

OPEN DRIVE
OPEN DRIVE

Vector Manual
Version 4.0

TDE MACRO

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OPEN DRIVE

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**Standard closed loop
application**

**Standard closed loop application
(references generation)**

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The OPEN DRIVE standard application makes it possible to control the motor in speed or in current by inputting the references analogically and digitally. Management of digital input/output and Field-Bus references can also be carried out.

1. Application configuration

1.1. Application parameters

PAR	DESCRIPTION	Variation FIELD	Default VALUE	Normalisation UNIT	internal Repr.
P01	14 bit analog ref. correction factor 1 (AN_INP_1)	±400.0	100.0	%	10
P02	14 bit analog corrective offset ref. 1 (AN_INP_1)	±16383	0	16383=100%	1
P03	14 bit analog ref. correction factor 2 (AN_INP_2)	±400.0	100.0	%	10
P04	14 bit analog corrective offset ref. 2 (AN_INP_2)	±16383	0	16383=100%	1
P05	14 bit analog ref. correction factor 3 (AN_INP_3)	±400.0	100.0	%	10
P06	14 bit analog corrective offset ref. 3 (AN_INP_3)	±16383	0	16383=100%	1
P07	Digital speed reference (JOG1)	±100.00	0.00	% n _{MAX}	16383
P08	Digital motor potentiometer starting speed	±100.0	2.0	% n _{MAX}	16383
P09	Analog torque reference time filter constant	0.0÷20.0	0.0	ms	10
P10	Offset on high precision analog reference	±19999	0	/100 mV	1
P11	NUM – Frequency input slip ratio	±16383	100		1
P12	DEN – Frequency input slip ratio	0÷16383	100		1
P13	Correction factor for analog speed reference at 16 bit	±400.0	100.0	%	10
P14	Offset correction factor for analog speed reference at 16 bit	±16383	0	16383=100%	1
P16	Maximum motor potentiometer speed reference	±105.0	105.0	% n _{MAX}	16383
P17	Minimum motor potentiometer speed reference	±105.0	-105.0	% n _{MAX}	16383
P20	Digital potentiometer acceleration time	0.3÷1999.9	50.0	s	10
P48	Speed reference frequency input time filter constant	0.0÷20.0	1.6	ms	10
P49	Correction factor for Speed reference frequency input	0÷200.0	100.0	%	16383
P180	Torque Feed-forward: II order time filter constant on speed reference	0.0÷1000.0	0.0	ms	10
P181	Torque Feed-forward: Startup time	0÷19999	0	ms	1
P182	% Increment multiplicative factor on speed reference	100.0 ÷ 800.0	100.0	%	4095
P183	% Decrement multiplicative factor on speed reference	0.0 ÷ 100.0	0.0	%	4095
P184	Velocità massima di lavoro – SECOND BANK	50-30000	2000	Rpm	1
P185	KpV speed regulator – SECOND BANK	0.1÷400.0	4.0		10
P186	TiV speed regulator – SECOND BANK	0.1÷3000.0	80.0	ms	10
P187	TfV (filter) – SECOND BANK	0÷25	0.8	ms	10
P188	CW acceleration time – SECOND BANK	0.01÷199.99	10.00	s	100
P189	CW deceleration time – SECOND BANK	0.01÷199.99	10.00	s	100
P190	CCW acceleration time – SECOND BANK	0.01÷199.99	10.00	s	100
P191	CCW deceleration time – SECOND BANK	0.01÷199.99	10.00	s	100

1.2. Application connections

CON	DESCRIPTION	Variation FIELD	Default value	Meaning of default	Type
C01	Logic input 1 meaning	-1÷63	8	RESET ALL	r
C02	Logic input 2 meaning	-1÷63	2	CONSENT	r
C03	Logic input 3 meaning	-1÷63	3	ENABLE REF AI1	r
C04	Logic input 4 meaning	-1÷63	0	RUN	r
C05	Logic input 5 meaning	-1÷63	4	ENABLE REF AI2	r
C06	Logic input 6 meaning	-1÷63	12	CW/CCW	r
C07	Logic input 7 meaning	-1÷63	5	ENABLE JOG	r
C08	Logic input 8 meaning	-1÷63	22	ENABLE RAMPS	r
C09	Frequency input determination : 0=analog; 1=digital encoder; 2=digital frequency/sign; 3=digital frequency/sign 1 edge	0÷3	1	DIGITAL ENCODER	r
C10	Logic output 1 meaning	-32÷31	3	RUN	r
C11	Logic output 2 meaning	-32÷31	0	RESET READY	r
C12	Logic output 3 meaning	-32÷31	6	END OF RAMP	r
C13	Logic output 4 meaning	-32÷31	10	SWITCH ON POWER INPUT	r
C15	Meaning of programmable analog output 1	-63÷64	11	CURRENT	
C16	Meaning of programmable analog output 2	-63÷64	4	SPEED	
C17	Meaning of 14 bit analog input A .I.1	0÷2	0	SPEED REF	r
C18	Meaning of 14 bit analog input A .I.2	0÷2	1	TORQUE REF	r
C19	Meaning of 14 bit analog input A .I.3	0÷2	2	LIMIT REF	r
C20	Load last digital potentiometer frequency	0,1	0		
C22	Enable 14 bit analog reference A.I.1	0,1	0		
C23	Enable 14 bit analog reference A.I.2	0,1	0		
C24	Parallel bit at REF3 (jog)	0,1	0		
C25	Parallel bit at REF4 (digital motor potentiometer)	0,1	0		
C26	Ramp inclusion	0,1	x		
C31	Enable 14 bit analog reference A.I.3	0,1	0		
C36	Reference signal software reversal	0,1	0		
C39	Impulses/revolution selection FREQUENCY INPUT	0÷9	5	1024 ppr	
C40	Enable 16 bit analog speed reference	0,1	0		
C43	Enables speed reference in frequency	0,1	0		
C52	Enable FIELD-BUS references	0,1	0		r
C53	Enable locked RUN	0,1	0		r
C70	Enable Speed reference frequency input decoded in time	0,1	0		
C79	Enable digital inputs active low	0÷255	0		r
C90	Enable Torque feed-forward on speed reference 0=not enabled; 1=analog speed ref; 2=frequency speed reference	0÷2	0		
C91	Enable offset on overlap position loop reference	0,1	0		
C92	Enable overlap position loop memory clear when power is switched-off	0,1	0		r
C93	Analog input selection for multiplicative factor 0=none 2=AI2 3=AI3 4=AI16bit	0÷4	0		
C94	Speed reference selection with multiplicative factor 0=none 1=AI enabled 2=AI16bit 3=NUM electrical gear	0÷3	0		
C95	Active bank speed regulator gains	0,1	0		

1.3. Input logic functions

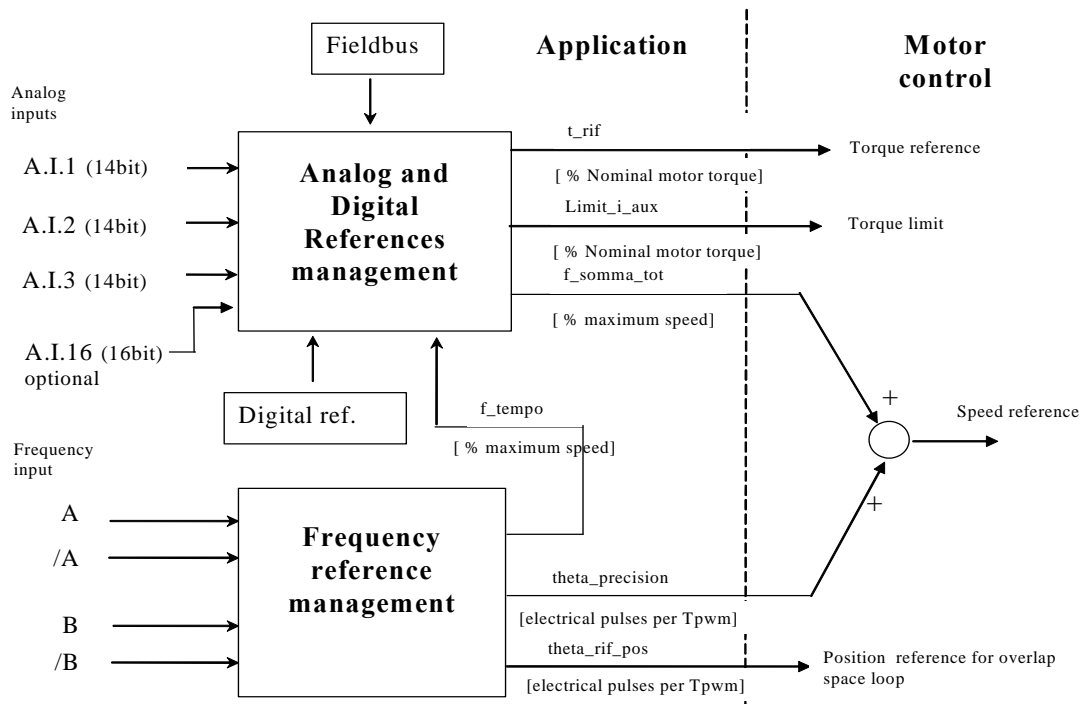
INP	LOGIC FUNCTION ASSIGNED
I00	Run
I01	Torque control
I03	Enable 14 bit analog reference A.I.1.
I04	Enable 14 bit analog reference A.I.2.
I05	Enable speed jog
I06	Enable digital potentiometer speed reference
I07	Enable 14 bit analog reference A.I.3.
I09	DP UP digital potentiometer up
I10	DP DOWN digital potentiometer down
I11	Load last digital potentiometer value
I12	Reference reversal
I14	Enable FIELD-BUS references
I18	Enable speed reference in frequency decoded in time
I19	Enable speed reference in frequency
I20	Enable 16 bit speed reference (if present)
I21	STOP command (run with retention)
I22	Enable line ramps
I24	Freeze PI speed regulator integral memory
I25	Enable offset on overlap position loop reference
I26	Enable second bank speed regulator gains

1.4. Application internal quantities

INT	INTERNAL ASSIGNED VARIABLE	Normalisation unit	Internal repr.
d06	16 bit analog speed reference	% n _{MAX}	16383
d10	Reference for torque generated by the application	% C _{NOM MOT}	4095
d12	14 bit analog speed reference	% n _{MAX}	16383
d14	Reference for speed in frequency generated by the application	% n _{MAX}	16383
d32	Reference for torque limit generated by the application	% C _{NOM MOT}	4095
d33	Reference for speed percentage generated by the application	% n _{MAX}	16383

2. References management

The standard application regards the configuration and management of various digital inputs for the generation of speed, torque and torque limit references for the actual control of the motor.

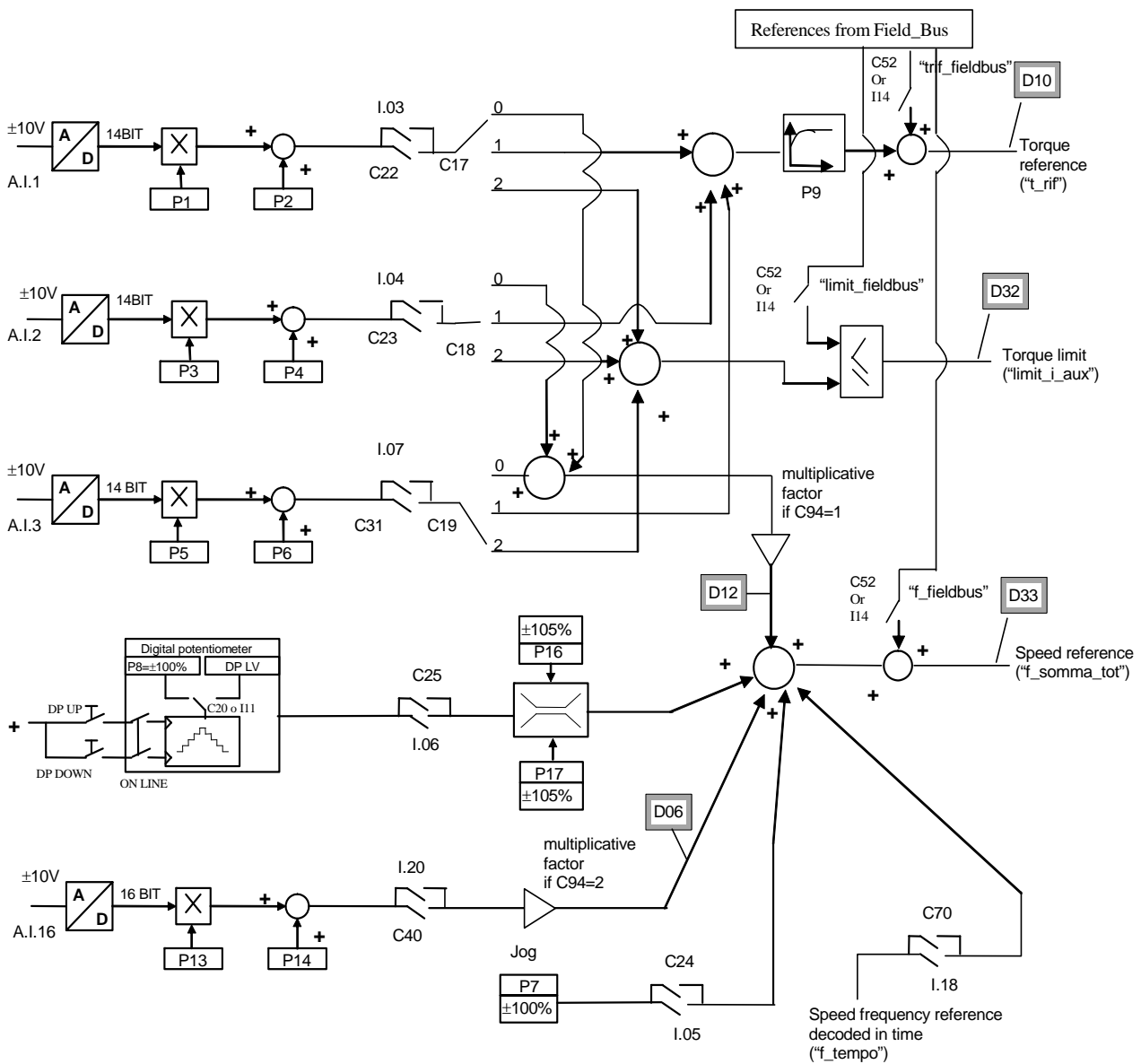


5 references for the motor control are generated by this block:

1. a torque reference (“t_rif”) as percentage of the motor's nominal torque
2. a torque limit reference (“limit_i_aux”) as percentage of the motor's nominal torque.
3. a speed reference (“f_somma_tot”) as percentage of the maximum speed (set in parameter P65)
4. another speed reference (“theta_precision”) in electrical pulses for the period of PWM. This particular reference is to ensure no pulse is lost if frequency input is used. Internal normalisation requires there to be 65536 pulses per mechanical revolution and these are considered the pulses multiplied by the motor's number of polar pairs: this so as not to lose sensor resolution.
5. a incremental position reference (“theta_rif_pos”) in electrical pulses for the period of PWM, that will be the reference for the overlap space loop.

Inside the motor control, the two speed references are added up after they have been suitably adapted.

2.1. Digital and analog references management



It's possible to enable separately all references using connections or logic input functions. For speed and torque references the active reference is the sum of all enabled references, for torque limit prevails the more constrain active reference, between the sum of analog and the Fieldbus references.

2.1.1. 14 bit analog references

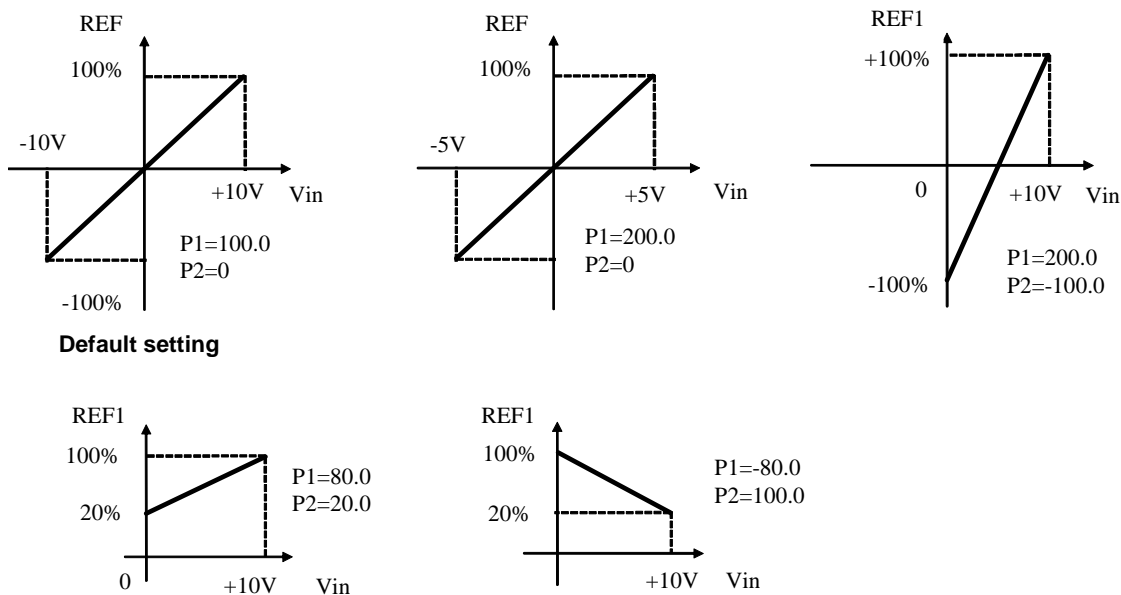
There can be up to 3 differential analog inputs (A.I.1 ÷ A.I.3) ± 10V which, after being digitally converted with a resolution of 14 bits, can be:

- conditioned by digital offset and a multiplicative coefficient
- enabled independently through configurable logic inputs or connections
- configured as meaning through the corresponding connection (C17 ÷ C19)
- added together for the references with the same configuration

For example in the case of A.I.1, the result of the conditioning is given by the following equation:

$$\text{REF1} = ((\text{A.I.1}/10) * \text{P1}) + \text{P2}$$

By selecting a suitable correction factor and offset the most varied linear relationships can be obtained between the input signal and the reference generated, as exemplified below.



Note: for the offset parameters (P02, P04 and P06) an integer representation has been used on the basis of 16383, in order to obtain maximum possible resolution for their settings.

For example if P02=100 \implies offset = 100/16383 = 0.61%

As said above, the enabling of each analog input is independent and can be set permanently by using the corresponding connection or can be controlled by a logic input after it has been suitably configured.

For example to enable input **A.I.1** the connection **C22** or the input logic function **I03** can be used, with the default allocated to logic input 3.

The connections C17 and C19 are used to separately configure the three analog inputs available:

C17 – C19	Meaning
0	Speed reference
1	Torque reference
2	Torque limit reference

Several inputs can be configured to the same meaning so that the corresponding references, if enabled, will be added together.

Note: using the appropriate multiplicative coefficient for each reference it is therefore possible to execute the subtraction of two signals.

In the case of the torque limit, if there is no analog input configured to the given meaning and enabled, the reference is automatically put at the maximum that can be represented, i.e. 400%. In internal quantities **d32** it is possible to view the torque limit imposed by the application.

In the case of the torque reference there is a first order filter with time constant that can be set in milliseconds in parameter **P9**. In the internal quantity **d10** the torque reference can be viewed as set by the application

2.1.2. Digital speed reference (Jog)

The value programmed in parameter **P7** can be used as digital speed reference either by activating the logic function “Enable Jog” I.05 assigned to an input (default input L.I.5) or with the connection **C24**=1. The resolution is 1/10000 of the maximum working speed.

2.1.3. Digital Potentiometer speed reference

A function that makes it possible to obtain a terminal board adjustable speed reference through the use of two logic inputs to which are assigned the input functions digital potentiometer up **I09** (DP.UP) and “Digital potentiometer down **I10**” (DP.DOWN) .

The reference is obtained by increasing or decreasing an internal counter with the DP.UP and DP.DOWN functions respectively.

The speed of increase or decrease set by parameter **P20** (acceleration time of the digital potentiometer) which sets how many seconds the reference takes to go from 0 to 100%, keeping the DP.UP active (this times is the same as to go from 100.0% to 0.0% by holding DP.DN active). If DU.UP are DP.DOWN are activated at the same time the reference remains still.

The movement of the reference is only enabled when the converter is in RUN.

The initial reference value at the time of start up of the converter, is set by the value programmed by the parameter **P8** (P8=2.0% default) if neither the function “last digital potentiometer value **I20**” (DP.LV not active by default), nor connection **C20** (C20=0 default) is active, while the initial reference value remains the same as that when the converter was stopped, even if power has been removed in the meantime, when the DP.LV function is active or connection C20 is active. Thanks to this permanent memory, even if the power supply is lost, the digital potentiometer can be used as if it were a physical potentiometer.

The functioning is summarised in the following table :

Converter running on-line	DP.UP	DP.DOWN	DP.LV	C20	REF
H	H	L	x	x	increases
H	L	H	x	x	decreases
H	L	L	x	x	stopped
H	H	H	x	x	stopped
L	x	x	x	x	stopped
L -> H	x	x	L	L	P8
L -> H	x	x	H	L	REF4 L.v.
L -> H	x	x	L	H	REF4 L.v.
L -> H	x	x	H	H	REF4 L.v.

H = active x = does not matter L = not active L -> H = From Off-line to On-line

The digital potentiometer reference requires, to be enabled, activation of function **I06** after allocating an input or activating connection **C25** (C25=1) .

In the parameters **P16** and **P17** the maximum and the minimum admitted reference values can be marked for the digital potentiometer reference.

2.1.4. 16 bit analog speed reference (optional)

When very precise speed sensors such as Sin/Cos Encoders, Endat can have an analog speed reference $\pm 10V$ converted into 16 bit digital so also to have an excellent resolution reference. For correct wiring of this 16 bit speed reference see the speed sensor appendix to the installation manual.

Also for this speed reference it possible to condition with offset and multiplicative coefficient:

$$REF16 = ((A.I.16/10) * P13) + P14$$

The 16 bit analog speed reference requires activation of function **I20** after assigning an input or activation of connection **C40** (C40=1) .

In internal quantity **d6** this reference can be viewed as a percentage of the maximum working speed.

2.1.5. Speed frequency reference decoded in time

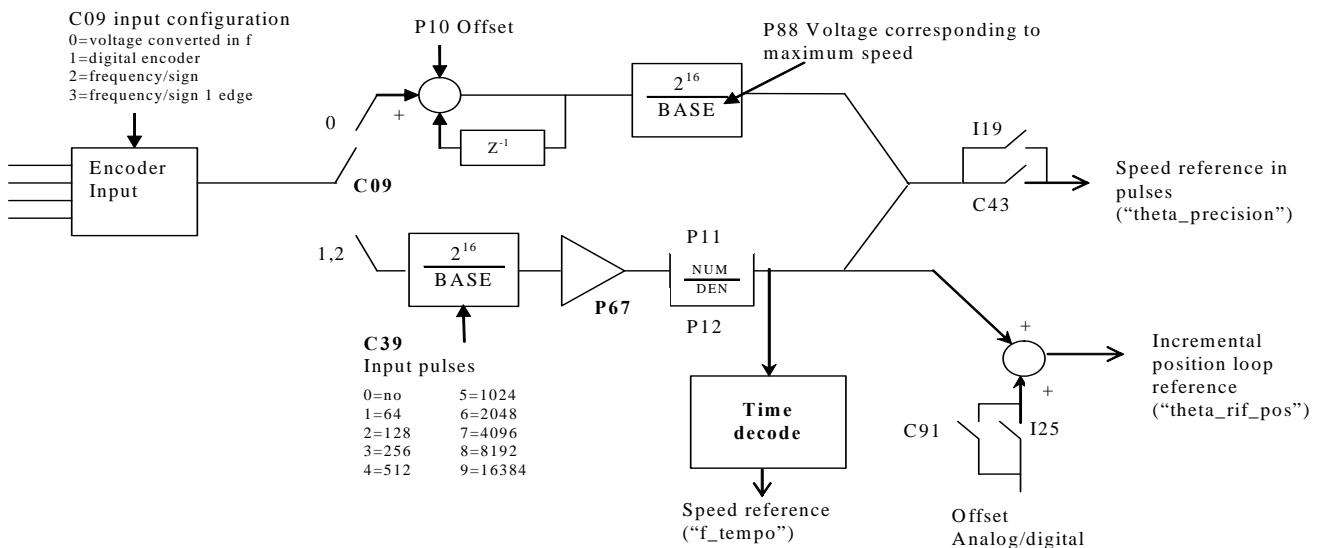
The speed frequency reference decoded in time can be used as digital speed reference either by activating the logic function **I.18** assigned to an input or with the connection **C70=1**.

View in paragraph 2.2.3 for more detailed explanation.

2.2. Speed frequency reference management

This speed reference in pulses (“theta_precision”) can be provided in 3 different ways (alternatives to each other), that can be selected by means of connection C09.

C 09	Mode of working
0	Analog reference $\pm 10V$ (optional)
1	4 track frequency reference (default)
2	Frequency reference (freq. and up/down) counting all edges
3	Frequency reference (freq. and up/down) counting one edge

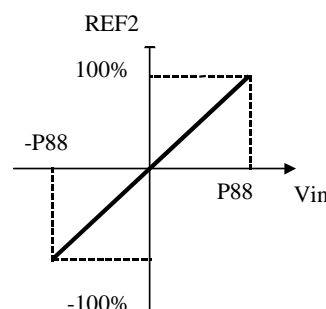


To be used Speed reference in pulses must be enabled either by activating the function “ Enable reference in frequency I19 “assigned an input or by means of connection C43=1 . The incremental position reference is always enabled and it’s possible to add an offset depending on analog and digital speed reference enable (“f_somma_tot”).

2.2.1. High resolution analog reference (optional)

Putting C09 = 0 (with the optional hardware) an analog signal can be provided \pm of 10V that will be converted into frequency while impulse counting will be taken from the high precision speed reference. Parameter P10 permits compensation of any offset present in the analog input and is expressed in units of $10\mu V$;

Parameter P88 permits setting of the voltage to which maximum speed will correspond (default value of 10000mV or 10V).



2.2.2. Frequency reference

Two working modes can be selected with C09 :

- Setting **C09 = 1** a reference can be provided with an encoder signal with 4 tracks of a maximum range varying between 5V and 24V and a maximum frequency of 300KHz.
- Setting **C09 = 2** a speed reference can be provided with an frequency signal with a maximum range varying between 5V and 24V and a maximum frequency of 300KHz. (setting **C09 =3** will be manage the same input, but internally will be count only rising edge, this option is useful only if it is used the time decode, see par. 2.2.3)

The number N of impulses/revolution for the reference is set by connection **C39**:

	0	1	2	3	4	5	6	7	8	9
N° of impulses/revolution	disable	64	128	256	512	1024	2048	4096	8192	16384

There are the parameters **P11** and **P12** that permit specification of the ratio between the reference speed and input frequency as a Numerator/Denominator ratio.

In general terms, therefore, if you want the speed of rotation of the rotor to be **x** rpm, the relationship to use to determine the input frequency is the following:

$$f = \frac{x \times N_{\text{pulses/revolution}} \times P12}{60 \times P11} \quad \text{and vice versa} \quad x = \frac{f \times 60 \times P11}{N_{\text{pulses/revolution}} \times P12}$$

Let us now look at a few examples of cascade activation (MASTER SLAVE) with frequency input according to a standard encoder.

By a MASTER drive the simulated encoder signals A,/A,B,/B are picked up to be taken to the frequency input of the SLAVE. By means of parameters P11 and P12 the slipping between the two is programmed.

MASTER	SLAVE
N° of pulses/revolution = 512	N° of pulses/revolution = 512
P65 = 2500 rpm	P65 = 2500 rpm
	P11=P12=100
The SLAVE goes at the same speed as the MASTER	

MASTER	SLAVE
N° of pulses/revolution = 512	N° of pulses/revolution = 512
P65 = 2500 rpm	P65 = 2500 rpm
	P11=50 P12=100
The SLAVE goes at half the speed of the MASTER	

MASTER	SLAVE
N° of pulses/revolution = 512	N° of pulses/revolution = 512
P65 = 2500 rpm	P65 = 2500 rpm
	P11 =100 P12=50
The SLAVE goes at double the speed of the MASTER	

To obtain good performance at low Speed it is necessary to select an encoder resolution for the MASTER that is sufficiently high.

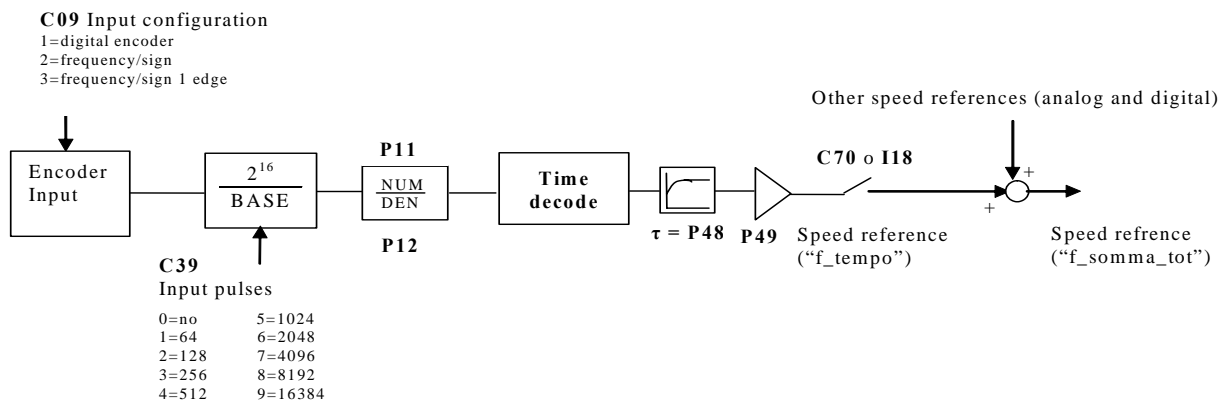
2.2.3. Time decode of frequency input

The speed reference in pulses is very accurate (no pulses is lost) but for its nature it has an irregular shape because are counted the edges every sampling period (TPWM) and this produce a speed reference with many noise. Also if the frequency input is constant, between a PWM period and another could be counted a variable number of pulses, \pm one pulse. This produce a low resolution reference, expecially when the frequency input decreases.

For not use a big filter with frequency reference it's possible to use its time decode that has a good resolution. It is measured the time between various edges of frequency input with resolution of 25ns, reaching a percentage resolution not less than 1/8000 (13 bit) working to 5KHz of PWM (increasing PWM resolution decreases linearly).

It is produced the speed reference as percentage of maximum speed, knowing the pulses per revolution in input and the transformation ratio P11 over P12.

Following the time decode there is a first order filter with time constant set in milliseconds into parameter **P48** and a proportional gain imposed with parameter **P49** as percentage.



