CANOPEN USER MANUAL

CAMOZZI
Automation

SERIES DRCS
DRIVE
FOR STEPPER MOTORS

Contents

CE ISO Made in Italy

The products are in compliance with the requirements stated in the following directives:
- 2004/108/CE
The products comply either fully, or for the applicable parts, with the following standards:
- CEI EN 61131-2

1. Introduction

This manual describes the implementation of the Cia 301 and Cia 402 profiles of the CanOpen for the DRCS Camozzi drive. With this information, the customer can configure and use the drive through the CanOpen commands, and then implement the movements through the available profiles.

Information regarding the CanOpen standard was taken from the official website http://www.can-cia.com

For all drive information, not concerning the CanOpen, refer to the Camozzi manual:
- 5000002102_DRCS Manual.docx
- 5000002010_Foglio Istruzioni DRCS.pdf

2. Drive configuration

CanOpen may only be used with the following models:
• DRCS-A05-8-C-0-A
• DRCS-A05-8-C-0-B

The CanOpen function must be enabled via the "QSet" Camozzi configurator (see manual), through which the "Node-id" and the "baudrate" must be set. The following speeds are allowed:
• 10 Kbit/s   • 250 Kbit/s
• 20 Kbit/s   • 500 Kbit/s
• 50 Kbit/s   • 800 Kbit/s
• 125 Kbit/s   • 1 Mbit/s

After configuring the drive in CanOpen mode, the drive must be switched off and on for the new management to be enabled, the USB cable must also be disconnected from the device, otherwise serial communication remains active and CanOpen communication suspended.
The two serial communications (USB) and CanOpen do not work simultaneously: when the drive is switched on, with the USB cable connected to the PC, serial communication is activated and the CanOpen communication is suspended, which will be activated as soon as the serial connection is interrupted by removing the cable.

The operating modes supported by the Camozzi drive are:
• Position profile
• Velocity profile
• Homing

For all the connections necessary for the correct working of the driver, for the description of all the connectors, you refer to the manual "DRCS_manual.pdf".
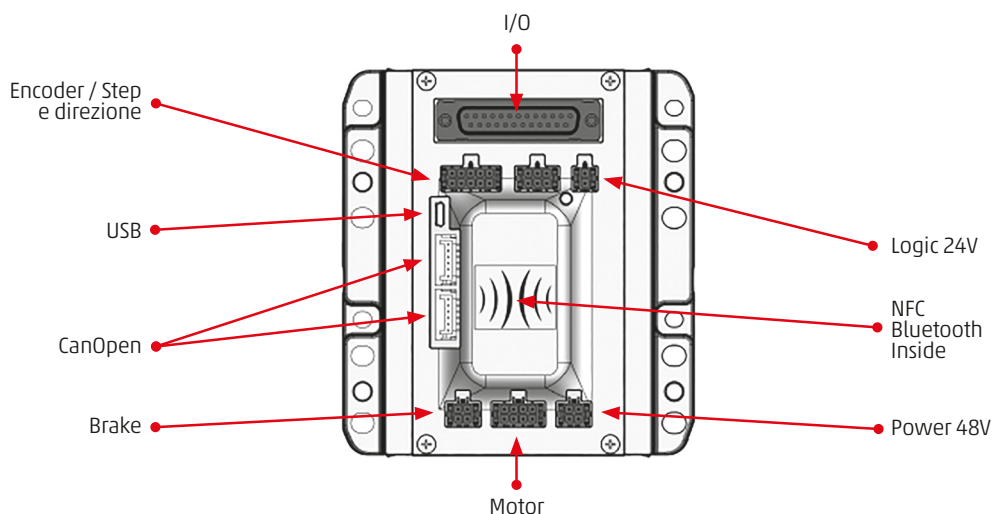
For the CanOpen wiring it is to use the Camozzi cables. When the device is the last into the CanOpen line it is to use the terminal resistor.
It is very importanto to activate the hardware enable with the pin 4 "ENB" of the connector I/O, this pin is referred to the pin 14 "EXCOM". Look the manual "DRCS_manual.pdf" for this connection.

3. Object dictionary

The object dictionary is at the heart of every CanOpen device, it is defined in the EDS configuration file "drcs_rev102.eds" which can be downloaded from the Camozzi website. The objects are defined by the Cia 301 profile, the Cia 401 profile and the manufacturer's specifications.

3.1 CIA301 profile objects

ID	Sub	Description	Type	Access	PDO mapping	Default value
1000	0	Device Type	U32	RO		0xFF7C0192
1001	0	Error register	U8	RO	Yes	
1002	0	Manufacturer status register	U32	RO	Yes	
1003		Pre defined error list				
	0	Number of error	U32	RO		
	1	Standard error field	U32	RO		
	2	Standard error field	U32	RO		
	3	Standard error field	U32	RO		
	4	Standard error field	U32	RO		
	5	Standard error field	U32	RO		
	6	Standard error field	U32	RO		
	7	Standard error field	U32	RO		
	8	Standard error field	U32	RO		
1005	0	COB_ID sync	U32	RW		0x00000080
1006	0	Communication Cycle Period	U32	RW		0
1007	0	Syncronous Window Lenght	U32	RW		0
1008	0	Manufacturer device name	STR	CONST		DRCS
1009	0	Manufacturer hardware version	STR	CONST		1
100A	0	Manufacturer software version	STR	CONST		1.18
100C	0	Guard time	U16	RW		0 ms
100D	0	Life time factor	U16	RW		0
1010		Store parameter field				
	0	Highest sub-index supported	U32	RO		
	1	Save all parameters	U32	RW		
1011		Restore default parameters				
	0	Highest sub-index supported	U32	RO		
	1	Restore all default parameters	U32	RW		
1012	0	COB-ID time stamp	U32	RW		0x80000100
1014	0	COB_ID emcy	U32	RO		0x00000080
1015	0	Inhibit time emergency	U16	RW		0
1017	0	Producer heartbeat time	U16	RW		0 ms
1018		Identity object				
	0	Number of entries	U8	RO		4
	1	Vendor id	U8	RO		0x151
	2	Product code	U32	RO		0x5A
	3	Revision number	U32	RO		1
	4	Serial number	U32	RO		0
1019	0	Synchronous counter overflow value	U8	RW		0
1020		Verify configuration				
	0	Highest sub-index supported	U32	RO		2
	1	Configuration date	U32	RW		-
1200		Server SDO parameter				
	0	Highest sub-index supported	U8	RO		2
	1	COIB-ID client->server	U32	RO		0x00000600
	2	COIB-ID server->client	U32	RO		0x00000580
1400		Rx PDO communication parameter 1				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x00000200
	2	Trasmission type	U8	RW		0xFF
1401		Rx PDO communication parameter 2				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000300
	2	Trasmission type	U8	RW		0xFF
1402		Rx PDO communication parameter 3				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000400
	2	Trasmission type	U8	RW		0xFF

