間 · t必須不一樣 (0跟1輪流 · 第一個 t 為 0)

Upload segment response 的 t 必須跟 Upload segment request 的 t 一樣

c : 用來指示資料是否全部傳出

0 : 還有資料需要回傳

1 : 資料已全部回傳

Seg-data：單次最多可回傳 7Bytes 資料

n：Seg-data 欄位內沒有資料的Byte數，如果 n = 0，則代表資料大小沒有被指示。

x：沒有使用，數值為0。

ex：讀取驅動器序號 (Index = 3082h · Sub-Index = 0)

首先使用 SDO Upload initiate

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			40h	82h	30h	00h	00h	00h	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			41h	82h	30h	00h	10h	00h	00h	00h

Byte 0 = 41h · n = 0 · e = 0 · s = 1 ·

e = 0 · s = 1：d包含回傳資料大小的資訊 (Byte數)

d = 10h，為回傳資料Byte數

接著使用 SDO Upload segment (t = 0)

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			60h	00h	00h	00h	00h	00h	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			00h	32h	30h	33h	36h	49h	30h	34h

t = 0 · n = 0 · c = 0

c = 0，表示還有資料需要回傳，因此繼續使用 SDO Upload segment (t = 1)

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			70h	00h	00h	00h	00h	00h	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			10h	41h	30h	30h	32h	30h	20h	20h

t = 1 · n = 0 · c = 0

c = 0，表示還有資料需要回傳，因此繼續使用 SDO Upload segment (t = 0)

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			60h	00h	00h	00h	00h	00h	00h	00h

從站回應如下：

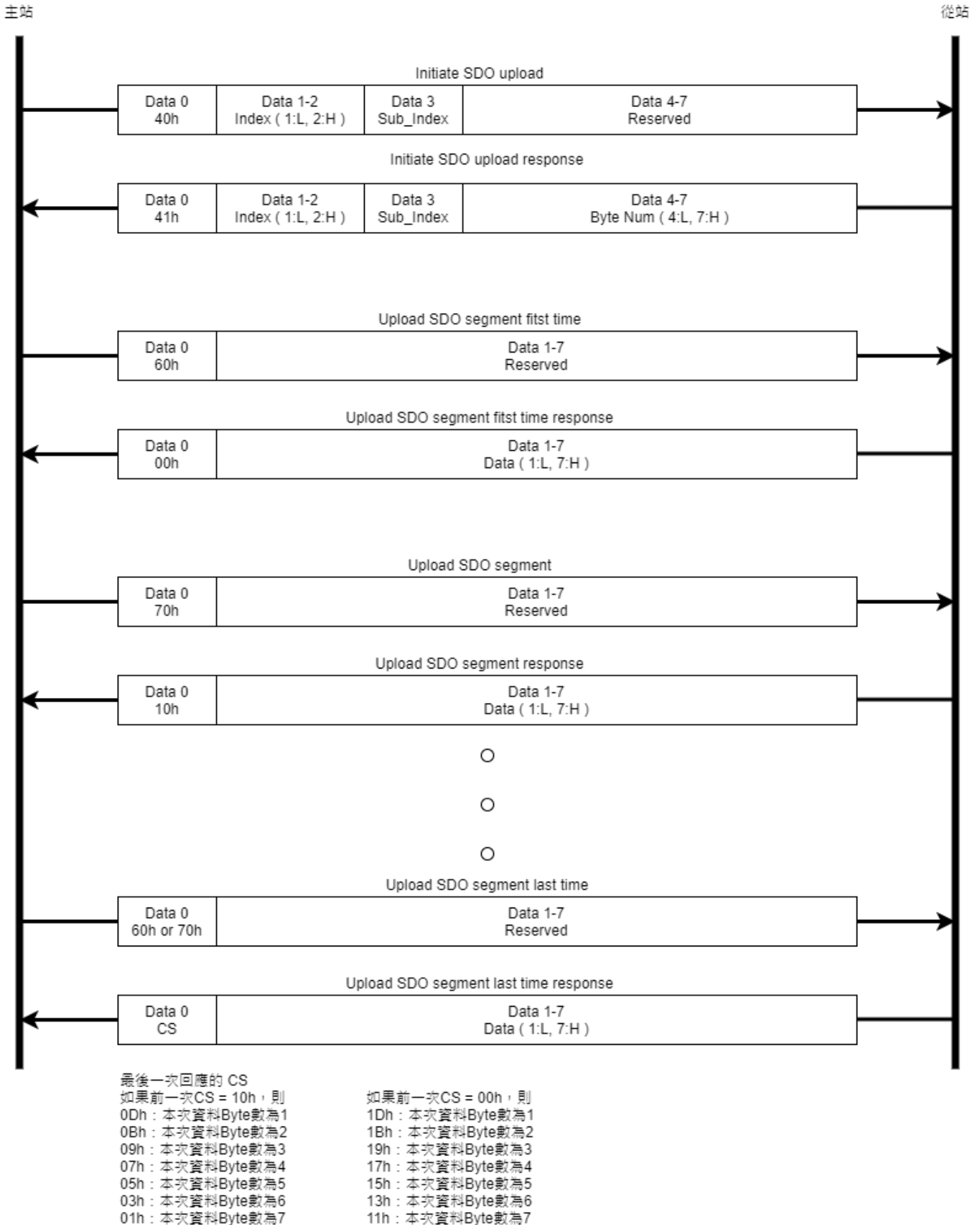
ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			08h	20h	20h	00h	00h	00h	00h	00h

t = 0 · n = 5 · c = 1

c = 1，表示資料已全部傳回，n = 5 則表示最後回傳的資料只有 7 - 5 = 2 Bytes 為回傳資料

綜合以上資訊，回傳的資料為 0x32 · 0x30 · 0x33 · 0x36 · 0x49 · 0x30 · 0x34 · 0x41 · 0x30 · 0x30 · 0x32 · 0x30 · 0x20 · 0x20 · 0x20 · 0x20，由於這是序號，編碼為ASCII Code，解譯後為 2036I04A0020

整理流程圖如下



三、Abort SDO transfer protocol (中斷SDO傳輸)

在某些情況下，主站跟從站都會需要中斷SDO傳輸，例如：讀取唯讀的Object，或者讀取/寫入的物件不存在，亦或是主站基於某種原因需要終止SDO傳輸等。

底下是主站Abort SDO通訊格式：

ID	RTR	DLC	Data		
600h + Node-ID	0	8	0		1~3
			7~5	4~0	m
			cs = 4	x	d

底下是從站Abort SDO通訊格式：

ID	RTR	DLC	Data		
580h + Node-ID	0	8	0		1~3
			7~5	4~0	m
			cs = 4	x	d

cs：Command specified (4：abort transfer request)

m：Multiplexer (多功器)，前兩個Byte為Index (Byte 1 為Index_L，Byte 2 為 Index_H)，最後一個Byte為Sub-Index

x：沒有使用，數值為0。

d：Abort Code，中斷SDO的原因 (其中Byte4為Least Significant Byte，Byte7為Most Significant Byte)

Abort code	Description
0503 0000h	Toggle bit not alternated.
0504 0000h	SDO protocol timed out.
0504 0001h	Client/server command specifier not valid or unknown.
0504 0002h	Invalid block size (block mode only).
0504 0003h	Invalid sequence number (block mode only).
0504 0004h	CRC error (block mode only).
0504 0005h	Out of memory.
0601 0000h	Unsupported access to an object.
0601 0001h	Attempt to read a write only object.
0601 0002h	Attempt to write a read only object.
0602 0000h	Object does not exist in the object dictionary.
0604 0041h	Object cannot be mapped to the PDO.
0604 0042h	The number and length of the objects to be mapped would exceed PDO length.
0604 0043h	General parameter incompatibility reason.
0604 0047h	General internal incompatibility in the device.
0606 0000h	Access failed due to an hardware error.
0607 0010h	Data type does not match, length of service parameter does not match
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0011h	Sub-index does not exist.
0609 0030h	Invalid value for parameter (download only).
0609 0031h	Value of parameter written too high (download only).
0609 0032h	Value of parameter written too low (download only).

0609 0036h	Maximum value is less than minimum value.
060A 0023h	Resource not available: SDO connection
0800 0000h	General error
0800 0020h	Data cannot be transferred or stored to the application.
0800 0021h	Data cannot be transferred or stored to the application because of local control.
0800 0022h	Data cannot be transferred or stored to the application because of the present device state.
0800 0023h	Object dictionary dynamic generation fails or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of a file error).
0800 0024h	0800 0024h No data available

ex : 讀取位址 Index = 3000h, Sub-Index = 21h

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			40h	00h	30h	21h	00h	00h	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			80h	00h	32h	21h	00h	00h	02h	06h

cs = 4 · 表示中斷SDO傳輸

中斷代碼 = 0602 0000h (Object does not exist in the object dictionary)

PDO (Process Data Object) 通訊

- [PDO Basic](#)
- 一、TPDO
 - [1.1 Acyclic synchronous 非循環同步](#)
 - [1.2 Cyclic synchronous 循環同步](#)
 - [1.3 Asynchronous 異步製造商特定事件](#)
 - [1.4 Asynchronous 異步設備子協議特定事件](#)
- 二、RPDO
 - [2.1 Synchronous同步](#)
 - [2.2 Asynchronous異步](#)
- [三、PDO Mapping](#)

PDO Basic

PDO 一般用於傳輸即時性的資料，其特色為單向傳輸，不需要回應。主要分成TPDO跟RPDO

- TPDO為裝置傳送資料
- RPDO為裝置接收資料

 Dexmart drive 支援的 PDO 請參照各機種 OD。如: [DEV OD](#)

PDO 的通訊參數如下：

Index	Sub-Index	Description	Data Type
RPDO :	00h	Number of entries	unsigned 8
1400h : RPDO1	01h	COB-ID	unsigned 32
1401h : RPDO2	02h	Transmission type	unsigned 8
...	03h	Inhibit time	unsigned 16
15FFh : RPDO512	04h	Reserved	
1800h : TPDO1	05h	Event time	unsigned 16
1801h : TPDO2	06h	SYNC start value	unsigned 8
...			
19FFh : TPDO512			

Number of entries : PDO參數數量

COB-ID : PDO傳送或接收的 CAN-ID

Transmission type : 傳輸類型，通常使用循環同步 (01h) 跟異步製造商特定事件 (FEh)

- 00h : Acyclic synchronous 非循環同步
- 01h ~ F0h : Cyclic synchronous 循環同步
- FCh : RTR synchronous 遠程同步 (不支援)
- FDh : RTR asynchronous 遠程異步 (不支援)
- FEh : Asynchronous 異步，製造商特定事件
- FFh : Asynchronous 異步，設備子協議特定事件

Inhibit time : 約束PDO發送的最小間隔，單位為0.1ms

Event time : TPDO方有效，單位為1ms

- Transmission type = 00h : 非循環同步時 : Event timer設定PDO更新的時間
- Transmission type = FFh : 異步設備子協議特定事件時 : Event timer設定PDO更新與傳送的時間
- Transmission type = 其他 : Event timer無功能