If the input is a frequency/sign reference it's very important to set **C09=3** because only counting the rising edge it will be possible to measure the time between one pulse and the other, and not the pulse width.

The speed reference obtained could be used as in sum with the other analog and digital references. (see par. 2.1).

In the follow paragraph it is explain how to use frequency input decoded in time within the pulses reference in a electric axis.

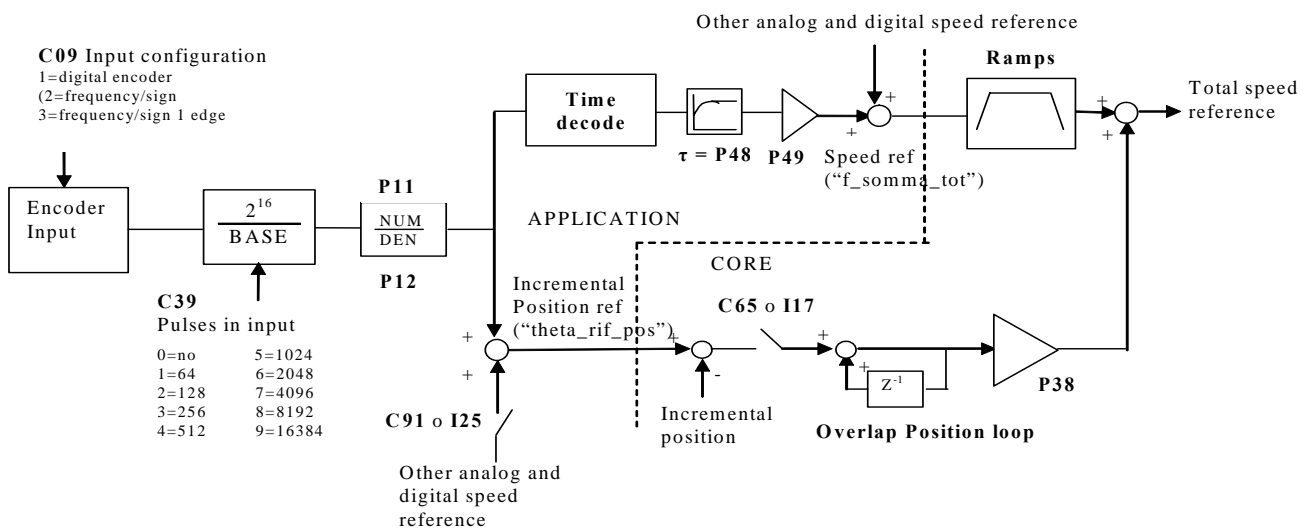
2.2.3.1. Electric axis with frequency reference decoded in time

Manage a frequency position reference meaning ensure every time the correct phase between master and slave. For obtain this result can be used the time decode of frequency input for giving the speed reference in feed-forward, enabling the overlap position loop to ensure the synchronization in phase between master and slave.

Set:

CON	DESCRIPTION	VALUE to set	MEANING
C43 e I19	Enable speed reference in frequency	0	Not enable
C52 e I14	Enable references from Fieldbus	0	Not enable
C70 o I18	Enable Speed reference frequency input decoded in time	1	Enable

With this configuration there is the follow control scheme:



The speed reference in time ("f_somma_tot") has a good resolution also for low frequency in input, allowing to have high gains in speed regulator.

The overlap position loop has to be enabled setting **C65=1** or **I17=H**, after that no pulse will be lost and it will ensure the correct phase between master and slave.

When the overlap position loop works it's useless enable the ramps in speed reference decoded in time.

It's possible to add an offset to the position reference, setting **C91=1** or **I25=H**. The offset is equal to the sum of the other analog and digital speed reference enabled.

2.3. Multiplicative factor on speed reference

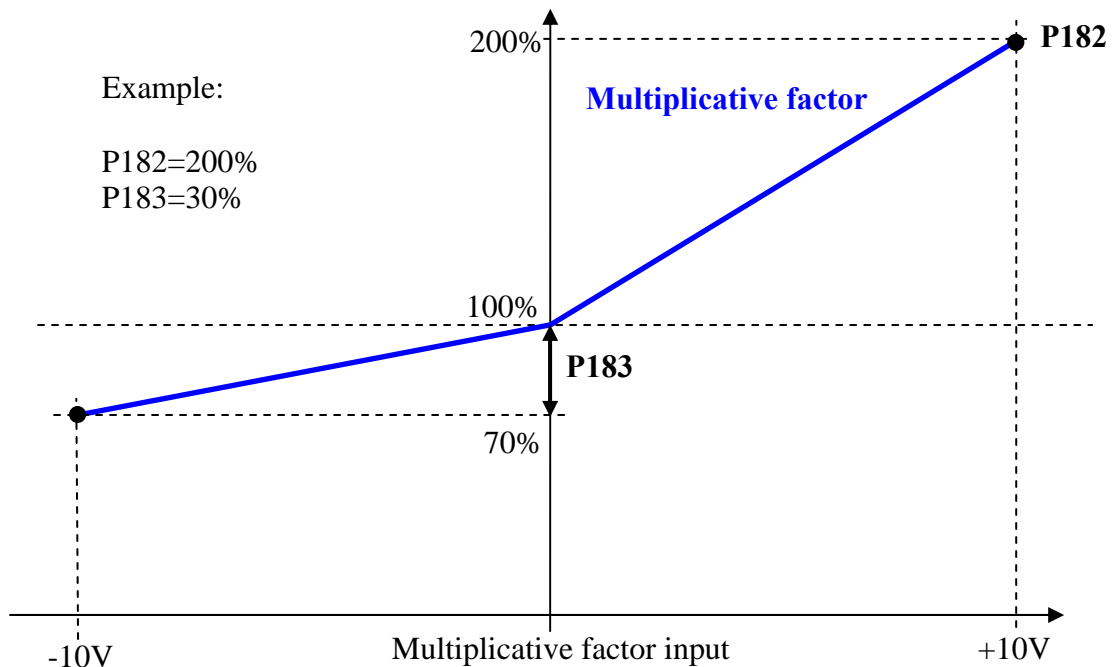
This function enables a multiplicative factor, depending on analog input, on speed reference. It's possible to choose the input for the multiplicative factor using **C93** connection:

C93	Multiplicative factor input
0	None
1	AI1
2	AI2
3	AI3
4	AI16

With **C94** connection, it's possible to choose the speed reference that will be multiply by the factor:

C94	Speed ref. multiplied
0	None
1	AI1+AI2+AI3 (if configured)
2	AI16
3	NUM electrical gear

With parameters **P182** e **P183** it's possible to choose the percentage variation of the speed reference corresponding to $\pm 10V$ of multiplicative factor input.

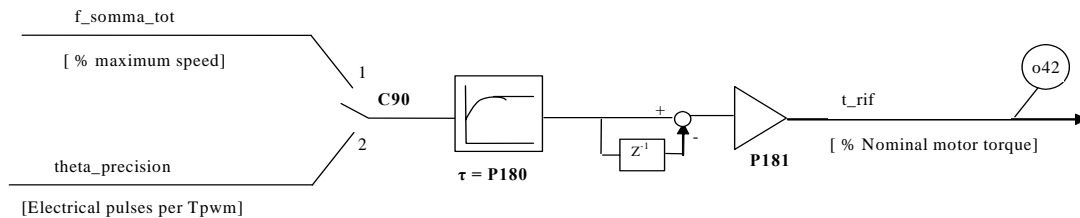


2.4. Torque feed-forward on speed reference

It's possible to enable the Torque feed-forward on speed reference using **C90** connection:

C90	Mode of working
0	Not enabled
1	"f_somma_tot" speed reference derivative (analog a/o Fieldbus)
2	"theta_precision" speed reference derivative (analog to frequency, frequency or from Fieldbus)

It's possible to estimate the torque reference needing for the speed variation requested with the speed reference derivative using a II° order filter (time constant in **P180** in ms) and taking account of total inertia (setting parameter P181 Startup time).



The Startup time is the time necessary for motor and load to reach the maximum speed (set in P65) with the nominal motor torque. This data has to be set in milliseconds in parameter P181.

It's useful to set some milliseconds of filter (P180) on order to avoid too much noise on torque reference for the time derivative.

When it's enabled this function the torque reference "t_rif" cannot be imposed using the analog and digital references see before.

The torque feed-forward can be very useful in the servo-drive application when the target is to follow very promptly the speed reference, because it increases the bandwidth without using high gains on speed regulator.

Note 1: for understand if the torque compensation is correct it's useful to compare it with the total torque reference from speed regulator. The internal monitoring variables are o42 for feed-forward term and o5 for the final torque reference.

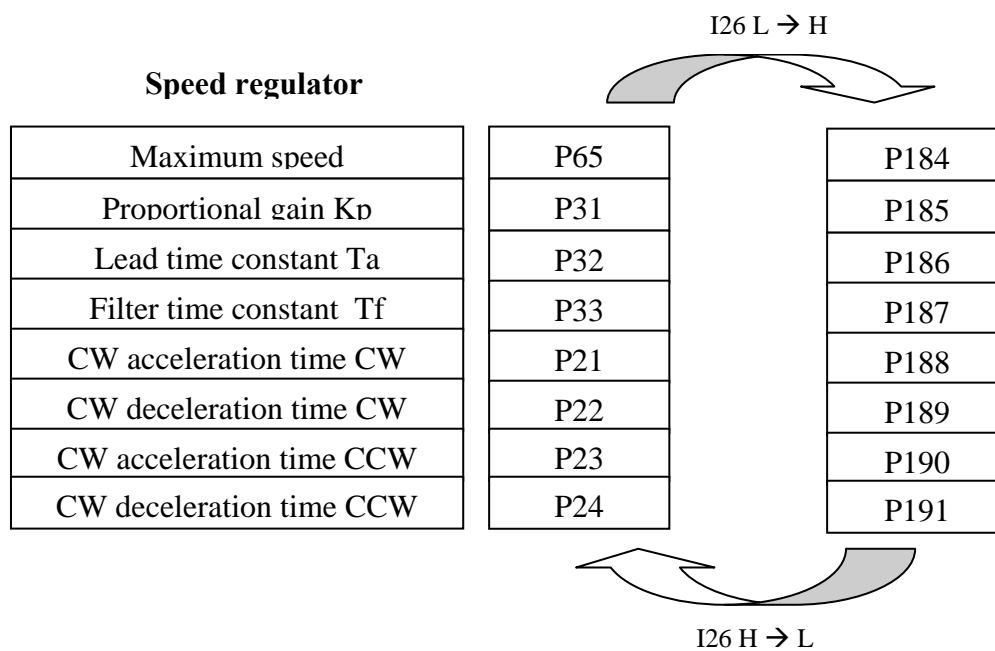
Note2: torque feed-forward isn't appropriate in load variable inertia applications.

2.5. Speed regulator second parameters bank

This function is used to change on-line the speed regulator parameters (P31÷P33), the maximum speed (P65) and the linear ramps acceleration times (P21÷P24), to achieve a good reference resolution, working at low speed.

For enable the second parameters bank (P184÷P187) it's necessary to set the connection **C95=1**, otherwise to bring at high level the logical function **I26** using one of the 8 logical inputs.

When the function is activated the standard data (P31÷P33, P65 and P21÷P24) are automatically exchanged with the second bank (P184÷P191) and the connection C95 is set to 1.



The exchange will be executed only if the working speed is lower than the new maximum speed, this is useful to avoid the over speed alarm A09.

If the speed is greater than new maximum speed, the activation command is ignored.

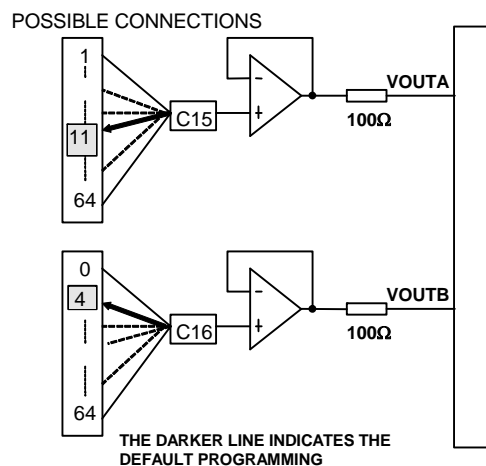
If the speed ramps are active your value will be automatically calculated to avoid sharp transitory.

The connection C95 keep memory of second parameters bank activation. When the drive is switched on, the connection C95 and the logical input I26 are tested: if there is coherence no action is taken, otherwise the connection C95 is automatically changed to line up with logical input I26 and the data are exchanged.

When the function is disabled, bringing I26 to low level or clearing C95=0, data are automatically exchanged, with initial value restore.

3. Analog outputs management

There can be a maximum of two analog outputs, VOUTA and VOUTB ± 10 V, 2mA. To each of the two outputs can be associated an internally regulated variables selected from the list here below; the allocation is made by programming the connection corresponding to the output concerned, C15 for VOUTA and C16 for VOUTB, with the number given in the table below corresponding to the relative quantities. By means of the parameters P57 (for VOUTA) and P58 (for VOUTB) it is also possible to set the percentage of the variables selected to correspond to the maximum output voltage (default values are P57=P58=200% so 10V in output correspond to 200% of variable selected). The default for VOUTA is a signal proportional to the current supplied by converter (C15=11), in VOUTB the signal is proportional to the working speed (C16=4). It is also possible to have the absolute internal variable value desired: to do this it is simply necessary to program the connection corresponding to the denied desired number: for example taking C15=-21 there will be an analog output signal proportional to the absolute value of the working frequency. It is also possible to have a analog output fixed to +10V: to do this it is simply necessary to program the connection corresponding to 64.



NORMALISED BASE INTERNAL VARIABLES FOR ANALOG OUTPUTS			
O 00	Actual mechanical position read by the sensor (if the sensor has more than 2 poles it regards the current revolution sector)	100%=180° (with 2 poles) 100% = semi-sector (+ poles)	32767
O 01	Actual electrical position read by the sensor (delta m)	100%=180°	32767
O 02	Reference speed after the ramp	% n _{MAX}	16383
O 03	Output reference speed from the torque regulator	% n _{MAX}	16383
O 04	Speed of rotation (filtered T _f = 8×T _{PWM} , 1,6ms at 5KHz)	% n _{MAX}	16383
O 05	Torque requirement	% C _{NOM MOT}	4095
O 07	Torque current requirement at current loop	% I _{NOM AZ}	4095
O 08	Flow current requirement at current loop	% I _{NOM AZ}	4095
O 09	Voltage requirement at maximum revolutions	% V _{NOM MOT}	4095
O 11	Current module	% I _{NOM AZ}	4095
O 12	Zero top	100%=180°	32767

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Standard closed loop application

O 13	U phase current measured	% I _{MAX AZ}	4095
O 15	Torque component of measured current	% I _{NOM AZ}	4095
O 16	Magnetising component of current measured	% I _{NOM AZ}	4095
O 17	Duty-cycle U phase voltage		32767
O18	Reference stator ground voltage module	% V _{NOM MOT}	4095
O19	Modulation index	0 ↔ 1	4095
O20	Q axis voltage requirement (Vq_rif)	% V _{NOM}	4095
O21	Power supplied	% P _{NOM}	4095
O22	D axis voltage requirement (Vd_rif)	% V _{NOM}	4095
O24	Bus voltage	100%=900V	4095
O25	Measured radiator temperature	% 37.6°	4095
O26	Measure motor temperature	% 80°	4095
O27	Rotor flux	% φ _{NOM}	4095
O28	Motor thermal current	% A6 action threshold	4095
O29	Current limit	% I _{MAX AZ}	4095
O30	CW maximum torque	% C _{NOM MOT}	4095
O31	CCW maximum torque	% C _{NOM MOT}	4095
O34	Measured phase V current	% I _{MAX AZ}	4095
O35	Measured phase W current	% I _{MAX AZ}	4095
O36	Actual electrical position (alfa_fi)	100%=180°	32767
O37	Analog input A.I.1	100%=16383	16383
O38	Analog input A.I.2	100%=16383	16383
O39	Analog input A.I.3	100%=16383	16383
O40	Analog input A.I.16	100%=16383	16383
O41	Total speed reference (f_somma_tot)	% n _{MAX}	16383
O42	Total torque reference (t_rif) for the application	% C _{NOM MOT}	4095
O43	Total torque limit reference (limit_i_aux)	% C _{NOM MOT}	4095
O44	Total speed reference (theta_precision)	Pulses per Tpwm	1
O45	Reference for overlapping position loop (theta_rif_pos)	Pulses per Tpwm	1
O46	Amplitude at square of sine and cosine feedback signals	1=100%	32767
O47	Sen_theta (Direct resolver and Sin/Cos Encoder)	Max amplitude = 200%	16383
O48	Cos_theta (Direct resolver and Sin/Cos Encoder)	Max amplitude = 200%	16383
O49	Unfiltered speed of rotation	% n _{MAX}	16383
O50	Delta pulses on PWM period from frequency input	Pulses per Tpwm	1
O51	Lsw memory space error (overlapped position loop)	Electrical pulses	1
O52	Msw memory space error (overlapped position loop)	Electrical turns	1
o53	----- Reserved for special applications -----		
÷			
o63	see special application enclosure		
o64	Output fixed to +10V		

4. Input logic management

The control requires up to 8 optically insulated digital inputs (L.I.1 ... L.I.8.) whose logic functions can be configured by means of connection **C1 ÷ C8**.

The following table shows the logic functions managed by standard application:

		INPUT LOGIC FUNCTIONS	DEFAULT INPUT	DEFAULT STATUS
I	00	Run command	L.I.4	L
I	01	Torque control		L
I	02	External consent	L.I.2	H
I	03	Enable 14 bit analog reference A.I.1.	L.I.3	L
I	04	Enable 14 bit analog reference A.I.2.	L.I.5	L
I	05	Enable speed jog	L.I.7	L
I	06	Enable digital potentiometer speed reference		L
I	07	Enable 14 bit analog reference A.I.3.		L
I	08	Alarms reset	L.I.1	L
I	09	UP digital potentiometer		L
I	10	DOWN digital potentiometer		L
I	11	Load last digital potentiometer value		L
I	12	Reversal reference	L.I.6	L
I	13	Enable power soft-start		H
I	14	Enable FIELD-BUS references		L
I	15	Enable Φ external flux (only in the DVET)		L
I	16	Activation second bank of parameters		L
I	17	Enable space loop for electrical axis		L
I	18	Enable time decode speed reference in frequency		
I	19	Enable speed references in frequency		L
I	20	Enable 16 bit speed reference (if present)		L
I	21	STOP command (locked run)		L
I	22	Enable line ramps	L.I.8	L
I	23	Motor termo-switch		L
I	24	Freeze PI speed regulator integral memory		L
I	25	Enable offset on overlap position loop reference		L
I	26	Enable second bank speed regulator gains		L
I	29	--- Reserved for special applications ----		
I	63	see special application enclosure		

NB: pay particular attention to the fact that it is absolutely not possible to assign the same logic function to two different logic inputs: after changing the connection value that sets a determined input, check that the value has been accepted, if not check that another has not already been allocated to that input. In order to disable a logic input it's necessary to assign to it the logic function -1 : this is the only value that can be assigned to more than one inputs.

For example, to assign a specific logic function to logic input 1 you must first write the desired logic number for connection C01 :

C01 = 14 → logic input 1 can be used to enable Fieldbus references

The logic functions that have been configured become active (H) when the input level is at high status ($20V < V < 28V$), and there is a 2.2ms hardware filter. With the connection **C79** it's possible to enable the active logic low state for a particular digital input, it's necessary to sum 2 to the power of ordinal input number:

For example to set digital inputs I0 and I3 to active low state, set: $C79 = 2^0 + 2^3 = 9$

The functions that have not been assigned assume default value ; for example, if the function “external enable“ is not assigned it becomes, as default, “active (H)” so the converter is as if there were no assent from the field.

4.1.1. Input logic functions set in other ways

In reality the input logic functions can also be set by serial connection and by fieldbus, with the following logic:

- I00 Run = stands alone, it has to be confirmed by terminal board inputs, by the serial and by the fieldbus, though in the case of the latter the default is active and so, if unaltered, controls only the terminal board input.
- I01 ÷ I28 = is the parallel of the corresponding functions that can be set at the terminal board, the serial or the fieldbus.
- I29 ÷ I63 = only the functions reserved for special applications, they can certainly be changed by suitably configuring the terminal board inputs, and other possibilities can be attributed by the application itself.

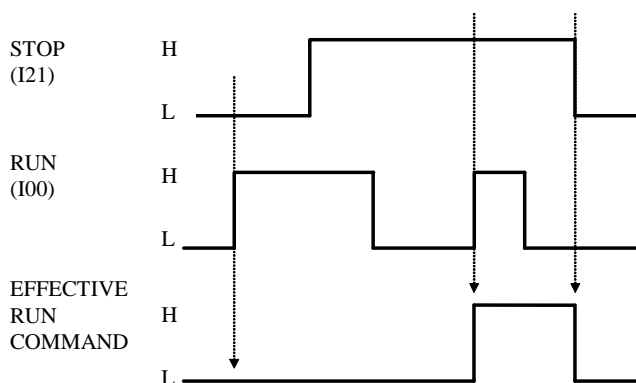
4.1.2. Locked Run from terminal board

It may be a matter of interest that the RUN command can be given by the commutation edge from a low to high signal: to enable this function set **C53=1**.

In this operational mode the STOP command is also used (I21, after having configured one of the logic inputs) which is level sensitive:

- low level: converter in STOP, power disabled
- high level: the converter can be at RUN

The diagram below shows the working logic:



- The RUN command is only given if there is a risign edge L->H on I00 with I21 high.
- Once RUN has been give to logic input I00 can return to low level
- As soon as the STOP signal (I21) goes to low the RUN command is switched off
- If the converter goes into an alarm state the run command will be switched off and so it will be necessary to repeat the start up procedure as soon as the converter is ready again.

5. Logic outputs management

The control can have up to 4 optically insulated digital outputs (L.O.1 ... L.O.4) whose logic functions can be configured as active high (H) by means of connection **C10 ÷ C13**.

The following table shows the logic functions managed by standard application:

		OUTPUT LOGIC FUNCTIONS	DEFAULT OUTPUT
O	00	Drive ready	L.O.2
O	01	Thermal motor alarm	
O	02	Speed above minimum	L.O.4
O	03	Run drive	L.O.1
O	04	CW / CCW	
O	05	Current/torque relay	
O	06	End of ramp	L.O.3
O	07	Current limit drive	
O	08	Torque limit drive	
O	09	Incremental position error > threshold (P37 and P39)	
O	10	Switch on power soft-start	
O	11	Braking active	
O	12	No supply mains	
O	13	Bus regeneration activated (Support 1)	
O	14	Motor thermal current above threshold (P96)	
O	15	Radiator temperature too high (above threshold P120)	
O	16	Speed reached (above absolute value at P47)	
O	17	No supply main to Power electronic card	
O	19	Regulation card supplied and DSP not in reset state	
O	20	DC Bus above threshold (P177)	
O	21	----- Reserved for special application -----	
o	31	see special application enclosure	

If you wish to have the logic outputs active at the low level (L) you need just configure the connection corresponding to the chosen logic function but with the value denied: for example, if you want to associate the function “ end of ramp ” to logic output 1 active low, you have to program connection 10 with the number -6 (C10=-6).

Note: if you want to configure Output logic 0 to active low you have to set the desired connection to value -32

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Common functions

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The standard functions of the OPEN DRIVE are common to all versions of the product.

1 Storage and recall of the working parameters

The drive has three types of memory:

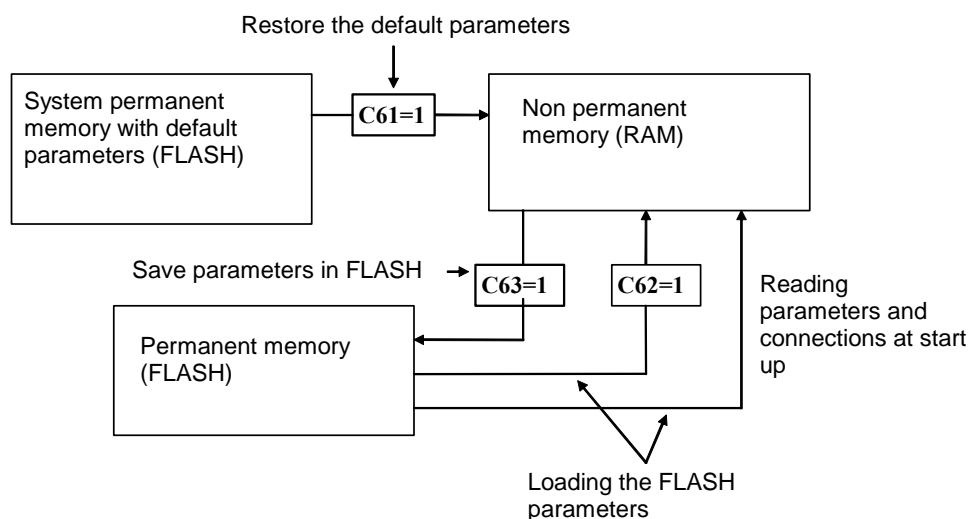
1. The non permanent work memory (RAM), where the parameters become used for operation and modified parameters become stored; such parameters become lost due to the lack of feeding regulation.
2. The permanent work memory (FLASH), where the actual working parameters become stored to be used in sequence (C63=1, Save Parameters on FLASH).
3. The permanent system memory where the default parameters are contained.

When switched on, the drive transfers the permanent memory parameters on to the working memory in order to work. If the modifications carry out on the parameters, they become stored in the work memory and therefore become lost in the break of feeding rather than being saved in the permanent memory.

If after the work memory modifications wants to return to the previous security, it is acceptable to load on such a memory, a permanent memory parameter (Load FLASH Parameter C62=1).

If for some reason the parameters in FLASH change, it is necessary to resume the default parameters (C61=1 Load Default Parameters), to make the appropriate corrections and then save them in the permanent working parameter (C63=1).

It is possible to save the data in the permanent memory also at drive switched on/RUN, while the loading may only be affected aside with drive switched off/STOP, after having opened the key to reserved parameters.



Because the default parameters are standard to be different than those that are personalized, it is correct that after the installation of each drive, there is an accurate copy of permanent memory parameters to be in the position to reproduce them on an eventual drive exchange.

2 Voltage break control for mains feeding

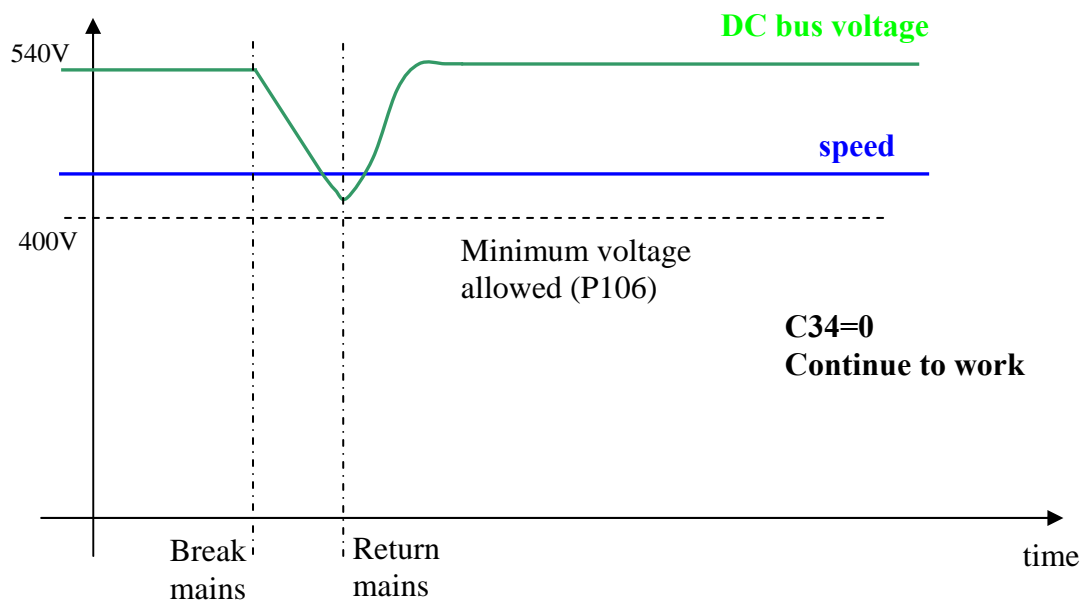
The mains break control is configurable through the following connections:

Connection	Significance
C34	Mains break out control 0= continuing to work; 1= recovery of Kinetic Energy; 2= free; 3= emergency brake
C35	Alarms automatically reset when the mains return

2.1 Continuing to work (C34=0; default)

This operating procedure is adapted to those applications in which it is fundamental to have unchanged working conditions in each situation. Setting C34=0 the drive, even if the mains supply voltage is no longer available, continues to work as though nothing has been modified over the control, pulling the energy from the present capacitor to the inner drive. This way making the intermediate voltage of the DC Bus will begin to go down depending on the applied load; when it reaches the minimum tolerated value (in parameter P106) the drive goes into alarm A10 of minimum voltage and leaves to go to the motor in free evolution.

Therefore, this function will allow exceeding short-term mains break out (tenths/hundredths of milliseconds on the basis of the applied load) without changing the motor operation in any way.



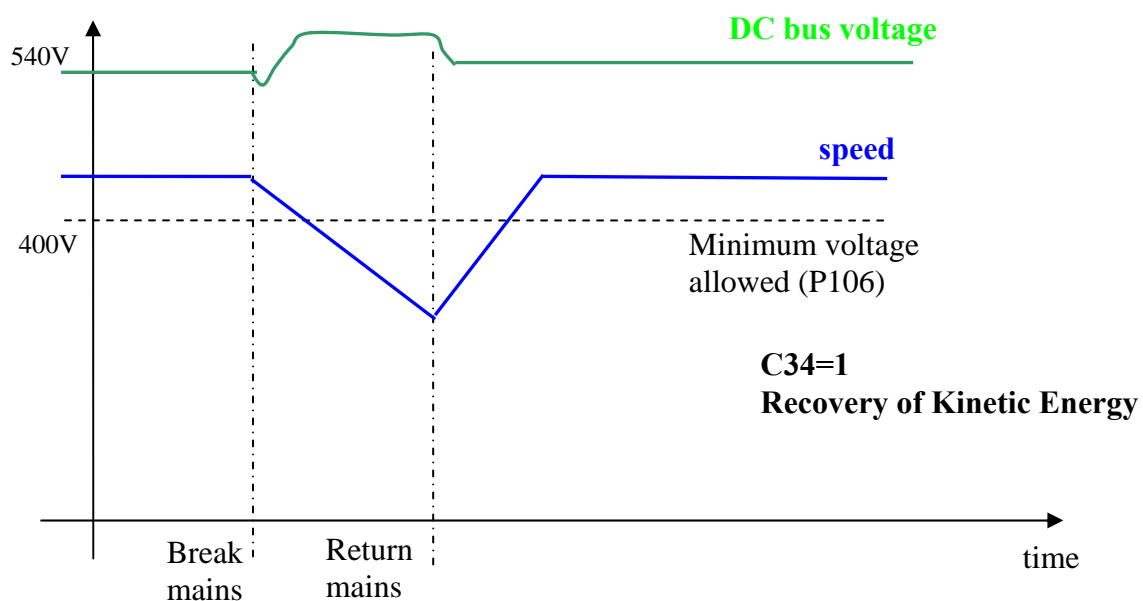
If the alarm condition starts, there is the possibility to enable, setting C35=1 the alarms to an automatic reset at the mains restore.