ID	Sub	Description	Type	Access	PDO mapping	Default value
1403		Rx PDO communication parameter 4				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000500
	2	Trasmission type	U8	RW		0xFF
1404		Rx PDO communication parameter 5				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000000
	2	Trasmission type	U8	RW		0xFF
1405		Rx PDO communication parameter 6				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000000
	2	Trasmission type	U8	RW		0xFF
1406		Rx PDO communication parameter 7				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000000
	2	Trasmission type	U8	RW		0xFF
1407		Rx PDO communication parameter 8				
	0	Highest sub-index supported	U8	RO		2
	1	COB-ID	U32	RW		0x80000000
	2	Trasmission type	U8	RW		0xFF
1600		Rx PDO mapping parameter 1				
	0	Number of mapped object	U8	RW		1
	1	Mapping entry 1	U32	RW		0x60400010
	2	Mapping entry 2	U32	RW		-
	3	Mapping entry 3	U32	RW		-
	4	Mapping entry 4	U32	RW		-
	5	Mapping entry 5	U32	RW		-
	6	Mapping entry 6	U32	RW		-
	7	Mapping entry 7	U32	RW		-
	8	Mapping entry 8	U32	RW		-
1601		Rx PDO mapping parameter 2				
1602		Rx PDO mapping parameter 3				
1603		Rx PDO mapping parameter 4				
1604		Rx PDO mapping parameter 5				
1605		Rx PDO mapping parameter 6				
1606		Rx PDO mapping parameter 7				
1607		Rx PDO mapping parameter 8				
1800		Tx PDO communication parameter 1				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x00000180
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1801		Tx PDO communication parameter 2				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000280
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1802		Tx PDO communication parameter 3				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000380
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1803		Tx PDO communication parameter 4				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000480
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0

ID	Sub	Description	Type	Access	PDO mapping	Default value
1804		Tx PDO communication parameter 5				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000000
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1805		Tx PDO communication parameter 6				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000000
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1806		Tx PDO communication parameter 7				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000000
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1807		Tx PDO communication parameter 8				
	0	Sub-index supported	U8	RO		5
	1	COIB-ID	U32	RW		0x80000000
	2	Tranmission type	U8	RW		0xFF
	3	Inhibit time	U16	RW		0
	4	Compatibility entry	U8	RW		0
	5	Event timer	U16	RW		0
1A00		Tx PDO mapping parameter 1				
	0	Number of mapped object	U8	RW		1
	1	Mapping entry 1	U32	RW		0x60410010
	2	Mapping entry 2	U32	RW		-
	3	Mapping entry 3	U32	RW		-
	4	Mapping entry 4	U32	RW		-
	5	Mapping entry 5	U32	RW		-
	6	Mapping entry 6	U32	RW		-
	7	Mapping entry 7	U32	RW		-
	8	Mapping entry 8	U32	RW		-
1A01		Tx PDO mapping parameter 0				
1A02		Tx PDO mapping parameter 1				
1A03		Tx PDO mapping parameter 2				
1A04		Tx PDO mapping parameter 3				
1A05		Tx PDO mapping parameter 4				
1A06		Tx PDO mapping parameter 5				
1A07		Tx PDO mapping parameter 6				
1F80	0	NMT startup	U32	RW		0x00000004

3.2 CIA 301 profile object description

3.2.1 1000h Device time
This object contains information on the device type and its functions. It consists of a first 16-bit field describing the profile used, and a second 16-bit field containing specific additional information.

3.2.2 1001h Error register
This object contains the device's internal error mapping, it is a mandatory object for all devices and forms part of the emergency objects.

The defined values are:

Bit	Optional	Description
0	Mandatory	Generic error
1	Optional	Current
2	Optional	Voltage
3	Optional	Temperature
4	Optional	Communication error
5	Optional	Profile-specific
6	Optional	Reserved
7	Optional	Reserved

3.2.3   1002h Manufacturer status register
This object contains the device status, it is manufacturer-specific.

3.2.4   1003h Pre-defined error field
This object contains errors that have occurred on the device and have been reported by emergency messages.
It provides an error history.
Sub-index 0 contains the number of errors that are currently saved from sub-index 1 to sub-index 8.
When there are no errors it contains the value zero. Each new error is saved to index 1 and former ones are moved to higher indices.
Entering zero into sub-index 0 deletes the error history , resetting all saved errors.
Each error consists of a 16-bit field with the error code, defined by the CanOpen, and another 16-bit field with additional manufacturer information.

Manufacturer info	Error type
0x2310	Overcurrent error
0x3120	Power voltage absent/too low error
0x4210	Temperature too high error
0x7305	Position, step loss (if external encoder present) error
0x8613	Homing procedure timeout error
0x6320	Motor configuration error
0x7320	Positioning out of software limits error
0xFF13	Operation without reset
0x5530	Flash data lost

3.2.5   1005h COB-ID sync
This object contains the COB-ID configuration of the synchronization message (SYNC), indicating whether or not the device generates the message.

Bit	Value	Description
31(MSB)	X	Not used
30	0	Device not generating SYNC message
	1	Device generating SYNC message
29	0	11-bit CAN-ID
	1	29-bit CAN-ID
28-0	X	29 bit extended address
11-0	X	11 bit standard address

3.2.6   1006h Communication cycle period
This object contains the cyclic communication period for SYNC messages in milliseconds, when its value is zero the device does not send synchronism messages.

3.2.7   1007h Syncronous Window Length
This object contains the synchronous window length for PDO messages i.e. the time from the synchronism message within which the synchronous PDOs must arrive in order to be valid.
If the value is set to zero, the synchronization window is disabled.

3.2.8   1008h Manufacturer hardware name
This object contains the device name given by the manufacturer.

3.2.9   1009h Manufacturer hardware version
This object contains the hardware version of the device.

3.2.10   100Ah Manufacturer software version
This object contains the firmware version of the device.

3.2.11   100Ch Guard time
This object, together with the next 100Dh, represent the configuration of the "life guarding " protocol. The Guard time contains the period in which the "guarding" message is sent , it is expressed in ms, if set to zero the "life guarding" protocol is disabled.

3.2.12   100Dh Life time factor
This object contains the number of "guarding" messages that can be lost. This value multiplied by the "Guard time" is the maximum amount of time within which the guarding messages must arrive in order to avoid an error and reset the communication.

3.2.13   1010h Store parameter field
This object stores the parameters in eprom.
Sub- index 1 refers to saving all objects supported by the device.
To avoid unintentionally saving data, saving is only performed if the "save" signature is written in the object:

	MSB			LSB
Character	e	v	a	s
Hex	65h	76h	61h	73h

When the correct signature is received, the device saves it in eprom and when this has been completed successfully it responds with confirmation of the SDO transmission , whereas in the event of an error, the device responds with the SDO transmission failure.

Below is the list of stored objects:
- 1005h – COB-ID sync
- 1006h- Communication cycle period
- 1007h – Sincrhronous window length
- 100Ch – Guard time
- 100Dh – Life time factor
- 1012h – COB-ID time stamp
- 1015h – Inhibit time emergency
- 1017h – Producer heartbeat time
- 1019h – Synchronous counter overflow value
- 1020h – Verify configuration
- 1400h-14007h – Rx PDO communication parameter
- 1600h-16007h – Rx PDO mapping parameter
- 1800h-18007h – TxPDO communication parameter
- 1A00h-1A007h – Tx PDO mapping parameter

- 1F80h – NMT startup
- 2001h – Feed converter
- 606Dh – Velocity window
- 606Eh – Velocity window time
- 606Fh – Velocity threshold
- 6070h – Velocity threshold time
- 607Ch – Home offset
- 607Eh - Polarity
- 6081h – Profile velocity in pp mode
- 6083h – Profile acceleration
- 6984h – Profile deceleration
- 6098h – Homing method
- 6099h – Homing speed
- 60FFh – Target velocity

3.2.14   1012h COIB-ID time stamp
This object contains the time stamp (TIME) message configuration, indicating whether the device consumes or produces the message.