SYNC start value : 循環同步傳輸中，若此值不為0，方有效

在收到 SYNC 封包時，需檢查 SYNC Counter 是否等於 SYNC start value，若是則需要將此 SYNC 封包當作收到的第一個SYNC 封包。

一、TPDO

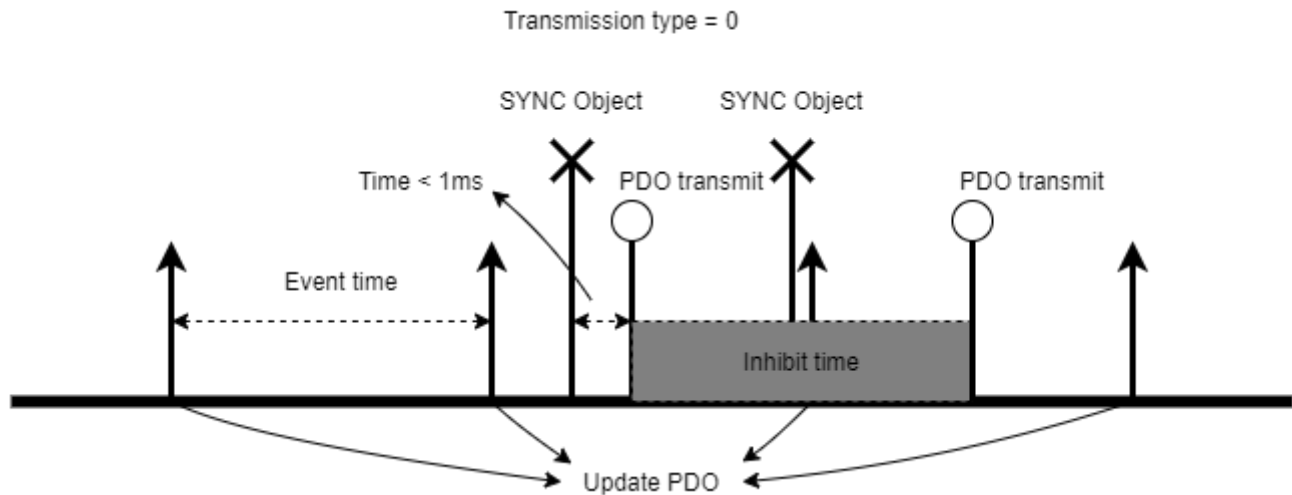
Transmission type可以設定為

- 00h : Acyclic synchronous 非循環同步
- 01h ~ F0h : Cyclic synchronous 循環同步
- FEh : Asynchronous 異步 · 製造商特定事件
- FFh : Asynchronous 異步 · 設備子協議特定事件

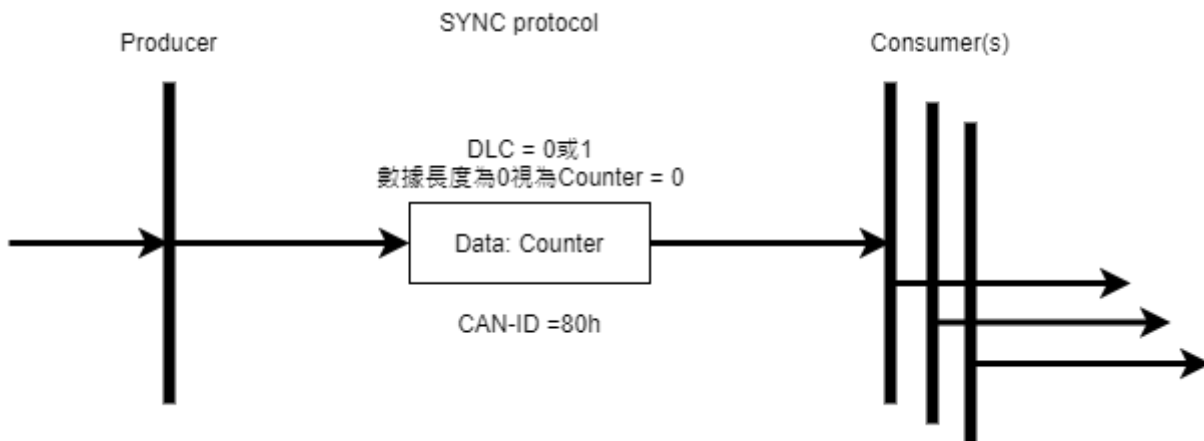
1.1 Acyclic synchronous 非循環同步

當 Transmission type = 0 時 · PDO 傳輸類型為 Acyclic synchronous 非循環同步。

PDO內容會依照 Event timer 之設定來更新 · 在裝置收到同步封包訊號 (SYNC) 時將PDO內容傳出。



其中 · 同步封包訊號 (SYNC) 如下：



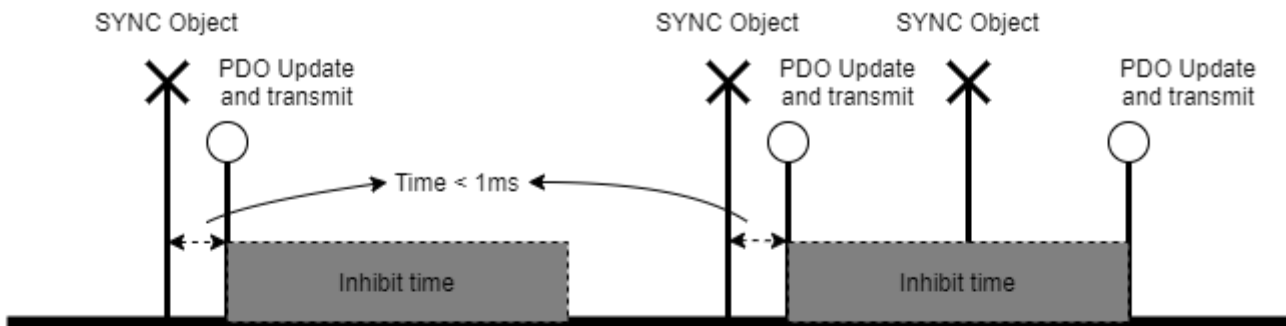
1.2 Cyclic synchronous 循環同步

當 Transmission type = 1 ~ 240 時 · PDO 傳輸類型為 Cyclic synchronous 循環同步。

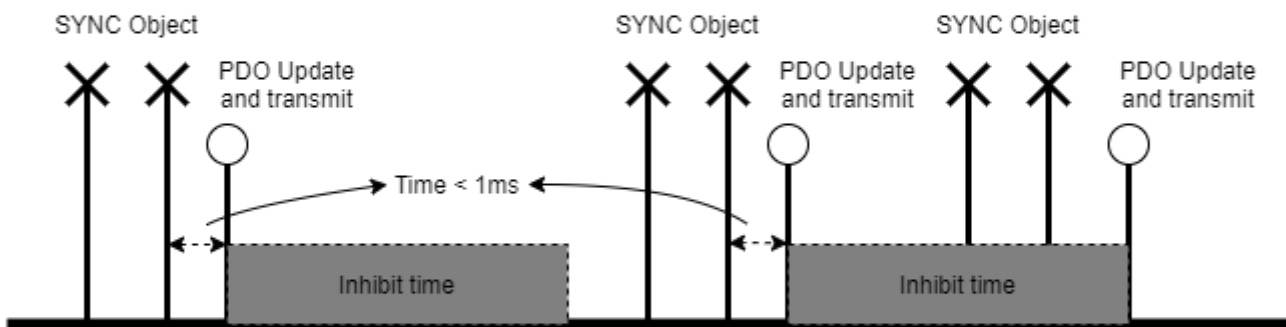
裝置每收到1個同步封包訊號 (SYNC) · 內部計數器會加1 · 當計數器的數值 = Transmission type 時 · PDO會更新內容並且傳出去。

此外 · 若PDO參數 SYNC start value 不為0 · 則在收到 SYNC 封包時 · 裝置會檢查 SYNC Counter 是否等於 SYNC start value · 若是 · 則會將此 SYNC 封包當作收到的第一個SYNC 封包 (內部計數器 = 1)。

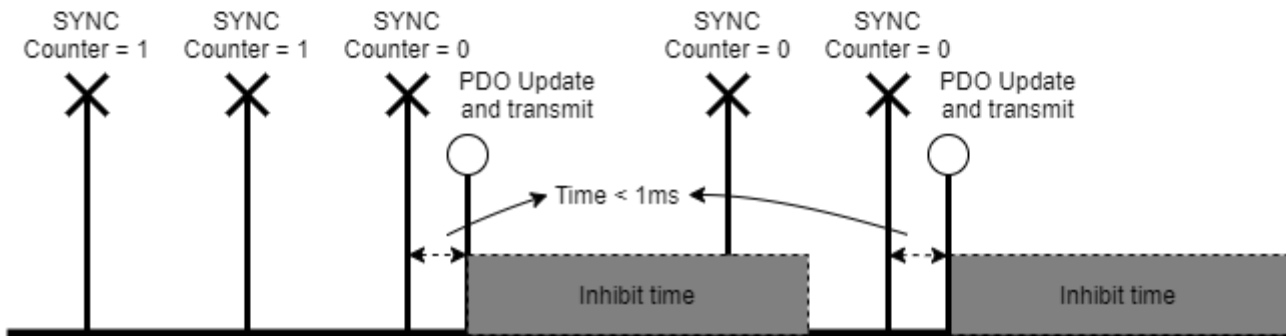
Transmission type = 1



Transmission type = 2; SYNC state value = 0



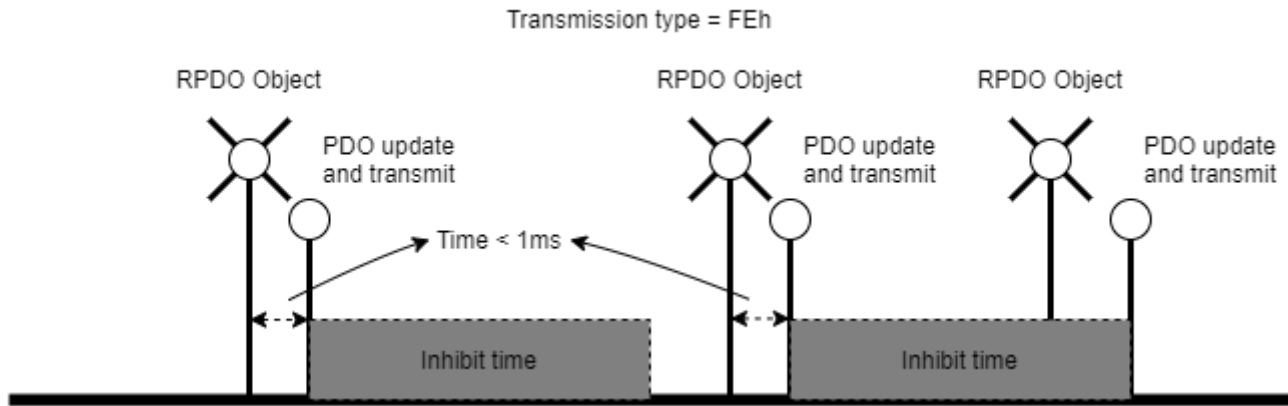
Transmission type = 2; SYNC state value = 1