2.2 Recovery of Kinetic Energy (C34=1)

This operating procedure is adapted to those applications in which it is temporarily possible to reduce the speed of rotation to confront the mains break. This function particularly adapts in the case of fewer applied motors and with high energy.

The qualification of such a function is obtained setting C34=1.

During the mains break out, the voltage control of the DC Bus is achieved using a proportional regulator, with fixed proportional gain set in P86 (default=3.5), that controls the DC Bus voltage d24, compare it with the threshold in P98 (default=600V) and functions on the torque limits d30 of the motor that, in time, will slow down to work in recovery. Such regulation, when qualified (C34=1), at mains break out (o.L.12=H) or if the DC Bus voltage goes below the threshold set in P97 (425V), replaces the normal regulation (o.L.13=H) and is excluded when mains supply is on.



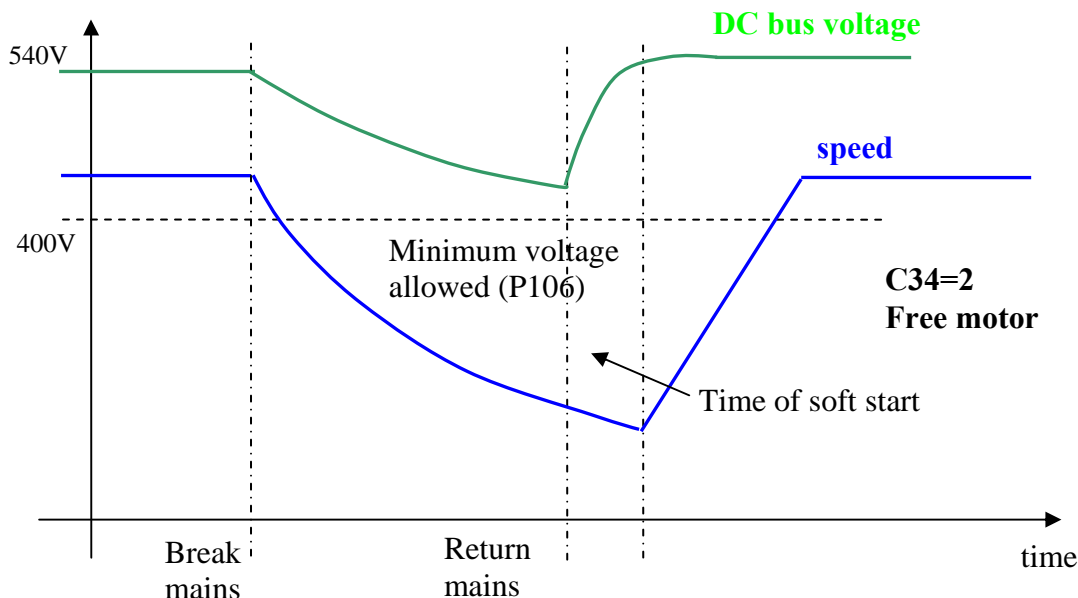
If the alarm condition starts, there is the possibility to enable, setting C35=1 the alarms to an automatic reset at the mains restore.

2.3 Overcoming mains breaks of a few seconds with flying restart (C34=2)

This operating procedure is adapted to those applications in which it is fundamental to not go into alarm in the case of mains break out and is temporarily prepared to disable the power in order for the motor to resume when the mains returns.

The qualification of such a function is obtained setting C34=2.

When there is a mains break or if the voltage of the Bus goes below the threshold set in P97r (425 V), the drive is immediately switched off, the motor rotates in free evolution and the Bus capacitors slowly discharges. If the mains returns in a few seconds, a fast recovery of the motor is carried out in a way in which the working regulation of the machine is resumed.

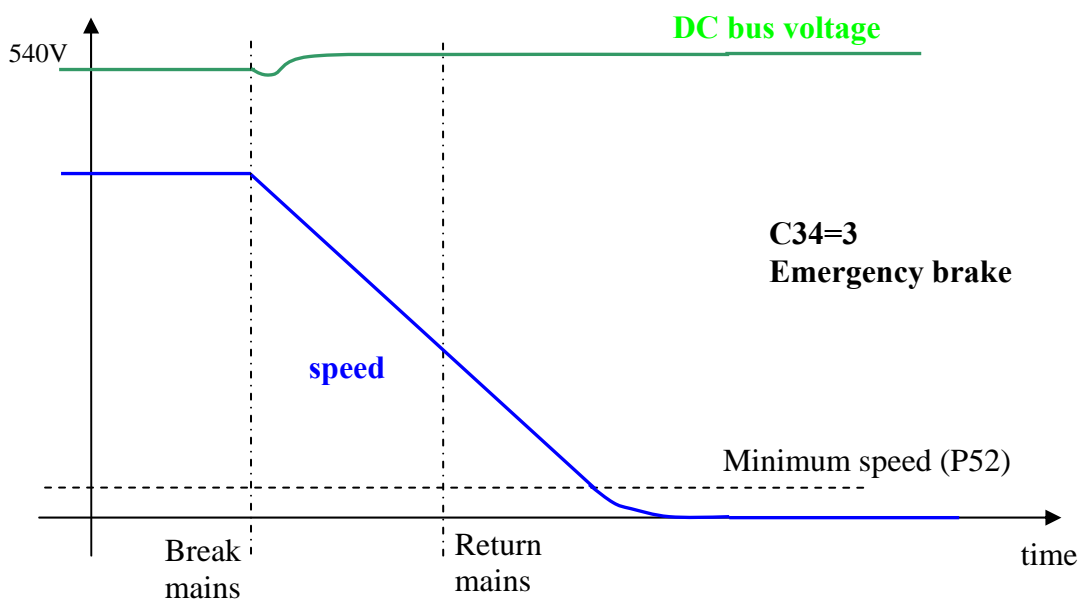


At the return of the mains, it will need to wait for the time of soft start for the gradual recharging of capacitors for the motor to be able to resume.

2.4 Emergency brake (C34=3)

This particular control is adapted to those applications in which the machine may be stopped with an emergency brake in case of mains breaks.

Under this circumstance, the linear ramps becomes qualified and the ramp time is imposed with the parameter P30. When the minimum speed is reached, alarm A10 of minimum voltage starts and the motor is left rotating in free evolution. If in the meantime the mains returns, the emergency brake will be not interrupted.



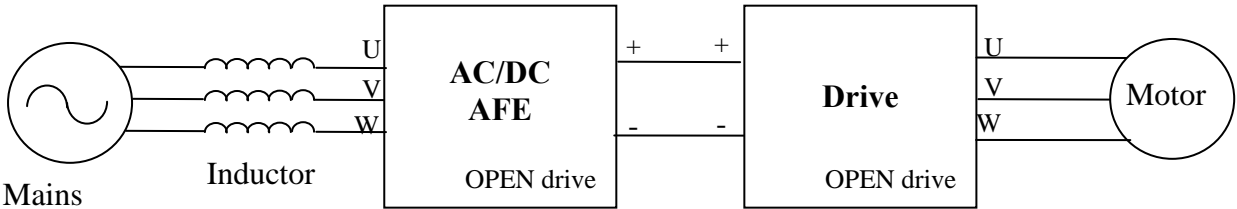
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3 Braking management

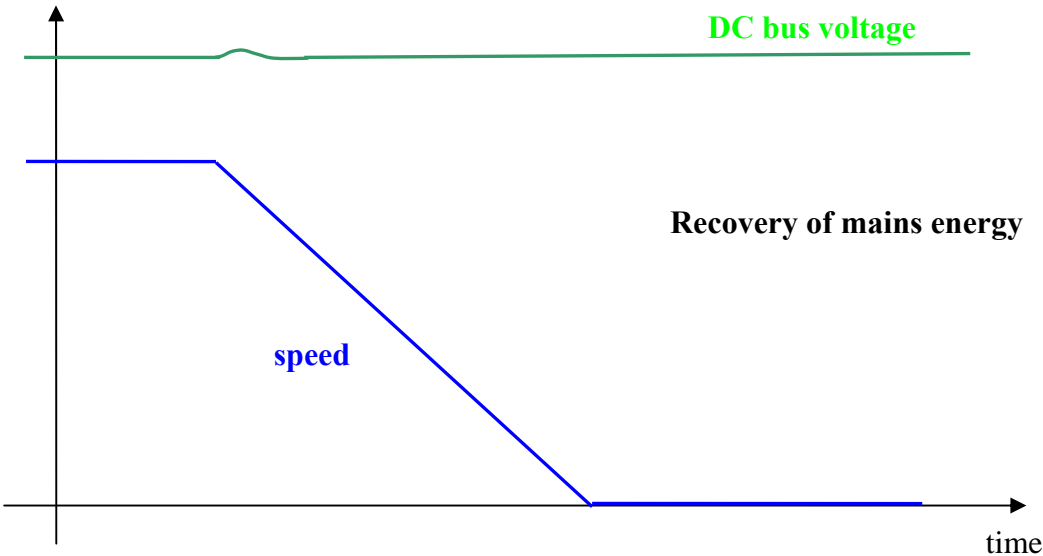
The drive is in a position to work on four quadrants, therefore is also in a position to manage the motor recovery Energy. There are three different, possible controls:

3.1 Recovery mains energy

To be able to restore the kinetic Energy into the mains, it is necessary to use another OPEN drive , specifically the **AC/DC Active Front End (AFE)**. A Power Factor Controller deals with the position to have a power factor close to unity. Specific documentation is sent back from specific details. This solution is adapted to those applications in which the additional cost justifies another drive with a lot of energy that is recovered in the mains or for particular thermal dissipation problems in the use of a braking resistor.



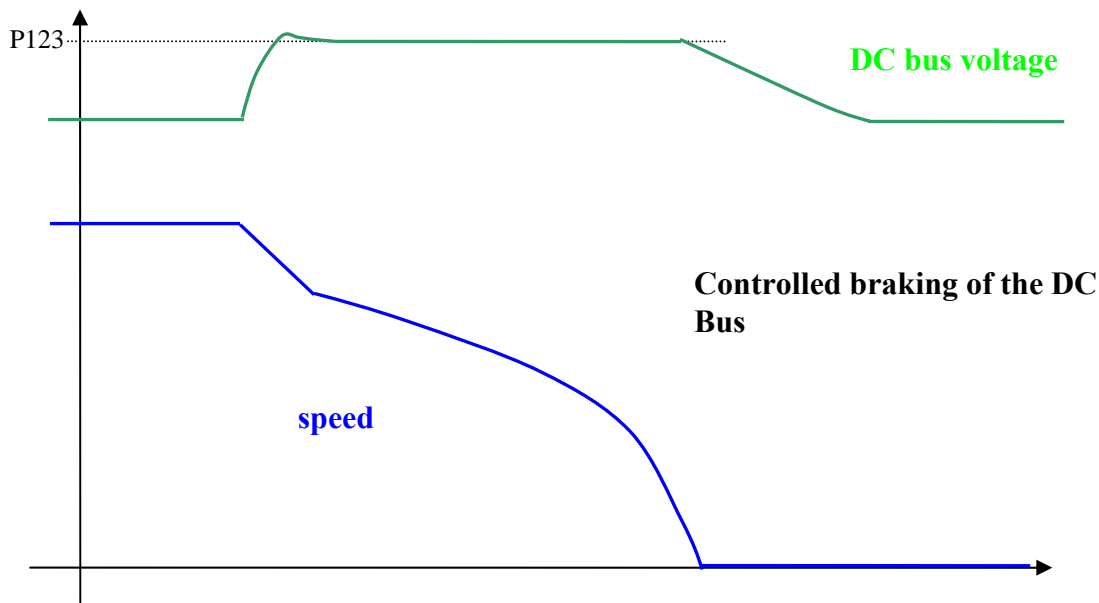
The use of an AC/DC AFE permits a controlled voltage level of the intermediate power (DC Bus) and raises to best control the motors winded to a voltage close to the line voltage. The drive's dynamic behavior results in a way that optimizes the work as motor or generator. There is a possibility to connect more than one drive to the DC Bus, with the advantage of energy exchange between drives in case of contemporary movements and only one energy exchange with the mains.



3.2 Braking with DC Bus control (C47=1)

A further possibility of recovery control of kinetic energy exists: if the outer braking resistance is not present (or is not working properly), it is possible to enable (setting C47=1) the braking with DC Bus control. This function, when the Bus voltage reaches the threshold set in P123, limits the maximum admitted regenerated torque, slowing down the motor. In practice, the motor will slow down in minimum time thus the over voltage alarm does not start.

This function is not active by default (C47=0) in a way to leave the intervention of the braking circuit.



3.3 Kinetic energy dissipation on braking resistance

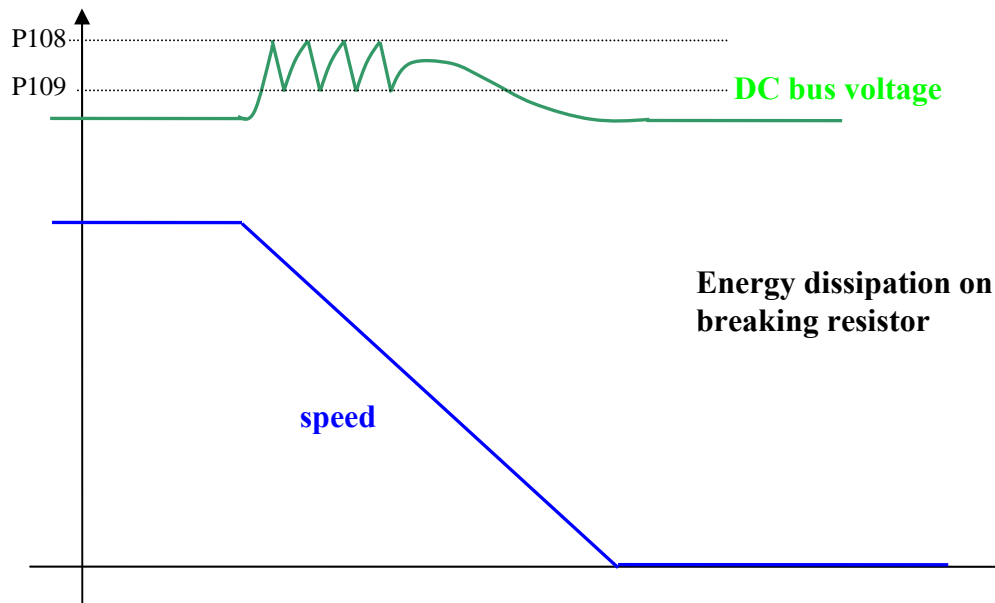
The standard solution for the OPEN drive is the dissipation of kinetic Energy on braking resistor. All the OPEN drives are equipped with an eternal braking circuit, while the braking resistor must be connected externally, with the appropriate precautions.

With this solution, the Bus' maximum level of voltage becomes limited through a power device that connects in parallel the resistor with the DC Bus capacitors, if the voltage exceeds the threshold value in P108, the drive keeps it inserted until the voltage goes below the value of P109; in such a way, the energy that the motor transfers onto the DC Bus during the braking, is dissipated from the resistor.

This solution guarantees good dynamic behavior also in braking mode.

In the follow figure it's shown the Bus voltage and the speed during a dissipation on braking resistance.

OPEN DRIVE



A maximum voltage limit allowed exists for the DC Bus voltage. This is checked by the software (threshold **P107**), and by the hardware circuitry: in case the voltage exceeds this level, the drive will immediately go into an over voltage alarm **A11** to protect the internal capacitors. In case of **A11** alarm condition starts, verify the correct dimensioning of the braking resistor power.

Refer to the installation manual for the correct dimensioning of the outer braking resistor.



The braking resistor may reach high temperatures, therefore appropriately place the machine to favor the heat dissipation and prevent accidental contact from the operators.

3.3.1 Braking Resistance Thermal protection

The Braking Resistance Thermal protection protects the resistance both from Energy peaks and from average Power that have to be dissipated.

It's possible to enable this protection setting **C72=1**, by default this function is disabled.

Instantaneous Power: the quickly Energy exchange is an adiabatic process since heat diffusion on case resistance is very slow, in the meantime the resistance is dimensioning for a maximum energy overload. This protection is based on the follow parameters:

PAR	DESCRIPTION	RANGE	DEFAULT	UNIT	Internal rappr.
P167	Braking resistance value	1 ÷ 1000	82	Ohm	1
P168	Braking resistance Maximum Adiabatic Energy	0.0 ÷ 500.0	4.5	KJoule	10
P169	Time to test the Maximum Adiabatic Energy	1 ÷ 30000	2000	ms	1

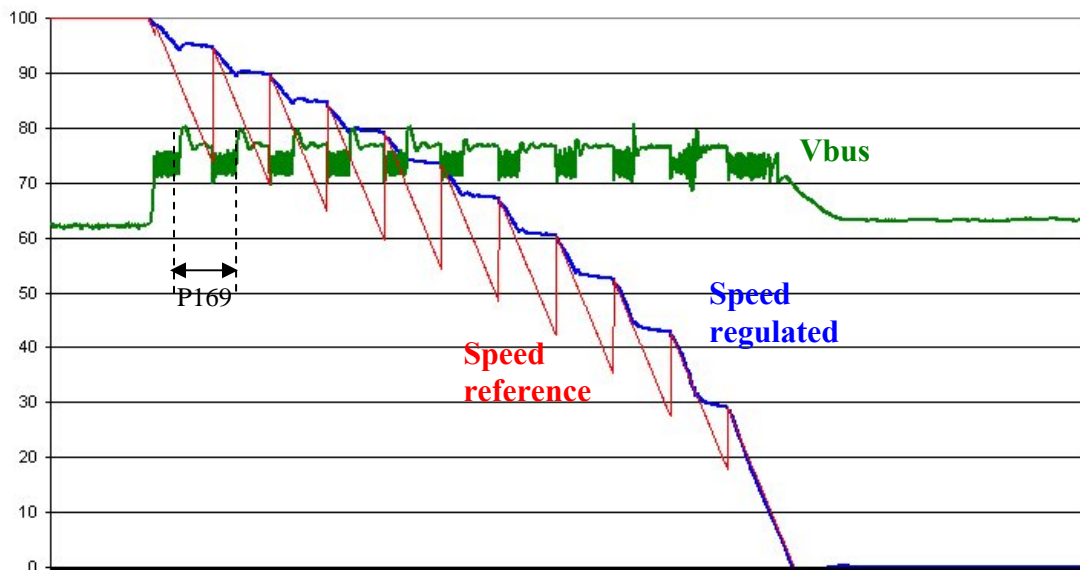
After the first Braking resistance activation, the dissipated Energy is accumulated, knowing the DC bus voltage, the Braking resistance value and the activation time.

This accumulation is done for a time set in milliseconds in **P169** parameter: if in this period the Energy becomes greater than maximum threshold (set in KJoule into **P168** parameter) the control disables the Braking resistance. At that point, if it is enables the braking with DC Bus control (**C47=1**, see par.3.2) it starts to work, otherwise the alarm **A4** code **d49=1** (Instantaneous Power Braking Resistance) becomes active.

At the end of every accumulation period it is possible to show the total dissipated Energy on the period in KJoule in the internal value **d39**, than can start a new period, the Braking resistance is enabled again and the speed reference is aligned with the real speed.

NB: this function has two possible uses:

- It takes the converter in alarm if the Instantaneous Power is too high (C47=0)
- It is possible to choose how many Energy could be dissipated on Braking resistance and in the remaining time braking with the DC Bus control (C47=1). With P169=1000ms it is possible to set in P168 the Power in KWatt that could be dissipated on the resistance. In the follow figure is shown an experimental measurement of this function:



Average Power: the Energy dissipated every PWM period is used to estimate the average Power dissipated on Braking Resistance. The parameters used are:

PAR	DESCRIPTION	RANGE	DEFAULT	UNIT	Internal rappr.
P167	Braking resistance value	1 ÷ 1000	82	Ohm	1
P170	Braking Resistance Maximum Average Power	1 ÷ 30000	150	Watt	1
P171	Average Power Filter time constant	1 ÷ 2000	720	s	1

Every second the total dissipated Energy is equal to the Average dissipated Power.

This value is filtered with a first order filter with a time constant set in seconds in **P171** (the time constant depends on Braking Resistance thermal characteristics). In **P170** parameter is possible to set the maximum average power. In the internal value **d38** it's possible to see the Average Dissipated Power in Watt, if this value becomes greater than the threshold P170 the alarm **A4** code **d49=2** (Average Power Braking Resistance) becomes active.

4 Power soft start

The bridge rectifier build in the drive may be uncontrolled (diode) or semi-controlled (up to OPEN 40 it is uncontrolled). If the diode bridge is implemented, the power soft start function acts bypassing a soft start resistor (in series with the output of the power bridge), after the DC Bus Voltage has charged; otherwise the same function unblocks the semi-controlled input power bridge permitting the gradual charge of the DC Bus voltage and supplying the drive feeding for the following work.

N.B: It is fundamental to correctly set up the connection C45 build in Power Bridge : 0= uncontrolled (diode) ; 1 = semi-controlled

The function becomes active if the entry functions are active “**Enable soft start**” I.13, and the connection C37 (C37=1) and the presence of mains supply voltage becomes noticed, with the following logic:

Mains supply presence: in case the presence of alternated mains supply voltage becomes noticed once (at soft start) with the logic power input **MAINS_OFF=H**, from that moment the control refers only to the **MAINS_OFF** to check the mains presence. Otherwise, in the case of drive feeding with a continuous direct voltage on the DC Bus, it is possible to begin the soft start, even if the measured voltage on the DC Bus exceeds the indicated value in P97.

Mains break out: the mains break becomes noticed either when the MAINS_OFF signal is monitored (if this went to the high logic level at least one time during the soft start) either monitoring directly the DC Bus voltage with minimum threshold setup in P97.

The function of “Soft start enable” may be assigned to one of the logic input thus to enable or disable the soft start through an external contact.

The power fault alarm (power fault A03), that checks drive over current, insert the soft start limiting current.

The soft start follows the following criteria:

I13	C37	A03	Mains Presence	Soft start enable	oL10
X	X	H	X	OFF	L
0	X	L	X	OFF	L
X	0	L	X	OFF	L
1	1	L	L	OFF	L
1	1	L	H	ON	H

From default PR.ON=1 and C37=1 thus connecting the drive to the mains supply, the power is enable immediately with the soft charging of the capacitors.

The soft start charge of the intermediate circuit capacitors lasts a preset time set in P154, after this time the voltage level is checked to verify the voltage level reached: if this is below the minimum (P97), the soft start alarm starts.



The drive is not enabled to switch on if soft start function has not ended successfully.

4.1 Safety Stop

The OPEN drive converters have the possibility to give the separated IGBT supply, see Installation manual. This supply voltage can be see like safety STOP input and there are two different managements for this input, selectable with **C73** connection:



For OPEN DRIVE versions with Safe Torque Off safety function (STO) according to EN 61800-5-2 and EN 13849-1 see STO installation manual.

4.1.1 Machine safety (C73=0)

Setting **C73=0** (default) the Safety STOP is compatible with EN945-1 specification against accidental starts. When this input is at low logical level the IGBT power bridge isn't supplied and the motor couldn't run more than 180°/motor poles couple for brushless motor (for asynchronous motors the movement is zero), also if there is a brake in the power bridge.

The converter signals this state with the alarm **A13 d49=1**, the output **o17 "Power electronic not supplied"** goes at high level, the output **o0 "Drive ready"** goes at low level and the Power Soft start command is taken off.

To recover the normal converter state, follow this steps:

- Give +24V to the IGBT driver supply input (Safety STOP). At this point the converter goes at low level the output **o17 "Power electronic not supplied"**.
- After 500ms the converter is able to start the Soft start sequence, like to see in par.4
- Reset the converter alarms for eliminate the alarm **A13**.The normal converter state is recovered.

4.1.2 Power part enable input (C73=1)

Setting **C73=1** the Safety STOP is like a Power part enable input. Like in the preceding case, when this input is at low logical level the IGBT power bridge isn't supplied and the motor couldn't run more than 180°/motor poles couple for brushless motor (for asynchronous motors the movement is zero), also if there is a brake in the power bridge.

The converter signals this state with the output **o17 "Power electronic not supplied"** that goes at high level, the Power Soft start command is taken off, but unlike before no alarms goes at active state. To recover the normal converter state, follow this steps:

- Give +24V to the IGBT driver supply input (Safety STOP). At this point the converter goes at low level the output **o17 "Power electronic not supplied"**.
- After 500ms the converter is able to start the Soft start sequence, like to see in par.4, there is an automatic alarm reset and the normal converter state is recovered.

In this case it isn't necessary to reset the alarms after take back at high level the Safety STOP input, it will be sufficient to wait 500ms + soft start time, after that the converter could be goes on run.

5 Sequences of drive switch on and switch off

5.1 Drive ready

The Drive Ready condition (**o.L.0=H**) is given by alarms are not active and at the same time both the software and hardware enables:

- * The software enable, given by state of the connection **C29**, (C29=1 of default).
- * The external enable (the function of the input is assigned to the default input L.I.2)

If an enable is missing or an alarm is active, the ready drive signal goes into a non-active state **o.L.0=L** and this state remains until the causes that brought about the alarm conditions are removed and the alarms are reset. An alarm reset can be achieved by activating the function “Alarm reset” that, by default, is assigned to input L.1 (or setting C30=1).

Keep in mind that the “Alarm reset” is achieved by the active front of the signal, not on the active level.

5.2 Drive switch on / RUN

When the drive is “Ready to switch on / RUN” **o.L.0=H**, motor may start running “Drive switch on/run” **o.L.3=H**, by activating both the hardware and software switch on enables:

- * Function “Logic switch on/RUN input” (default input 4 assigned) **RUN=H**
- * Software switch on/RUN **C21** (C21=1) is active by default.

Switch on/RUN disable and enable (from STOP offline, to RUN online) is given by the logic of the following table:

Drive ready o.L.0	Switch on / RUN	C21	ON-LINE
L	X	X	L
H	L	X	L
H	X	0	L
H	H	1	H

It is mentioned that the input function “Switch on/RUN input” can be given also via serial line or field-bus. See for details the Standard Application Manual.

5.3 Drive switch off / STOP

By default, the drive switch off instantaneously as soon as one of the switch on functions is disabled (immediate shutdown); that may also cause an almost immediate rotation shutdown, if the motor is loaded and the inertia is low, while coasting if the motor is without load and mechanical inertia is high.

Using the connection **C28**, it is possible to choose to switch off the drive only with motor at minimum speed. With **C28=1**, 0=immediate switch off by default, when SWITCH ON/RUN function is disabled, the speed reference is brought to zero, thus the motor starts to slowdown following the ramp (the drive is still switched on). The system is switched off /STOP (offline) only once the motor absolute speed goes below the threshold set in **P50** (2.0% default), that is when the motor is almost motionless (shutdown for minimum speed).

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Calibrating P50 may coincide the drive block with the motionless motor. The state of speed above the minimum is signaled from the logical output function **o.L.2**, moreover the output function **o.L.16** is available, that signals the drive speed (absolute value) is above the threshold speed level P47. In every way, whichever is the chosen type of shutdown, there is an immediate drive block in presence of any alarm condition, $oL.0 = L$.

6 Thermal protections hardware

Thermal probes are managed by the drive with the intent of protecting the drive itself and the motor from damage.

6.1 Thermal protection drive

The drive is equipped with thermal probe in the heatsink that may be a PTC or a NTC depending on the size of the drive. Setting the connection **C57≠0** the thermal probe control is enabled. In this case, it is possible to visualize the heatsink temperature in internal value **d25**, in degrees Celsius. The following thresholds are foreseen:

- With the parameter **P120** it is possible to set a temperature level above which the function **o15** “excessive radiator temperature” goes to a logic level high.
- If the temperature exceeds the maximum value setup in the parameter **P118**, the drive goes into **A4 d49=0** alarm “Thermal heatsink”
- If the measured temperature is above the threshold level set in parameter **P119** and the RUN command is switched on, the drive goes into **A12 d49=2** alarm.

6.2 Motor thermal protection

The drive can manage the motor thermal probe. For the correct wiring of the probe, make reference to the installation manual.

The connection C46 selects the type of probe used:

C46	Description	Visualization in d26
0	No motor thermal protection enabled	
1	PT100 management : The motor’s temperature is measured and compared to the maximum setup in parameter P91 , If the temperature exceeds the threshold, the A5 alarm starts.	Motor temperature in °C
2	PTC management : The thermal resistance is measured and compared to the maximum setup in the parameter P95 , If the temperature exceeds the threshold, the A5 alarm starts.	Thermal probe resistance in Ω
3	NTC management : The thermal resistance is measured and compared to the minimum setup in the parameter P95 , If the value is below, the A5 alarm starts.	Thermal probe resistance in Ω
4	Termo-switch management : it’s possible to configure a logic input to I23 function, in this case if this input goes to a low level the A5 alarm starts.	-----

7 Current/power relay

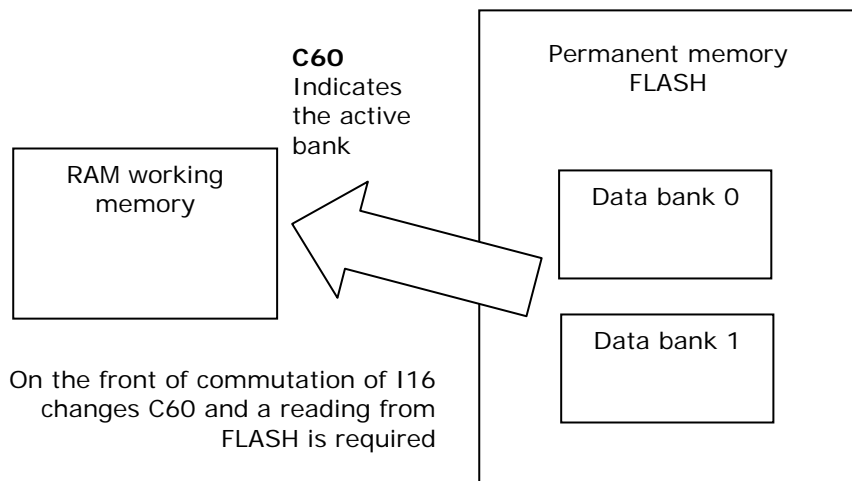
The drive is in the position to control a logic output of current/power relay.
The connection C55 serves to select the type of monitored values:

C55	Description
1	Current : Current model referred to the motor's nominal current
2	Torque of currents : refers to the torque of the motor nominal current
3	Power . Refers to the motors nominal power

The selected value is filtered with a first order filter with constant time setup in seconds in P27, and then compared with threshold setup in the parameter P26; if it is greater, the high logic level brings the logic function **o.L.5** to the logic level high.