Bit	Value	Description
31(MSB)	0 1	Device does not consume the TIME message Device consumes the TIME message
30	0 1	Device does not produce the TIME message Device produces the TIME message
29	0 1	11-bit CAN-ID 29-bit CAN-ID
28-0	X	29 bit extended address
11-0	X	11 bit standard address

3.2.15   1014h COIB-ID EMCY
This object contains the EMCY service configuration

Bit	Value	Description
31(MSB)	0 1	EMCY present / valid EMCY absent / invalid
30	0	Reserved
29	0 1	11-bit CAN-ID 29-bit CAN-ID
28-0	X	29 bit extended address
11-0	X	11 bit standard address

3.2.16   1015h Inhibit time emergency
This object contains the EMCY message inhibit time, it must be a multiple of 100 useconds. Inhibit time will disable if set to zero.

3.2.17   1017h Producer hearbeat time
This object contains the heartbeat protocol configuration, indicating the period in which the heartbeat message is produced. The period must be a multiple of 1msecond, heartbeat management will disable if set to zero.

3.2.18   1018h Identity object
This object contains information about the device:

Sub-index	Description	Value
0	Sub-index number	4
1	Vendor ID	151h
2	Product code	05Ah
3	Revision number	001h
4	Serial number	000h

3.2.19   1019h Synchronous counteroverflow value
This object contains the SYNC message configuration, if the value is set to zero the SYNC message will have no parameter, if the value is between 2 and 240 then the SYNC message will have a parameter byte, which will contain a counter.

3.2.20   1020h Verify configuration
This object contains the date and time of the last configuration. The device supports saving in eprom , the date and time may be set on the PLC that saves to the device in order to have this information available for subsequent power ups.

3.2.21   1400h – 1407h Rx PDO communication parameter

These objects contain the configuration of the PDO communication that the device can receive. The PDO transmission parameters are described in the CIA301 document, section 7.4.8.1.

The PDO COB-ID is contained in sub-index 1:

Bit	Value	Description
31(MSB)	0 1	PDO present / valid PDO absent / invalid
30	X	Reserved
29	0 1	11 bit CAN-ID 29 bit CAN-ID
28-0		29 bit CAN-ID (extended address)
11-0		11 bit CAN-ID (standard address)

Transmission type is contained in sub-index 2:
• Value = 0 Synchronous transmission (with SYNC messages)
• Value = 1-240 Synchronous transmission every N SYNC messages
• Value = 252-253 Transmission only upon transmission request (RTR)
• Value = 254 Manufacturer-specific asynchronous transmission
• Value = 255 Device profile-specific asynchronous transmission
RPDOs with transmission type set to 255 require the immediate updating of all mapped objects, as foreseen by the Cia drive specifications.

3.2.22   1600h – 1607h Rx PDO mapping parameter

These objects contain the PDO mapping that the device is able to receive.
The sub-index 0 contains the number of objects mapped in the PDO, no object is mapped if the value is set to zero.
Each sub-index from 1 to the previously specified number, contains information on the object mapped in the PDO:

31		16	15		8	7		0
	Index			Sub-index			Lenght	
MSB								LSB

Below is the sequence to change PDO mapping:
• Disable the Rx PDO by setting the bit 31, in sub-index 1 of the RPDO communication parameter, to the value 1
• Disable the existing mapping by setting sub-index 0 to zero
• Change the mapping by adjusting the value of the corresponding sub-index
• Enable mapping by setting the sub-index 0 to the number of mapped objects
• Enable the Rx PDO by setting the bit 31, in sub-index 1 of the RPDO communication parameter, to the value 0

3.2.23   1800h – 1807h Tx PDO communication parameter

These objects contain the configuration of the PDO communication that the device can transmit. The PDO transmission parameters are described in the CIA301 document, section 7.4.8.1.

The PDO COB-ID is contained in sub-index 1:

Bit	Value	Description
31(MSB)	0 1	PDO present / valid PDO absent / invalid
30	0 1	RTR supported RTR unsupported
29	0 1	11 bit CAN-ID 29 bit CAN-ID
29-11		29 bit CAN-ID (extended address)
10-0		11 bit CAN-ID (standard address)

Transmission type is contained in sub-index 2:
• Value = 0   Synchronous transmission (with SYNC messages)
• Value = 1-240   Synchronous transmission every N SYNC messages
• Value = 252-253   Transmission only upon transmission request (RTR)
• Value = 254   Manufacturer-specific asynchronous transmission
• Value = 255   Device profile-specific asynchronous transmission
TPDOs with transmission type set to to 255 are only transmitted when the "status word" object is mapped and has changed, all other mapped objects do not lead to transmission, as foreseen by the CIA drive specifications.
Sub-index 3 contains the minimum time interval for which the TPDO can be transmitted when the transmission type set is 255 or 254.
This value is a multiple of 100usec, the minimum interval is disabled if set to zero.
Sub-index 4 is reserved.
Sub-index 5 contains the maximum time interval for which the TPDO can be transmitted when the transmission type set is 255 or 254.
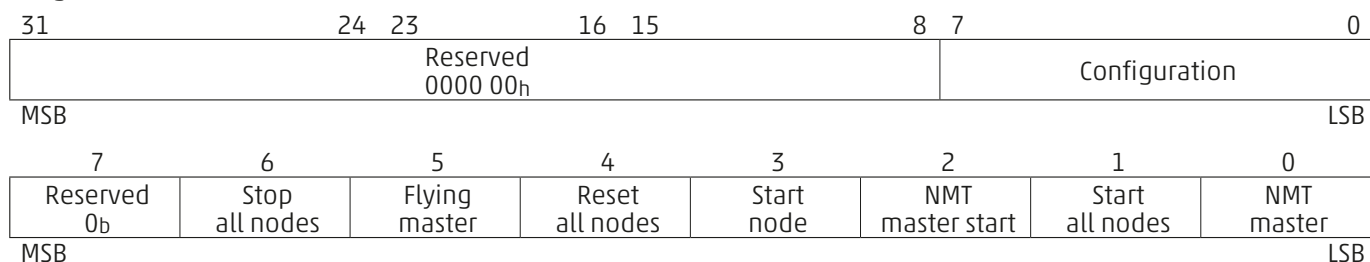This value is a multiple of 1msec, the maximum interval is disabled if set to zero.

3.2.24   1A00h – 1A07h Tx PDO mapping parameter

See RxPDO mapping.

3.2.25 1F80h NMT Startup

This object contains the drive startup behaviour configuration, the bit description of its value is described in the following image:

31	24	23	16	15	8	7	0
	Reserved 0000 00h					Configuration	
MSB							LSB

7	6	5	4	3	2	1	0
Reserved 0b	Stop all nodes	Flying master	Reset all nodes	Start node	NMT master start	Start all nodes	NMT master
MSB							LSB

The drive allows the modification of bit 2 "NMT master start":
- 0 = Allows the device to go into "operating status" automatically at startup
- 1 = Does not allow the device to go into the "operating status" automatically.