1.3 Asynchronous 異步製造商特定事件

當 Transmission type = FEh 時，PDO 傳輸類型為 Asynchronous 異步製造商特定事件。

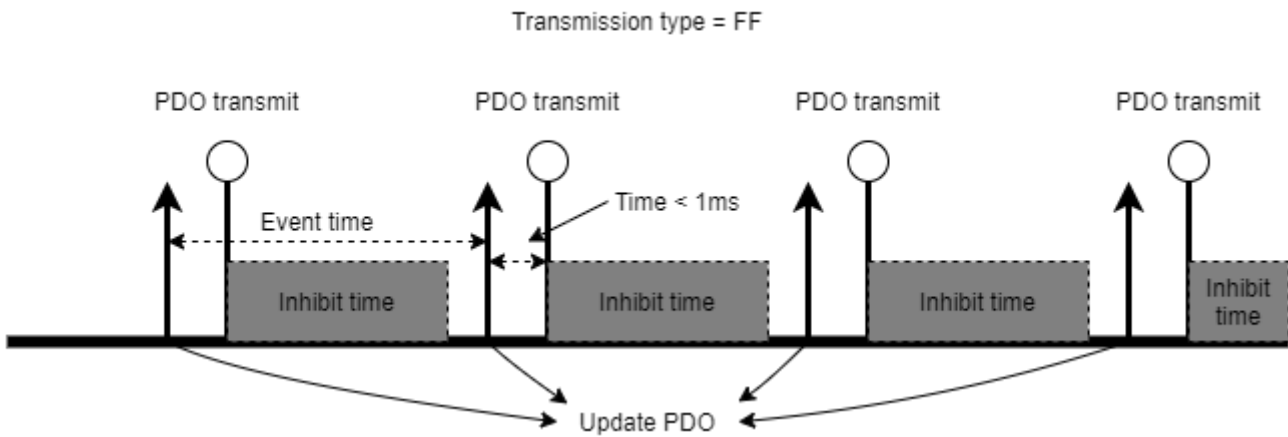
這邊的製造商特定事件為接收到對應的RPDO封包，例如：收到RPDO1後會觸發TPDO1的傳送



1.4 Asynchronous 異步設備子協議特定事件

當 Transmission type = FFh 時，PDO 傳輸類型為 Asynchronous 設備子協議特定事件。

PDO內容會依照 Event timer 之設定來更新以及傳送。



二、RPDO

Transmission type可以設定為

Synchronous同步：00 ~ F0h

Asynchronous異步：FEh ~ FFh

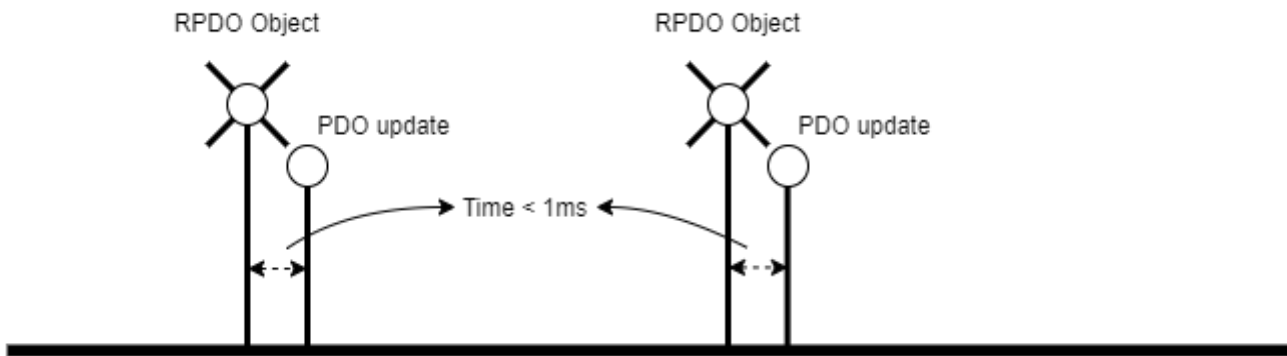
2.1 Synchronous同步

當 Transmission type 為 Synchronous同步時，收到 RPDO 封包，不會馬上拿來使用，需要等待同步封包訊號 (SYNC)：

裝置每收到1個同步封包訊號 (SYNC)，內部計數器會加1，當計數器的數值 $\geq$ Transmission type 時，剛才的 RPDO 封包才會拿來使用。

此外，若PDO參數 SYNC start value 不為0，則在收到 SYNC 封包時，裝置會檢查 SYNC Counter 是否等於 SYNC start value，若是，則會將此 SYNC 封包當作收到的第一個SYNC 封包 (內部計數器 = 1)。

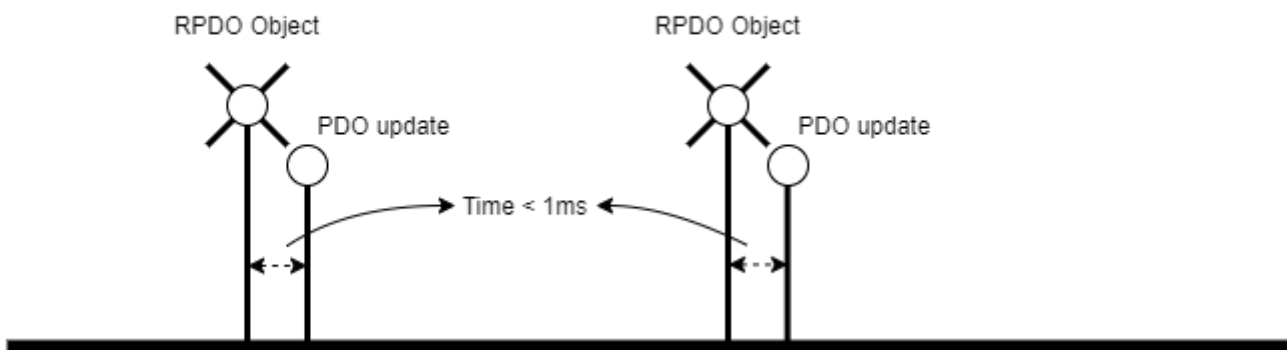
Transmission type = FEh or FFh



2.2 Asynchronous異步

當 Transmission type 為 Asynchronous異步時，收到 RPDO 封包，會馬上拿來使用

Transmission type = FEh or FFh



三、PDO Mapping

前面講了如何傳送PDO資料，以及接收到的PDO資料何時拿來使用，現在我們講講PDO的資料代表的是甚麼。

PDO Mapping 參數

Index	Sub-Index	Description	Data Type
RPDO :	00h	Number of entries	unsigned 8
1600h : RPDO1	01h	Mapping Parameter 1	unsigned 32
1601h : RPDO2	02h	Mapping Parameter 2	unsigned 32
...	03h	Mapping Parameter 3	unsigned 32
17FFh : RPDO512	04h	Mapping Parameter 4	unsigned 32
1A00h : TPDO1	05h	Mapping Parameter 5	unsigned 32
1A01h : TPDO2	06h	Mapping Parameter 6	unsigned 32
...	07h	Mapping Parameter 7	unsigned 32
1BFFh : TPDO512	08h	Mapping Parameter 8	unsigned 32

Number of entries : PDO Mapping 參數數量 (Dexmart drive 最多只到8)

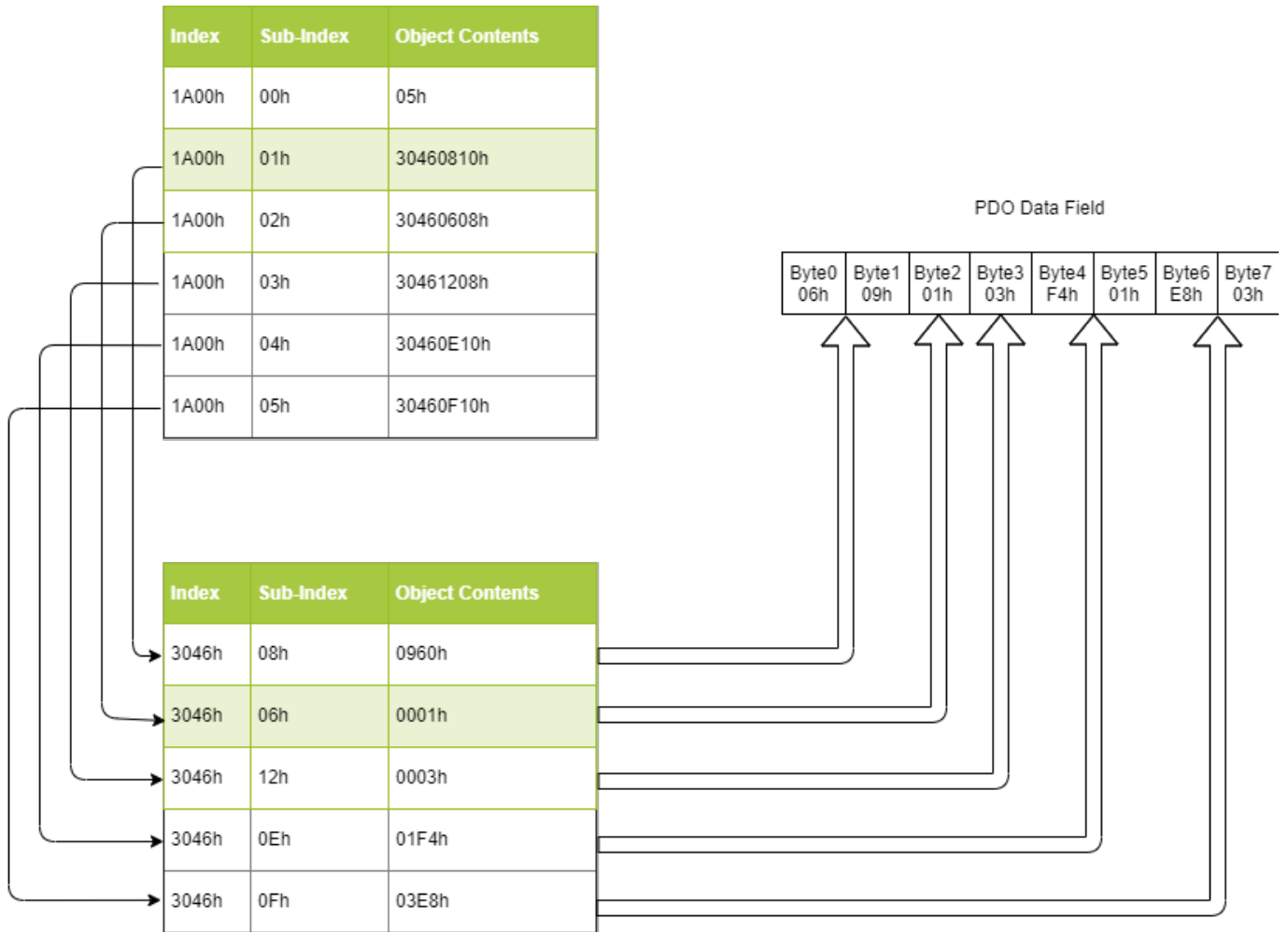
Mapping Parameter 1 ~ 8 : 每一個 Mapping Parameter 對應一個 OD 中 Object，對應方式如下：