8 Active bank parameters

This function allows to switch over the internal sets of parameters and connections between two distinct memory banks (drive must be switched off, no RUN).
To activate this function, it is necessary to use the logic input I16, configuring it on a logic input on both banks. The connection C60 indicates the actual data bank in the permanent memory: C60=0 bank 0; C60=1 bank 1. The commutation of the functions logic stage I16 brings an automatic variation of data of C60 and a successive automatic reading of data from the permanent memory.



For initial configuration of the input function I16, follow these steps:

1. Prepare in RAM, the data in bank 0, configuring input function I16 and holding it to a low logic level (make sure C60=0).
2. Save to the permanent memory with C63=1.
3. Always keep I16=L, prepare in RAM the data from bank 1, configuring the same input to the function I16.
4. Set C60=1 and save the data in the permanent memory with C63=1.
5. At this point, changing the state of logic input corresponding to function I16, the bank's commutation will have automatic reading

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Vector Core

“Vett” Vector Core

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The “Vector core” controls the current or speed within a feedback vector induction motor. The speed and current reference values are generated by the application. See specific documentation for further information. As an absolute position value is not required for the sensors (managed with an optional internal electronic board) incremental TTL Encoders and incremental Sin/Cos Encoders may be used. Absolute sensors such as Resolver can also be used, as can digital sensors such as Endat or Hiperface if required. See the “Feedback Option” file for information about connecting the sensor correctly and the functional tests.

The “Vector core” also manages the auto-tuning test, which is crucial if the control is to adapt perfectly to the motor and to ensure excellent dynamic performance all-round.

1. Complete list of control values

1.1. Parameters

The parameters are drive configuration values that are displayed as a number within a set range. The parameters are mostly displayed as percentages, which is especially useful if the motor or drive size have to be changed in that only the reference values (**P61÷P65**) have to be modified and the rest changes automatically. The parameters are split up into free, reserved and TDE MACNO reserved parameters.

The following rules apply:

- **Free parameters:** may be changed without having to open any key, even when running;
- **Reserved parameters (r):** may be changed only at a standstill after having opened the reserved parameter key in P60 or the TDE MACNO reserved parameters key in P99;
- **TDE MACNO reserved parameters (t):** may be changed only at a standstill after having opened the TDE MACNO reserved parameters key in P99. While the key for these parameters is closed, they will not be shown on the display.

Hereunder is a complete list of vector control parameters.

Take careful note of the reference values for each parameter so that they are set correctly. The penultimate column shows the internal representation base of the parameters. This value is important if the parameters have to be read or written with a serial line or fieldbus.

Example1: P7 = Speed jog

Normalization unit = % n_{MAX}
Int. rep. base = 16383
Internal value = 4000 → real value = 4000/16383 = 24.4% of the maximum speed

Example1: P62 = Rated motor voltage

Normalization unit = Volt
Int. rep. base = 10
Internal value = 3800 → real value = 3800/10 = 380.0 Volt

The last column explains the parameter: a number refers to a paragraph in this file; letters refer to an abbreviated name for the document to be consulted.

1.1.1. List of free parameters

PAR	DESCRIPTION	Range	Default value	Normalization unit	Int. rep. base	See
P01	Corrective factor for 14 bit analog reference 1 (AN_INP_1)	±400.0	100.0	%	10	APPL
P02	Corrective offset for 14 bit analog reference 1 (AN_INP_1)	±16383	0	16383=100%	1	APPL
P03	Corrective factor for 14 bit analog reference 2 (AN_INP_2)	±400.0	100.0	%	10	APPL
P04	Corrective offset for 14 bit analog reference 2 (AN_INP_2)	±16383	0	16383=100%	1	APPL
P05	Corrective factor for 14 bit analog reference 3 (AN_INP_3)	±400.0	100.0	%	10	APPL
P06	Corrective offset for 14 bit analog reference 3 (AN_INP_3)	±16383	0	16383=100%	1	APPL
P07	Digital speed reference value (JOG1)	±100.00	0.00	% n _{MAX}	16383	APPL
P08	Motor potentiometer starting speed	±100.0	2.0	% n _{MAX}	16383	APPL
P09	Filter time constant for analog torque reference value	0.0÷20.0	0.0	ms	10	APPL
P10	Offset for high precision analog reference value	±19999	0	/100 mV	1	APPL
P11	NUM – Frequency input slip ratio	±16383	100		1	APPL
P12	DEN – Frequency input slip ratio	0÷16383	100		1	APPL
P13	Corrective factor for 16 bit analog speed reference value	±400.0	100.0	%	10	APPL
P14	Corrective offset for 16 bit analog speed reference value	±16383	0	16383=100%	1	APPL
P15	Logic input I08 digital filter	0.0÷20.0	2.2	ms	10	
P16	Max. motor potentiometer speed reference value	±105.0	105.0	% n _{MAX}	16383	APPL
P17	Min. motor potentiometer speed reference value	±105.0	-105.0	% n _{MAX}	16383	APPL
P18	Max. CW speed reference value limit	±105.0	105.0	% n _{MAX}	16383	4.2.1
P19	Max. CCW speed reference value limit	±105.0	105.0	% n _{MAX}	16383	4.2.1
P20	Digital potentiometer acceleration time	0.3÷1999.9	50.0	s	10	APPL
P21	CW acceleration time	0.01÷199.99	10.00	s	100	4.2.2
P22	CW deceleration time	0.01÷199.99	10.00	s	100	4.2.2
P23	CCW acceleration time	0.01÷199.99	10.00	s	100	4.2.2
P24	CCW deceleration time	0.01÷199.99	10.00	s	100	4.2.2
P25	Rounded filter time constant	0.1÷20.0	5.0	s	10	4.2.2
P26	Current/power relay cut-in threshold	0.2 ÷ 150.0	100.0	%	4095	COMM
P27	Filter time constant for current/power relay	0.1 ÷ 10.0	1.0	s	10	COMM
P29	Machine magnetizing time	50 ÷ 3000	300	ms	1	4.6
P30	Emergency brake deceleration time	0.01÷199.99	10.00	s	100	COMM
P31	KpV speed regulator proportional gain	0.1÷400.0	4.0		10	4.3
P32	TiV speed regulator lead time constant	0.1÷3000.0	80.0	ms	10	4.3
P33	TfV speed regulator (filter) time constant	0.0÷25.0	0.8	ms	10	4.3
P34	TfV initial speed regulator (filter) time constant	0.0÷25.0	0.8	ms	10	4.3.2
P35	Constant torque work flux	0÷120.0	100.0	% Φ _{NOM}	4095	4.3.3
P36	Kv voltage multiplication factor at max. revolutions	0.0÷100.0	100.0		32767	4.3.3
P37	Maximum tracking error (less significative part)	0 ÷ 65536	32767	Pulses rev.		4.3.3
P38	Kv position loop proportional gain	0.0 ÷ 100.0	4.0		10	4.2.3
P39	Maximum tracking error (less significative part)	0 ÷ 32000	0	Revolutions		4.2.3
P40	Current limit	0 ÷ P103	P103	% I _{NOM AZ}	4095	4.5.2
P41	Maximum motor torque with full magnetic field	0 ÷ 800.0	400.0	% τ _{NOM}	4095	4.5.1
P42	Maximum torque in the positive direction of rotation	0 ÷ 400.0	400.0	% τ _{NOM}	4095	4.5
P43	Maximum torque in the negative direction of rotation	- 400.0 ÷ 0	- 400.0	% τ _{NOM}	4095	4.5
P44	End speed for speed PI gain change	0.0÷100.0	0.0	% n _{MAX}	16383	4.3.2
P45	KpV initial speed PI proportional gain	0.1÷400.0	4.0		10	4.3.2
P46	TiV initial speed PI lead time constant	0.1÷3000.0	80.0	ms	10	4.3.2
P47	Speed threshold for logic output o.16	0÷100.0	0.0		16383	COMM
P48	Filter time constant of frequency input decoded in time	0.0÷20.0	1.6	ms	10	APPL
P49	Corrective factor for frequency input decoded in time	0.0÷200.0	100.0	%	16383	APPL
P50	Minimum speed for relay	0÷100.0	2.0	% n _{MAX}	16383	COMM
P51	Maximum speed for alarm	0÷125.0	120.0	% n _{MAX}	16383	5.2
P52	Minimum flux for alarm	0÷100.0	2.0	% Φ _{NOM}	4095	4.6

PAR	DESCRIPTION	Range	Default value	Normalization unit	Int. rep. base	See
P53	Rated drive current (I_{NOMAZ})	0.0÷400.0		Ampere	10	4.5.2.1
P54	MONITOR sampling period	1÷19999	1	T_{PWM}	1	SUP
P55	Points memorized after MONITOR trigger	1÷2000	1		1	SUP
P56	MONITOR trigger level	-200.0÷200.0	0.0	%	4095	SUP
P57	% value of 10V for analog output A	100.0÷400.0	200.0	%	10	APPL
P58	% value of 10V for analog output B	100.0÷400.0	200.0	%	10	APPL
P59	Minimum speed and speed reached Hysteresis	0.0÷100.0	1.0	% n_{MAX}	16383	
P60	Access key to reserved parameters	0÷19999	P100		1	1.1

1.1.2. List of reserved parameters

PAR	DESCRIPTION	Range	Default value	Normalization unit	Int. rep. base	See
P61	Rated motor current (I_{NOMMOT})	1.0÷100.0	100.0	% I_{NOMAZ}	32767	2
P62	Rated motor voltage (V_{NOMMOT})	100.0÷1000.0	380.0	Volt.	10	2
P63	Rated motor frequency	10.0-800.0	50.0	Hz	10	2
P64	Max. operating voltage	1.0-200.0	100.0	% V_{NOMMOT}	4095	2
P65	Max. operating speed (n_{MAX})	50-30000	2000	Rpm	1	2
P67	Number of motor poles	0÷12	4		1	2
P68	Number of absolute sensor poles	0÷12	2		1	SENS
P69	Number of encoder pulses/revolution	0÷60000	1024	pulses/rev.	1	SENS
P70	Motor thermal current	10÷110.0	100.0	% I_{NOMMOT}	10	4.5.2.2
P71	Motor thermal time constant	30÷2400	180	s	1	4.5.2.2
P72	I_r rated torque current	0÷100.0	95.2	% I_{NOMMOT}	32767	3.2.3
P73	I_μ magnetizing current	5.0÷100.0	30.2	% I_{NOMMOT}	32767	3.2.3
P74	Rotor time constant τ_R	10÷10000	200	ms	1	3.2.4
P75	Stator time constant τ_S	0.0÷50.0	9.1	ms	10	3.2.4
P76	Voltage drop due to stator resistor	1.0÷25.0	2.0	% V_{NOMMOT}	32767	3.2.1
P77	Voltage drop due to leakage inductance	5.0÷40.0	20.0	% V_{NOMMOT}	32767	3.2.2
P78	Rated motor torque reading	0.5÷3000.0	0.0	Nm	10	3.2.4
P79	Connection tests: Encoder: pulses counted, Resolver or Sin Cos Enc: time reading	± 19999	0		1	SENS
P80	K_{pi} voltage regulator proportional gain	0.1÷100.0	10.0		10	4.3.3
P81	T_{ii} voltage regulator lead time constant	0.0÷1000.0	200.0	ms	10	4.3.3
P82	T_{fi} voltage regulator (filter) time constant	0÷1000.0	12.0	ms	10	4.3.3
P83	K_{pc} current regulator proportional gain	0.1÷100.0	2.6		10	4.4
P84	T_{ic} current regulator lead time constant	0.0÷1000.0	9.1	ms	10	4.4
P85	T_{fc} current regulator (filter) time constant	0.0÷25.0	0.0	ms	10	4.4
P86	K_{p3} Bus control proportional gain	0.05÷10.00	3.50		100	COMM
P87	Main Supply voltage	180.0÷690.0	400	Volt rms	10	
P88	High precision analog speed reference value: Voltage matches max. speed	2500÷10000	10000	mVolt	1	APPL
P89	Tracking loop bandwidth direct decoding of resolver	100÷10000	1800	rad/s	1	
P90	Tracking loop damping direct decoding of resolver	0.00÷5.00	0,71		100	
P91	Maximum motor temperature (if read with PT100)	0.0÷150.0	130.0	°C	10	COMM
P92	Serial identification number	0÷255	1		1	SERIAL
P93	Serial baud rate	19.2, 38.4, 57.6	19.2	Kbit/s	10	SERIAL
P95	Motor NTC or PTC resistance value for alarm	0-19999	1500	Ω	1	COMM
P96	Motor thermal logic output 14 cut-in threshold	0.0÷200.0	100.0	%P70	4095	4.5.2.2
P97	Minimum voltage level for forced mains off	0÷800	425	Volt	10	COMM
P98	Voltage reference value in Support 1	220÷1200	600	Volt	10	COMM
P99	Access key to TDE parameters	0÷19999	-----		1	1.1

PAR	DESCRIPTION	Range	Default value	Normalization unit	Int. rep. base	See
P101	PWM frequency	2500÷16000	5000	Hz	1	
P114	Current in connection tests for UVW, Poles and reading Rs	0.0÷100.0	50.0	% I _{NOMMOT}	32767	SENS
P129	Test current to establish ΔV_{LS}	0÷100.0	30%	% I _{NOMMOT}	32767	3.2.2
P130	10 pairs of points			% Φ_{NOM}	4095	3.2.3
↓	of the					
P149	magnetic characteristic			% I _{ll}	4095	3.2.3
P151	Xb = cubic coupling zone amplitude	0÷50.0	0.0	% I _{NOMAZ}	16383	
P152	Yc = compensation at rated drive current	0÷100.0	100.0	% P102	32767	
P153	Xoo = dead zone amplitude	0÷50.0	0.0	% I _{NOMAZ}	16383	
P162	CAN BUS node ID	1÷127	1		1	FIELD
P163	Enable alarms	-100.0÷100.0			16383	
P167	Braking resistance value	1 ÷ 1000	82	Ohm		COMM
P168	Braking resistance Maximum Adiabatic Energy	0.0 ÷ 500.0	4.5	KJoule		COMM
P169	Time to test the Maximum Adiabatic Energy	1 ÷ 30000	2000	ms		COMM
P170	Braking Resistance Maximum Average Power	1 ÷ 30000	150	Watt		COMM
P171	Average Power Filter time constant	1 ÷ 2000	720	s		COMM
P172	Vbus measure filter	0 ÷ 1000	5	R=Tf/Tc		
P173	Maximum delay admitted between 2 byte of the same frame	0 ÷ 19000	32	1/10 ms	1	
P177	DC Bus logic output function o20 threshold	220.0÷1200.0	400.0	Volt	10	

1.1.3. List of TDE MACNO reserved parameters

PAR	DESCRIPTION	Range	Default value	Normalization unit	Int. rep. base	See
P100	Value of access key to reserved parameters	0÷9999			1	1.1
P102	Dead time compensation	0÷100.0	22.0	% V max	3276	3.2.1
P103	I drive limit current	0÷800.0	200.0	% I _{NOMAZ}	4095	4.5.2.1
P104	Radiator time constant	10.0÷360.0	80.0	Seconds	10	4.5.2.1
P105	Corrective factor for Bus voltage	80.0÷120.0	100.0	%	10	
P106	Minimum voltage of DC Bus	220.0÷1200.0	400.0	Volt	10	COMM
P107	Maximum voltage of DC Bus	300.0÷1200.0	760.0	Volt	10	COMM
P108	Bus voltage threshold for brake ON	300.0÷1200.0	730.0	Volt	10	COMM
P109	Bus voltage threshold for brake OFF	300.0÷1200.0	710.0	Volt	10	COMM
P110	Offset A/D 1	-100.0÷100.0	0.0	% Vmax	32767	
P111	Offset A/D 2	-100.0÷100.0	0.0	% Vmax	32767	
P112	Display screensaver cut-in time	3÷20	10	Seconds	1	TAST
P113	Maximum drive current	0÷900.0	0	Ampere	10	4.5.2.1
P115	Multiplication factor for motor PTC/NTC/PT100 analog reference value	0.0÷200.0	100.0		16383	COMM
P116	Junction time constant	0.1÷10.0	3.5	Seconds	10	4.5.2.1
P117	Multiplication factor for radiator PTC/NTC analog reference value	0.0÷200.0	100.0		16383	COMM
P118	Max. temperature permitted by radiator PTC/NTC	0.0÷150.0	100.0	°C	10	COMM
P119	Max. temperature permitted by radiator for start-up	0.0÷150.0	75.0	°C	10	COMM
P120	Radiator temperature threshold for logic output o.15	0.0÷150.0	90.0	°C	10	COMM
P121	Acceleration time in auto-tuning tests 3 and 4	0.01÷199.99	4.0	s	100	3.2.3
P122	Max. modulation index	0.500÷0.995	0.98		1000	
P123	Smart brake voltage cut-in level	300.0÷1200.0	750.0	Volt	10	COMM

PAR	DESCRIPTION	Range	Default value	Normalization unit	Int. rep. base	See
P124	Simulated encoder Kv gain multiplication coeff.	0.0÷100.0	100.0	%	32767	
P125	Voltage reference function of DC bus (safety margin)	0.0÷100.0	96.0	%	32767	
P126	KpI Corrective coeff. estimated Kp for current loops	0.5÷200.0	100.0		4095	4.4
P127	Kcφ Corrective coeff. estimated Kp and Tf for flux loop	0.5÷800.0	100.0		4095	4.3.3
P128	K_V_test3_real	0÷100.0	100		32767	3.2.3
P150	High precision analog speed reference value: VCO setting for positive voltage reference values	± 16383	4095		1	APPL
P154	Soft start enabling time	150÷19999	250	ms	1	COMM
P155	Ambient temperature reference value during overload	0.0÷150.0	40.0	°C	10	
P156	PWM frequency for drive definition	3000÷16000	5000	Hz	1	
P157	Dead time duration	3.0÷10.0	4.0	usec	10	
P158	Corrective coefficient for decoupling terms	0.0÷800.0	50.0		4095	
P159	High precision analog speed reference value: VCO setting for negative voltage reference values	±16383	4095		1	
P160	PWM delay compensation on the currents	-400.0÷400.0	40.0	%T _{PWM}	4095	
P161	PWM delay compensation on the voltages	-400.0÷400.0	50.0	%T _{PWM}	4095	
P164	Sensor sine and cosine signal amplitude compensation	0÷32767	16383	=100%	16383	
P165	Incremental sine offset (sin/cos encoder)	± 16383	0		1	
P166	Incremental cosine offset (sin/cos encoder)	± 16383	0		1	
P174	Main Supply voltage for drive definition	180.0÷690.0	400	Volt rms	10	
P175	Hardware dead time	0.0÷10.0	0.0	usec	10	
P176	IGBT command minimum pulse	0.0÷10.0	0.0	usec	10	

1.1.4. Reserved parameters for specific applications

The parameters ranging from **P180** to **P199** are available for specific applications and other 100 parameters. See the specific applications file for their meaning.

1.2. Connections

The connections are drive configuration values that are displayed as a whole number in the same way as a digital selector.

They are split up into free, reserved and TDE MACNO reserved connections, and are changed in the same way as the parameters.

The internal representation base is always as whole number.

1.2.1. Free connections

CON	DESCRIPTION	Range	Default value	Default meaning	See
C00	Automatic display of internal values	0÷63	21	Speed	TAST
C14	Choose TRIGGER type 0 ≤ inputs 1 = 1st alarm 2..63= analog value	-31÷63	0	Trigger on Run	SUP
C15	Meaning of programmable analog output 1	-63÷64	11	Current module	APPL
C16	Meaning of programmable analog output 2	-63÷64	4	Rotation speed	APPL
C20	Load final digital potentiometer reference value	0.1	0		APPL
C21	Run software	0.1	1	Run sw enabled	COMM
C22	Enable 14 bit analog reference value A.I.1	0.1	0		APPL

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C23	Enable 14 bit analog reference value A.I.2	0.1	0		APPL
C24	Enable JOG digital speed reference value (P7)	0.1	0		APPL
C25	Enable digital potentiometer speed reference value	0.1	0		APPL
C26	Enable linear ramp	0.1	1	Ramps enabled	4.2.2
C27	Rounded ramp	0.1	0		4.2.2
C28	Stop with minimum speed	0.1	0		COMM
C29	Drive software enable	0.1	1	sw enabled	COMM
C30	Reset alarms	0.1	0		COMM
C31	Enable 14 bit analog reference value A.I.3	0.1	0		APPL
C32	Motor thermal switch → Block drive ?	0.1	1	Alarm A5 on ther. swtch	4.5.2.2
C33	Choose thermal curve	0÷3	0	Assisted ventilation	4.5.2.2
C34	Managing mains failure 0 = trying to work; 1 = recovery; 2= free; 3= emergency brake	0÷3	0	Trying to work on mains failure	COMM
C35	Automatic alarm reset when mains back on	0.1	0		COMM
C36	Invert reference signal software	0.1	0		4.2.1
C37	Enable soft start	0.1	1	Enabled	COMM
C38	Start up type with or without Φ	0÷2	0		4.6
C39	Choose pulses\rev. FREQUENCY INPUT	0÷9	5	1024 impulses/rev.	APPL
C40	Enable 16 bit analog speed reference value - if present	0.1	0		APPL
C43	Enable frequency speed reference value	0.1	0		APPL
C47	Enable smart brake	0.1	0		COMM
C53	Enable locked RUN	0.1	0		APPL
C55	Choose value for current relay 0 = $ I /I_{NOM\ MOT}$ 1 = $I\tau / I\tau_{NOM}$ 2 = P / P_{NOM}	0÷2	0	Current module	COMM
C58	Reset CAPTURE monitor	0.1	0		SUP
C61	Read default parameters	0.1	0		COMM
C63	Save parameters in permanent memory (FLASH)	0.1	0		COMM
C66	Intervention edge monitor TRIGGER 0 = up ; 1 = down	0.1	0	Raising edge	SUP
C70	Enable frequency speed reference value decoded in time	0,1	0		ALL

1.2.2. Reserved connections

CON	DESCRIPTION	Range	Default value	Default meaning	See
C01	Meaning of logic input 1	-1÷63	8	Reset alarms	APPL
C02	Meaning of logic input 2	-1÷63	2	External enable	APPL
C03	Meaning of logic input 3	-1÷63	3	Enable ref. A.I.1	APPL
C04	Meaning of logic input 4	-1÷63	0	Run	APPL
C05	Meaning of logic input 5	-1÷63	4	Enable ref. A.I.2	APPL
C06	Meaning of logic input 6	-1÷63	12	Towards CW/CCW	APPL
C07	Meaning of logic input 7	-1÷63	5	Enable JOG	APPL
C08	Meaning of logic input 8	-1÷63	22	Enable ramps	APPL
C09	Frequency input setting: 0 = analog; 1 = digital encoder; 2=digital f/s; 3=digital f/s 1 edge	0÷3	1	2-channel Encoder	APPL
C10	Meaning of logic output 1	-32÷31	3	Run	APPL
C11	Meaning of logic output 2	-32÷31	0	Drive ready	APPL
C12	Meaning of logic output 3	-32÷31	6	End of ramp	APPL
C13	Meaning of logic output 4	-32÷31	2	Speed above minimum	APPL
C17	Meaning of 14 bit analog input A.I.1 0 = speed ref. 1 = torque ref. 2 = torque limit ref.	0÷2	0	Speed reference value	APPL

C18	Meaning of analog input A.I.2 14 bit 0 = speed ref. 1 = torque ref. 2 = torque limit ref.	0÷2	1	Torque reference value	APPL
C19	Meaning of analog input A.I.3 14 bit 0 = speed ref. 1 = torque ref. 2 = torque limit ref.	0÷2	2	Torque limit ref. value	APPL
CON	DESCRIPTION	Range	Default value	Default meaning	See
C41	Enable sensor and motor phase tests	0.1	0		3.1
C42	Enable auto-tunings	0÷3	0		3.2
C46	Enable motor thermal probe management 0=no 1=PT100 2=PTC 3=NTC 4=I23	0÷4	2	Motor PTC enabled	COMM
C48	Configuration CAN Bus BAUD RATE 0=1M 1=800K 2=500K 3=250K 4=125K 5=50K 6=20K 7=10K	0÷7	0	1 Mbit/s	FIELD
C49	Choose zero phase for SIMULATED ENCODER	0÷3	0		SENS
C50	Invert channel B SIMULATED ENCODER	0.1	0		SENS
C51	Choose pulses\rev. SIMULATED ENCODER	0÷11	5	1024 pulses\rev.	SENS
C52	Enable FIELD-BUS reference values	0.1	0		APPL
C54	Incremental or Absolute Simulated Encoder	0,1	0	incremental	SENS
C56	Type of overload 0=120%×30"; 1=150%× 30"; 2=200%× 30"; 3=200%× 3"+155%×30"	0÷3	3	200%× 3"+155%×30"	4.5.2.1
C57	Enable radiator heat probe management 0=no 1=PTC modulo 2=NTC new 3=NTC inverter 4=Tyco	0÷4	1	Radiator probe enabled	COMM
C59	Disable dynamic decoupling + feedforward	0.1	0		4.4
C60	Parameter bank active	0.1	0		COMM
C62	Read parameters from permanent memory	0.1	0		COMM
C64	Enable current control	0.1	0		4.1
C65	Enable overlapped space loop	0.1	0		4.2.3
C69	Enable 2 nd order filter on speed regulator	0.1	0		4.3.1
C71	Enable theta precision by-pass	0.1	0		
C72	Enable Braking Resistance Thermal Protection	0,1	0		COMM
C73	Enable Safety STOP only like signaling	0,1	0		COMM
C74	Enable Incremental Encoder Time Decode	0,1	0		SENS
C75	Disable autotuning starting with default parameters	0,1	0		3.2
C76	Invert positive speed rotation	0,1	0		4.2.1
C77	Enable memory speed regulator correction on gains dynamic change	0,1	0		
C79	Enable negative logic for digital inputs	0÷255	0		APPL

1.2.3. Reserved connections TDE MACNO

CON	DESCRIPTION	Range	Default value	Default meaning	See
C44	Reset alarm counters and save serial number	0.1	0		
C45	Rectification bridge 0 = diodes 1 = semicontrolled	0.1	0	Diode bridge	COMM
C67	Resolver carrier frequency	-3,3	0		
C68	Enable Sin/Cos Encoder auto-tuning	0.1	0		
C80	Enable PWM frequency divided by 2	0,1	0		

1.2.4. Reserved connections for specific applications

The connections ranging from **C90** to **C99** are available for specific applications. See the specific application file for their meaning.

1.3. Input logic functions

The input logic functions are commands that come from configured terminal board logic inputs, from the serial line, and from the fieldbus.

INPUT LOGIC FUNCTIONS		DEFAULT INPUT	DEFAULT STATUS	See
I00	Run	4	L	COMM
I01	Torque control		L	4.1
I02	External enable	2	H	COMM
I03	Enable 14 bit analog reference value A.I.1.	3	L	APPL
I04	Enable 14 bit analog reference value A.I.2.	5	L	APPL
I05	Enable speed jog	7	L	APPL
I06	Enable digital potentiometer speed reference value		L	APPL
I07	Enable 14 bit analog reference value A.I.3.		L	APPL
I08	Reset alarms	1	L	COMM
I09	Digital potentiometer UP		L	APPL
I10	Digital potentiometer DOWN		L	APPL
I11	Load final digital potentiometer value		L	APPL
I12	Invert reference value	6	L	4.2.1
I13	Enable soft start		H	COMM
I14	Enable FIELD-BUS reference values		L	APPL
I15	Enable external flux Φ		L	4.6
I16	Enable second parameter bank		L	COMM
I17	Enable space loop for electric axis		L	4.2.3
I18	Enable frequency speed reference value decoded in time		L	APPL
I19	Enable frequency speed reference value		L	APPL
I20	Enable 16 bit speed reference value (if present)		L	APPL
I21	STOP command (Run locked)		L	APPL
I22	Enable linear ramps	8	L	4.2.2
I23	Motor thermo-switch		L	COMM
I24	Freeze PI speed regulator integral memory		L	APPL
I25	Enable offset on overlap position loop reference		L	APPL
I26	Enable speed regulator second bank parameters		L	APPL
I29	--- Reserved for specific applications ---			
I63	See specific application file			

1.4. Internal values

Internal values are variables within the drive that can be shown on the display or via serial on the supervisor. They are also available from the fieldbus.

Pay close attention to the internal representation base of these values as it is important if readings are made via serial line or fieldbus.

INT	DESCRIPTION	UNIT	Int. rep. base
d00	Software version		256
d01	Active power delivered	KWatt	16

d02	Speed reference value before ramp	% n _{MAX}	16383
d03	Speed reference value after ramp	% n _{MAX}	16383
d04	Speed reading	% n _{MAX}	16383
d05	Torque request	% C _{NOM MOT}	4095
d06	16 bit analog speed reference value	% n _{MAX}	16383
d07	Request torque current I _q rif	% I _{NOM AZ}	4095
d08	Request magnetizing current I _d rif	% I _{NOM AZ}	4095
d09	Voltage reference value at max. rev.	% V _{NOM MOT}	4095
d10	Torque reference value (application generated)	% C _{NOM MOT}	4095
d11	Current module	A rms	16
d12	14 bit analog speed reference value	% n _{max}	16383
d13	Rotor flux frequency	Hz	16
d14	Frequency speed reference value (application generated)	% n _{MAX}	16383
d15	Current torque component	% I _{NOM AZ}	4095
d16	Current magnetizing component	% I _{NOM AZ}	4095
d17	Stator voltage reference value module	Volt rms	16
d18	Stator voltage reference value module	% V _{NOM MOT}	4095
d19	Modulation index	assoluto	4095
d20	V _q rif	% V _{NOM MOT}	4095
d21	Motor rotation speed	rpm	1
d22	V _d rif	% V _{NOM MOT}	4095
d23	Actual position	± 16384	1
d24	Bus voltage	Volt	16
d25	Radiator temperature reading	°C	16
d26	Motor temperature reading (if C46=1, PT100 present) NTC/PTC resistor (if C46=2 or 3, PTC/NTC present)	°C Ω	16
d27	Rotor flux	% φ _{NOM}	4095
d28	Motor thermal current	% alarm threshold A6	4095
d29	Current limit	% I _{NOM AZ}	4095
d30	Maximum torque	% C _{NOM MOT}	4095
d31	Maximum torque set by current limit	% C _{NOM MOT}	4095
d32	Maximum torque limit (application generated)	% C _{NOM MOT}	4095
d33	Speed reference value as a percentage (application generated)	% n _{MAX}	16383
d34	Slip frequency	Hertz	16
d35	Torque produced	% C _{NOM MOT}	4095
d36	Absolute mechanical position (on current turn)	± 16384	1
d37	Absolute mechanical position (turns number)	± 16384	1
d38	Braking Resistance Average Power Dissipated	Watt	1
d39	Adiabatic Energy Dissipated in the measure period	KJoule	32
d47	OD firmware version		1
d48	OPEN DRIVE serial number		1
d49	Alarm code		1
d50	----- Reserved for application -----		
÷			
d60	See application file		
d61	Application code		4095
d62	Code of firmware-managed sensor		1
d63	Code of hardware-managed sensor		1

1.5. Output logic functions

The logic functions display drive status and can be assigned to one of the 4 logic outputs. See the chapter in the applications file for an explanation of their configuration.