And change bit 3 "Start node":
- 0 = The master must put the device into "operating status"
- 1 = the device immediately goes into "operating status" at startup
Attempting to set a bit that is not managed by the device, returns an object writing abort error.

3.3 CIA 402 profile objects

ID	Sub	Description	Type	Access	PDO mapping	Default value
603Fh	0	Error code	U16	RO	Yes	
6040h	0	Controlword	U16	WO	Yes	
6041h	0	Statusword	U16	RO	Yes	
6060h	0	Modes of operatoin	S8	RW	Yes	0
6061h	0	Modes of operation display	S8	RO	Yes	0
6062h	0	Position demand value	S32	RO		
6064h	0	Position actual value	S32	RO	Yes	0 mm
606Bh	0	Velocity demand value	S32	RO		0 mm/s
606Ch	0	Velocity actual value	S32	RO	Yes	0 mm/s
606Dh	0	Velocity window	U16	RW		0 mm/s
606Eh	0	Velocity window time	U16	RW		0 ms
606Fh	0	Velocity threshold	U16	RW		0 mm/s
6070h	0	Velocity threshold time	U16	RW		0 ms
607Ah	0	Target position	S32	RW	Yes	0 mm
607Ch	0	Home offset	S32	RW	Yes	0 mm
607Dh		Software position limit				
	0	Sub-index support	U32	CONST		
	1	Min software position limit	S32	RO		QSet
	2	Max software position limit	S32	RO		Qset
607Eh	0	Polarity	U8	RW	Yes	0
6081h	0	Profile velocity in pp-mode	U32	RW	Yes	0 mm/s
6083h	0	Profile acceleration	U32	RW	Yes	0 mm/s2
6084h	0	Profile deceleration	U32	RW	Yes	0 mm/s2
608Fh		Position encoder resolution				
	0	Sub-index supported	U32	CONST		2
	1	Encoder increments	U32	RO		1000
	2	Motor revolutions	U32	RO		1
6091h		Gear ratio				
	0	Sub-index supported	U32	RO		2
	1	Motor revolutions	U32	RO		Qset
	2	Shaft revolutions	U32	RO		Qset
6092h		Feed constant				
	0	Sub-index supported	U32	RO		2
	1	Feed	U32	RO		QSet
	2	Shaft revolutions	U32	RO		QSet
6098h	0	Homing metod	U8	RW	Yes	17
6099h		Homing speed				
	0	Sub-index supported	U32	RO		2
	1	Fast homing speed	U32	RW	Yes	0 mm/s
	2	Slow homing speed	U32	RW	Yes	0 mm/s
60FFh	0	Target velocity	S32	RW	Yes	0 mm/s
6402h	0	Motor type	U16	RO		0x09
6402h	0	Motor manufacturer	STR	RO		Camozzi
6502h	0	Supported drive modes	U32	RO		0x25
67FFh	0	Single device type	U32	RO		0x00440192

## 3.4 CIA 402 profile object descriptions

3.4.1   603Fh Error code

This object contains the last error code that occurred on the drive, it is the same information present in object 1003h sub-index 1.

3.4.2   6040h Controlword

This object checks the drive status and function. It is used to enable / disable power and start / stop a movement.

This object together with the "status word" are used for the management of the state machine of the Cia402 profile, refer to the relative manual Cia402-2.
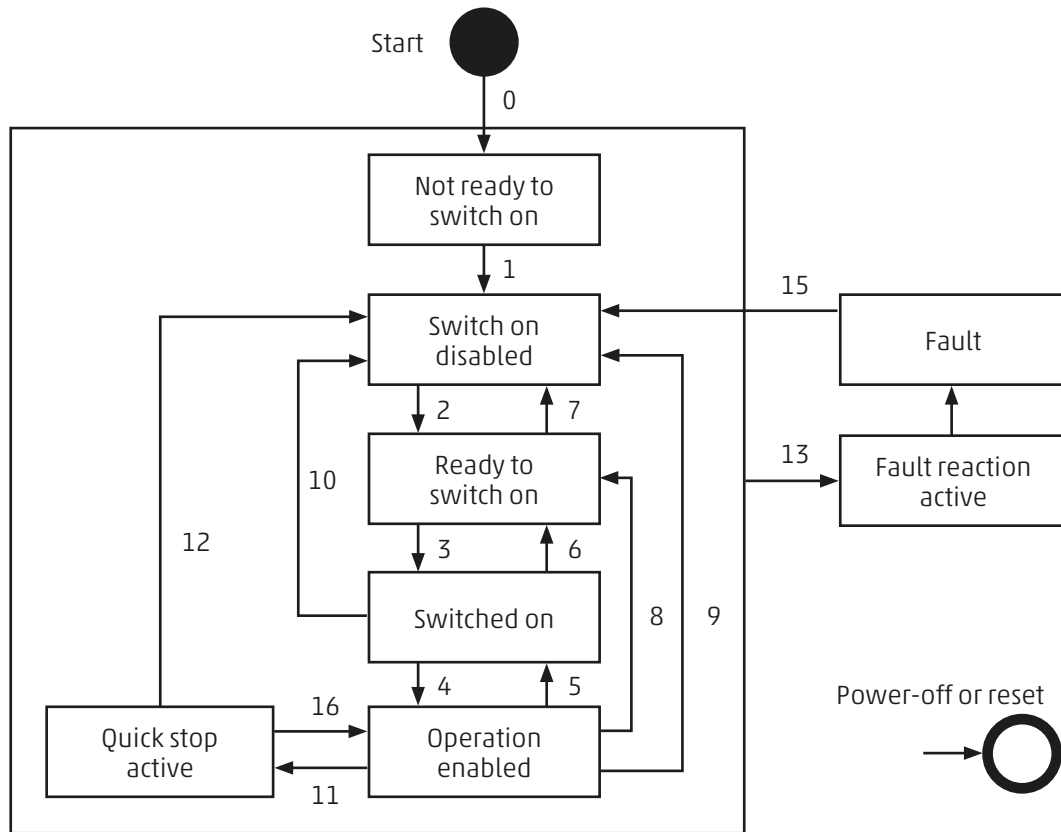
The word is subdivided into bits with the following meanings:

15			11	10	9	8	7	6		4	3	2	1	0
ms				r	oms	h	fr	oms			eo	qs	ev	so

MSB   LSB

- ms =   manufacturer specifications
- r =   reserved
- oms = dependant on operating mode
- h =   halt
- fr =   error reset

- eo = enable command
- qs = quick stop
- ev = enable power
- so = startup

The possible commands to change the drive status are summarised in the following table:

Command	fr (bit7)	eo (bit3)	qs (bit2)	ev (bit1)	so (bit0)	FSA
Shutdown	0	x	1	1	0	2,6,8
Switch on	0	0	1	1	1	3
Enable operation	0	1	1	1	1	4,16
Disable voltage	0	x	x	0	x	7,9,10,12
Quick stop	0	x	0	1	x	7,10,11
Disable operation	0	0	1	1	1	5
Fault reset	⌐	x	x	x	x	15

Bit 8, the halt function , interrupts the command in execution, but as soon as it is reset, the command resumes if possible, depending on the operating mode.