Bit 16 ~ 31 : Index

Bit 8 ~ 15 : Sub-Index

Bit 0 ~ 7 : Bit 數 (Dexmart drive 僅支援 8 或 16 Bits)

例如：Mapping Parameter 1 = 30460810h，則對應的OD Object Index = 3046h，Sub-Index = 08h，Bit 數 = 10h (16 Bits)



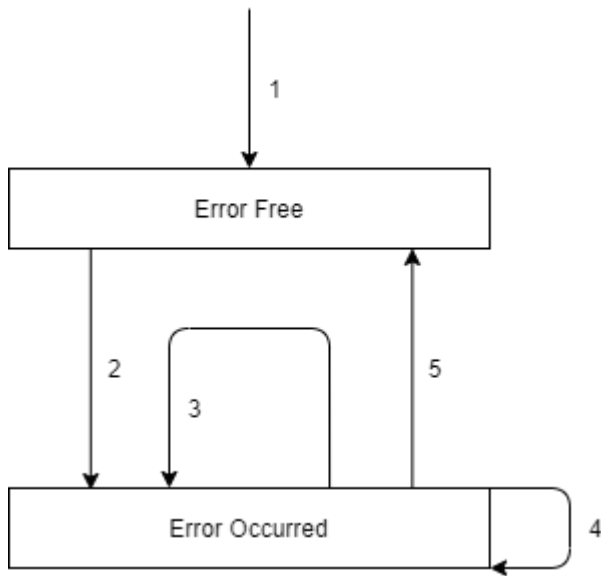
EMCY (Emergency Object)

當裝置偵測到內部錯誤時，會發出 EMCY 封包，並且一個錯誤事件只會發送一次 EMCY 封包。

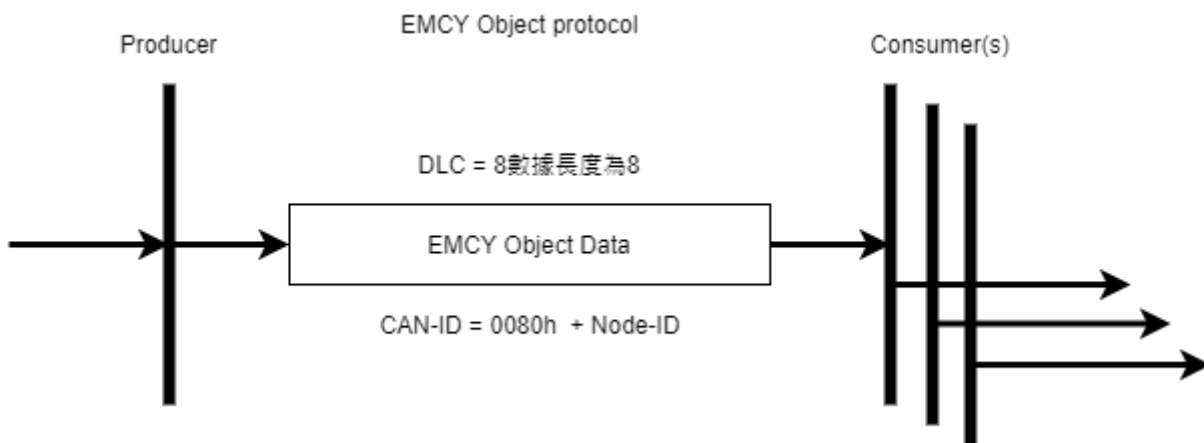
詳細機制如下：

1. 開機後裝置進入Error Free狀態，如果沒有偵測到異常，則不會有任何 EMCY 發送。
2. 如果裝置偵測到一個內部異常，則裝置進入Error State，並且發送 EMCY 封包。
 - a. 此封包前3 Bytes 為 Error Code 跟 Error Register
 - b. 此封包最後5個 Bytes 為製造商定義碼，以DEV系列來說，最後2個Bytes分別為 M1 與 M2 的Alarm Code
3. 如果其中一個內部異常解除 (但並非全部異常都解除)，則裝置維持在Error State，並且需要發送一個 EMCY 封包。
 - a. 此封包前2個 Byte 為 0x0000 (Error Reset)，第3個 Byte 為 Error Register
 - b. 此封包最後5個 Bytes 為製造商定義碼，以DEV系列來說，最後2個Bytes分別為 M1 與 M2 的Alarm Code
4. 如果此時又產生一個新的內部異常，則裝置一樣維持在Error State，並且一樣需要發送一個 EMCY 封包。
 - a. 此封包前3 Bytes 為 Error Code 跟 Error Register
 - b. 此封包最後5個 Bytes 為製造商定義碼，以DEV系列來說，最後2個Bytes分別為 M1 與 M2 的Alarm Code
5. 如果所有的 Error 都被解除，則裝置重新進入 Error Free狀態，並且發送 EMCY 封包。
 - a. 此封包的所有 Byte 皆為 0x00 (No Error)

狀態圖如下：



EMCY 封包如下：



其中 EMCY Object Data如下：

Byte	0	1	2	3	4	5	6	7
Content	EMCY Error Code L	EMCY Error Code H	Error Register	Reserved	Reserved	Reserved	M1 Alarm Code	M2 Alarm Code

其中 EMCY Error Code 如下：

Error code	Error code Description

0000h	Error reset or no error
1000h	Generic error
2000h	Current – generic error
2100h	Current, CANopen device input side – generic
2200h	Current inside the CANopen device – generic
2300h	Current, CANopen device output side – generic
3000h	Voltage – generic error
3100h	Mains voltage – generic
3200h	Voltage inside the CANopen device – generic
3300h	Output voltage – generic
4000h	Temperature – generic error
4100h	Ambient temperature – generic
4200h	Device temperature – generic
5000h	CANopen device hardware – generic error
6000h	CANopen device software – generic error
6100h	Internal software – generic
6200h	User software – generic
6300h	Data set – generic
7000h	Additional modules – generic error
8000h	Monitoring – generic error
8100h	Communication – generic
8110h	CAN overrun (objects lost)
8120h	CAN in error passive mode
8130h	Life guard error or heartbeat error
8140h	recovered from bus off
8150h	CAN-ID collision
8200h	Protocol error - generic
8210h	PDO not processed due to length error
8220h	PDO length exceeded
8230h	DAM MPDO not processed, destination object not available
8240h	Unexpected SYNC data length
8250h	RPDO timeout
9000h	External error – generic error
F000h	Additional functions – generic error
FF00h	Device specific – generic error

Error Register 如下：

Bit	Meaning	備註
0	Generic error	
1	Current	
2	Voltage	

3	Temperature	
4	Communication Error	
5	Device profile specific	
6	Reserved (always 0)	
7	Manufacturer specific	

Network management (NMT) 網路管理

- 一、NMT節點狀態
- 二、NMT節點上線報文 (Boot-up)
- 三、NMT節點心跳報文 (Heartbeat)
- 四、NMT節點狀態切換

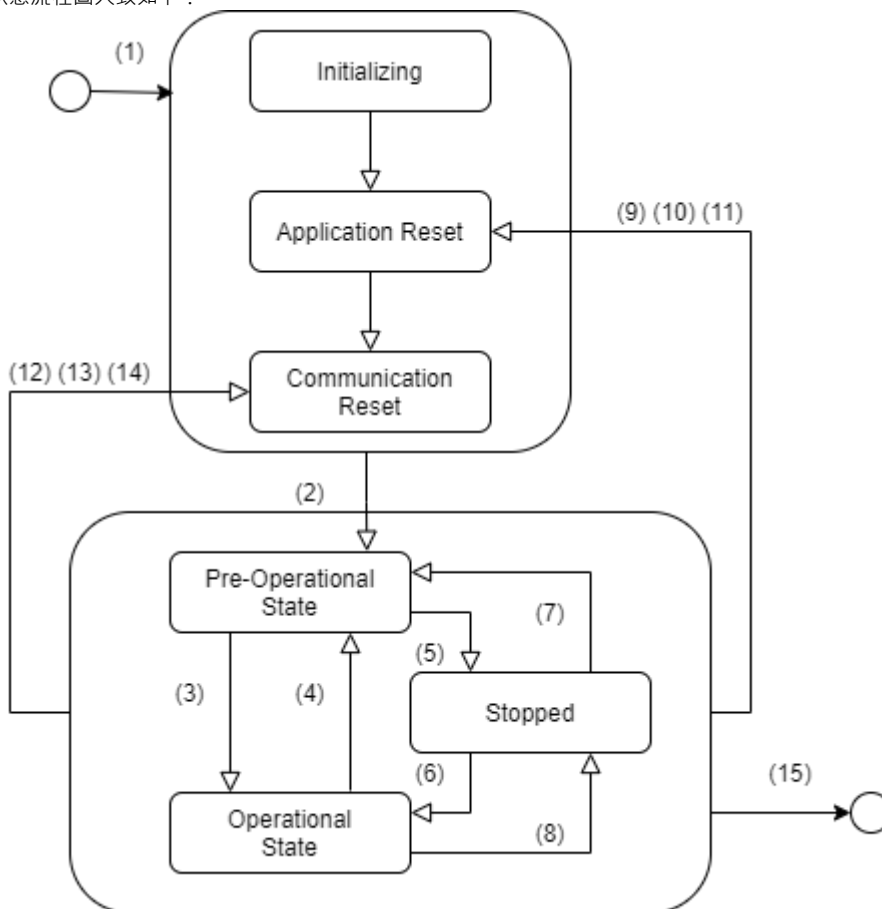
一、NMT節點狀態

CANopen 節點從上電開始, 大致上有6種狀態, 分別為:

1. Initializing : 初始化
2. Application Reset : 應用層重置 (效果相當於重新開機)
3. Communication Reset : CANOPEN通訊重置
4. Pre-operational State : 預操作狀態 (開機後節點會依序執行Initializing, Application Reset與Communication Reset , 接著進入預操作狀態) , 此時除了PDO , 其他通訊都能執行
5. Operational State : 操作狀態 , 此時可以進行所有通訊
6. Stopped : 停止狀態 , 此時可以執行NMT通訊 , 但不能進行其他通訊

	Pre-operational State	Operational	Stopped
PDO		O	
SDO	O	O	
SYNC	O	O	
TIME	O	O	
EMCY	O	O	
Node control and error control	O	O	O

狀態流程圖大致如下:



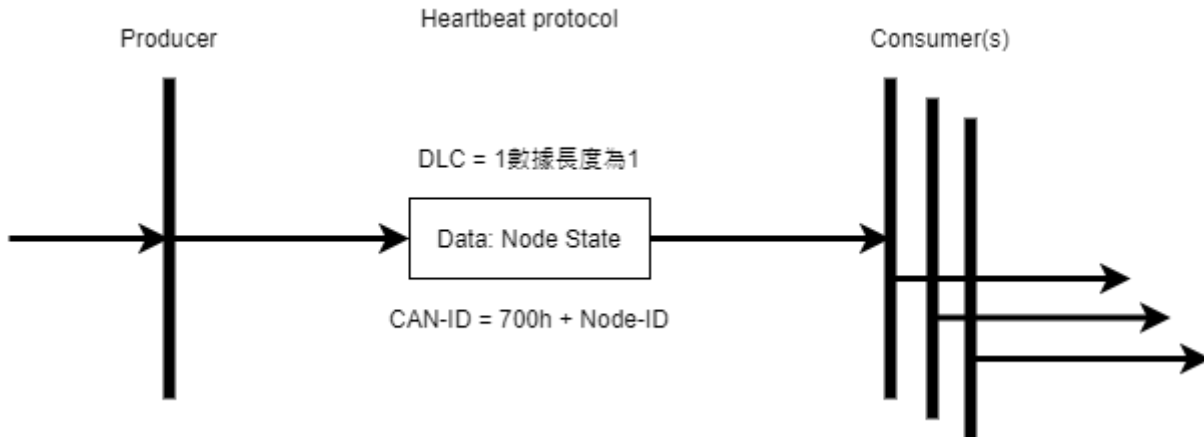
- (1) Power on
- (2) Automatic switch to Pre-operational State
- (3) and (6) NMT switch to Operational State
- (4) and (7) NMT switch to Pre-operational State
- (5) and (8) NMT switch to Stopped

(9), (10) and (11) NMT switch to Application reset
 (12), (13) and (14) NMT switch to Communication reset
 (15) Power-off or hardware reset

二、NMT節點上線報文 (Boot-up)

任何一個節點上線後，必須發出節點上線報文 (為了提醒主站其已上線，以及避免與其他從站Node-ID衝突)：

- ID: 700h + Node-ID
- Data : 0

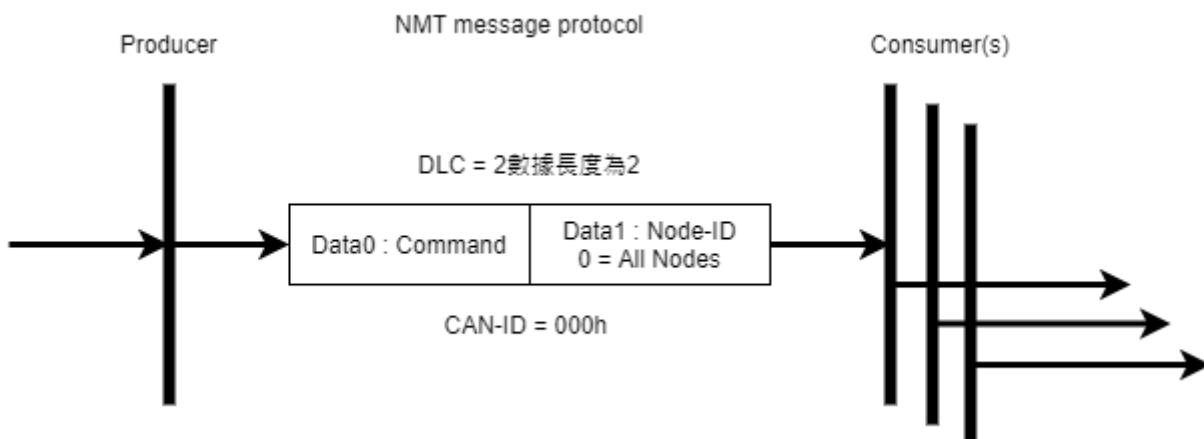


三、NMT節點心跳報文 (Heartbeat)

為了得知節點是否在線以及目前的狀態，主站經常都會要求節點定時發出狀態報文

- ID: 700h + Node-ID
- Data : 節點狀態

Data	節點狀態
00h	Initializing
04h	Stopped
05h	Operational State
7Fh	Pre-operational State



四、NMT節點狀態切換

CANOPEN中，NMT網路管理具有最高級別的優先順序

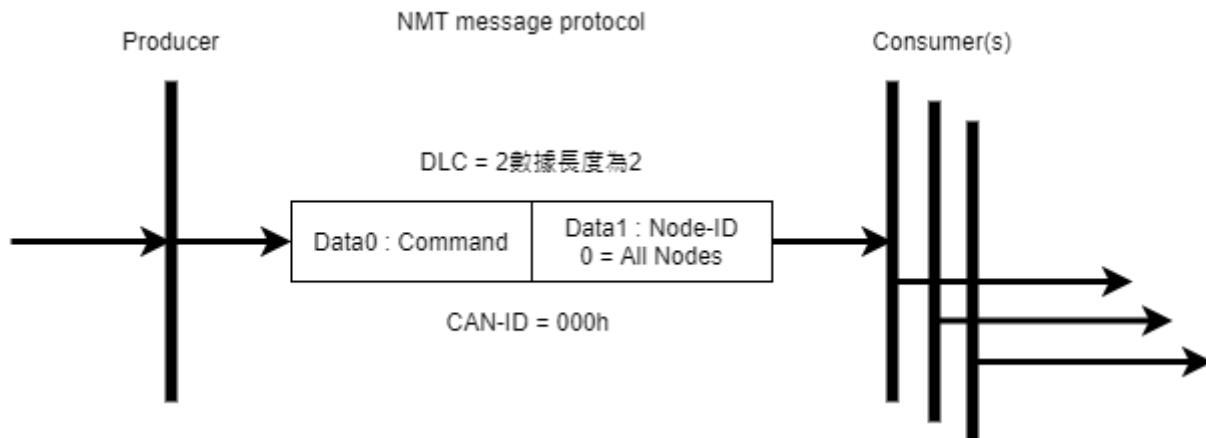
ID : 000h

Data : 資料為2個Byte

- Byte0 : 命令

- Byte1 : Node-ID

Byte0	命令	說明
01h	Start remote node	節點進入Operational State
02h	Stop remote node	節點進入Stopped
80h	Enter pre-operational state	節點進入Pre-operational State
81h	Reset node	應用層重置 (效果相當於重新開機)
82h	Reset communication	讓節點的CANOPEN通訊重新初始化



OD (Object Dictionary)

- 一、通用結構
 - Object dictionary overview
 - Communication profile area
 - General communication objects
- 二、Dexmart drive 參數

一、通用結構

Object Dictionary描述了CANOPEN節點中所有的參數 (這邊用Object來稱呼) · 每個Object用一個主索引 (Index · 2Bytes) 跟副索引 (Sub-Index · 1Byte) 來尋址。

其主要索引如下：

Object dictionary overview

Index Range	Description
0000h	Reserved保留
0001h to 025Fh	Data types 數據類型
0260h to 0FFFh	Reserved保留
1000h to 1FFFh	Communication profile area通訊對象協議區
2000h to 5FFFh	Manufacturer-specific profile area製造商特定子協議區
6000h to 9FFFh	Standardized profile area標準化設備子協議區
A000h to AFFFh	Network variables網路變量 (符合IEC61131-3)
B000h to BFFFh	System variables用于路由網路的系統變量
C000h to FFFFh	Reserved保留

其中Communication profile area通訊對象協議區如下：

Communication profile area

Index Range	Description
1000h to 1029h	General communication objects通用通訊對象
1200h to 12FFh	SDO parameter objects SDO參數對象
1300h to 13FFh	CANopen safety objects 安全對象
1400h to 1BFFh	PDO parameter objects PDO參數對象 1400h~15FFh: RPDO的通訊參數 1600h~17FFh: RPDO的映射參數 1800h~19FFh: TPDO的通訊參數 1A00h~1BFFh: TPDO的映射參數
1F00h to 1F11h	SDO manager objects SDO管理對象
1F20h to 1F27h	Configuration manager objects配置管理對象
1F50h to 1F54h	Program control object程序控制對象
1F80h to 1F89h	NMT master objects網路管理主機對象

其中General communication objects通用通訊對象如下：

General communication objects

Index Range	Type	Description
1000h	VAR	Device type設備類型
1001h	VAR	Error register錯誤暫存器

1002h	VAR	Manufacturer status register製造商狀態暫存器
1003h	ARRAY	Pre-defined error field預定義錯誤場
1005h	VAR	COB-ID Sync message同步報文COB標示符
1006h	VAR	Communication cycle period同步通信循環周期 (單位us)
1007h	VAR	Synchronous windows length同步窗口長度(單位us)
1008h	VAR	Manufacturer device name製造商設備名稱
1009h	VAR	Manufacturer hardware version製造商硬件版本
100Ah	VAR	Manufacturer software version製造商軟件版本
100Ch	VAR	Guard time守護時間 (單位ms)
100Dh	VAR	Life time factor壽命因子 (單位ms)
1010h	VAR	Store parameters保存參數
1011h	VAR	Restore default parameters恢復默認參數
1012h	VAR	COB-ID time stamp時間報文COB標示符 (發送網路時間)
1013h	VAR	High resolution time stamp高分辨率時間標示
1014h	VAR	COB-ID emergency緊急報文COB標示符
1015h	VAR	Inhibit time emergency緊急報文禁止時間 (單位100us)
1016h	ARRAY	Consumer heartbeat time消費者心跳時間間隔(單位ms)
1017h	VAR	Producer heartbeat time生產者心跳時間間隔 (單位ms)
1018h	RECORD	Identity object廠商ID標示對象
1019h	VAR	Sync.counter overflow value同步計數溢出值
1020h	ARRAY	Verify configuration驗證配置
1021h	VAR	Store EDS儲存EDS
1022h	VAR	Storage format儲存格式
1023h	RECORD	OS command操作系统命令
1024h	VAR	OS command mode操作系统命令模式
1025h	RECORD	OS debugger interface操作系统調適接口
1026h	ARRAY	OS prompt操作系统提示
1027h	ARRAY	Module list模塊列表
1028h	ARRAY	Emergency consumer緊急報文消費者
1029h	ARRAY	Error behavior錯誤行為

二、Dexmart drive 參數

Index Range	Type	R/W	Description
3000h	ARRAY	R	創盟Dynamic Data
3001h to 3009h	ARRAY	RW	創盟Parameter EEP
300Ah	VAR	W	創盟Command
300Bh to 3013h	ARRAY	RW	創盟Parameter Default
3014h	VAR	RW	創盟Net-IO Xin
3015h to 301Dh	ARRAY	RW	創盟Parameter Max
301Eh	VAR	R	創盟Net-IO Yout
301Fh to 3027h	ARRAY	RW	創盟Parameter Min

3033h to 303Bh	ARRAY	R	創盟ReadOnly EEP
303Dh to 3045h	ARRAY	RW	創盟Parameter Ram
3046h	ARRAY	R	創盟Monitor Data1
3047h	ARRAY	R	創盟Warning History
3048h	ARRAY	R	創盟Com Error History
3049h	ARRAY	R	創盟Monitor Data2
304Ah	ARRAY	R	創盟Monitor Data3

DEV OD

📘 CANopen Object Dictionary of DEV drives.