	OUTPUT LOGIC FUNCTIONS	DEFAULT	See
o	00 Drive ready	2	COMM
o	01 Motor thermal alarm		
o	02 Speed exceeds minimum	4	
o	03 Drive running	1	COMM
o	04 CW / CCW		
o	05 Current/torque relay		COMM
o	06 End of ramp	3	
o	07 Drive at current limit		
o	08 Drive at torque limit		
o	09 Tracking incremental error > threshold (P37 and P39)		4.2.3
o	10 Soft start active		COMM
o	11 Braking active		COMM
o	12 No mains power		COMM
o	13 Bus regeneration enabled (Support 1)		COMM
o	14 Motor thermal current exceeds threshold (P96)		
o	15 Radiator overheating (higher than P120 threshold)		COMM
o	16 Speed reached (absolute value higher than P47)		
o	17 Power electronic card not supplied		COMM
o	19 Regulation card supplied and DSP not in reset state		
o	20 DC Bus exceeds threshold (P177)		
o	21 ----- Reserved for specific applications -----		
o	31 See specific application file		

1.6. List of alarms

Hereunder is a list of all the alarms managed. Some alarms have more than one meaning; if these are triggered check internal value d49 to establish the cause.

ALARMS		Code d49
A0	Failed attempt to save data in EEPROM	
A1	EEPROM contains altered data	
A2	Machine not magnetized	
A3	Power fault	
A4	Radiator thermal alarm	0 = radiator temperature too high 1 = Braking Resistance Instantaneous Power 2 = Braking Resistance Average Power
A5	Motor thermal alarm	
A6	Motor thermal switch	
A7	Auto-tuning test unfinished	
A8	External alarm	
A9	Speed sensor	0 = HW board and SW incompatible 1 = sensor present 2 = over speed (for 10 consecutive Tpwm)
A10	Minimum power circuit voltage	
A11	Power circuit overvoltage	
A12	Internal alarm	0 = C29 ≠ 1 1 = Run command without power soft start 2 = Run command with trad > P119
A13	Soft start not enabled	0 = power soft start problems 1 = Safe Torque Off
A14	Connection U,V,W error alarm	0 = phase exchanged 1 = motor not connect
A15	Parameter setting error alarm	0 = motor/sensor parameters (static) 1 = simulated encoder pulses 2 = motor parameters (in auto-tuning) 3 = motor/sensor parameters (in auto-tuning)

1.7. List of internal values for monitors and analog outputs

Hereunder is a list of the internal values that can be monitored via the analog outputs or via the Supervisor's monitor.

INTERNAL VALUES		NORMALIZ.	BASE
o00	Actual mechanical position read by sensor (if sensor has more than 2 poles, it regards the actual turn sector)	100%=180° (with 2 poles) 100% = semi-sector (+ poles)	32767
o01	Actual electrical position read by sensor (delta m)	100%=180°	32767
o02	Reference speed value after ramp	% n _{MAX}	16383
o03	Reference speed value produced by torque regulator	% n _{MAX}	16383
o04	Rotation speed (filtered T _f = 8×T _{PWM} , 1.6ms at 5KHz)	% n _{MAX}	16383
o05	Torque request	% C _{NOM MOT}	4095
o06	Internal value: <i>status</i> (MONITOR only)		
o07	Request to current loop for torque current	% I _{NOM AZ}	4095
o08	Request to current loop for flux current	% I _{NOM AZ}	4095
o09	Request voltage at maximum rev.	% V _{NOM MOT}	4095
o10	Internal value: <i>alarms</i> (MONITOR only)		
o11	Current module	% I _{NOM AZ}	4095
o12	Zero top	100%=180°	32767
o13	U phase current reading	% I _{MAX AZ}	4095
o14	Internal value: <i>inputs</i> (MONITOR only)		
o15	Torque component of current reading	% I _{NOM AZ}	4095
o16	Magnetizing component of current reading	% I _{NOM AZ}	4095
o17	U phase voltage duty-cycle		32767
o18	Stator voltage reference value module	% V _{NOM MOT}	4095
o19	Modulation index	0 ⇔ 1	4095
o20	Request Q axis voltage (V _{q_rif})	% V _{NOM}	4095
o21	Delivered power	% P _{NOM}	4095
o22	Request D axis voltage (V _{d_rif})	% V _{NOM}	4095
o23	Torque produced	% C _{NOM MOT}	4095
o24	Bus voltage	100%=900V	4095
o25	Radiator temperature reading	% 37,6°	4095
o26	Motor temperature reading	% 80°	4095
o27	Rotor flux	% φ _{NOM}	4095
o28	Motor thermal current	% alarm threshold A6	4095
o29	Current limit	% I _{MAX AZ}	4095
o30	CW maximum torque	% C _{NOM MOT}	4095
o31	CCW maximum torque	% C _{NOM MOT}	4095
o32	Internal value: <i>outputs</i> (MONITOR only)		
o33	Internal value: <i>inputs_hw</i> (MONITOR only)		
o34	V phase current reading	% I _{MAX AZ}	4095
o35	W phase current reading	% I _{MAX AZ}	4095
o36	Actual electrical position (alfa _{fi})	100%=180°	32767
o37	Analog input A.I.1	100%=16383	16383
o38	Analog input A.I.2	100%=16383	16383
o39	Analog input A.I.3	100%=16383	16383
o40	Analog input A.I.16	100%=16383	16383
o41	Overall speed reference value (f _{somma_tot})	% n _{MAX}	16383
o42	Overall torque reference value (t _{rif}) from application	% C _{NOM MOT}	4095
o43	Overall torque limit reference value (limit _{i_aux})	% C _{NOM MOT}	4095
o44	Frequency speed reference value from application (theta _{prec})	Electrical pulses per T _{PWM}	
o45	Overlapped space loop reference value from application	Electrical pulses per T _{PWM}	
o46	Amplitude to the square of sine and cosine feedback signals	1=100%	32767
o47	Sen_theta (Direct resolver and Sin/Cos Encoder)	Max amplitude = 200%	16383
o48	Cos_theta (Direct resolver and Sin/Cos Encoder)	Max amplitude = 200%	16383

o49	Rotation speed not filtered	% n _{MAX}	16383
o50	Delta pulses read in PWM period in frequency input	Pulses per PWM	
o51	Overlapped space loop memory lsw	Electrical pulses (x P67)	16383
o52	Overlapped space loop memory msw	Electrical turns (x P67)	1
o53	----- Reserved for specific applications -----		
÷			
o63	See specific application file		

2. Setting basic parameters

Setting the parameters that establish the exact type of motor used is important if the drive is to run correctly. These parameters are:

P61	Rated motor current as a % of the rated drive current
P62	Rated motor voltage in Volt
P63	Rated motor frequency in Hertz
P67	Number of motor poles

These parameters are fundamental in that they are the basis of all the motor operating characteristics: frequency, speed, voltage, current, torque and thermal protection. P62 and P63 can be read directly on the motor rating plate and P61 can be calculated with the following formula:

$$P61 = (I_{nom_motor} * 100.0) / (I_{nom_drive})$$

Example: Drive: OPEN 22 I_{nom_drive} = 22A overload 200%
 Motor: MEC series, V_n = 380V, f = 50Hz, I_{nom_motore} = 20A,

$$P61 = (20 * 100) / 22 = 90.9\%$$

$$P62 = 380.0$$

$$P63 = 50.0$$

There are also parameters that establish the maximum values for voltage, thermal current and operating speed:

P64	Maximum operating voltage as a percentage of the rated motor voltage
P65	Maximum operating speed in rpm
P70	Motor thermal current as a percentage of the rated motor current
P71	Motor thermal time constant in seconds

These important parameters must be specified alongside the exact characteristics of the feedback sensor used. See the “Feedback option” file. Once the sensor has been established, the “**Sensor and motor pole tests**” can be carried out (enabled with C41) which will confirm that the parameters have been set correctly.

The system is now ready to read all the electrical motor characteristics with the “**Auto-tuning test**” (enabled with C42) as explained below.

2.1. Auto-tuning parameters

P41	Maximum motor torque with full magnetic field as a % of the rated motor torque
P72	I_T rated torque current as a % of the rated motor current
P73	I_ϕ magnetizing current as a % of the rated motor current
P74	Rotor time constant τ_R in milliseconds
P75	Stator time constant τ_S in milliseconds
P76	ΔV_{RS} Voltage drop due to stator resistor and IGBT at rated motor current as a % of the rated motor voltage
P77	ΔV_{LS} % Voltage drop due to total leakage inductance on stator rated motor current as a % of the rated motor voltage
P78	Rated motor torque reading

These parameters are extremely important for modelling the motor correctly so that it can be used to its full potential. The best procedure for obtaining the correct values is the “**Auto-tuning test**”, which is enabled with connection C42: this test must be carried out with the motor decoupled from the load. Failure to do so may invalidate the results.

If the tests cannot be carried out for any reason, these values will have to be estimated by reading the motor plate and following these points:

- The magnetizing current value is sometimes shown on the motor plate under I_0 . In this case, $P73 = I_0 / I_{nom}$ motore. If this value is not available, it will have to be estimated: set P73 to a value that supplies a no-load motor running at rated speed with a three-phase alternate voltage which is effective but slightly lower than the rated motor voltage. Then change P73 until d18 displays a value of about 96 - 97% .
- Once P73 is established, rated torque current P72 can be established as: $\sqrt{100^2 - P73^2}$
- The rotor time constant (in seconds) can be calculated with the following formula:

$$Tr = \frac{1}{6,28} \cdot \frac{1}{fs} \cdot \frac{P72}{P73} \quad \text{with fs rated slip frequency. } P74 = Tr \text{ in milliseconds}$$

Establish fs by reading the rated slip value, usually in rpm, on the motor plate, then compare it with the rated speed and multiply everything by the rated motor frequency.

Check P74 by forcing the motor to request a torque current:

- changing the speed reference value brusquely
- applying different loads to the motor

and observing the behaviour of the stator voltage module. If this value is correct, the voltage should only vary slightly in the transient phase.

- These other parameters are not as important and the default values may be left if more reliable data are unavailable.

3. Auto-tuning procedures

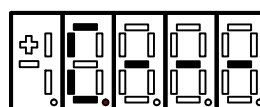
3.1. Sensor and motor pole tests

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the sensor correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the speed sensor used is set correctly.

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. The following setting will appear on the display:



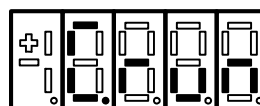
display



7 segments

The drive is now ready to start the test. To start reading, enable RUN with its digital input or working with connection C21 (commands in series)

Once the test has started, this setting will appear alongside and the motor will rotate in the positive direction first to ensure the direction matches and will then rotate again to ensure the motor phases and the sensor are set correctly.



display



7 segments



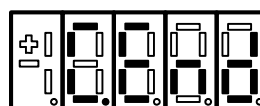
During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

If the drive sets off an alarm during the test, an error has occurred. Check to see which alarm has been triggered and deal with the problem accordingly:

- If **A14 d49=1** is enabled, the test current is too low, check if the motor phases are correctly connected to the drive
- If **A14 d49=0** is enabled, connections U,V,W do not match the internal phases of the drive. Invert two phases and repeat the test.
- If **A15 d49=3** is enabled, the values set do not comply with the motor pole and sensor settings.

At the end of the test, check parameter **P79** as it may give some indication as to the problem. See the “Feedback Option” file for the meaning of P79 as it depends on which sensor is used.

The test is successful if this setting appears alongside and the drive does not trigger an alarm.



display



7 segments

Now disable RUN by setting its digital input to 0 or clearing C21. The subsequent tests can now be carried out.

3.2. Identifying models of induction motor

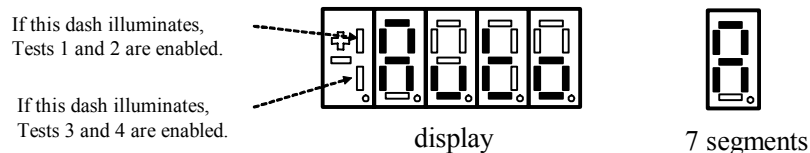
This test reads the basic electrical parameters that characterise the induction motor being used so that it can be modelled according to the rotor magnetic flux. After these values have been established, the PI regulators in the current and flux loops are self-set .

There are 4 test functions. Each requires a no-load motor, i.e. decoupled from the load, if they are to function correctly.

Connection C42 is used to enable these tests. See the table below:

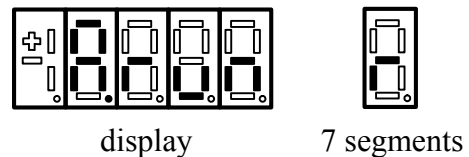
C42	Enabled function
0	No test enabled
1	Only Tests 1 and 2 enabled. Motor does not need to be rotating.
2	Only Tests 3 and 4 enabled. Motor needs to be rotating.
3	All tests enabled. Tests carried out in quick succession.

The display will show the following setting according to which tests are enabled:

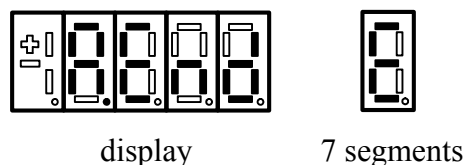


The drive is now ready to start the test. Start reading by enabling RUN with its digital input and setting C21=1 (command in series).

Once the tests have started, this setting will appear alongside:



The test finishes successfully if this setting appears alongside and the drive does not trigger an alarm.



Now disable RUN by setting its digital input to 0 or clearing C21=0.

The tests may be halted at any moment by disabling RUN; the drive will trigger an alarm (A7) but any results will be saved.

Once C42≠0 has been set again, if C75=0 the default values of the parameters being tested will be automatically reloaded, on the contrary if C75=1 remain active actual data.

In order to refine data measured it's better to execute Autotuning test the first time with C75=0 and then the second time with C75=1.

3.2.1. Test 1: Reading stator drop and dead time compensation

This test establishes the voltage drop caused by the stator resistor and the IGBT. It also estimates the signal amplitude required to compensate for the effects of the dead times so that the internal representation base of the stator voltage and the one actually generated match.

During this reading, the motor remains still in its original position and a range of flux currents are emitted. By reading the voltages and the correlated voltages the required values can be collected. This test modifies the following parameters:

P76	ΔV_{RS} Voltage drop due to stator resistor and IGBT at the rated motor current as a % of the rated motor voltage
1P02	Dead-time compensation

3.2.2. Test 2: Learning the total leakage induction drop reported to the stator

This test establishes the voltage drop due to the total leakage inductance reported to the stator in order to calculate the proportional gain of the current loop PI.

During this test, the motor stays practically still in its original position. Flux currents in a range of values and frequencies are emitted so that by reading the voltages and correlated voltages the required values can be collected. The motor has a tendency to rotate, but this phenomenon is managed in such a way that readings are only taken when the speed is equal to zero, otherwise the results may be unreliable.

Nevertheless it is important that the motor does not rotate at a speed exceeding more than several tens of revolutions per minute. If it does, stop the test by disabling RUN and lower parameter **P129** as this is the test current used to establish ΔV_{LS} .

This test modifies the following parameters:

P77	ΔV_{LS} % Voltage drop due to total leakage inductance reported to the stator at the rated motor current as a % of the rated motor voltage
P83	K _{pc} current regulator proportional gain



During this test the motor may start rotating, but at low speed.

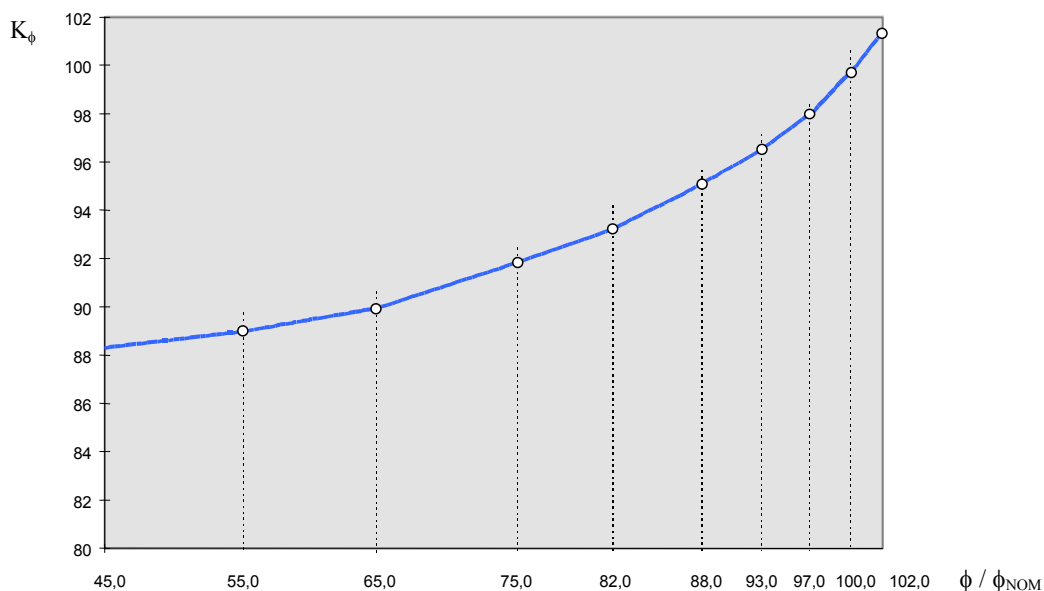
3.2.3. Test 3: Reading the magnetizing current and the magnetizing characteristic

This test has the dual task of establishing the motor magnetizing current and reading its magnetic characteristic.

During this test, the motor is rotated at high speed (about 80% of the rated speed) and readings are taken at a range of voltages. After establishing the magnetizing value, 10 points of the magnetic characteristic are taken, after which linear interpolation is carried out in order to obtain a curve similar to the one below.



During this test the motor will rotate at a speed equal to about 80% of the rated value.



The term K_ϕ is equal to: $\frac{I_d/I_\phi}{\Phi/\Phi_{NOM}}$ i.e. it is the coefficient that when multiplied by the normalized flux in relation to the rated flux gives the normalized flux current in relation to the magnetizing current.

The characteristic is assumed to be constant for normalized fluxes under 45%.

At the end of these readings, the results will be shown in the parameters below, which may still be changed by the user.

	1	2	3	4	5	6	7	8	9	10
ϕ / ϕ_{NOM}	P130	P132	P134	P136	P138	P140	P142	P144	P146	P148
	45.0%	55.0%	65.0%	75.0%	82.0%	88.0%	93.0%	97.0%	100.0%	102.0%
K_ϕ	P131	P133	P135	P137	P139	P141	P143	P145	P147	P149

The magnetizing current may also be viewed in the parameter below:

P73	I_μ magnetizing current as a % of the rated motor current
-----	---

3.2.4. Test 4: Reading the rotor time constant and estimating the stator time constant

This test establishes the rotor time constant from the motor and helps to estimate the stator time constant by using data from other auto-tuning values.

During the test, the motor is rotated at the same speed as the previous test and then it goes in free revolution



During the test, the motor rotates at a speed equal to about 80% of the rated speed and is temporarily left to idle.

The following parameters are modified at the end of the test:

P41	Maximum motor torque with full magnetic field
P74	Rotor time constant τ_R
P75	Stator time constant τ_S
P78	Rated motor torque in Nm
P80	KpV flux regulator proportional gain
P81	TiV flux regulator lead time constant
P82	TfV flux regulator (filter) time constant
P84	TiV current regulator lead time constant
P85	TfV current regulator (filter) time constant

By the end of this test, the current and flow regulators will have been completely self-set and made compatible with the motor connected to the drive.

These readings also help estimate the Maximum motor torque (**P41**) which is important if the motor flux has to be considerably weakened.

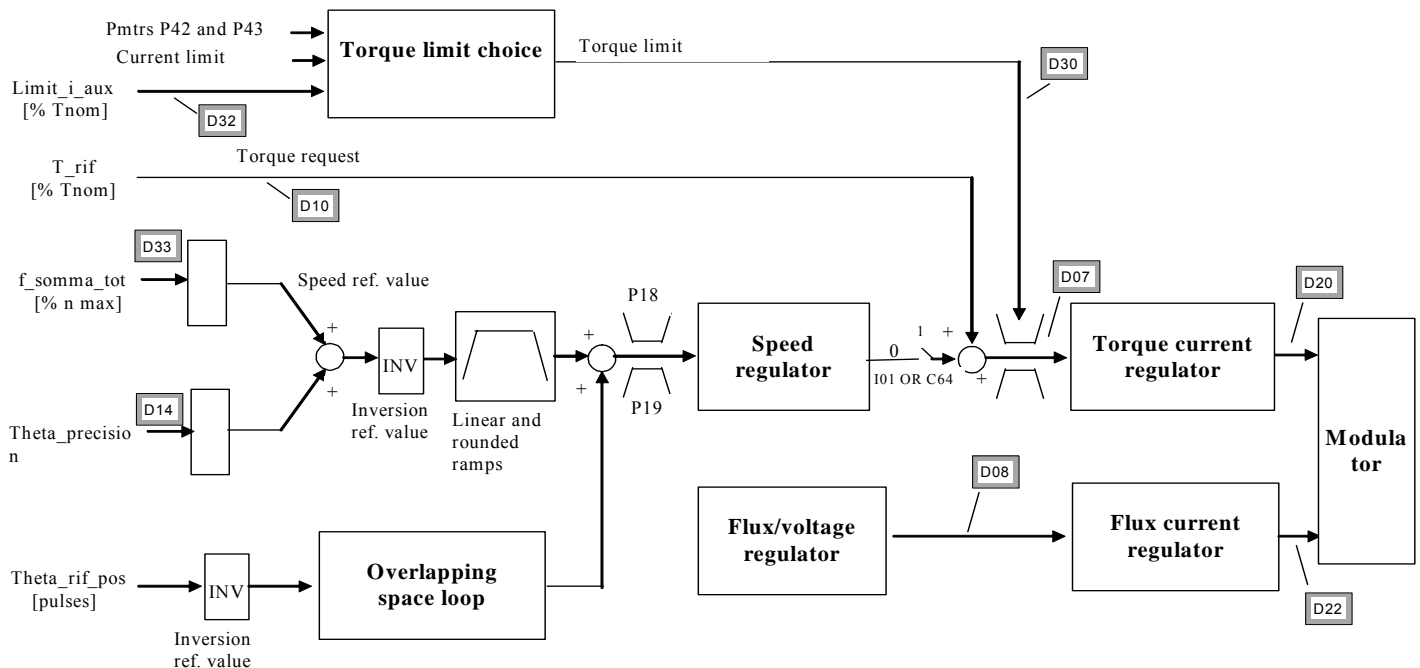
The speed regulator gains are set with the default values so that the user can set the most suitable gains for the applications. The speed loop bandwidth depends heavily on the overall load inertia, thus high frequency values can only be obtained if the motor-load coupling has no elasticity or mechanical play and if the speed sensor resolution is good enough not to introduce too much noise.

P31	KpV speed regulator proportional gain
P32	TiV speed regulator lead time constant
P33	TfV speed regulator (filter) time constant

4. Regulation

The regulation system consists of a speed regulation loop and a flux or voltage regulation loop according to drive operation. These loops manage the reference values from the application and generate reference values for the internal torque and flux current loops.

All the loops are controlled by integral proportional regulators with an error signal filter and work with normalized signals so that the regulation constants are as independent as possible from the size of the motor in relation to the drive and from the system mechanics. An additional space loop that overlaps the speed loop can also be enabled.



The following paragraphs analyse each regulation block in detail.

4.1. Choosing control type: speed or torque

Regulation controls speed by default; here the application manages the speed reference values, and the torque request is used as a reference value added to the speed regulator output (feed-forward).

Torque control can be enabled on its own by setting function **I01** “**Torque control**” to high logic level or by setting **C64=1**. In this case, only the torque request generated by the application will be considered as long it is within the admitted torque limits.

Note that it is a torque control and not a current control, consequently during flux weakening the control automatically generates the request for the active current needed to obtain the required torque.

4.2. Managing speed reference values

The application generates two speed reference values:

- One (“f_somma_tot”) is a percentage of the maximum speed (set in parameter P65) displayed in internal value d33 and on monitor o41.
- The other (“theta_precision”) is electrical pulses for a period of PWM. This particular reference is used so as not to lose any pulses if the frequency input is used. Internal normalization is done with 65536 pulses per mechanical revolution and the pulses are multiplied by the number of motor pole pairs in order to maintain sensor resolution.

After these two reference values have been processed they are added together in order to obtain the total speed reference value.

4.2.1. Inverting and limiting speed reference values

Logic function **I12** “Speed reference value inversion”, which is assigned to an input (the default is input 6), or connection **C36** are used to invert the reference value according to the following logic (OR-exclusive):

I12 = 0	C36 = 0	Reference value not inverted (default values)
I12 = 1	C36 = 0	Reference value inverted
I12 = 0	C36 = 1	Reference value inverted
I12 = 1	C36 = 1	Reference value not inverted

The reference value is inverted before the ramp thus, if the ramp is not disabled, the direction of rotation changes gradually (default C36=0 and I12=0).

There is another chance, to invert positive speed rotation setting **C76=1**.

Enabling this function, with the same speed reference and speed measured, the motor rotates in reverse direction.

Parameters P18 and P19 are used to limit the total reference value within a range set between these two values; P18 is the maximum limit (positive speed) and P19 is the minimum limit (negative speed). These two parameters may be set at a range from $\pm 105\%$, thus special settings may be used to limit operation within the 2 quadrants or within just one quadrant.

The following settings are provided by way of example:

P18 = 100.0%	P19 = 100.0%	-100.0% < speed reference value < 100%
P18 = 30.0%	P19 = 20.0%	-20.0% < speed reference value < 30%
P18 = 80.0%	P19 = -20.0%	20.0% < speed reference value < 80.0%
P18 = -30.0%	P19 = 60.0%	-60.0% < speed reference value < -30.0%

4.2.2. Linear and rounded ramps

By default (**C26=1**) the speed reference value passes across a ramp circuit that graduates its variations before it is used. Parameters **P21**, **P22**, **P23** and **P24** can be used to establish independent acceleration and deceleration slopes in both directions of movement, establishing the time required to pass from 0 to 100% in seconds. In particular (see diagram):

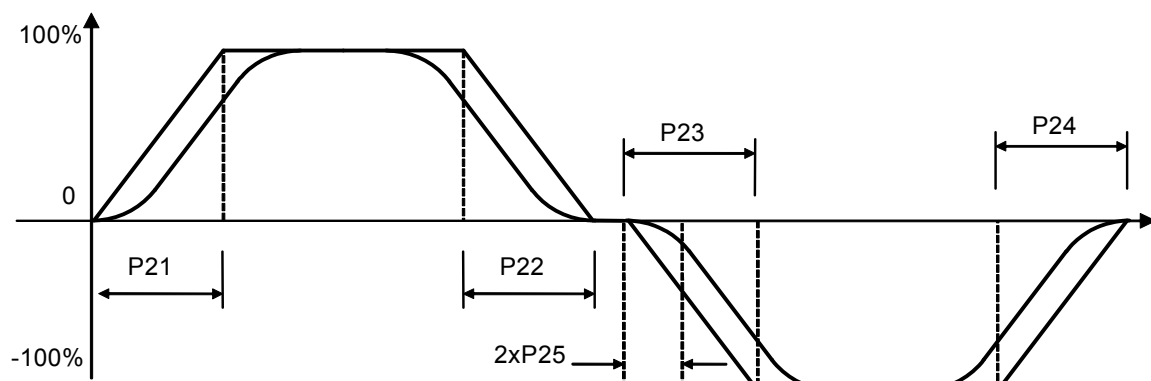
- P21 sets the time the reference value requires to accelerate from 0 to +100%
- P22 sets the time the reference value requires to decelerate from 100% to 0%
- P23 sets the time the reference value requires to accelerate from 0% to -100%
- P24 sets the time the reference value requires to decelerate from -100% to 0%

Setting sensitivity is 10 msec and the time must be between 0.01 and 199.99 seconds.

The default values are the same for all the parameters and are equal to 10 sec.

Ramps can be enabled via a configurable logic input (**I22**) which works parallel to connection C26: I22=H is the same as setting C26=1. This input ensures maximum flexibility in ramp use in that the ramps are enabled only when required.

The ramp may also be rounded in the starting and finishing phases by setting **C27=1** via the rounding time set in seconds in **P25** with resolution 0.1 sec and a range from 1 to 199.9 sec. (default 10 sec).



Rounding can be enabled on its own with C27=1, which will filter the overall speed reference value only.

Some special applications may enable the linear ramps differently. See the respective instruction file for further information.

4.2.3. Overlapped space loop

Continuous position control during rotation is used to synchronise both speed and space with the speed reference value used.

To enable this function, set input function **I17** “Enable overlapped space loop” to high logic level or set **C65=1**. From then on, an internal counter will be save any position errors regarding the space crossed by the reference value. If the drive RUN command is disabled, the error will be accumulated until it can be corrected once RUN has been enabled again.

Using parameters **P37** (65536=1 mechanical turn) and **P39** (number of mechanical turns) it’s possible to set a maximum tracking error threshold, if the absolute error value becomes greater than this value, the logic output **o.9** “Tracking error” goes at high level.

The overlapped space loop reference value is generated by the application and regards the “theta_rif_pos” value, which is also expressed in electrical pulses for a period of PWM.

Note that once this function has been enabled, the overlapped space loop reference value will become the real position reference value, while the other speed reference values will represent feed-forward.

The space loop regulator is a pure proportional gain and its gain can be set on **P38**: set a value that ensures a quick response, but one that does not make the motor vibrate at a standstill.

The continuous position control is most commonly applied to the electric axis: by taking the speed reference value from the MASTER’s Simulated Encoder and taking it to the SLAVE’s frequency input, the motion of the two motors can be synchronised. Once the overlapped space loop is enabled, the two motors will always maintain the same relative position whatever their load. If the SLAVE reaches its torque limit, the counter will save the position error and then correct it as long as the internal counter limit has not been reached, in which case the synchronisation will be lost.

4.3. Speed and stability regulator

The speed regulator generates the request for torque current needed to maintain the rotation speed reading the same as the reference speed value.

The speed is normalized in relation to the maximum operating speed and is displayed as a percentage: D3 is the speed percentage reference value, D4 is the speed percentage reading while the operating frequency value is displayed in Hz in D13.

The speed regulator constants are set in engineering units by parameters **P31**, proportional gain Kp; **P32**, time in ms of the lead time constant Ta equal to the time constant of the integral regulator multiplied by the gain (Ta = Ti*Kp); **P33**, 1st order filter constant Tf in ms.