3.4.3   6041h Statusword
This read-only object represents the current status of the drive.
The word is subdivided into bits with the following meanings:

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

MSB   LSB

- ms =   manufacturer specifications
- oms =   dependant on operating mode
- ila =   internal limits active
- tr =   target reached
- rm =   remote
- w =   warning (drive status does not change)
- sod =   operation disabled

- qs =   quick stop
- ve =   Power enabled
- f =   error (drive in error status)
- oe =   command enabled
- so =   active operation
- rtso =   ready for operation

The below table shows the bit configurations according to drive status:

statusword (bit15...bit0)	drive status
xxxx xxxx x0xx 0000	Not ready to operate
xxxx xxxx x1xx 0000	Operation disabled
xxxx xxxx x01x 0001	Ready for operation
xxxx xxxx x01x 0011	Operation active
xxxx xxxx x01x 0111	Command active
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Error during command
xxxx xxxx x0xx 1000	Drive in error status

3.4.4   6060h Mode of operation
This object contains the drive operating mode request.
The operating modes are specified in the following table:

Value	Operating mode
0	No mode requested
1	Profile position
3	Velocity profile
6	Homing

For the profile descriptions, see chapters 4,5 and 6.

3.4.5   6061h Mode of operation display
This object contains the operating mode value in which the drive is located. It can be one of the profiles listed above.

3.4.6   6064h Position actual value
This object contains the current position value measured by the drive, expressed in the set unit of measurement.

3.4.7   606Ch Velocity actual value
This object contains the actual velocity value measured by the drive, expressed in the set unit of measurement.

3.4.8   606Dh Velocity window
This object contains the value within which the measured velocity must be in comparison to the required velocity, in order for the velocity condition to be reached , and set the bit number 10 "target reached" of the statusword.
 The specified minimum time condition for the next object must be respected to set the bit.
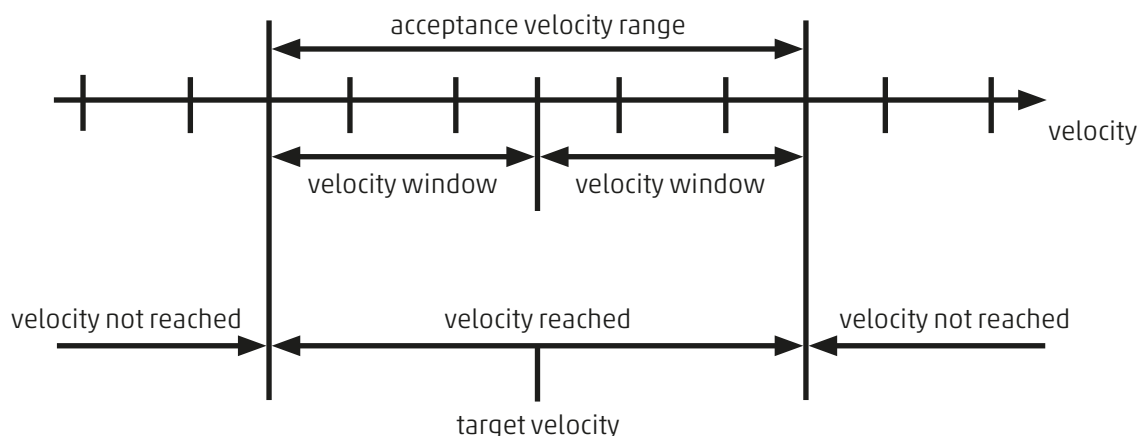
3.4.9   606Eh velocity window time
This object contains the minimum time in which the measured velocity must remain within the window specified by the previous object, in order for it to be in the velocity reached condition, and set the bit 10 "target reached" of the statusword.

3.4.10   606Fh Velocity threshold
This object contains the zero velocity threshold value. When the current velocity is lower than the minimum time threshold set in the next object, the motor is considered stationary and bit 12 of the statusword is set .

3.4.11   6070h velocity threashold time
This object contains the minimum time in which the current velocity must remain below the threshold value specified in the previous object, for the motor to be considered stationary, and then set bit 12 of the statusword.

3.4.12   697Ah Target position
This object contains the position that the motor must reach when the operation is in the position profile, using the velocity and acceleration parameters specified by the designated objects. The target position can be considered as an absolute or relative value according to the bit " abs / rel" of the controlword (specific bits for the profile).
Upon reaching the position, bit 10 "target reached" of the statusword is set.

3.4.13   607Ch Homeoffset
This object contains the offset to apply to the physical zero position (imposed by the proximity position) to obtain the zero position of the motor.
During the homing procedure, the proximity is found and then the motor is moved until the offset is reached and this position is set as the motor zero.

3.4.14   607Dh Software position limit
This object contains two parameters, the minimum and maximum limit of the absolute motor position.
If the target position reached is not within the set limits, an error is generated and the motor will not move.
The limits are expressed in the set unit of measurement and refer to the homing position.

3.4.15   607Eh Polarity
This object allows the motor rotation direction to be reversed, in order to change the movement direction based on the physical mounting of the motor without intervening in the phase wiring.
Setting bit 7 reverses the rotation direction.

Value	Direction
0x00	Forwards
0x80	Reverse

3.4.16   6081h Profile velocity in pp-mode
This object contains the value of the velocity reached after the acceleration phase, during the position profile movement, valid for both directions. If the velocity is higher than the set maximum, the drive is limited.

3.4.17   6083h Profile acceleration
This object contains the acceleration value used during the position profile movement, which determines the ramp with which the velocity set in the previous object will be reached.

3.4.18   6084h Profile deceleration
This object contains the deceleration value used during the position profile movement, which determines the ramp with which the zero velocity will be reached.

3.4.19   608Fh Position encoder Resolution
This object contains two read-only parameters, the number of pulses per revolution and the number of revolutions per turn of the optional encoder.

Sub-index 1	Encoder increments	1000
Sub-index 2	Motor revolutions	1

3.4.20   6091h Gear ratio
This object contains two read-only parameters that provide the reduction ratio (if present) between the motor and the connected cylinder / axis.
These parameters are set by the QSet, when the axis is configured.
Reduction ratio = motor revolution / shaft revolution

3.4.21   6092h Feed constant
This object contains two read-only parameters that provide the linear motion ratio in mm / pulley revolution, these parameters are set by the QSet at configuration, based on the code of the cylinder or axis on which the motor is mounted.
Linear ratio = feed / shaft revolutions

3.4.22   6098h Homing metod
This object contains the zeroing method used by the device for the homing procedure, the permitted values are:
- 17 = Homing with zero proximity search in the positive direction.
- 18 = Homing with zero proximity search in the negative direction.
- 37 = Homing without zero proximity, the actual position will be zero position
For a description of this procedure, see chapter 7 of this document.

3.4.23   6099h Homing speed
This object contains the speed values used during the zero procedure.
- Fast homing speed = speed used to search for the zero proximity.
- Slow homing speed = speed used to depart from the zero proximity.

3.4.24   60FFh Target velocity
This object contains the target velocity during the velocity profile operation.