- General communication objects
- PDO
 - PDO Setting
 - PDO Mapping
 - 當參數09-26 CANOpen PDO Mapping選擇 = 0 時, PDO Mapping如下
 - 當參數09-26 CANOpen PDO Mapping選擇 = 1 時, PDO Mapping如下
- Modbus Register對應
- Multi-CMD 對應 (Multi-drive / Multi-drive Lite)

General communication objects

Index	Description	Sub-Index	Read or Write	Data Type	參考值	備註
1000h	Device type設備類型	00h	Read Only	unsigned32	00000000h	保留
1001h	Error register錯誤暫存器	00h	Read Only	unsigned8	00h	ErrorRegister = error_reg_m0 error_reg_m1
1002h	Manufacturer status register製造商狀態暫存器	00h	Read Only	unsigned32	00000070h	Byte0 = Motor State M1, Byte1 = Motor State M2
1003h	Pre-defined error field預定義錯誤場	00h	Read /Write	unsigned8	00h	表示歷史錯誤碼的數量 寫入0為清除歷史錯誤碼
		01 ~ 10h	Read Only	unsigned32	00000000h	歷史錯誤碼 Sub-Index 01h 為最新的錯誤碼 (alarm_m1 << 24) (alarm_m0 << 16) error_code
1005h	COB-ID Sync message同步報文COB標示符	00h	Read Only	unsigned32	000000080h 200000080h	11Bits-ID : 00000080h 29Bits-ID : 20000080h
1006h	Communication cycle period同步通信循環周期 (單位us)	00h	Read Only	unsigned32	00000000h	保留
1007h	Synchronous windows length同步窗口長度(單位us)	00h	Read Only	unsigned32	00000000h	保留
1008h	Manufacturer device name製造商設備名稱	00h	Read Only	String	"DLV-N050CQE"	
1009h	Manufacturer hardware version製造商硬件版本	00h	Read Only	String	"1", "2", "3"	"1" = A版, "2" = B版, 依此類推
100Ah	Manufacturer software version製造商軟件版本	00h	Read Only	String	"I04VDU1V0201a2021092210"	
100Ch	Guard time守護時間 (單位ms)	00h	Read Only	unsigned16	0000h	保留
100Dh	Life time factor壽命因子 (單位ms)	00h	Read Only	unsigned8	00h	保留
1010h	Store parameters保存參數	00h	Read Only	unsigned8	04h	表示最大可支援的Sub-Index
		01 ~ 04h	Read Only	unsigned32	00000000h	
1011h	Restore default parameters恢復默認參數	00h	Read Only	unsigned8	04h	表示最大可支援的Sub-Index
		01 ~ 04h	Read Only	unsigned32	00000000h	
1014h	COB-ID emergency緊急報文COB標示符	00h	Read Only	unsigned32	000000080h + Node-ID 29Bits-ID : 20000080h + Node-ID	

					20000080h + Node-ID	
1017h	Producer heartbeat time生產者心跳時間間隔 (單位ms)	00h	Read /Write	unsigned 16	0000h	 初始數值 = 開機時從參數 09-29 讀取

PDO

PDO Setting

Index	Description	Sub-Index	Read or Write	Data Type	參考值	備註
1400h 1401h 1402h 1403h	RPDO1 通訊參數 RPDO2 通訊參數 RPDO3 通訊參數 RPDO4 通訊參數	00h	Read Only	unsigned8	06h	表示最大可支援的Sub-Index
		01h	Read Only	unsigned 32	RPDO1 00000200h + Node-ID 11Bits-ID : 00000200h + Node-ID 29Bits-ID : 20000200h + Node-ID RPDO2 20000200h + Node-ID 11Bits-ID : 00000300h + Node-ID 29Bits-ID : 20000300h + Node-ID RPDO3 00000300h + Node-ID 11Bits-ID : 00000400h + Node-ID 29Bits-ID : 20000400h + Node-ID RPDO4 20000300h + Node-ID 11Bits-ID : 00000500h + Node-ID 29Bits-ID : 20000500h + Node-ID RPDO3 00000400h + Node-ID 11Bits-ID : 20000400h + Node-ID RPDO4 00000500h + Node-ID 11Bits-ID : 20000500h + Node-ID	此 PDO COB-ID
		02h	Read /Write	unsigned8	FEh	TransmissionType Synchronous同步 : 00 ~ F0h Asynchronous異步 : FEh ~ FFh  上電初始值由參數09-28 CANOpen RPDO Trigger Type設定 0: TransmissionType = FEh 1: TransmissionType = 01h 2: TransmissionType = 02h 3: TransmissionType = 03h 4: TransmissionType = 04h 其他: TransmissionType = FEh
		03h	Read /Write	unsigned16	0Ah	InhibitTime(單位:0.1us) RPDO 中無功能
		04h	Read Only	unsigned8	00h	保留
		05h	Read /Write	unsigned16	0Ah	EventTime (單位: 1ms) RPDO 中無功能
		06h	Read /Write	unsigned8	00h	SYNC_StartValue
1800h 1801h 1802h 1803h	TPDO1 通訊參數 TPDO2 通訊參數 TPDO3 通訊參數 TPDO4 通訊參數	00h	Read Only	unsigned8	06h	表示最大可支援的Sub-Index
		01h	Read Only	unsigned 32	TPDO1 00000180h + Node-ID 11Bits-ID : 00000180h + Node-ID 29Bits-ID : 20000180h + Node-ID TPDO2 20000180h + Node-ID 11Bits-ID : 00000280h + Node-ID 29Bits-ID : 20000280h + Node-ID TPDO3 00000280h + Node-ID 11Bits-ID : 00000380h + Node-ID 29Bits-ID : 20000380h + Node-ID TPDO4 20000280h + Node-ID 11Bits-ID : 00000480h + Node-ID 29Bits-ID : 20000480h + Node-ID TPDO3 00000380h + Node-ID	此 PDO COB-ID

					20000380h + Node-ID TPDO4 00000480h + Node-ID 20000480h + Node-ID
	02h	Read /Write	unsigned8	FEh	TransmissionType Acyclic synchronous 非循環同步: 0 Cyclic synchronous 循環同步: 01h ~ F0h Asynchronous 異步製造商特定事件: FEh Asynchronous 異步設備子協議特定事件: FFh
	03h	Read /Write	unsigned16	0Ah	InhibitTime(單位:0.1us)
	04h	Read Only	unsigned8	00h	保留
	05h	Read /Write	unsigned16	0Ah	EventTime (單位: 1ms)
	06h	Read /Write	unsigned8	00h	SYNC_StartValue

i 上電初始值由參數09-27 CANOpen TPDO Trigger Type設定

0 : TransmissionType = FEh (TPDO在收到RPDO後傳送)
 1 : TransmissionType = 01h
 2 : TransmissionType = 02h
 3 : TransmissionType = 03h
 4 : TransmissionType = 04h
 5 : TransmissionType = FEh (TPDO在收到RPDO1後傳送)
 6 : TransmissionType = FEh (TPDO在收到RPDO2後傳送)
 7 : TransmissionType = FEh (TPDO在收到RPDO3後傳送)
 8 : TransmissionType = FEh (TPDO在收到RPDO4後傳送)
 9 : TransmissionType = FFh; EventTime = 10
 10 : TransmissionType = FFh; EventTime = 25
 11 : TransmissionType = FFh; EventTime = 50
 12 : TransmissionType = FFh; EventTime = 100
 13 : TransmissionType = FFh; EventTime = 250
 14 : TransmissionType = FFh; EventTime = 500
 15 : TransmissionType = FFh; EventTime = 1000

PDO Mapping

i PDO Mapping 參數上電時的初始值由參數09-26 CANopen PDO Mapping 選擇決定。
 上電後可透過 SDO 依照需求修改 PDO Mapping。

當參數09-26 CANOpen PDO Mapping選擇 = 0 時, PDO Mapping如下

Index	Description	Sub-Index	Read or Write	Data Type	參考值	備註
1600h	RPDO1 Mapping	00h	Read /Write	unsigned8	03h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned32	30510108h	Index = 3051h, Sub-Index = 01h, Size = 8Bits, M1: MultiDrive CMD
		02h	Read /Write	unsigned32	30510210h	Index = 3051h, Sub-Index = 02h, Size = 16Bits, M1: MultiDrive Data1
		03h	Read /Write	unsigned32	30510310h	Index = 3051h, Sub-Index = 03h, Size = 16Bits, M1: MultiDrive Data2
		04h	Read /Write	unsigned32	00000000h	
		05h	Read /Write	unsigned32	00000000h	
		06h	Read /Write	unsigned32	00000000h	
		07h	Read /Write	unsigned32	00000000h	
		08h	Read /Write	unsigned32	00000000h	
1601h	RPDO2 Mapping	00h			03h	表示最大有意義的Sub-Index

			Read /Write	unsigned d8		
		01h	Read /Write	unsigned d32	30520108h	Index = 3052h, Sub-Index = 01h, Size = 8Bits, M2: MultiDrive CMD
		02h	Read /Write	unsigned d32	30520210h	Index = 3052h, Sub-Index = 02h, Size = 16Bits, M2: MultiDrive Data1
		03h	Read /Write	unsigned d32	30520310h	Index = 3052h, Sub-Index = 03h, Size = 16Bits, M2: MultiDrive Data2
		04h	Read /Write	unsigned d32	00000000h	
		05h	Read /Write	unsigned d32	00000000h	
		06h	Read /Write	unsigned d32	00000000h	
		07h	Read /Write	unsigned d32	00000000h	
		08h	Read /Write	unsigned d32	00000000h	
1602h	RPDO3 Mapping	00h	Read /Write	unsigned d8	03h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	30140010h	Index = 3014h, Sub-Index = 00h, Size = 16Bits, Net-IO
		02h	Read /Write	unsigned d32	303F0110h	Index = 303Fh, Sub-Index = 01h, Size = 16Bits, M1: Digital Speed 0
		03h	Read /Write	unsigned d32	303F1110h	Index = 303Fh, Sub-Index = 11h, Size = 16Bits, M2: Digital Speed 0
		04h	Read /Write	unsigned d32	00000000h	
		05h	Read /Write	unsigned d32	00000000h	
		06h	Read /Write	unsigned d32	00000000h	
		07h	Read /Write	unsigned d32	00000000h	
		08h	Read /Write	unsigned d32	00000000h	
1603h	RPDO4 Mapping	00h	Read /Write	unsigned d8	04h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	305B0108h	Index = 305Bh, Sub-Index = 01h, Size = 8Bits, M1: MultiDrive-Lite CMD
		02h	Read /Write	unsigned d32	305B0210h	Index = 305Bh, Sub-Index = 02h, Size = 16Bits, M1: MultiDrive-Lite Data
		03h	Read /Write	unsigned d32	305C0108h	Index = 305Ch, Sub-Index = 01h, Size = 8Bits, M2: MultiDrive-Lite CMD
		04h	Read /Write	unsigned d32	305C0210h	Index = 305Ch, Sub-Index = 02h, Size = 16Bits, M2: MultiDrive-Lite Data
		05h	Read /Write	unsigned d32	00000000h	
		06h	Read /Write	unsigned d32	00000000h	
		07h	Read /Write	unsigned d32	00000000h	
		08h	Read /Write	unsigned d32	00000000h	
1A00h	TPDO1 Mapping	00h	Read /Write	unsigned d8	05h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	30460108h	Index = 3046h, Sub-Index = 01h, Size = 8Bits, M1: Motor State
		02h	Read /Write	unsigned d32	30460208h	Index = 3046h, Sub-Index = 02h, Size = 8Bits, M1: Alarm Code