The overall transfer function of the speed regulator is:

$$T_rif(s) = [Rif_vel(s) - Velocità(s)] \cdot Kp \cdot \left[\frac{1}{1 + sTf} + \frac{1}{sTa} \right]$$

Rif_vel(s)=speed reference value (normalized at max speed)
 Velocità(s)=rotation speed (normalized at max speed)
 T_rif(s)=torque request (normalized at rated motor torque)
 Kp = Proportional gain (**P31**)
 Ta = Lead time constant (**P32** in ms)
 Tf = Filter time constant (**P33** in ms)

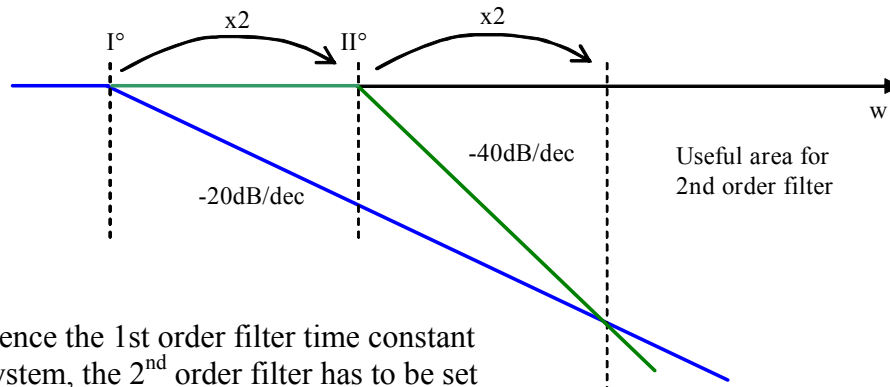
The default values of these constants are calculated in order to ensure stability in almost all conditions. However if the machine is a little too jittery, use P31 to reduce the gain until it stabilises. Likewise the gain has to be increased if the regulator is too slow.

4.3.1. 2nd order speed regulator filter

The speed regulator filter can be changed by using a 2nd order one.

To enable this function set **C69=1**. Parameter **P33** will always set the filter time constant in milliseconds, and thus its natural pulsation, given that internal damping is always set to 0.8 so that the filter is quick to respond but does not overshoot.

Note that enabling a 2nd order filter means reducing the margin of system stability, hence the filter time constant value must be thought through carefully before setting so as not to create instability:



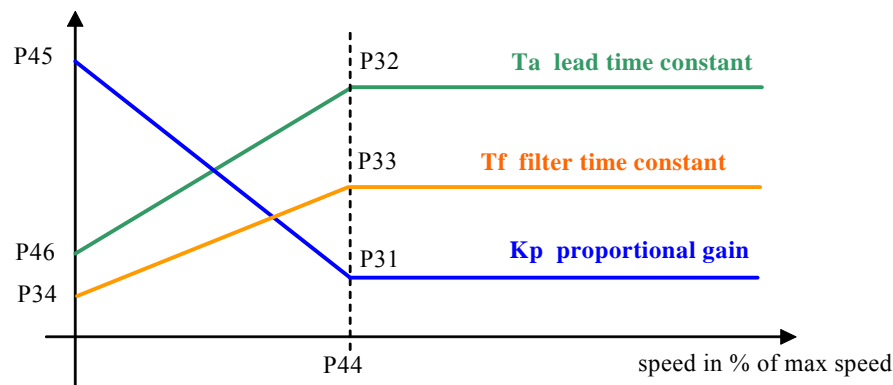
By taking as reference the 1st order filter time constant tolerated by the system, the 2nd order filter has to be set to double frequency (half time) so that it has the same phase margin.

The effects of the 2nd order filter will be better than the 1st order filter only when the frequency is double that of the 2nd order filter.

Example: if a 1st order filter with a time constant $P33=0.8$ ms passes to a 2nd order filter, $P33=0.4$ ms has to be set to have the same stability margin.

4.3.2. Variable speed regulator gains

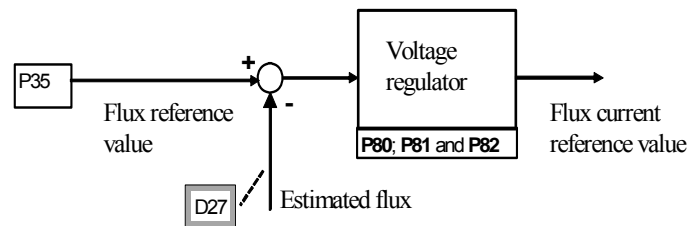
Speed regulator gains can be varied according to actual speed: **P45** is the proportional gain at zero speed, **P46** is the initial lead time constant and **P34** is the initial filter time constant. Setting **P44** (a percentage of the maximum speed) with the end variation gain speed establishes a linear gain variation that ranges from the initial values (**P45**, **P46** and **P34**) to the final values in **P31**, **P32**, **P33**. Setting **P44=0.0** disables this function so that the gains set in **P31**, **P32** and **P33** are used.



4.3.3. Flux or voltage regulator

The flux regulator generates the request for the flux current required to maintain the magnetic rotor flux equal to the reference value set in parameter **P35** when the working area is with **Constant torque**.

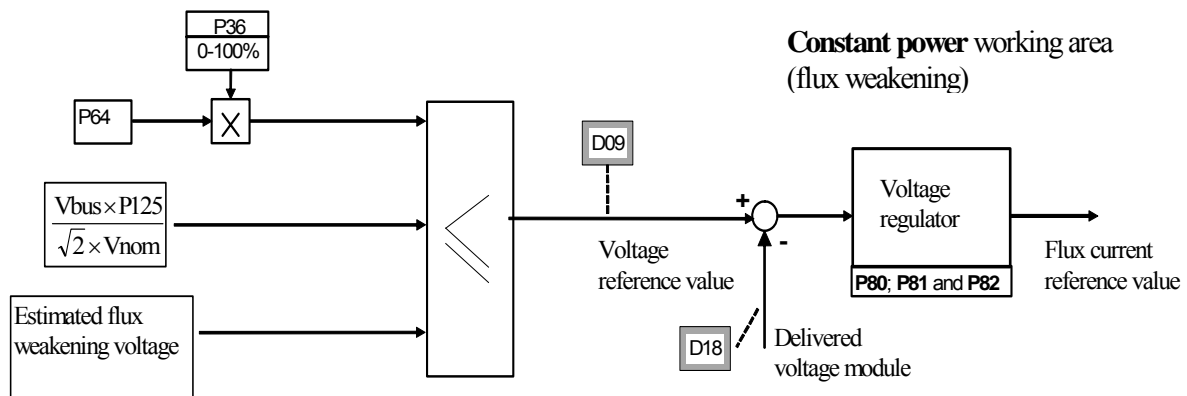
Constant torque working area



When operating with **Constant Power** the regulator generates a request for the flux current required to ensure the stator voltage module is the same as the voltage reference value and thus to weaken the flux gradually as the speed increases.

The active voltage reference value (displayed in d09) is always the smallest of the three values, which are all normalized in relation to the rated motor voltage (**P62**):

- Parameter **P64** “Maximum operating voltage” multiplied by coefficient **P36**;
- A term linked to the direct bus voltage with a margin set with **P125** (default 96%), because the maximum stator voltage that can be delivered may not exceed the direct voltage divided by $\sqrt{2}$;
- A term linked to the estimated stator voltage to be applied during flux weakening based on the required current so that there is a margin with regard to the maximum voltage available and thus to be better equipped to deal with variations in the required torque.



The flux current is normalized in relation to the magnetizing current (P73), the rotor flux is normalized in relation to the rated flux and is displayed as a percentage in d27. The stator voltage module is normalized in relation to the rated motor voltage (P62) and is displayed as a percentage in d18 and as a value in Volt rms in d17.

The constants of this regulator are established in engineering units by parameters **P80**, proportional gain K_p ; **P81**, time in ms of the lead time constant T_a equal to the integral regulator time constant multiplied by the gain ($T_a = T_i * K_p$); and **P82**, filter constant in ms.

NB **Parameters P80 and P81 cannot be changed directly because they are considered to be perfectly calculated by the auto-tuning.** They can only be changed by accessing TDE MACNO reserved parameter **P127** “Multiplication coefficient K_p and T_a flux loop”.

The voltage/flux regulator limit is normally set at \pm rated motor current so that the total flux may be changed quickly during the transient state.

If the estimated flux drops below 5% of the rated flux, the lower voltage regulator limit is brought to a value that will generate a flux of at least 4%. This is done so as not to lose control in a zone where the flux has been weakened widely.

4.4. Current regulation

Current regulators generate the voltage reference values required to ensure torque and flux currents that are equal to their reference values.

The current signals processed by these regulators are expressed according to the maximum drive current, which means that they are affected by the ratio between the rated motor current and the rated drive current (P61). To ensure good control, this ratio should not drop below 35 - 40% i.e. Do not use a drive that is more than two and a half times larger than the motor, nor a motor that is more than one and a half times larger than the drive.

The flux current is displayed as a percentage of the rated motor current in d16, while the torque current is displayed as a percentage of the rated motor current in d15. The constants of these regulators are established in engineering units by parameters **P83**, proportional gain K_p ; **P84**, time in ms of the lead time constant T_a equal to the integral regulator time constant multiplied by the gain ($T_a = T_i * K_p$); and **P85**, filter constant in ms.

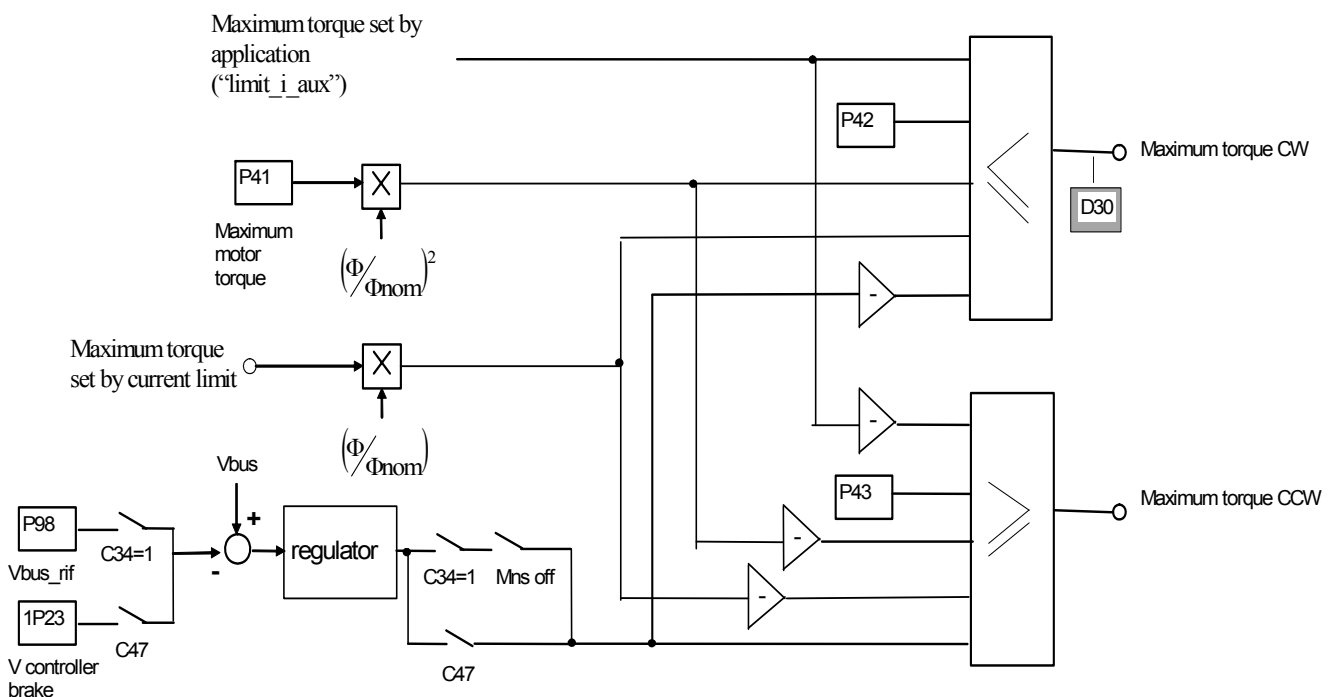
NB **Parameters P83 and P84 cannot be changed directly because they are considered to be perfectly calculated by the auto-tuning.** P83 can only be changed by accessing TDE MACNO reserved parameter **P126** “Multiplication coefficient K_p and current loop”.

There is dynamic decoupling between the direct axis and the orthogonal axis with a low default gain. Should there be any doubts as to whether the dynamic decoupling is working properly, then it can be disabled by setting **C59=1**.

4.5. Choosing the active torque limit

The positive and negative torque limits are chosen to restrict the following values:

- P42 / P43 = maximum torque, in both directions according to rated torque;
- Maximum torque linked to maximum motor torque according to the rated torque (parameter **P41**);
- Maximum torque set by the current limit;
- Maximum torque limit reference value generated by the application (“limit_i_aux”);
- Maximum torque limited by the regulator output in order to back up the bus voltage should the mains fail (as long as this function is enabled by setting **C34=1**);
- Maximum torque controlled in the startup phase with the motor magnetized;
- Maximum torque limited in the controlled braking phase (as long as this function is enabled by setting **C47=1**).



The following paragraphs analyse the existing torque limits in detail.

4.5.1. Maximum motor torque limit

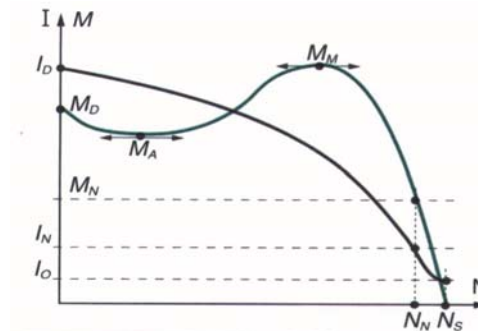
The induction motor has a maximum torque that depends on its construction characteristics. The graph below illustrates the progress of a torque curve according to speed with the motor powered by a constant frequency (N_s). The same graph can also be referred to when an inverter is used, reading it as torque delivered according to slip, i.e. the difference between the rotation speed of the electrical values and the rotor ($N_s - N$ in the graph).

3-phase induction motor torque (M) and current (I) curve according to number of revolutions (N).

- I_d** = starting current
- I_n** = rated current
- I_o** = no-load current

- M_d** = starting torque
- M_a** = acceleration torque
- M_m** = max. torque
- M_n** = rated torque

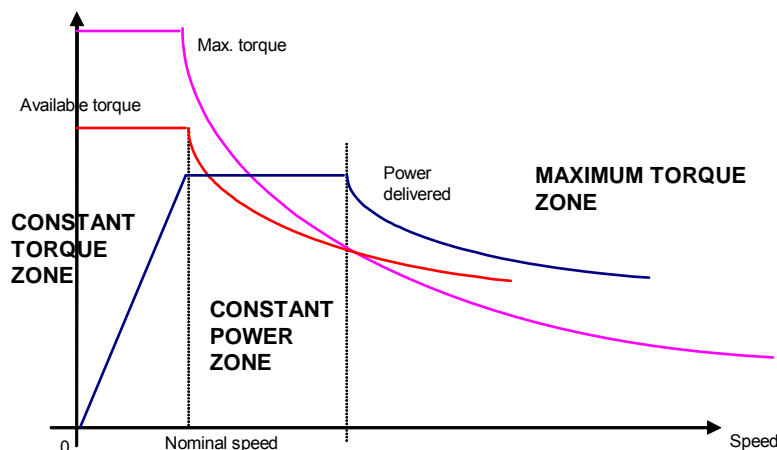
- N_n** = rated speed
- N_s** = synchronism speed



The graph illustrates how the delivered torque increases according to slip up to a certain point represented by the maximum motor torque. If the maximum torque is exceeded, control is lost in that the torque decreases even when the current is increased.

It is proved that the maximum motor torque decreases during flux weakening in proportion to the square of the ϕ/ϕ_{nom} ratio. Thus the motor has three working areas:

- **Constant torque:** the maximum torque is available up to the rated speed (as long as the current to deliver it is available);
- **Constant power:** over the rated speed, flux is reduced proportionally to speed, the available torque also drops in proportion to speed, the power delivered is constant;
- **Maximum torque:** after reaching the maximum torque, which decreases with the square of the speed, the available torque will start to drop with the square of the speed and the power delivered will decrease in proportion to the speed.

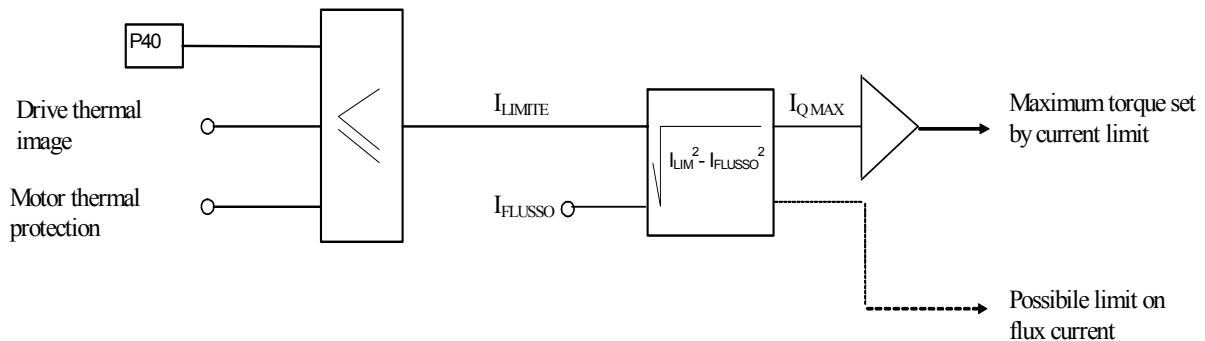


To ensure regulation stability, **P41** must be set with the Maximum torque divided by Rated motor torque. This limit will decrease during flux weakening with the square of the speed.

4.5.2. Maximum current limit

The drive is fitted with a maximum current limiting circuit that cuts in if exceeded, restricting the maximum current delivered to the lowest value from among parameter **P40**, the value calculated by the drive thermal image circuit, and the motor thermal protection circuit.

P40 is used to programme the maximum current limit delivered by the drive from 0% to the maximum authorised value, which depends on the type of overload chosen with connection **C56**.



If the current limit exceeds the flux current, then only the torque current will be limited and thus the maximum torque delivered is limited. Otherwise, the delivered torque is set to zero and the flux current is also limited.

4.5.2.1. Drive thermal image

Four types of drive overload can be set on **C56**:

C56	Overload type for rated drive current (P53)
0	120% for 30 seconds
1	150% for 30 seconds
2	200% for 30 seconds
3	200% for 3 seconds and 155% for 30 seconds

NB: the choice also changes the rated drive current as shown by the tables in the installation file and the correct value is always displayed in ampere rms in **P53**.

The delivered current is also used to calculate the operating temperature reached by the power component junctions with the drive presumed to be working with standard ventilation at the maximum ambient temperature permitted.

If this temperature reaches the maximum value permitted for the junctions, the delivered power limit is restricted to a value that is just over the rated drive current, i.e. the system's effective thermal current (see following table).

Now the drive will only overload if the temperature drops below the rated value, which will only occur after a period of operation at currents below the rated current.

The junction temperature calculation also considers the temperature increase that occurs while operating at low frequencies (below 2.5 Hz) due to the fact that the current is sinusoidal and thus has peak values that are higher than the average value. With electrical operating frequencies lower than 2.5Hz, the drive goes into maximum overload for 20-30ms after which the maximum current limit is reduced by $\sqrt{2}$ as shown by the following table:

C56	Max. drive current	Drive thermal current	Limit below 2.5 Hz
0	120% $I_{NOM AZ}$ for 30 seconds	103% $I_{NOM AZ}$	84% $I_{NOM AZ}$
1	150% $I_{NOM AZ}$ for 30 seconds	108% $I_{NOM AZ}$	105% $I_{NOM AZ}$
2	200% $I_{NOM AZ}$ for 30 seconds	120% $I_{NOM AZ}$	140% $I_{NOM AZ}$
3*	200% $I_{NOM AZ}$ for 3 seconds 155% $I_{NOM AZ}$ for 30 seconds	110% $I_{NOM AZ}$	140% $I_{NOM AZ}$

N.B. = the overload time illustrated is calculated with the drive running steady at the rated motor current. If the average delivered current is lower than the rated motor current, then the overload time will increase. Thus the overload will be available for a longer or identical time to the ones shown.

N.B. 3* = the 200% overload is available until junction temperatures are estimated to be 95% of the rated value; at the rated value the maximum limit becomes 180%. For repeated work cycles, TDE MACNO is available to estimate the drive's actual overload capacity.

4.5.2.2. Motor thermal protection

Parameters **P70** (thermal current as a % of the rated motor current), **P71** (motor thermal constant in seconds) and the current delivered by the drive are used to calculate the presumed operating temperature of the motor considering an ambient temperature equal to the permitted maximum; the losses are evaluated with the square of the absorbed current and filtered with the motor thermal constant. When this value exceeds the maximum thermal current set in P70 (value proportional to the square of this current) the thermal protection cuts in, enabling logic output **o.L.1** and alarm **A06**. The action taken may be programmed via connection **C32** and by enabling alarm **A06**:

If A06 is disabled, no action will be taken.

If A06 is enabled, action will depend on C32:

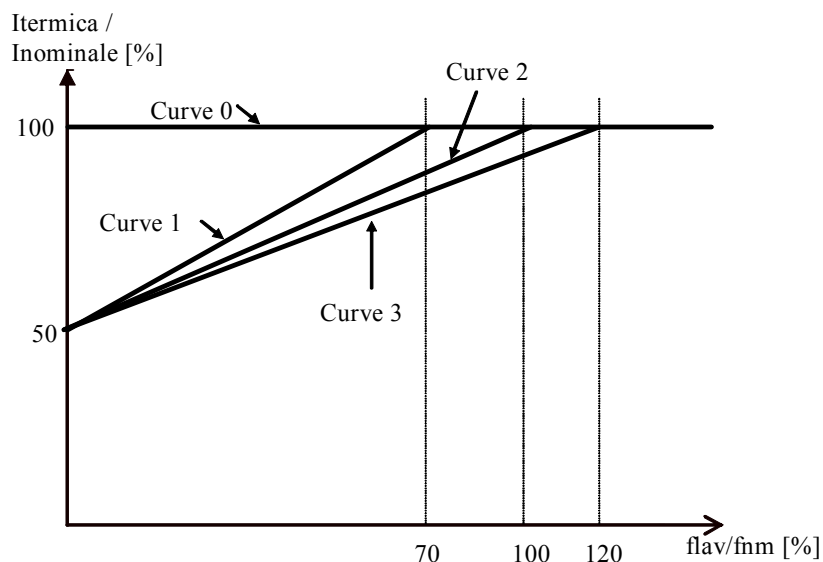
- C32 = 0 (default value) the thermal alarm will cut in and reduce the current limit to match the motor thermal current.
- C32 = 1 the thermal alarm cuts in and stops the drive immediately.

Internal value d28 and analog output 28 display a second-by-second reading of the motor thermal current as a percentage of the rated motor current. When 100% is reached, the motor thermal switch cuts in.

P96 can be set with an alarm threshold which, when breached, commutes logic output **o.L.14** to a high level indicating the approximation to the motor thermal limit.

The maximum motor thermal current depends on the operating frequency, provided that the motor does not have assisted ventilation regardless of its revolutions.

Four permitted thermal current curves are used to reduce the current in accordance with motor operating frequency (see diagram); the required curve is chosen with Connection C33 as per the table.



C33	Characteristics
0	No reduction according to frequency; to be chosen for assisted ventilation motors
1	Choose for self-ventilated high speed motors (2 poles) where ventilation is more efficient. There is no current reduction for frequencies over 70% of the rated frequency
2 default	Typical curve for self-ventilated motors
3	Curve for motors that heat up excessively with curve 2

4.6. Startup with a motor magnetized

C38 provides 3 different ways for starting up the motor:

C38=0	Standard operation	When RUN is enabled, the machine is magnetized with the maximum delivered torque at zero for a time equal to P29 . The flux is then checked to see whether it exceeds the minimum (P52). If it does, the torque is “freed”, if it does not the drive triggers alarm A2 “Machine not magnetized”.
C38=1	Enable independent flux	In this case, logic input (I15) is used to magnetize the machine. After setting I15=H (configuring one of the logic inputs as required) the machine is magnetized with the maximum delivered torque at zero for a time equal to P29. The flux is then checked to see whether it exceeds the minimum (P52). If it does, the torque is “freed”; the display shows that the machine has been magnetized and the next time the RUN command is enabled, the motor will start up straight away. If the flux does not exceed the minimum, the drive triggers alarm A2 “Machine not magnetized”
C38=2	Machine always magnetized	The machine is always magnetized. If the flux drops below the minimum value (P52) the drive triggers alarm A2 . If the drive is ready, the motor will start up as soon as the Run command is enabled.



When the machine is magnetized, it means that the motor is powered and that a current equal to the magnetizing current is being delivered. Thus special care must be taken especially when $C38 \neq 0$ in that a voltage $\neq 0$ may be created on terminals U,V,W without enabling the RUN command.

5. Maintenance and controls

The drive has a range of functions that cut in if there is a fault in order to prevent damage to both the drive and the motor. If a protection switch cuts in, the drive output is blocked and the motor coasts.

If one or more of the protection switches (alarms) cut in, they are signalled on the displays, which start to flash and to show a cycle of all the alarms triggered (the 7-segment display shows the alarms that have been set off in hexadecimal).

Should the drive malfunction or an alarm be triggered, check the possible causes and act accordingly.

If the causes cannot be traced or if parts are found to be faulty, contact TDE MACNO and provide a detailed description of the problem and its circumstances.

5.1. Malfunctions without an alarm: troubleshooting

MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
Motor does not run	RUN command not given	Check operating status of input I00
Motor does not turn	Terminals L1, L21 and L3 are not wired properly or the power voltage is disabled	Ensure wiring is correct and check mains and motor connection Check any contactors upstream and downstream of drive are closed
	Terminals U,V and W are not wired properly	
	An alarm has been triggered	See following paragraph
	Parameters programmed incorrectly	Check parameter values via the programming unit and correct any errors
Motor direction inverted	Wrong Positive direction	Invert positive speed rotation setting C76=1.
	Speed reference value inverted	Invert reference value
Motor revolutions cannot be regulated	No reference signal	Check wiring and apply reference signal if not present
	Excessive load	Reduce motor load
Irregular motor acceleration and braking	Acceleration – deceleration time/times is/are too low	Check parameters and change if necessary
	Load too high	Reduce load
Number of motor revolutions too high or too low	Rated motor speed, minimum or maximum speed, offset, or reference gain value are set incorrectly	Check parameters and compare setting with motor rating plate
Motor does not turn smoothly	Excessive load	Reduce load
	Motor load changes a lot or displays excessive load points	Reduce load points. Increase motor size or use a larger frequency drive

5.2. Malfunctions with an alarm: troubleshooting

ALARM		DESCRIPTION	CORRECTIVE ACTION
A0	FLASH writing	When data is being written in the FLASH the required values are always shown afterwards: an alarm triggers if differences are detected.	Try rewriting the values in the FLASH. The information may have been disturbed in some way. If the problem continues contact TDE as there must be a memory malfunction.
A1	FLASH reading	A Check Sum error occurred while the FLASH was reading the values. Default values loaded automatically.	Try rereading the values with the FLASH. The reading may have been disturbed in some way. If the problem continues contact TDE as there must be a memory malfunction.
A2	Machine not magnetized	Magnetic flux (d27) is below the minimum flux set in P52 .	Check that the motor is properly connected to the drive. Try to increase parameter P29 (machine magnetizing waiting time) and reduce P52 if necessary as this specifies the minimum flux alarm threshold. Check d27 to ensure that the flux increases when RUN is enabled.
A3	Power circuit	The drive output current has reached a level that has set off an alarm; this may be caused by an overcurrent due to leakage in the wires or the motor or to a short circuit in the phases at the drive output. There may also be a regulation fault.	Check the connection wires on the motor side, in particular on the terminals, in order to prevent leakages or short circuits. Check the motor insulation by testing the dielectric strength, and replace if necessary. Check the drive power circuit is intact by opening the connections and enabling RUN; if the safety switch cuts in, replace the power. If the safety switch cuts in only during operation, there may be a regulation problem (replace along with current transducers) or vibrations causing transient D.C.
A4	Radiator thermal switch	d49=0	The radiator temperature (d25) is higher than the maximum (P118). Check the temperature reading on d25 and then check the radiator. If -273.15 is displayed, the electrical connection towards the radiator heat probe has been interrupted. If the reading is correct and the motor is overheating, check that the drive cooling circuit is intact. Check the fan, its power unit, the vents, and the air inlet filters on the cabinet. Replace or clean as necessary. Ensure that the ambient temperature around the drive is within the limits permitted by its technical characteristics. Check parameter P118 is set correctly.
		d49=1	The Adiabatic Energy dissipated on Braking resistance during the time selected in P169 has overcome the threshold set in KJoule in P168 Check the correct setting of parameters P167, P168 and P169 compared to the Resistance plate. Check the correct dimensioning of Braking Resistance Maximum Power related to maximum speed, load inertia and braking time.
		d49=2	The Average Power dissipated on Braking has overcome the threshold set in Watt in P170 Check the correct setting of parameters P167, P170 and P171 compared to the Resistance plate. Check the correct dimensioning of Braking Resistance Average Power related to maximum speed, load inertia and braking time

ALARM		DESCRIPTION		CORRECTIVE ACTION
A5	Motor thermal switch	Connection C46 runs a range of motor heat probes. If C46=1, a PT100 is being used: the temperature reading (d26) must be higher than the maximum temperature (P91). If C46=2 or 3, a PTC/NTC is being used and its Ohm value (d26) has breached the safety threshold (P95).		Check the temperature reading in d26 and then check the motor. With a PT100, if -273.15 appears the electrical connection towards the motor heat probe has been interrupted. If the reading is correct and the motor is overheating, check that the motor cooling circuit is intact. Check the fan, its power unit, the vents, and the air inlet filters on the cabinet. Replace or clean as necessary. Ensure that the ambient temperature around the motor is within the limits permitted by its technical characteristics.
A6	Motor heat overload	The motor electronic overload safety switch has cut in due to excessive current absorption for an extensive period.		Check the motor load. Reducing it may prevent the safety switch cutting in. Check the thermal current setting, and correct if necessary (P70). Check that the heat constant value is long enough (P71). Check that the safety heat curve suits the motor type and change the curve if necessary (C33).
A7	Auto-tuning test unfinished	The RUN command was disabled during a test.		Reset the alarms and repeat the test by re-enabling with C42.
A8	External alarm triggered	The control input can no longer detect the high level of the signal from the field that authorises drive operation.		The external safety switch has cut in disabling drive enable. Restore and reset. The connection has been broken. Check and eliminate the fault. Input function has been assigned, but enable has not been given. Authorise or do not assign the function.
A9	Speed sensor	d49=0	Feedback option card and drive firmware incompatible	Check internal values d62 and d63 for the firmware and option card codes. There must be some irregularity.
		d49=1	Sensor not connected	Check the connection towards the sensor.
		d49=2	Overspeed: speed reading higher than threshold set in P52.	In a transient state, the speed reading has exceeded the permitted limit. Adjust the speed regulator gains or raise the limit in P52.
A10	DC power circuit voltage at minimum	Intermediate drive circuit voltage (DC Bus see d24) has dropped below the minimum value (P106).		Undervoltage may occur when the mains transformer is not powerful enough to sustain the loads or when powerful motors are started up on the same line. Try to stabilise the line by taking appropriate measures. If necessary, enable the BUS support function for mains failure (C34=1). This however can only help motors with light loads.
A11	Overvoltage on DC power circuit	Intermediate drive circuit voltage (DC Bus see d24) has exceeded the maximum value (P107).		The safety switch cuts in mainly due to excessively short braking times. The best solution is to lengthen the braking times. An overvoltage in the mains may also trigger the safety switch. If the drive is fitted with a braking circuit, check that the resistance value is not too high to absorb the peak power. If the resistor is not too hot, check the resistor and connection continuity and ensure that the circuit functions correctly.
A12	Internal alarm	d49=0	Software Enable C29	Check and enable connection C29 "Drive software enable"
		d49=1	RUN without Power Soft start	Check why the Power Soft start isn't enabled
		d49=2	RUN with Trad>P119	Check the radiator temperature (d25)

ALARM		DESCRIPTION		CORRECTIVE ACTION
A13	Power not delivered	The bridge that enables the line by gradually loading the DC bus condensers has not managed to load the intermediate drive circuit sufficiently within the time set (P154).		Check the voltage of the three input phases. Try switching off and then back on, measuring the DC Bus level (with the monitor or tester). If the problem repeats, contact TDE as there must be a soft start circuit malfunction.
A14	U,V,W connection alarm	d49=0	Drive and motor not connected properly	Swap over two phases and repeat the connection tests.
		d49=1	Motor not connected	Check motor phases
A15	Incorrect parameter setting alarm	d49=0	Motor/sensor parameters being written	Number of motor poles (P67) set incorrectly or more sensor poles (P68) than motor poles have been set.
		d49=1	Simulated Encoder pulses	Number of revolutions per pulse selected (C51) is not compatible with the maximum speed (P65). See “Feedback Option” enclosure.
		d49=2	Motor parameters being self-set	During the auto-tuning test, a magnetizing current reading (P73) exceeded 80%: check the motor settings in Parameters P61, P62 and P63.
		d49=3	Motor/sensor parameters being self-set	An error occurred during the “Sensor and motor poles” test. See specific test description in the “Feedback Option” enclosure.