3.4.25   6402h Motor type
This read-only object contains the motor type that can be used with the drive:
- 9 = microstep stepper motor

3.4.26   6502h Supported drive modes
This read-only object specifies the operating modes supported by the drive, its value is described below:

31	16	15	11	10	9	8	7	6	5	4	3	2	1	0
manufactured-specific		reserved		cstca	cst	csv	csp	ip	hm	r	tq	pv	vl	pp
MSB														LSB

Bit number	Operation	supported
0	Profile position	Yes
1	Speed operation	-
2	Velocity profile	Yes
3	Torque profile	-
4	Reserved	
5	Homing	Yes
6	Interpolation.	-
7	Reserved	
8	Reserved	
9	Reserved	
10…15	Reserved	
16…31	Manufacturer specifications	

For a detailed description of this procedure, see chapter 7 of this document.

3.5 Manufacturer custom objects

ID	Sub	Description	Type	Access	PDO mapping
2001h		Feed converter			
	0	Sub-index supported	U32	RO	-
	1	Numerator	U32	RW	-
	2	Denominator	U32	RW	-
2002h	0	Input status	U32	RO	Yes
2003h	0	Output status	U32	RO	Yes
2004h	0	Homing status	U8	RO	Yes
2005h	0	Brake	U8	RW	Yes (R)

3.6 Description of manufacturer custom objects

3.6.1   2001h Feed converter
This parameter changes the unit of measurement used for the position, the speed and acceleration used to read and write dictionary objects and PDOs.
The default units of measurement are:
- Position [mm]
- velocity [mm/s]
- Acceleration [mm/s2]
It is possible to change the unit of measurement to that required with this object:
New unit = default unit * Numerator / Denominator
For example, to set the unit of measurement to inches:
- Numerator   = 100
- Denominator = 254

3.6.2   2002h Input status
This read-only parameter contains the status of the inputs present in the drive . The bit representation is described below:

Bit 11-31	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Proxy ext	Proxy home	Strobe	Enable	In 8	In 7	In 6	In 5	In 4	In 3	In 2	In 1

3.6.3   2003h Output status

This read-only object contains the status of the outputs present in the drive .
The bit representation is described below:

Bit 6-31	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Ready	Homing ok	Pos ok	Out	Busy	Alarm

Bit 2 contains the programmable output status via the Qset . See the relative manual.

3.6.4   2004h Homing status

This read-only object contains the reset homing status.
- 1   = Homing present
- 0   = Homing not performed

3.6.5   2005h Brake

This object contains the motor brake status, when present. The motor brake is automatically controlled by the drive, with a torqueless motor, the brake is active, with a torque motor, the brake is disabled.
The brake status can only be changed with a torqueless motor, in this case the brake can be deactivated to move the engine manually.

3.6.6   2100h Total time off

This read-only object contains the total time that the drive has been torqueless while powered on, since it left the factory. The time is expressed in seconds.

3.6.7   2101h Total time on

This read-only object contains the total time that the drive has been torque while switched on, but in stop status, since it left the factory. The time is expressed in seconds.

3.6.8   2102h Total time run

This read-only object contains the total time that the drive has been torque while switched on and in action, since it left the factory. The time is expressed in seconds.

3.6.9   2103h Total stroke

This read-only object contains the total stroke performed by the drive, considering each movement in absolute value excluding the rotation direction. The stroke is expressed in motor revolutions.

4.   Unit of measurement

The units of measurement with the default drive settings (when use of a Camozzi axis / cylinder is configured by QSet) are:
- Position [mm]
- Velocity [mm/s]
- Acceleration [mm/s2]
Furthermore, the minimum and maximum software limits are set to zero and the full scale of the selected actuator (axis / cylinder).
Therefore, all of the dictionary objects such as position target, velocity target and the movement profiles are expressed through these units of measurement.
To customise the unit of measurement, configure object 2001h "feed converter" in the object dictionary, composed of two parameters: parameter 1 "numerator" and parameter 2 "denominator". The conversion consists of the following formula:

New unit = default unit * "numerator" / "denominator"

For example, to set the unit of measurement to inches, adjust the "feed converter" as follows:
- Numerator   = 100
- Denominator   = 254
In doing so, the units of measurement become:
- Position   [Inch]
- Velocity   [Inch/s]
- Acceleration   [Inch/s2]

When the drive is configured (from QSet) to be used without a Camozzi axis / cylinder, but just with motor, the software limits are not set, and the units of measurement are:
- Position   [°]
- Velocity   [°/s]
- Acceleration   [°/s2]

This unit of measure can be changed via the **2001h "feed converter"** object, for example to change to the drive µstep (3200µstep / revolution) you have to set:
- Numerator   = 888
- Denominator   = 100

In doing so, the units of measurement become:
- Position   [µstep]
- Velocity   [µstep/s]
- Acceleration   [µstep/s2]
To perform a complete motor revolution, set a position of 3200µstep.

5. Profile position

The drive provides the operation with the velocity profile specified in the Cia 402 specifications.
This drive operation mode requires a specific movement profile, setting the velocity and accelerations, with which to reach the position target. The target cannot be changed during a movement, the movement in progress must be terminated or interrupted before being able to set a new target.
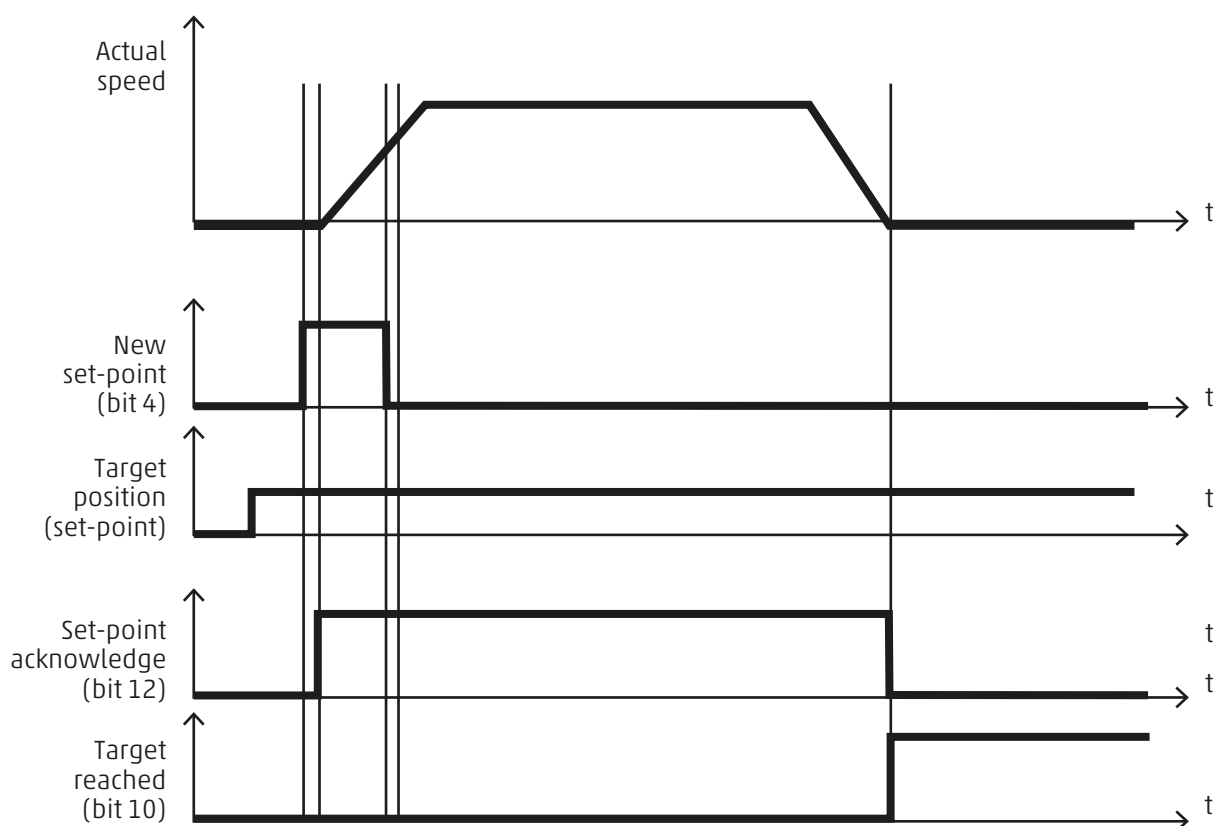
To enable this operation, set the operating mode to value 1 via object 6060h "Modes of operation" and check that the drive is effectively in the correct status with object 6061h "Modes of operation display".
In this operating mode the controlword (profile-specific) bits become:
- Bit 4 "new set point" = this bit must be raised to indicate the start of the movement to the set target, the drive response on the statusword is through bit 12, afterwards, bit 4 must be reset.
- Bit 6 "abs / rel" = this bit is used to indicate the target type to be reached, if absolute with the bit to zero, or relative with the bit set.