		03h	Read /Write	unsigned d32	3046051 0h	Index = 3046h, Sub-Index = 05h, Size = 16Bits, M1: Current Speed
		04h	Read /Write	unsigned d32	3046161 0h	Index = 3046h, Sub-Index = 16h, Size = 16Bits, M1: Current Encoder Index
		05h	Read /Write	unsigned d32	3046171 0h	Index = 3046h, Sub-Index = 17h, Size = 16Bits, M1: Current Encoder Pos
		06h	Read /Write	unsigned d32	0000000 0h	
		07h	Read /Write	unsigned d32	0000000 0h	
		08h	Read /Write	unsigned d32	0000000 0h	
1A01h	TPDO2 Mapping	00h	Read /Write	unsigned d8	05h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	304A010 8h	Index = 304Ah, Sub-Index = 01h, Size = 8Bits, M2: Motor State
		02h	Read /Write	unsigned d32	304A020 8h	Index = 304Ah, Sub-Index = 02h, Size = 8Bits, M2: Alarm Code
		03h	Read /Write	unsigned d32	304A051 0h	Index = 304Ah, Sub-Index = 05h, Size = 16Bits, M2: Current Speed
		04h	Read /Write	unsigned d32	304A161 0h	Index = 304Ah, Sub-Index = 16h, Size = 16Bits, M2: Current Encoder Index
		05h	Read /Write	unsigned d32	304A171 0h	Index = 304Ah, Sub-Index = 17h, Size = 16Bits, M2: Current Encoder Pos
		06h	Read /Write	unsigned d32	0000000 0h	
		07h	Read /Write	unsigned d32	0000000 0h	
		08h	Read /Write	unsigned d32	0000000 0h	
1A02h	TPDO3 Mapping	00h	Read /Write	unsigned d8	04h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	3046091 0h	Index = 3046h, Sub-Index = 09h, Size = 16Bits, M1: Duty
		02h	Read /Write	unsigned d32	30460A1 0h	Index = 3046h, Sub-Index = 0Ah, Size = 16Bits, M1: Shunt I
		03h	Read /Write	unsigned d32	304A091 0h	Index = 304Ah, Sub-Index = 09h, Size = 16Bits, M2: Duty
		04h	Read /Write	unsigned d32	304A0A 10h	Index = 304Ah, Sub-Index = 0Ah, Size = 16Bits, M2: Shunt I
		05h	Read /Write	unsigned d32	0000000 0h	
		06h	Read /Write	unsigned d32	0000000 0h	
		07h	Read /Write	unsigned d32	0000000 0h	
		08h	Read /Write	unsigned d32	0000000 0h	
1A03h	TPDO4 Mapping	00h	Read /Write	unsigned d8	05h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	3046081 0h	Index = 3046h, Sub-Index = 08h, Size = 16Bits, BusV
		02h	Read /Write	unsigned d32	3046060 8h	Index = 3046h, Sub-Index = 06h, Size = 8Bits, XIN
		03h	Read /Write	unsigned d32	3046120 8h	Index = 3046h, Sub-Index = 12h, Size = 8Bits, YOUT
		04h	Read /Write	unsigned d32	30460E1 0h	Index = 3046h, Sub-Index = 0Eh, Size = 16Bits, A0X
		05h	Read /Write	unsigned d32	30460F1 0h	Index = 3046h, Sub-Index = 0Fh, Size = 16Bits, A1X

		06h	Read /Write	unsigned d32	00000000h	
		07h	Read /Write	unsigned d32	00000000h	
		08h	Read /Write	unsigned d32	00000000h	

當參數09-26 CANOpen PDO Mapping選擇 = 1 時, PDO Mapping如下

Index	Description	Sub-Index	Read or Write	Data Type	參考值	備註
1600h	RPDO1 Mapping	00h	Read /Write	unsigned d8	02h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	305B0108h	Index = 305Bh, Sub-Index = 01h, Size = 8Bits, M1: MultiDrive-Lite CMD
		02h	Read /Write	unsigned d32	305B0210h	Index = 305Bh, Sub-Index = 02h, Size = 16Bits, M1: MultiDrive-Lite Data
		03h	Read /Write	unsigned d32	00000000h	
		04h	Read /Write	unsigned d32	00000000h	
		05h	Read /Write	unsigned d32	00000000h	
		06h	Read /Write	unsigned d32	00000000h	
		07h	Read /Write	unsigned d32	00000000h	
		08h	Read /Write	unsigned d32	00000000h	
1601h	RPDO2 Mapping	00h	Read /Write	unsigned d8	03h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	305C0108h	Index = 305Ch, Sub-Index = 01h, Size = 8Bits, M2: MultiDrive-Lite CMD
		02h	Read /Write	unsigned d32	305C0210h	Index = 305Ch, Sub-Index = 02h, Size = 16Bits, M2: MultiDrive-Lite Data
		03h	Read /Write	unsigned d32	00000000h	
		04h	Read /Write	unsigned d32	00000000h	
		05h	Read /Write	unsigned d32	00000000h	
		06h	Read /Write	unsigned d32	00000000h	
		07h	Read /Write	unsigned d32	00000000h	
		08h	Read /Write	unsigned d32	00000000h	
1602h	RPDO3 Mapping	00h	Read /Write	unsigned d8	03h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	30140010h	Index = 3014h, Sub-Index = 00h, Size = 16Bits, Net-IO
		02h	Read /Write	unsigned d32	303F0110h	Index = 303Fh, Sub-Index = 01h, Size = 16Bits, M1: Digital Speed 0
		03h	Read /Write	unsigned d32	303F1110h	Index = 303Fh, Sub-Index = 11h, Size = 16Bits, M2: Digital Speed 0
		04h	Read /Write	unsigned d32	00000000h	
		05h	Read /Write	unsigned d32	00000000h	

		06h	Read /Write	unsigned d32	00000000 0h	
		07h	Read /Write	unsigned d32	00000000 0h	
		08h	Read /Write	unsigned d32	00000000 0h	
1603h	RPDO4 Mapping	00h	Read /Write	unsigned d8	04h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	305B010 8h	Index = 305Bh, Sub-Index = 01h, Size = 8Bits, M1: MultiDrive-Lite CMD
		02h	Read /Write	unsigned d32	305B021 0h	Index = 305Bh, Sub-Index = 02h, Size = 16Bits, M1: MultiDrive-Lite Data
		03h	Read /Write	unsigned d32	305C010 8h	Index = 305Ch, Sub-Index = 01h, Size = 8Bits, M2: MultiDrive-Lite CMD
		04h	Read /Write	unsigned d32	305C021 0h	Index = 305Ch, Sub-Index = 02h, Size = 16Bits, M2: MultiDrive-Lite Data
		05h	Read /Write	unsigned d32	00000000 0h	
		06h	Read /Write	unsigned d32	00000000 0h	
		07h	Read /Write	unsigned d32	00000000 0h	
		08h	Read /Write	unsigned d32	00000000 0h	
1A00h	TPDO1 Mapping	00h	Read /Write	unsigned d8	05h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	3046010 8h	Index = 3046h, Sub-Index = 01h, Size = 8Bits, M1: Motor State
		02h	Read /Write	unsigned d32	3046020 8h	Index = 3046h, Sub-Index = 02h, Size = 8Bits, M1: Alarm Code
		03h	Read /Write	unsigned d32	3046051 0h	Index = 3046h, Sub-Index = 05h, Size = 16Bits, M1: Current Speed
		04h	Read /Write	unsigned d32	30460A1 0h	Index = 3046h, Sub-Index = 0Ah, Size = 16Bits, M1: Shunt I
		05h	Read /Write	unsigned d32	3046131 0h	Index = 3046h, Sub-Index = 13h, Size = 16Bits, M1: Hall Cnt
		06h	Read /Write	unsigned d32	00000000 0h	
		07h	Read /Write	unsigned d32	00000000 0h	
		08h	Read /Write	unsigned d32	00000000 0h	
1A01h	TPDO2 Mapping	00h	Read /Write	unsigned d8	05h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	304A010 8h	Index = 304Ah, Sub-Index = 01h, Size = 8Bits, M2: Motor State
		02h	Read /Write	unsigned d32	304A020 8h	Index = 304Ah, Sub-Index = 02h, Size = 8Bits, M2: Alarm Code
		03h	Read /Write	unsigned d32	304A051 0h	Index = 304Ah, Sub-Index = 05h, Size = 16Bits, M2: Current Speed
		04h	Read /Write	unsigned d32	304A0A 10h	Index = 304Ah, Sub-Index = 0Ah, Size = 16Bits, M2: Shunt I
		05h	Read /Write	unsigned d32	304A131 0h	Index = 304Ah, Sub-Index = 13h, Size = 16Bits, M2: Hall Cnt
		06h	Read /Write	unsigned d32	00000000 0h	
		07h	Read /Write	unsigned d32	00000000 0h	
		08h	Read /Write	unsigned d32	00000000 0h	

1A02h	TPDO3 Mapping	00h	Read /Write	unsigned d8	04h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	3046091 0h	Index = 3046h, Sub-Index = 09h, Size = 16Bits, M1: Duty
		02h	Read /Write	unsigned d32	30460A1 0h	Index = 3046h, Sub-Index = 0Ah, Size = 16Bits, M1: Shunt I
		03h	Read /Write	unsigned d32	304A091 0h	Index = 304Ah, Sub-Index = 09h, Size = 16Bits, M2: Duty
		04h	Read /Write	unsigned d32	304A0A 10h	Index = 304Ah, Sub-Index = 0Ah, Size = 16Bits, M2: Shunt I
		05h	Read /Write	unsigned d32	0000000 0h	
		06h	Read /Write	unsigned d32	0000000 0h	
		07h	Read /Write	unsigned d32	0000000 0h	
		08h	Read /Write	unsigned d32	0000000 0h	
1A03h	TPDO4 Mapping	00h	Read /Write	unsigned d8	05h	表示最大有意義的Sub-Index
		01h	Read /Write	unsigned d32	3046081 0h	Index = 3046h, Sub-Index = 08h, Size = 16Bits, BusV
		02h	Read /Write	unsigned d32	3046060 8h	Index = 3046h, Sub-Index = 06h, Size = 8Bits, XIN
		03h	Read /Write	unsigned d32	3046120 8h	Index = 3046h, Sub-Index = 12h, Size = 8Bits, YOUT
		04h	Read /Write	unsigned d32	30460E1 0h	Index = 3046h, Sub-Index = 0Eh, Size = 16Bits, A0X
		05h	Read /Write	unsigned d32	30460F1 0h	Index = 3046h, Sub-Index = 0Fh, Size = 16Bits, A1X
		06h	Read /Write	unsigned d32	0000000 0h	
		07h	Read /Write	unsigned d32	0000000 0h	
		08h	Read /Write	unsigned d32	0000000 0h	

Modbus Register對應

Index	Description	Sub-Index	Read or Write	Data Type	參考值	備註
3000h	Dynamic Data	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read Only	unsigned d16	XXXXh	Sub-Index 01h 對應Data1 (Modbus Address 0x0000)
3001h	參數EEP: 01-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數01-01 (Modbus Address 0x0100)
3002h	參數EEP: 02-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數02-01 (Modbus Address 0x0200)
3003h	參數EEP: 03-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數03-01 (Modbus Address 0x0300)
3004h	參數EEP: 04-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index