OPEN DRIVE

OPEN DRIVE

Feedback Options

FEEDBACK OPTIONS

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OPEN DRIVE

Feedback options



WARNING: Depending on feedback used, connector J2 changes as written in the following.

1. TTL ENCODER

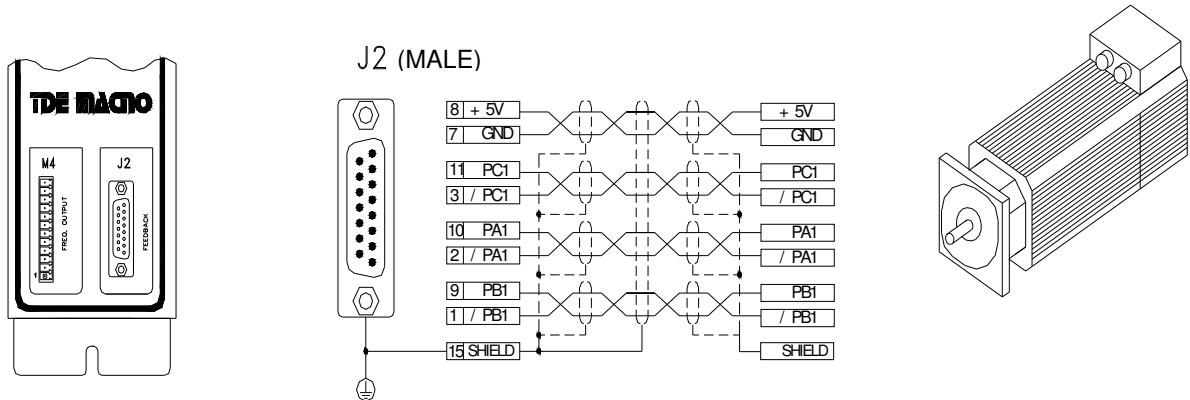


Fig 1

Only use 4-couples twisted and shielded couple cable with external shield.

Encoder feed is 5V and its differential output has to be "Line Driver", with a number of pulses per revolution that do not exceed 300KHz for channel at maximum speed; current absorbed must not be above 100 mA. Encoder feed can be different from 5V, up to 24V, in that case the power supply has to be external. Connect drive pin 7 (GND) with external supply negative pole.

1.1. SENSOR PARAMETERS

It's necessary to set correctly the parameter **P69** in order to define the Encoder used:

P69 = Encoder pulses per revolution with range 0÷60000

1.2. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Encoder correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Encoder used is correctly define as pulses per revolution with parameter **P69**

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input.

Once the test has started the motor will rotate in the positive direction at low speed and all Encoder edges are counted.



During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

OPEN DRIVE

Feedback options

In the first step is checked if the cyclic sense of motor phases and Encoder channels is the same: after 1 second parameter P79 is updated with the test result and the drive consequently goes in alarm A14 or it starts the second test:

- **P79=0** : meaning that is missing at least one Encoder channel, therefore A14 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 is triggered
- **P79>0** : everything is ok

In the second part is checked the Encoder pulses reading, well known from P69 parameter the number of edges in a mechanical turn (P69x4, because are counted both two channels edge). At the end of the test, P79 is updated again with the total edges number:

- **|P79- (P69x4)|(P69x4) < 12,5%** : test is successful
otherwise the alarm A15 code d49=3 is triggered. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles. Then:
- **P79 < (P69x4)**: the real pulses counted are less than expected. Encoder could have some problems or the motor load is too high. Try to increase the test current with parameter P114 that is the percentage of rated drive current applied in the test
- **P79 > (P69x4)** : the real pulses counted are more than expected. Could be some noise in the Encoder signals.

Note: for encoder with more than 8192 ppr the data showed in P79 loses of meaning

The test is successful if the drive switch off and does not trigger an alarm. Now disable RUN command by setting its digital input to 0. The subsequent tests can now be carried out.

1.3. TIME DECODE

By default (C74=0) the speed is measuring counting the number of pulses in the PWM period. This produces a poor resolution especially at low speed and the consequent need of signal filtering (see the related core document, P33 parameter of speed regulator). Setting **C74=1** the speed calculation is done measuring the time between one Encoder pulse to the other. This technique has a maximum resolution of 12.5 ns, so the measure can be very accurate. The Encoder time decode needs Incremental Encoder pulses with duty-cycle of 50%, a correct pulses time distribution and the cables would be shielded very well.

Example: Encoder TTL 40A AC motor OPEN DRIVE

5	O	D	S	0	4	0	X	A	1	A	1	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

OPEN DRIVE

Feedback options

2. RESOLVER

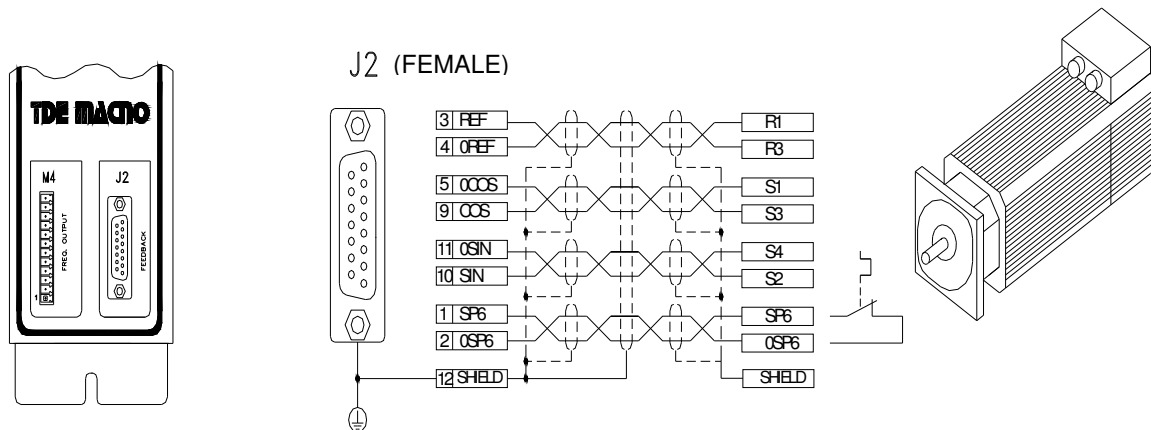


Fig. 2

R1	Red-White
R3	Yellow/White or Black/White
S1	Black
S2	Yellow
S3	Red
S4	Blue

Example of Resolver colors code

Only use 4-couples twisted and shielded couple cable with external shield.

Pin J2-12 and the metallic body of connector J2 are earthed inside the drive

By default the drive can manage a motor thermal switch (pin SP6 and OSP6). Managing NTC or PTC probes is also possible by specifying in the order the technical characteristics.

2.1. SENSOR PARAMETERS

It's necessary to set correctly the parameter **P68** in order to define the Resolver used:

P68 = Resolver poles number with range 0÷36

Note: resolve poles number cannot be grater than motor poles number (**P67**), otherwise it is triggered the alarm A15 with code d49=0.

2.2. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Resolver correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Resolver used is correctly define as poles number with parameter **P68**

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input.

Once the test has started the motor will rotate in the positive direction at low speed and some measure are done on Resolver signals.

OPEN DRIVE



During the test, the motor will make a complete revolution at low speed.
Do not worry if this revolution is a little noisy.

In the first step is checked if the cyclic sense of motor phases and Resolver channels is the same: after 1 second parameter **P79** is updated with the pulses number counted (there are 65536 pulses every turn/Resolver polar couples) and the drive consequently goes in alarm A14 or it starts the second test:

- **P79<0** : meaning that Resolver channels are exchanged, therefore A14 is triggered
- **P79>0** : everything is ok

In the second part is checked the Resolver channels reading, well known that current test frequency is 0,5Hz the time needed for read again the same Resolver position is equal to:

$$\text{time test} = 2 \cdot \frac{\text{Motor polar couple number}}{\text{Resolver polar couple number}} \text{ [seconds]}$$

At the end of the test, P79 is updated again with the time test measured in ms:

- **|P79- time test| < 500ms** : test is successful
otherwise the alarm A15 code d49=3 is triggered. In the first check if it is correct the Resolver poles number and the number of motor poles, with help of **P79**.

The test is successful if the drive switch off and does not trigger an alarm. Now disable RUN command by setting its digital input to 0. The subsequent tests can now be carried out.

Example: Resolver 40A AC motor OPEN DRIVE

5	O	D	S	0	4	0	X	A	1	A	4	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

3. ENCODER AND HALL SENSORS

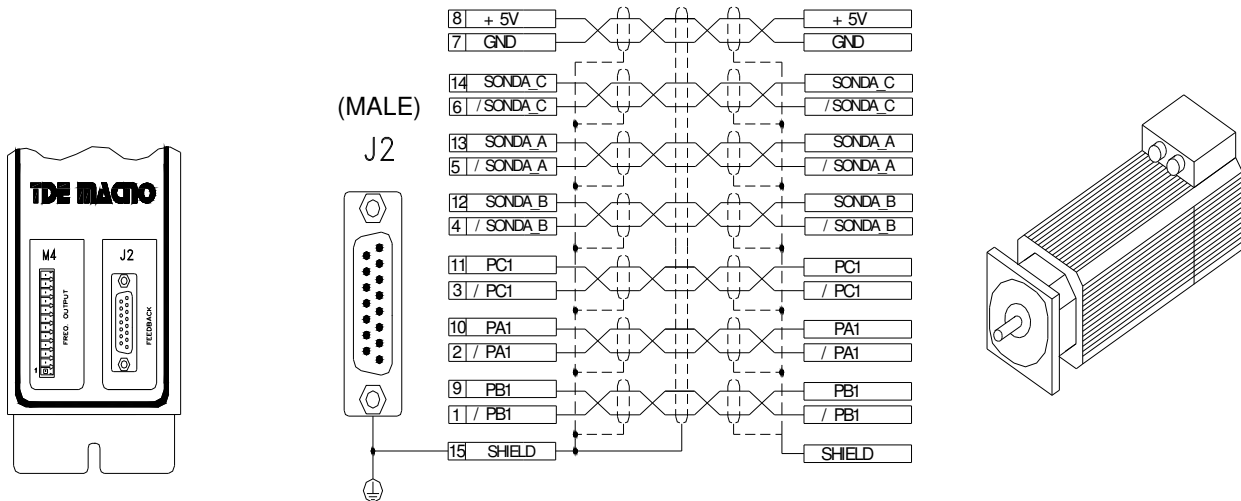


Fig. 3

Only use 4-couples twisted and shielded couple cable with external shield.

Encoder feed is 5V and its differential output has to be “Line Driver”, with a number of pulses per revolution that do not exceed 300KHz for channel at maximum speed; current absorbed must not be above 100 mA. Encoder feed can be different from 5V, up to 24V, in that case the power supply has to be external. Connect drive pin 7 (GND) with external supply negative pole.

3.1. SENSOR PARAMETERS

It's necessary to set correctly the parameter **P69** in order to define the Encoder used:

P69 = Encoder pulses per revolution with range 0÷60000

3.2. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Encoder correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Encoder used is correctly define as pulses per revolution with parameter **P69**

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input. Once the test has started the motor will rotate in the positive direction at low speed and all Encoder edges are counted.



During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

In the first step is checked if the cyclic sense of motor phases and Encoder channels is the same: after 1 second parameter P79 is updated with the test result and the drive consequently goes in alarm A14 or it starts the second test:

- **P79=0** : meaning that is missing at least one Encoder channel, therefore A14 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 is triggered
- **P79>0** : everything is ok

In the second part is checked the Encoder pulses reading, well known from P69 parameter the number of edges in a mechanical turn (P69x4, because are counted both two channels edge). Then it is checked the Hall sensor channels presence and their cyclic sense, that must be the same both motor phases and Encoder channels.

At the end of the test, it's possible to have:

- No alarm triggered: test is successful. It's possible to read in P79 the total Encoder edges number:

$$|P79 - (P69 \times 4)| / (P69 \times 4) < 12,5\% \text{ : test is successful}$$

Now disable RUN command by setting its digital input to 0. The subsequent tests can now be carried out.

- Alarm **A15** code **d49=3** is triggered, there are some Encoder problems. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles. Then:

- ❖ **P79 < (P69x4)**: the real pulses counted are less than expected. Encoder could have some problems or the motor load is too high. Try to increase the test current with parameter **P114** that is the percentage of rated drive current applied in the test
- ❖ **P79 > (P69x4)** : the real pulses counted are more than expected. Could be some noise in the Encoder signals.

Note: for encoder with more than 8192 ppr the data showed in P79 loses of meaning

- Alarm **A2** code **d49=0** is triggered, there are some Hall sensors problems. Parameter P79 is helpful for understand the problems present:
 - ❖ **P79 = 1** : it's wrong the Hall sensor cyclic sense. Exchange A and C channels.
 - ❖ **P79 = 2** : it's missing at least one Hall sensor channel. Check the Hall sensor channels presence.

3.3. TIME DECODE

By default (C74=0) the speed is measuring counting the number of pulses in the PWM period. This produces a poor resolution especially at low speed and the consequent need of signal filtering (see the related core document, P33 parameter of speed regulator).

Setting **C74=1** the speed calculation is done measuring the time between one Encoder pulse to the other. This technique has a maximum resolution of 12.5 ns, so the measure can be very accurate.

The Encoder time decode needs Incremental Encoder pulses with duty-cycle of 50%, a correct pulses time distribution and the cables would be shielded very well.

Example: Encoder and Hall sensors 40A AC motor OPEN DRIVE

5	O	D	S	0	4	0	X	A	1	A	5	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

4. INCREMENTAL SIN COS ENCODER

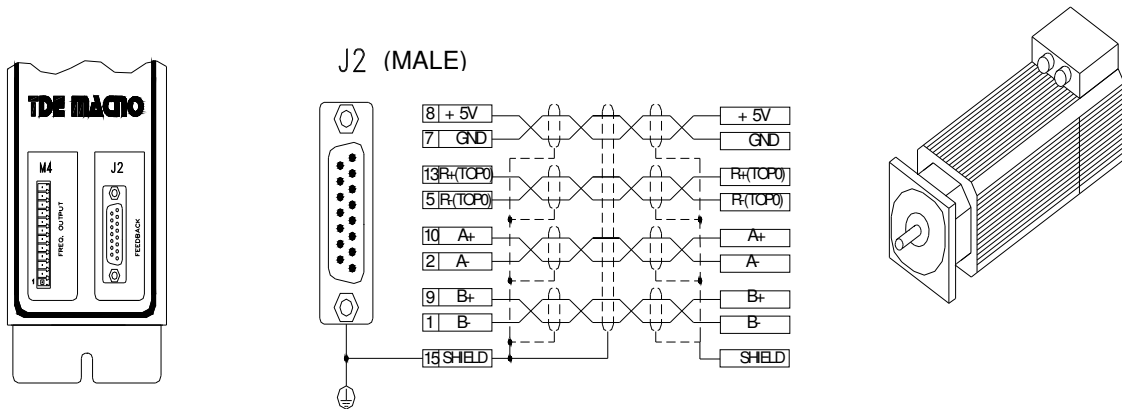


Fig. 4

Only use 4-couples twisted and shielded couple cable with external shield.

Sin Cos Encoder feed is 5V with a number of pulses per revolution that do not exceed 300KHz for channel at maximum speed; current absorbed must not be above 100 mA.

4.1. SENSOR PARAMETERS

It's necessary to set correctly the parameter **P69** in order to define the Encoder used:

P69 = Encoder pulses per revolution with range 0÷4096

4.2. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Encoder correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Encoder used is correctly define as pulses per revolution with parameter **P69**

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input.

Once the test has started the motor will rotate in the positive direction at low speed and all Encoder edges are counted.



During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

OPEN DRIVE

Feedback options

In the first step is checked if the cyclic sense of motor phases and Encoder channels is the same: after 1 second parameter P79 is updated with the test result and the drive consequently goes in alarm A14 or it starts the second test:

- **P79=0** : meaning that is missing at least one Encoder channel, therefore A14 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 is triggered
- **P79>0** : everything is ok

In the second part is checked the Encoder pulses reading, well known from P69 parameter the number of edges in a mechanical turn ($P69 \times 4$, because are counted both two channels edge).

At the end of the test, P79 is updated again with the total edges number:

- **$|P79 - (P69 \times 4)| / (P69 \times 4) < 12,5\%$** : test is successful
otherwise the alarm A15 code d49=3 is triggered. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles. Then:
- **$P79 < (P69 \times 4)$** : the real pulses counted are less than expected. Encoder could have some problems or the motor load is too high. Try to increase the test current with parameter P114 that is the percentage of rated motor current applied in the test (default value 50%).
- **$P79 > (P69 \times 4)$** : the real pulses counted are more than expected. Could be some noise in the Encoder signals.

The test is successful if the drive switch off and does not trigger an alarm. Now disable RUN command by setting its digital input to 0. The subsequent tests can now be carried out

Esempio: Sin/Cos Encoder 40A AC motor OPEN DRIVE

5	O	D	S	0	4	0	X	A	1	A	2	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

5. ABSOLUTE SIN COS ENCODER

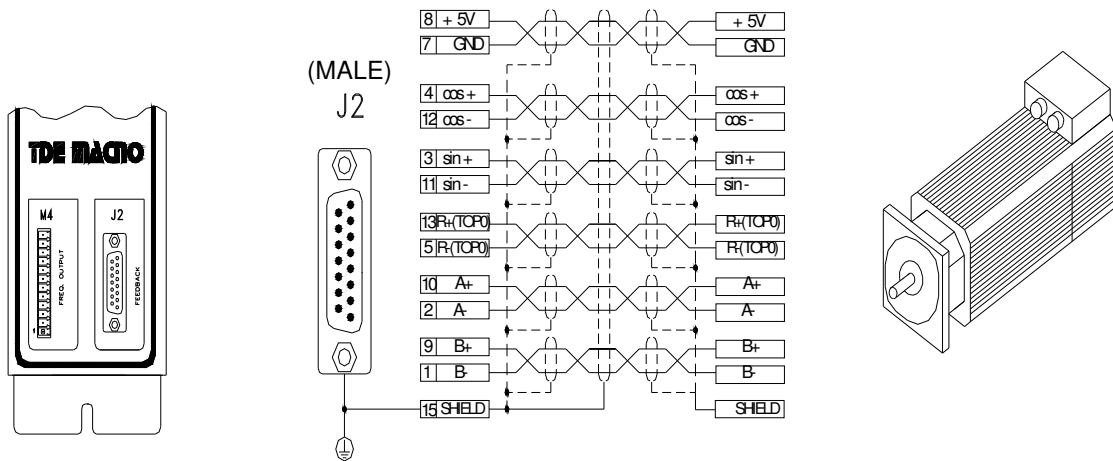


Fig. 5

Only use 4-couples twisted and shielded couple cable with external shield.

Sin Cos Encoder feed is 5V with a number of pulses per revolution that do not exceed 300KHz for channel at maximum speed; current absorbed must not be above 100 mA.

5.1. SENSOR PARAMETERS

It's necessary to set correctly the parameter **P69** in order to define the Encoder used:

P69 = Encoder pulses per revolution with range 0÷4096

5.2. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Encoder correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Encoder used is correctly define as pulses per revolution with parameter **P69**

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input.

Once the test has started the motor will rotate in the positive direction at low speed and all Encoder edges are counted.



During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

OPEN DRIVE

Feedback options

In the first step is checked if the cyclic sense of motor phases, incremental Encoder channels and absolute Encoder channels is the same.

After 1 second parameter P79 is updated with the test result and the drive consequently goes in alarm or it starts the second test. The alarm **A14** is triggered if the incremental channels have an opposite cyclic sense of motor phases, and it is displayed:

- **P79=0** : meaning that is missing at least one Encoder channel, therefore A14 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 is triggered

If the incremental channels have the same cyclic sense of motor phases it is checked if the same is true also for absolute Encoder channels: in this case the test continues without any alarm, otherwise the alarm **A2** is triggered con code **d49=0** and it is displayed:

- **P79<0** : difference in pulses between absolute initial and ending position

In the second part are checked the incremental Encoder channels, well known from **P69** parameter the number of edges in a mechanical turn ($P69 \times 4$, because are counted both two channels edge) and the correctness of absolute channels related to motor poles number (**P67**).

The test is successful if the drive switch off and does not trigger an alarm. Now disable RUN command by setting its digital input to 0.

In this case, at the end of the test, P79 is updated again with the total edges number

- $|P79 - (P69 \times 4)| / (P69 \times 4) < 12,5\%$: test is successful

In the event that the alarm **A15** code **d49=3** is triggered, **P79** is updated again with the total edges number. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles. Then:

- **P79 < (P69x4)**: the real pulses counted are less than expected. Encoder could have some problems or the motor load is too high. Try to increase the test current with parameter P114 that is the percentage of rated drive current applied in the test
- **P79 > (P69x4)** : the real pulses counted are more than expected. Could be some noise in the Encoder signals.

In the event that the alarm **A2** is triggered with **d49≠0** it's meaning that there are some problems into Encoder absolute channels. The internal value **d49** is updated with the time (in milliseconds) between two identical absolute positions, the correct value is :

$$\text{time test} = 2000 \cdot \text{Motor polar couple number} \text{ [ms]}$$

Check if the parameter **P67** is correctly set, than analyze the absolute channels (internal monitor value 47 and 48).

Example: Sin/Cos Encoder 40A AC motor OPEN DRIVE

5	O	D	S	0	4	0	X	A	1	A	2	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

6. ENDAT 2.2

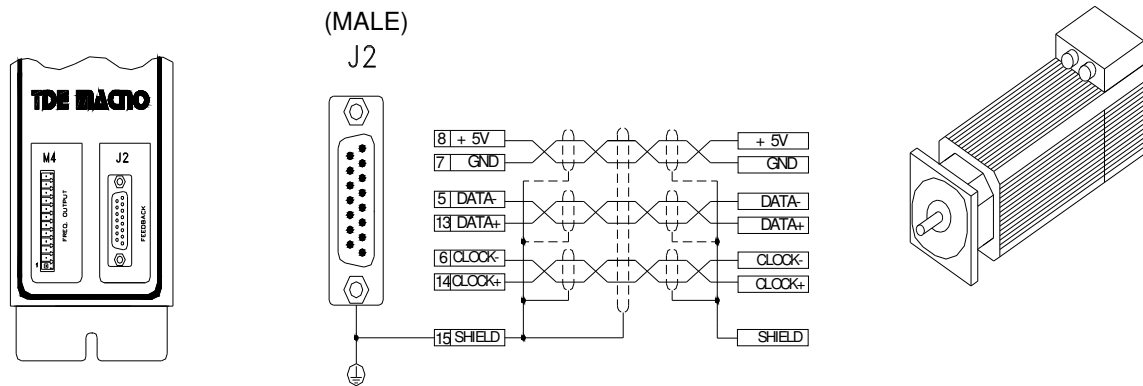


Fig. 6

Only use 4-couples twisted and shielded couple cable with external shield.

Endat feed is 5V with; current absorbed must not be above 100 mA.

Up today the ENDAT 2.2 sensors managed are:

- **ECl 1317** with 17 bit on turn.
- **EQI 1329** with 17 bit on turn and 12 bit multi-turn.

6.1. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Endat correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Endat used works correctly.

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input.

Once the test has started the motor will rotate in the positive direction at low speed and all Encoder edges are counted.



During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

OPEN DRIVE

Feedback options

In the first step is checked if the cyclic sense of motor phases and Endat sensor is the same: after 1 second parameter P79 is updated with the test result and the drive consequently goes in alarm A14 or it starts the second test:

- **P79<0** : meaning that motor phases have opposite cyclic sense of Endat sensor.
- **P79>0** : everything is ok

In the second part is checked the sensor reading, well known that current test frequency is 0,5Hz the time needed for read again the same position is equal to:

$$\text{time test} = 2 \cdot \text{Motor polar couple number} \quad [\text{seconds}]$$

At the end of the test, P79 is updated again with the time test measured in ms:

- **|P79- time test| < 500ms** : test is successful
otherwise the alarm **A15** code **d49=3** is triggered. In the first check if it is correct the number of motor poles, with help of **P79**.

The test is successful if the drive switch off and does not trigger an alarm. Now disable RUN command by setting its digital input to 0. The subsequent tests can now be carried out.

Example: Endat 40A AC motor OPEN DRIVE

5	O	D	S	0	4	0	X	A	1	A	6	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	----------	----------	---	---	---	---	---	---	---	---	---

7. ENDAT 2.1

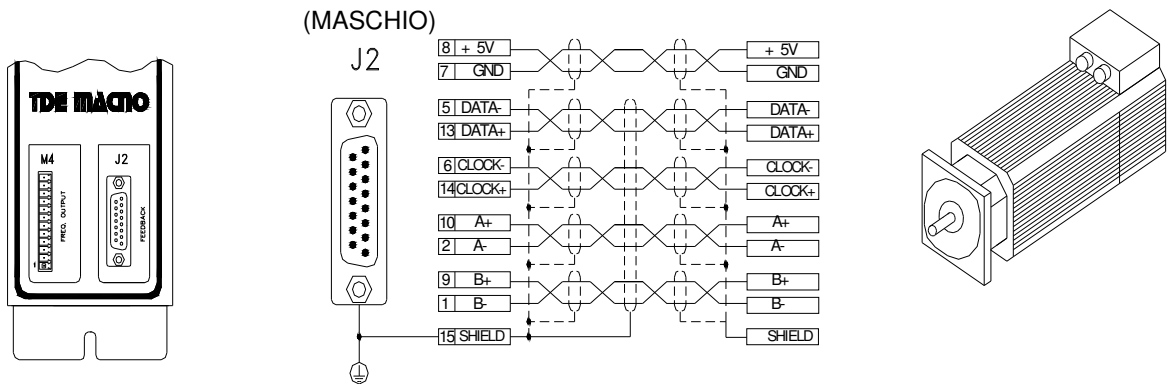


Fig. 7

Only use 4-couples twisted and shielded couple cable with external shield.

Endat feed is 5V with; current absorbed must not be above 100 mA.

Up today the Endat 2.1 sensors managed are:

- **ECN 1113** with 13 bit on turn + 512 pulses sin/cos
- **EQN 1125** with 13 bit on turn, 12 bit multi-turn + 512 pulses sin/cos
- **ECN 1313** with 13 bit on turn + 512/2048 pulses sin/cos
- **EQN 1325** with 13 bit on turn, 12 bit multi-turn + 512/2048 pulses sin/cos

In this case it's necessary to set **P69** = Encoder sin/cos pulses per revolution

7.1. SPEED SENSOR TEST

This is the first test to be carried out. It is in two parts:

- Check that the direction of rotation of the motor phases and the Encoder correspond;
- Check that the number of motor poles is written correctly in parameter **P67** and the Encoder used is correctly define as pulses per revolution with parameter **P69**

Correct operation requires a no-load motor so decouple it from the load.

After setting the drive to STOP and opening the reserved parameter key (P60=95), set **C41=1** to enable the test. To start the test enable RUN command with its digital input.

Once the test has started the motor will rotate in the positive direction at low speed and all Encoder edges are counted.



During the test, the motor will make a complete revolution at low speed. Do not worry if this revolution is a little noisy.

OPEN DRIVE

Feedback options

In the first step is checked if the cyclic sense of motor phases, incremental Encoder channels and absolute digital Encoder channel is the same.

After 1 second parameter **P79** is updated with the test result and the drive consequently goes in alarm or it starts the second test. The alarm **A14** is triggered if the incremental channels have an opposite cyclic sense of motor phases, and it is displayed:

- **P79=0** : meaning that is missing at least one Encoder channel, therefore A14 is triggered
- **P79<0** : meaning that Encoder channels are exchanged, therefore A14 is triggered

If the incremental channels have the same cyclic sense of motor phases it is checked if the same is true also for absolute digital channel: in this case the test continues without any alarm, otherwise the alarm **A2** is triggered con code **d49=0** and it is displayed:

- **P79<0** : difference in pulses ($65536=360^\circ$) between absolute initial and ending position

In the second part are checked the incremental Encoder channels, well known from P69 parameter the number of edges in a mechanical turn ($P69 \times 4$, because are counted both two channels edge).