At the end of the movement the statusword bits become:
- Bit 10 "target reached" = this bit indicates the achievement of the target at the end of the positioning.
- Bit 12 "Set-point reached" = this bit indicates the positioning is in progress and remains high until the end of the command, when it is low it indicates the driver is ready to receive a new command.

The dictionary objects related to this operating profile are:
- **6060h** "mode of operation" to be set to value 1 to select the operating mode
- **607Ah** "target position" to set the position to be reached
- **6081h** "profile velocity in pp.mode" to set the velocity of the movement
- **6083h** "profile acceleration" to set the acceleration of the movement
- **6084h** "profile Deceleration" to set the deceleration of the movement
The start of the movement is always controlled by bit 4 of the "Controlword".

6.   Velocity profile

The drive requires operation with the velocity profile specified in the Cia 402 specifications.
This operation mode provides for the operation of the motor at velocity, after setting the accelerations, once the velocity target is set, the motor accelerates until the target is reached and then maintains the required velocity until a new request is made.
To enable this operation, set the operating mode to value 3 via object 6060h "Modes of operation" and check that the drive is effectively in the correct status with object 6061h "Modes of operation display".
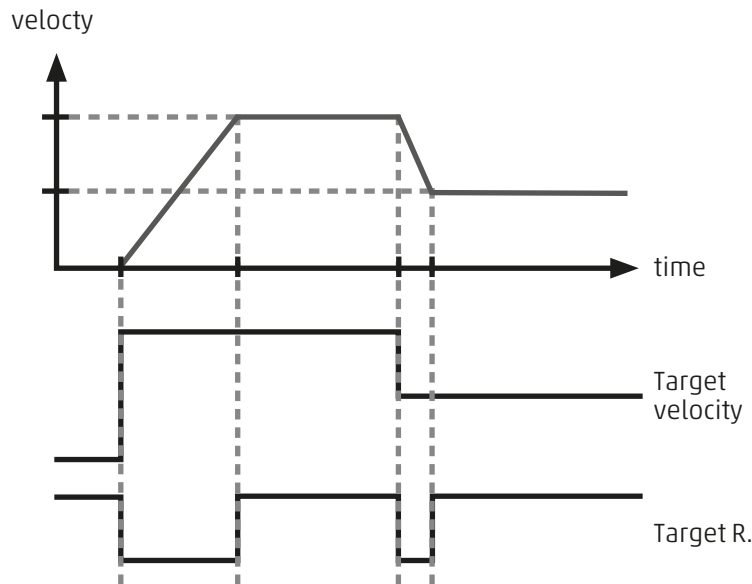
Bit 8 of the "controlword" (halt bit) stops the motor with the set deceleration ramp.
Bit 12 of the "statusword" (target reached) is set by the drive when the difference between the target velocity and the actual velocity is within the value specified in the "velocity window" (606Dh) for at least the time equal to or higher than the value set in the "velocity window time" (606Eh).

To set this operating mode, set the value 3 in object 6060h "modes of operation" and check the effective status of the drive with object 6061h "modes of operation display".
In this operating mode, the motor is moving when the halt bit, bit 8 of the "controlword" is not set and the velocity target value, 60FFh is different to zero.

The statusword is updated as follows:
- Bit 10 "target reached" = with the "halt" bit equal to zero this bit indicates the achievement of the velocity target, with the "halt" bit equal to one this bit indicates if motor is stopped: 1=motor stopped 0= motor being decelerated
- Bit 12 "Speed" this bit indicates if motor is stopped: 1= zero speed 0= in movement

The dictionary objects related to this operating profile are:
- **60FFh** "Target velocity" to set a velocity target and then start the movement
- **6083h** "Profile acceleration" to set the acceleration profile
- **6084h** "Profile deceleration" to set the deceleration profile
- **606Dh** "Velocity window time" to set the minimum target validation time
- **606Eh** "Velocity window time" per impostare il tempo minimo di validazione del target
- **606Fh** "Velocity threshold" to set the zero velocity threshold (motor stopped)
- **6070h** "Velocity threshold time" to set the minimum time for zero velocity.

7.   Homing

Homing requires operation with the reset profile set out in the Cia 402 specifications.
Homing is the procedure by which the motor searches for the zero position, identified by the zero proximity position, from this position the counting of all movements starts.
This is the procedure that must be performed immediately after startup to move the motor.
To enable this operation, set the operating mode to value 6 via object 6060h "Modes of operation" and check that the drive is effectively in the correct status with object 6061h "Modes of operation display".
To start the reset procedure, set bit 4 of the "controlword", during the zero search the drive sets bit 12 of the "statusword" and at the end of the procedure sets bit 10.
Bit 10 of the "statusword" identifies the correct homing execution, but only when the drive is in the reset operating mode, in the other operating modes this bit changes its functionality.
This is why the 2004h "Homing Ok" dictionary object contains the drive homing status:
- 0: drive without homing
- 1: drive with homing (ready for movement commands)

To configure the execution movement of the homing procedure, the following objects must be configured:
- **6099h** "Homing velocity"
    parameter 1 "fast speed " velocity for proximity search
    parameter 2 "slow speed" proximity output velocity
- **6083h** "Profile acceleration" acceleration to be used in the movement startup
- **6984h** "Profile deceleration" deceleration to be used when stopping the movement
- **607Ch** "Home offset" offset to be applied to the physical zero position to move the motor zero

The drive includes three possible resetting methods, two based on the search direction of the zero proximity, and one without the zero proximity:

- **Method 17**: Proximity search in a negative direction
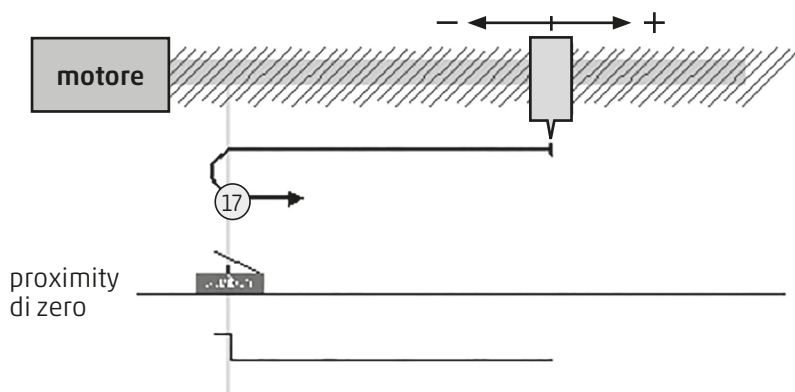
In this reset mode, the motor searches for the zero proximity in the negative direction of the movement, with the velocity set to "fast velocity", as soon as the proximity is detected, the motor stops and exits the proximity in the opposite direction with the velocity set to "slow velocity " .
If the proximity is not detected within the maximum motor stroke or after a timeout, the reset procedure is interrupted with the indication of an error.