		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數04-01 (Modbus Address 0x0400)
3005h	參數EEP: 05-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數05-01 (Modbus Address 0x0500)
3006h	參數EEP: 06-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數06-01 (Modbus Address 0x0600)
3007h	參數EEP: 07-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數07-01 (Modbus Address 0x0700)
3008h	參數EEP: 08-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數08-01 (Modbus Address 0x0800)
3009h	參數EEP: 09-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數09-01 (Modbus Address 0x0900)
300Ah	維修命令	00h	Write Only	unsigned d16	0000h 0022h 0026h 0027h	0000h = Alarm Reset 0022h = Alarm History Reset 0026h = Com Error History Reset 0027h = Configuration
3014h	Net-IO	00h	Read /Write	unsigned d16	0000h	Net-IO X狀態
3033h	Alarm 履歷	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read Only	unsigned d16	XXXXh	Sub-Index 01h 對應Data1 (Modbus Address 0x3300)
303Dh	參數RAM: 01-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數01-01 (Modbus Address 0x3D00)
303Eh	參數RAM: 02-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數02-01 (Modbus Address 0x3E00)
303Fh	參數RAM: 03-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數03-01 (Modbus Address 0x3F00)
3040h	參數RAM: 04-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數04-01 (Modbus Address 0x4000)
3041h	參數RAM: 05-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數05-01 (Modbus Address 0x4100)
3042h	參數RAM: 06-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數06-01 (Modbus Address 0x4200)
3043h	參數RAM: 07-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數07-01 (Modbus Address 0x4300)

3044h	參數RAM: 08-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數08-01 (Modbus Address 0x4400)
3045h	參數RAM: 09-XX	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read /Write	unsigned d16	XXXXh	Sub-Index 01h 對應參數09-01 (Modbus Address 0x4500)
3046h	M1 : Monitor Data	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read Only	unsigned d16	XXXXh	Sub-Index 01h 對應Data1 (Modbus Address 0x4600)
304Ah	M2 : Monitor Data	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read Only	unsigned d16	XXXXh	Sub-Index 01h 對應Data1 (Modbus Address 0x4A00)
3048h	通訊 (RS232, RS485) 錯誤碼履歷	00h	Read Only	unsigned d8	20h	表示最大可支援的Sub-Index
		01h ~ 20h	Read Only	unsigned d16	XXXXh	Sub-Index 01h 對應Data1 (Modbus Address 0x4800)

Multi-CMD 對應 (Multi-drive / Multi-drive Lite)

Index	Description	Sub-Index	Read or Write	Data Type	參考值	備註
3051h	Multi-Drive: M1	00h	Read Only	unsigned d8	03h	表示最大可支援的Sub-Index
		01h	Write Only	signed16	0000h	M1: MultiDrive CMD
		02h	Write Only	signed16	0000h	M1: MultiDrive Data1
		03h	Write Only	signed16	0000h	M1: MultiDrive Data2
3052h	Multi-Drive: M2	00h	Read Only	unsigned d8	03h	表示最大可支援的Sub-Index
		01h	Write Only	signed16	0000h	M2: MultiDrive CMD
		02h	Write Only	signed16	0000h	M2: MultiDrive Data1
		03h	Write Only	signed16	0000h	M2: MultiDrive Data2
305Bh	Multi-Drive Lite: M1	00h	Read Only	unsigned d8	02h	表示最大可支援的Sub-Index
		01h	Write Only	signed16	0000h	M1: MultiDrive-Lite CMD
		02h	Write Only	signed16	0000h	M1: MultiDrive-Lite Data
305Ch	Multi-Drive Lite: M2	00h	Read Only	unsigned d8	02h	表示最大可支援的Sub-Index
		01h	Write Only	signed16	0000h	M2: MultiDrive-Lite CMD
		02h	Write Only	signed16	0000h	M2: MultiDrive-Lite Data

DEV CANBus 範例

- 一、參數讀取 (細節請參考 SDO 通訊)
- 二、參數修改 (細節請參考 SDO 通訊)
- 三、Encoder馬達1速度控制 (細節請參考 PDO 通訊)
- 四、Encoder馬達1位置控制 (細節請參考 PDO 通訊)
- 五、Encoder馬達2速度控制 (細節請參考 PDO 通訊)
- 六、Encoder馬達2位置控制 (細節請參考 PDO 通訊)
- 七、Hall馬達1速度控制 (細節請參考 PDO 通訊)
- 八、Hall馬達2速度控制 (細節請參考 PDO 通訊)

一、參數讀取 (細節請參考 SDO 通訊)

ex：讀取Node-ID = 1 的驅動器，Dynamic Data 10 (Index = 3000h · Sub-Index = 0Ah) 的資訊

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			40h = 讀取	IndexL	IndexH	Sub-Index	補0	補0	補0	補0
			40h	00h	30h	0Ah	00h	00h	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			4Bh = 回應 2Byte資料	IndexL	IndexH	Sub-Index	DataL	DataH	補0	補0
			4Bh	00h	30h	0Ah	6E	09h	00h	00h

回傳資料 = 096Eh (2414)

二、參數修改 (細節請參考 SDO 通訊)

ex：想要把 Node-ID = 1 的驅動器，參數 03-01 的EEP數值 (Index = 3003h · Sub-Index = 01h) 設定為 3000 (0BB8h)

ID	RTR	DLC	Data							
601h	0	8	0	1	2	3	4	5	6	7
			2Bh = 寫入 2Byte資料	IndexL	IndexH	Sub-Index	DataL	DataH	補0	補0
			2Bh	03h	30h	01h	B8	0B	00h	00h

從站回應如下：

ID	RTR	DLC	Data							
581h	0	8	0	1	2	3	4	5	6	7
			60h = 成功寫入	IndexL	IndexH	Sub-Index	補0	補0	補0	補0
			60h	03h	30h	01h	00h	00h	00h	00h

三、Encoder馬達1速度控制 (細節請參考 PDO 通訊)

需要確認參數

- 參數 01-11 = 2
- 參數 09-26 = 0

控制Node-ID = 1 的驅動器，使用預設參數，讓馬達1以3000 (0BB8h) RPM運轉

ID	RTR	DLC	Data							
201h	0	5	0	1	2	3	4	5	6	7
			0Ah = 連續運轉	Data1L	Data1H	Data2L	Data2H	X	X	X
			0Ah	00h	00h	B8h	0Bh	X	X	X

從站回應如下：

ID	RTR	DLC	Data							
181h	0	8	0	1	2	3	4	5	6	7

			M1: Motor State	M1: Alarm Code	M1: Current Speed	M1: Current Encoder Index	M1: Current Encoder Pos
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四、Encoder馬達1位置控制 (細節請參考 PDO 通訊)

需要確認參數

- 參數 01-11 = 2
- 參數 09-26 = 0

控制Node-ID = 1 的驅動器，使用預設參數，讓馬達1相對移動100圈

ID	RTR	DLC	Data							
201h	0	5	0	1	2	3	4	5	6	7
			0Fh = 相對移動	Data1L	Data1H	Data2L	Data2H	X	X	X
			0Fh	64h	00h	00h	00h	X	X	X

從站回應如下：

ID	RTR	DLC	Data							
181h	0	8	0	1	2	3	4	5	6	7
			M1: Motor State	M1: Alarm Code	M1: Current Speed		M1: Current Encoder Index		M1: Current Encoder Pos	

五、Encoder馬達2速度控制 (細節請參考 PDO 通訊)

需要確認參數

- 參數 01-27 = 2
- 參數 09-26 = 0

控制Node-ID = 1 的驅動器，使用預設參數，讓馬達2以3000 (0BB8h) RPM運轉

ID	RTR	DLC	Data							
301h	0	5	0Ah = 連續運轉	Data1L	Data1H	Data2L	Data2H	X	X	X
			0Ah	00h	00h	B8h	0Bh	X	X	X
			0Ah	00h	00h	B8h	0Bh	X	X	X

從站回應如下：

ID	RTR	DLC	Data							
281h	0	8	0	1	2	3	4	5	6	7
			M2: Motor State	M2: Alarm Code	M2: Current Speed		M2: Current Encoder Index		M2: Current Encoder Pos	

六、Encoder馬達2位置控制 (細節請參考 PDO 通訊)

需要確認參數

- 參數 01-27 = 2
- 參數 09-26 = 0

控制Node-ID = 1 的驅動器，使用預設參數，讓馬達2相對移動100圈

ID	RTR	DLC	Data							
301h	0	5	0	1	2	3	4	5	6	7
			0Fh = 相對移動	Data1L	Data1H	Data2L	Data2H	X	X	X
			0Fh	64h	00h	00h	00h	X	X	X

從站回應如下：

ID	RTR	DLC	Data							
281h	0	8	0	1	2	3	4	5	6	7
					M2: Current Speed		M2: Current Encoder Index			

			M2: Motor State	M2: Alarm Code			M2: Current Encoder Pos
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七、Hall馬達1速度控制 (細節請參考 PDO 通訊)

需要確認參數

- 參數 01-11 = 0
- 參數 01-12 = 4
- 參數 09-26 = 1

Node-ID = 1 的驅動器，使用預設參數，讓馬達1以3000 (0BB8h) RPM運轉

ID	RTR	DLC	Data							
201h	0	3	0	1	2	3	4	5	6	7
			01h = 連續運轉	Data1L	Data1H	X	X	X	X	X
			01h	B8h	0Bh	X	X	X	X	X

從站回應如下：

ID	RTR	DLC	Data							
181h	0	8	0	1	2	3	4	5	6	7
			M1: Motor State	M1: Alarm Code	M1: Current Speed		M1: Motor Current		M1: Hall Cnt	

八、Hall馬達2速度控制 (細節請參考 PDO 通訊)

需要確認參數

- 參數 01-27 = 0
- 參數 01-28 = 4
- 參數 09-26 = 1

Node-ID = 2 的驅動器，使用預設參數，讓馬達2以3000 (0BB8h) RPM運轉

ID	RTR	DLC	Data							
301h	0	3	0	1	2	3	4	5	6	7
			01h = 連續運轉	Data1L	Data1H	X	X	X	X	X
			01h	B8h	0Bh	X	X	X	X	X

從站回應如下：

ID	RTR	DLC	Data							
281h	0	8	0	1	2	3	4	5	6	7
			M2: Motor State	M2: Alarm Code	M2: Current Speed		M2: Motor Current		M2: Hall Cnt	

DEV CAN ID

	CAN ID			
DEV Rev A	由參數 09-19 來設定			
DEV Rev B/C	ID1 (SW2-1)	ID2 (SW2-2)	Node ID (M1)	Node ID (M2)
	Off	Off	1	2
	Off	On	3	4
	On	Off	5	6
	On	On	7	8
DEV Rev D+	ID2 (SW2-2)	ID1 (SW2-1)	Node ID	Node ID (M2)
	Off	Off	1	2
	Off	On	3	4
	On	Off	5	6
	On	On	7	8