- **Method 18**: Proximity search in a positive direction:
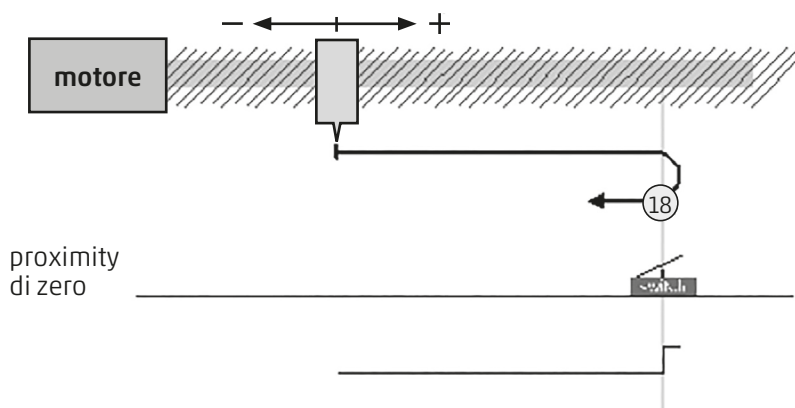
In this reset mode, the motor searches for the zero proximity in the positive direction of the movement, with the speed set to "fast velocity", as soon as the proximity is detected, the motor stops and exits the proximity in the opposite direction with the speed set to "slow velocity " .
If the proximity is not detected within the maximum motor stroke or after a timeout, the reset procedure is interrupted with the indication of an error.

- **Method 37**: Without zero proximity:
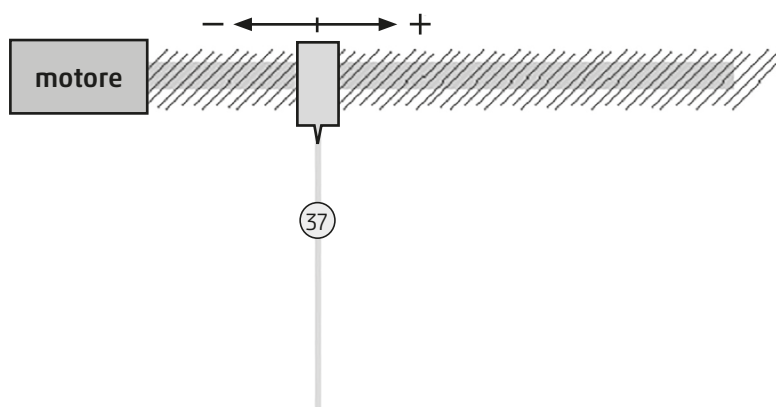
In this reset mode, the external proximity to find the zero position is not required, but the reset setting consists of adjusting the current position (without moving the motor) to zero position.
This mode is convenient when the drive is used without a Camozzi linear actuator (axis / cylinder), but is configured as "only motor" via QSet and when only the velocity profile is wanted, therefore, where the absolute zero position is not required.

During the homing procedure the "statusword" bits are updated as foolows:

Bit 13 "Homing error"	Bit 12 "Homing atteined"	Bit 10 "Target reached"	Definition
0	0	0	Homing in progress
0	0	1	Homing stopped or not started
0	1	0	Homing stopped
0	1	1	Homing complited successfully
1	0	0	Homing in error
1	0	1	Homing terminated with error
1	1	x	Reserved

8. Programming examples

The following are the commands to be sent to the drive, configured with address 3, to perform the main functions:

- Enable the motor to execute the commands

ID	size	data	description
$603	$8	$2B 40 60 00 06 00 00 00	"ready to switch on
$603	$8	$2B 40 60 00 07 00 00 00	"Switched on"
$603	$8	$2B 40 60 00 0F 00 00 00	"Operation enabled"

- Switch to the Homing mode profile

$603	$8	$2F 60 60 00 06 00 00 00	"set homing mode"
$603	$8	$2F 98 60 00 11 00 00 00	"set homing metod to 17"

- Setting the homing profile

$603	$8	$23 83 60 00 64 00 00 00	"set acceleration to 100mm/s2"
$603	$8	$23 84 60 00 64 00 00 00	"set deceleration to 100mm/s2"
$603	$8	$23 99 60 01 32 00 00 00	"set fast velocity home to 50mm/s"
$603	$8	$23 99 60 02 32 00 00 00	"set slow velocity home to 50mm/s"

- Start homing procedure

$603	$8	$2B 40 60 00 1F 00 00 00	"set start homing"
$603	$8	$2B 40 60 00 0F 00 00 00	"reset start command"

- Switch to position profile

$603	$8	$2F 60 60 00 01 00 00 00	"set profile position mode"

- Setting the motion profile

$603	$8	$23 81 60 00 32 00 00 00	"set velocity to 50mm/s"
$603	$8	$23 83 60 00 64 00 00 00	"set acceleration to 100mm/s2"
$603	$8	$23 84 60 00 64 00 00 00	"set deceleration to 100mm/s2"

- Command for movement to an absolute position

$603	$8	$23 7A 60 00 2C 01 00 00	"set target to 300mm"
$603	$8	$2B 40 60 00 1F 00 00 00	"set start command"
$603	$8	$2B 40 60 00 0F 00 00 00	"clear command"

- Command for movement to a relative position

$603	$8	$23 7A 60 00 2C 01 00 00	"set target to 300mm"
$603	$8	$2B 40 60 00 5F 00 00 00	"set start command"
$603	$8	$2B 40 60 00 0F 00 00 00	"clear command"

- Switch to the velocity profile

$603	$8	$2B 40 60 00 0F 01 00 00	"set motion halted"
$603	$8	$2F 60 60 00 03 00 00 00	"set profile velocity"

- Setting the motion profile

$603	$8	$23 FF 60 00 32 00 00 00	"set target velocity to 50mm/s"
$603	$8	$23 83 60 00 64 00 00 00	"set acceleration to 100mm/s2"
$603	$8	$23 84 60 00 64 00 00 00	"set deceleration to 100mm/s2"

- Speed movement start / stop command

$603	$8	$2B 40 60 00 0F 00 00 00	"set motion start"
$603	$8	$23 FF 60 00 64 00 00 00	"change target velocity to 100mm/s"
$603	$8	$2B 40 60 00 0F 01 00 00	"set motion halted"
$603	$8	$23 FF 60 00 00 00 00 00	"change target velocity to 0mm/s"

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