At the end of the test, P79 is updated again with the total edges number:

- $|P79 - (P69 \times 4)| / (P69 \times 4) < 12,5\%$: test is successful

otherwise the alarm A15 code d49=3 is triggered. In the first check if it is correct the Encoder number of pulses per revolution and the number of motor poles. Then:

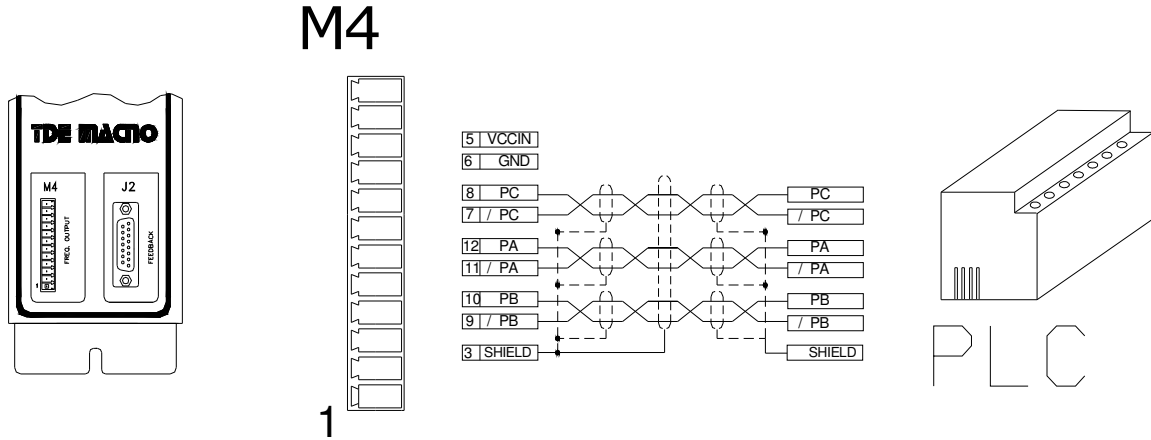
- **P79 < (P69x4)**: the real pulses counted are less than expected. Encoder could have some problems or the motor load is too high. Try to increase the test current with parameter **P114** that is the percentage of rated motor current applied in the test (default value 50%).
- **P79 > (P69x4)** : the real pulses counted are more than expected. Could be some noise in the Encoder signals

The test is successful if the drive switch off and does not trigger an alarm. Now disable RUN command by setting its digital input to 0. The subsequent tests can now be carried out

Esempio: OPEN DRIVE nella versione per AC motor a 40A con Endat

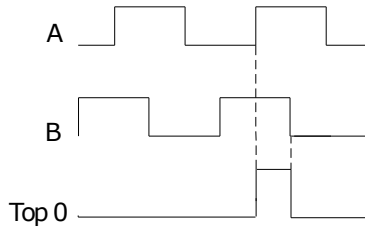
5	O	D	S	0	4	0	X	A	1	A	6	3	G	T	V	A	1	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

8. SIMULATED ENCODER SIGNALS

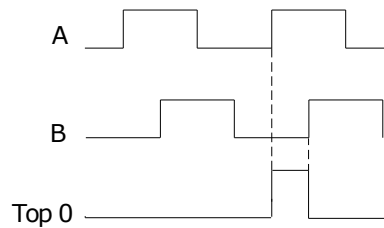


The frequency of the output signals depends on the motor revolutions, the number of sensor poles and the selection made (see connection **C51** in the core file) and their behaviour in time depends on rotation sense (CW or CCW) and on **C50** as shown in the figures below:

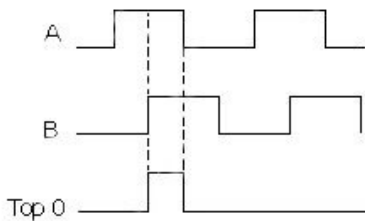
d21>0 C50=0



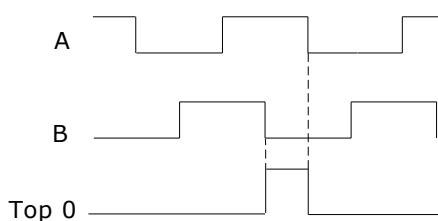
d21>0 C50=1



d21<0 C50=0



d21<0 C50=1



OPEN DRIVE

Feedback options

The simulated encoder outputs are all driven by a "LINE DRIVER". Their level in the standard drive version is referred to +5V and then it is connected to the internal supply (TTL +5V).

In option (to be requested in the ordering) there is the possibility to refer the signal level to an external supply whose value must be between +5V and +24V, connection on terminal 5 and 6.

In the connected device it is better to use a differential input to avoid loops with the 0V wire, to limit noise effects it is better to load this input (10mA max).

It is necessary to use a twisted shielded cable to make a proper connection.



WARNING: the external power supply GND is connected with the 0V of the drive (it is not optoisolated).



WARNING: for the encoder simulation with internal supply (standard drive version) you must not connect the terminal 5 (Vccin), because it could seriously damage the drive.

9. CONFIGURATION OF THE ENCODER SIMULATION OUTPUT

The two bidirectional simulation encoder channels could have a number of pulses per motor revolution selectable with **C51** according to the following table, that also depends on the number of sensor polar couples:

C51	Pul/rev motor/(P68/2)
0	0
1	64
2	128
3	256
4	512
5	1024
6	2048
7	4096
8	8192
9	16384
10	32768
11	65536



WARNING: The choice of the number of pulses for revolution depends on the maximum speed and the number of sensor polar couples (P68/2). In the following table are reported this limitation. If it is selected a number of pulses too high compared with the maximum speed it is triggered the alarm A15 code d49=1.

Maximum speed (rpm) x P68/2	Pul/rev motor/(P68/2)
250	65536
500	32768
1000	16384
2000	8192
4000	4096
8000	2048
16000	1024
32000	512

NB: In the particular case of **Resolver decoded with RDC19224**, the choice of the number of pulses for revolution depends on the maximum speed and the number of sensor polar couples (P68/2) in this way:

Maximum speed (rpm) x P68/2	Pul/rev motor/(P68/2)
1500	16384
6000	4096
24000	1024

The default value is **C51=5** correspond to 1024 pul/rev.

As can be seen, the number of pulses also depends on the number of sensor poles which are set in parameter **P68**, and, in particular, the above-mentioned values are valid if the sensor is two-pole.

The pulse output is controlled by a line driver (ET 7272); the limitation of the number of pulses regards the maximum speed is done for limit the maximum frequency for channel to 270KHz.

9.1. INCREMENTAL OR ABSOLUTE SIMULATED ENCODER

The **C54** connection allows to select two different modes of working for simulated encoder:

- **Incremental Simulated Encoder C54=0** (default): in this mode the simulated encoder channels follow the motor rotation in incremental way and the third channel (zero pulse) loses of meaning
- **Absolute Simulated Encoder C54=1**: in this mode also the third channel (zero pulse) is managed but in the first edge of sensor zero pulse there will be a correction into simulated encoder channels.

This choice is significant only for sensors with a zero pulse (Encoder, Encoder and Hall sensors, Sin/Cos Encoder), in the other case (Resolver, Endat) the Simulated Encoder is always absolute, without any correction into simulated encoder channels.

The third channel generates a number of zero pulses in phase with channel A, equal to the number of sensor poles divided by two (**P68/2**); in particular there is one single zero pulse per motor revolution with a two-pole sensor.

The position of the zero pulse depends on the fit of the sensor on the drive shaft; with reference to the original position, decoding the zero of the sensor position, this position may be changed with jumps of 90° electrical (with reference to the sensor) by means of connection **C49** according to the following table:

C49	displacement
0	+0°
1	+90°
2	+180°
3	+270°

The default value is 0.

These electrical degrees correspond to the mechanical degrees if the resolver has two poles .

Connection **C50** inverts the encoder B channel, thus inverting its phase with respect to channel A, with the same motor rotation direction.

By default **C50=0**.

10. SENSOR TYPE ALARM

Drive tests in real time the compatibility between sensor managed by firmware and optional feedback electronic card present, if there is an incompatibility it is triggered the alarm **A9** code **d49=0**.

In the internal values d62 and d63 it is possible to see the code of sensor managed by firmware and hardware:

D	62	Sensor code managed by firmware
D	63	Sensor code managed by hardware

In the following table are reported the sensor code:

Value	Corresponding Sensor
0	--No one--
1	Incremental Encoder
2	Incremental Encoder + Hall sensors
4	Resolver directly decoded
5	Resolver decoded with RDC19224
8	Analog Sin/Cos sinusoidal Encoder
9	Absolute Analog Sin/Cos sinusoidal Encoder
10	Endat

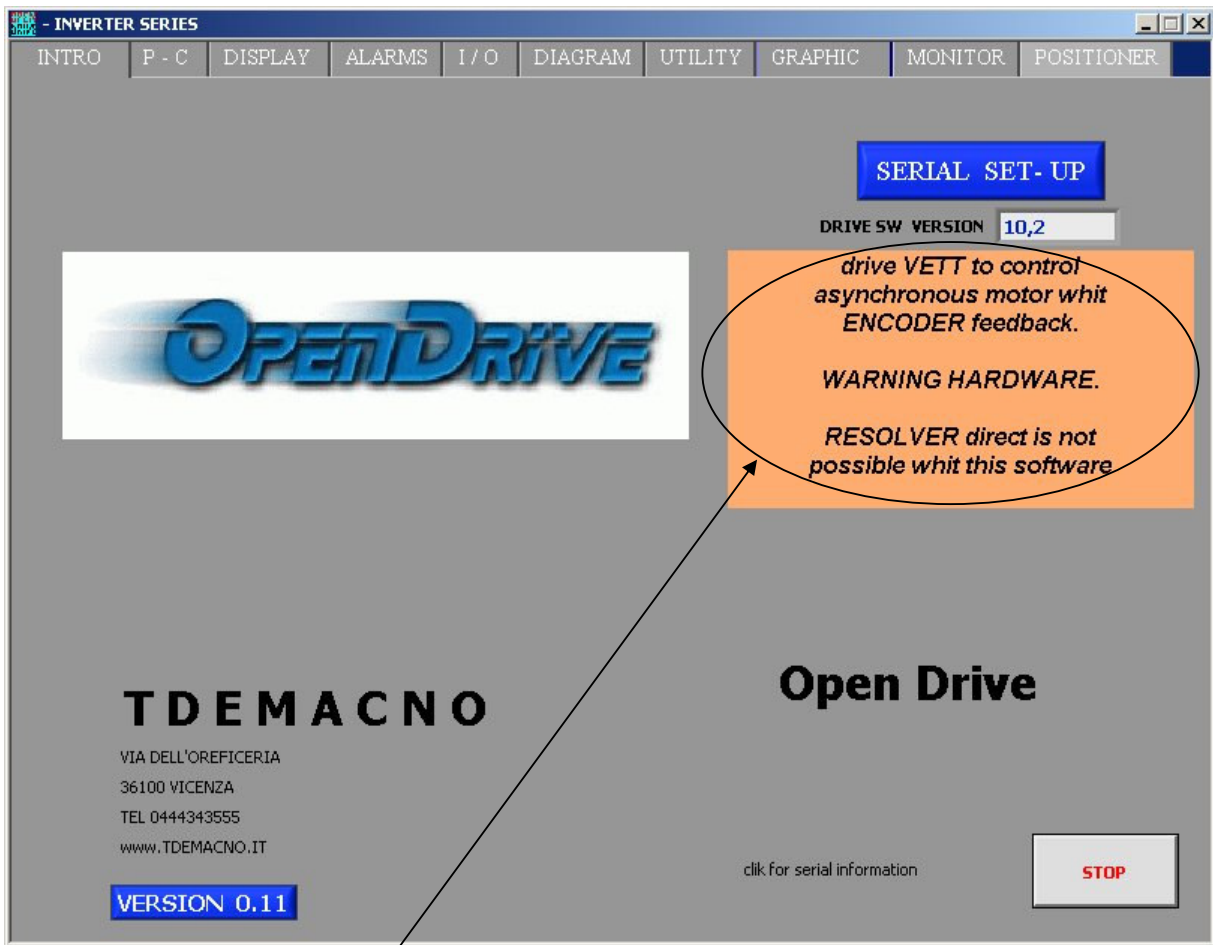


Fig. 4

Incompatibility example between firmware and hardware detected by supervisor.

OPEN DRIVE

OPEN DRIVE

Remote Keypad

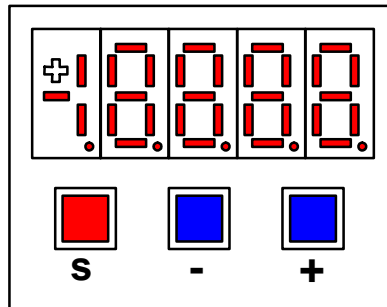
OPERATIONS OF THE REMOTE KEYPAD

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2.2.	Connections (CON)	3
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1. Physical disposition

The keypad has three buttons, ' S ' (selection), ' - ' (reduce), ' + ' (increase) and a four numbers and half display, with the decimal points and the sign ' - '.



2. Layout of the internal dimensions

The converter is a full digital, then other hardware settings are not necessary, if not made in factory, and the setups, settings and visualizations, all digital, they go effect through the keypad and the display, or by serial line or by fieldbus.

For easy access of formulations and mnemonics all the accessible greatnesses have been grouped in the following menu:

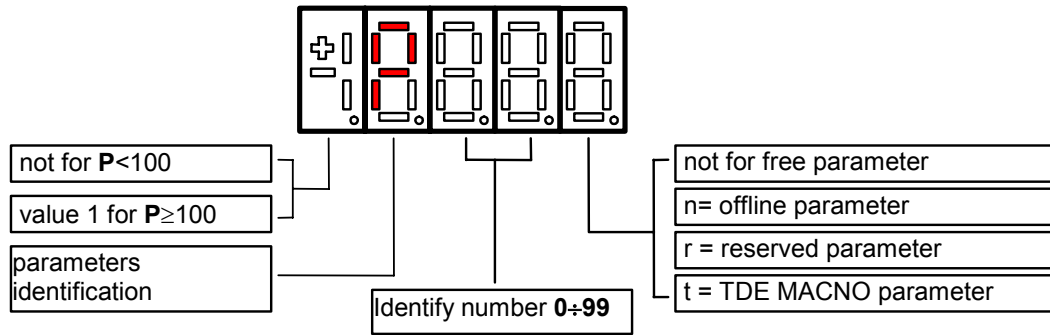
- Parameters (PAR),
- Connections (CON),
- Internal dimensions (INT),
- Alarms (ALL),
- Digital input (INP),
- Digital output (OUT).

in each group the dimensions are orderly in progressive order and they are visualized only that indeed use.

2.1. Parameters (PAR)

They are definite parameters of dimension of setting whose numerical value has an absolute meaning (for example: P63 = nominal frequency motor = 50 Hz) or they are of proportional value to the limit range (for example: P61 = motor nominal current = 100 % of the drive nominal current). They are distinguished in **free** parameters, some modifiable always (On-line), other only to converter not in run (off-line), **reserved**, modifiable only off-line and after access code to the reserved parameters (P60), or reserved for the TDE MACNO, visible after having written the access code TDE MACNO parameters (P99) and modifiable only off-line.

The characteristics of each parameter are recognizable from the code of identification as under:

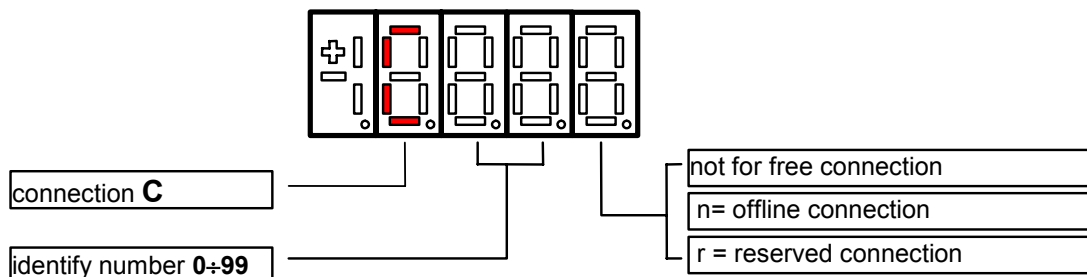


For example: P60 r = parameter 60: reserved
 1P00 t = parameter 100: TDE MACNO reserved

2.2. Connections (CON)

They are certain connections that dimensions approach that are of numerical value comes connected to a function or a clear command { for example: ramp insertion, C26 = 1; or no ramp, C26 = 0; or save parameters on EEPROM memory, C63 = 1 }. They are in free connections, some of the like modifiable always (On-line), other with converter in stop (off-line) and **reserved**, modifiable only off-line and after access code to the reserved parameters (P60)

The characteristics of each connection are individually recognizable of identification code as under report.



2.3. Alarms (ALL)

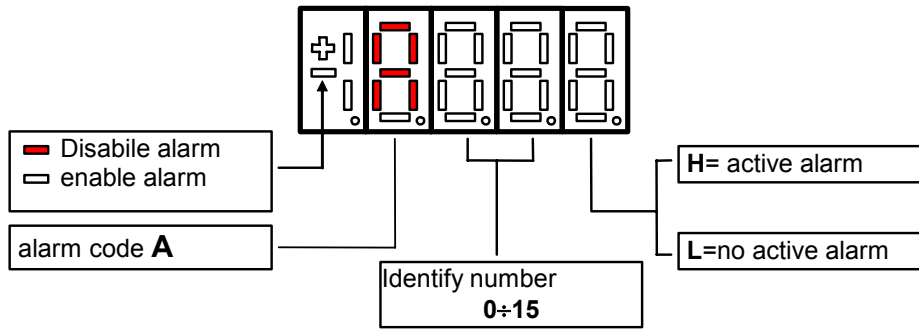
Overall functions of protection of the converter, of the motor or in the application whose status to active alarm or non active alarm it may be visualized in the display.

The activated protection, stops the converter and does flash the display, excepted if it is disabled.

With a single visualization is possible have all the indications with the following:

For example A03.1 = power fault doesn't activate

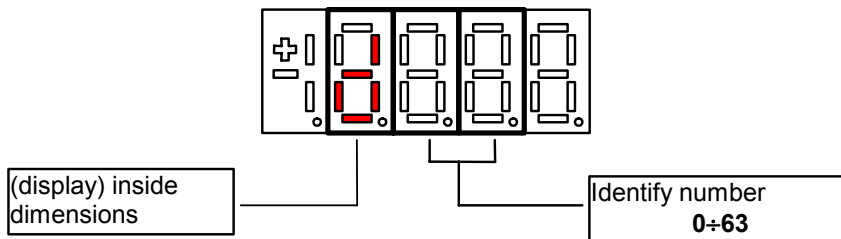
The alarms are all memorized and so they remain till that is not missing the cause of the alarm and have been resetted (input of resetting alarms activate) or (C30 = 1).



2.4. Internal values (INT)

Overall of working values of regulation (for example: voltage, speed, torque, ect...) showed in absolute unit or percent (for example: motor tension in volt or current in percent of the maximum value).

Code of identification:

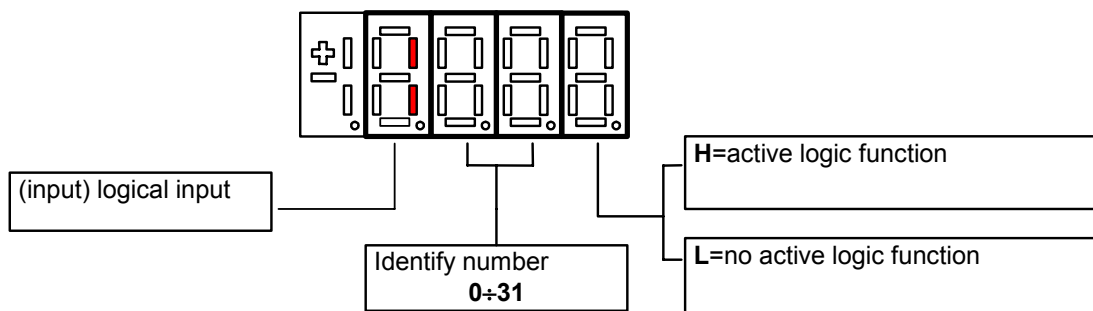


2.5. Logics functions of input (INP)

The visualization between I00 and I28 is the status of the logical functions of sequence or protection that is assigned in the all digital input of the regulation.

From I29 to I31 is the visualization of the status of the input from the power.

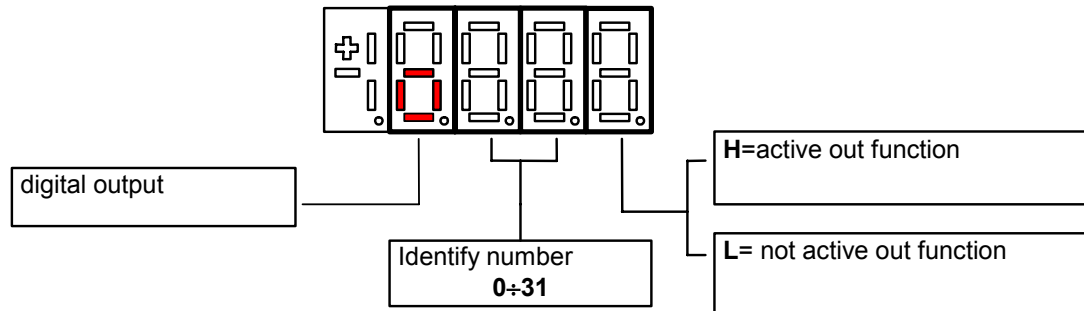
Code of identification (input) logical input.



2.6. Logics functions of output (OUT)

Visualization of the status, of the logical functions, of protection or sequence (for example: drive ready, converter in run) scheduled in the control, that may or may not be assigned of predicted digital output.

Code of identification:



3. Status of rest

It is the status that the display assumes right after the lighting or when none is programming (P112 seconds, 10 of default, after the last movement, except that is not is visualizing an internal dimensions, or an input, or a digital output).

When the keypad is on tat the status rest, if the converter is not in run comes visualized “STOP”; if the converter is in run comes visualized the internal dimension selected with C00 connection or the status run.

If the converter finds the status alarm, for intervention of an or more protections, the written on the keypad start to flash and they come visualized all the active alarms (one by one).

4. Main menu

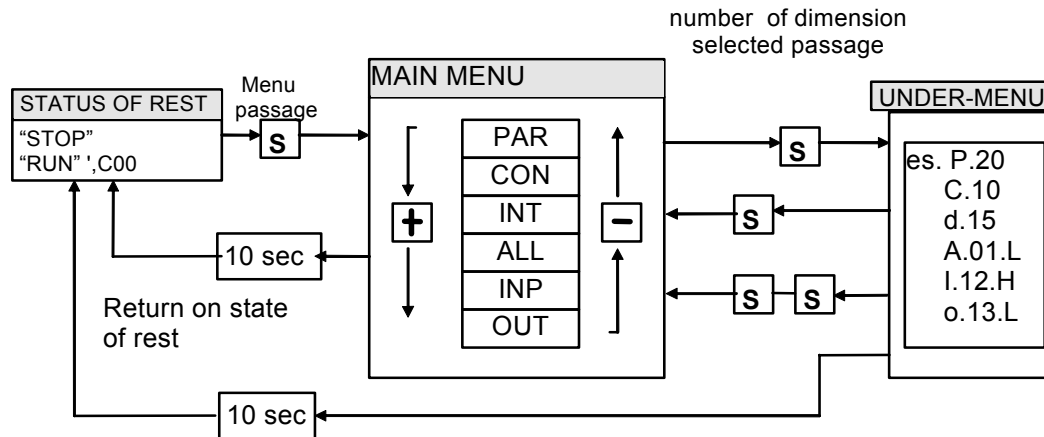
Leaving from the status of rest pressing the s key the principal menu is gone into of circular type that contains the indication of the type of visualizable dimensions:

PAR = parameters	CON = internal connections	INT = internal dimensions
ALL = alarm	INP = digital input	OUT= digital output

To change from a list to another enough is necessary to use the ' + ' or ' - ' keys and the passage will happen in the order of figure.

Once select the list you pass on the relative under-menu pressing ' s ' ; the re-entry to the main menu from the following visualizations will be able future through the pressure of the key ' s ' simple or double in brief succession (less in a second), like showed after.

The return to the status of rest comes instead automatically after 10 (P112) seconds of inactivity is from some under-menu that goes by the main menu.



4.1. Under-menu of parameters and connections management (PAR and CON)

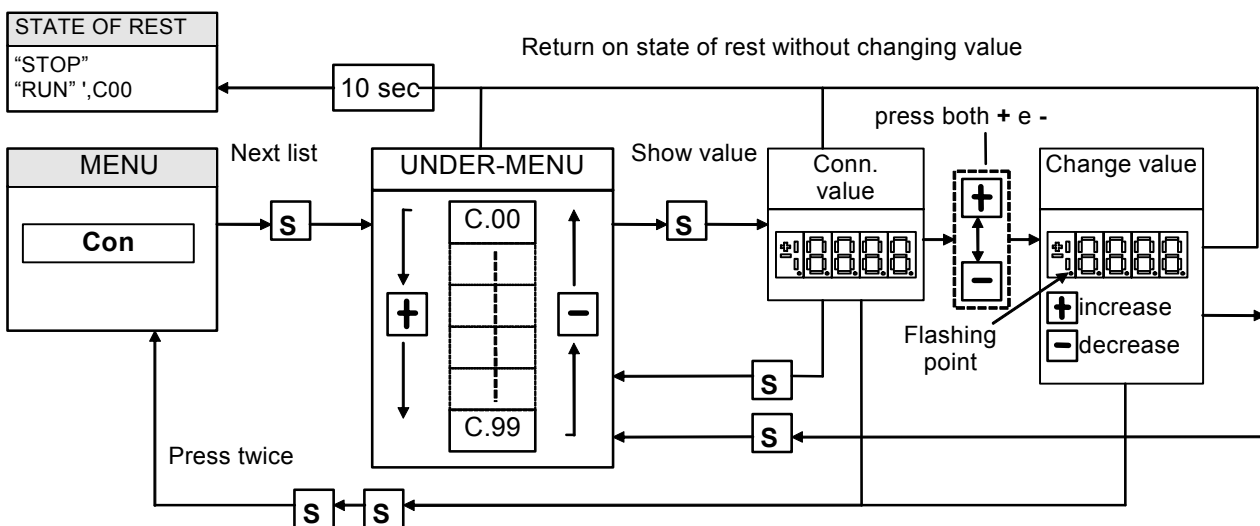
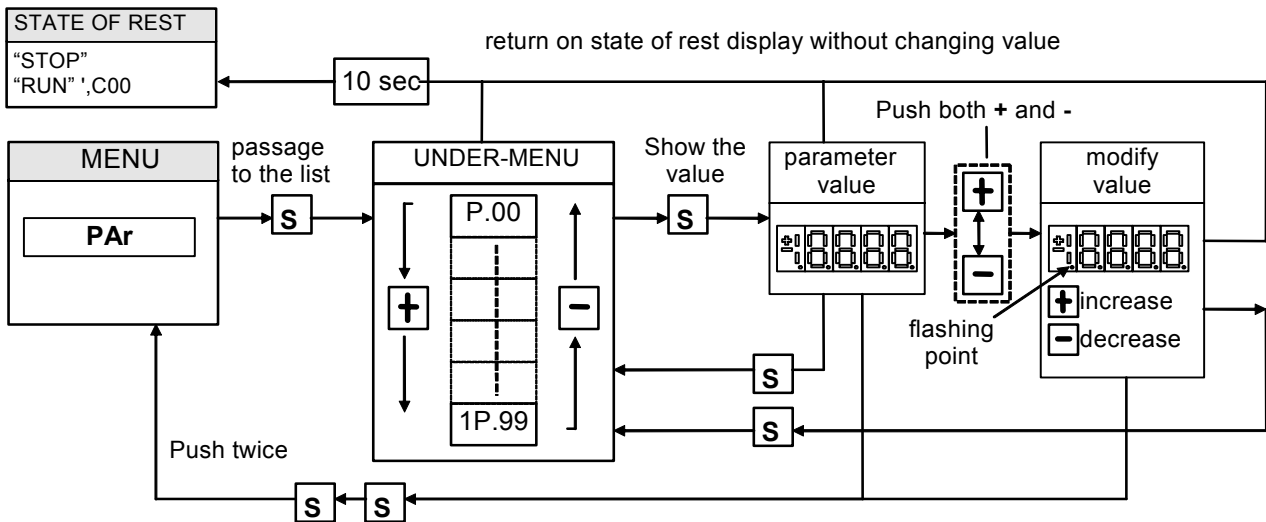
From ' PAR ' or ' CON ' You enter into the under-menu list pressing ' S ' ; once entered into the list is able look through the parameters or the existing connections by pressing the keys ' + ' or ' - ' to move in increase or in decrement; even in this case the list is circular.

At the number corresponding to the various parameters or connections appear the letter ' r ' if they are reserved, ' t ' if reserved in the TDE MACNO and the letter ' n ' if it modification requires that the converter in not in run (off-line); all the reserved parameters are of type ' n ' modifiable only by stop (off-line).

If You pressed the key ' S ' comes visualized the value of the parameter or of the connection that may be read; at this point re- press ' S ' once You return to the under-menu list, press twice ' S ' in fast succession (less 1 seconds), return to the main menu.

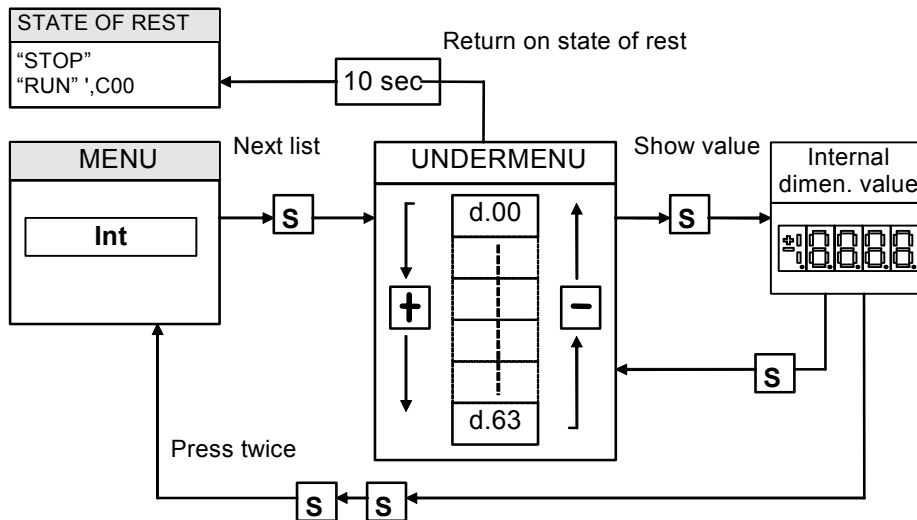
The system returns automatically to the status of rest and after 10 seconds of have past inactivity. To modify the value of the parameter or of connection once entered into visualization it necessary press both keys ' + ' and ' - ' ; in that moment it starts to flash the decimal point of the first figure to the left warning that from that moment the movement of the keys and '+' modifies the value; the change of value may only by stop if the parameter is of kind ' n ' and only after having set up the code of access P60, if the parameter is of the kind ' r ', only after having set up the code of P99 (access for the reserved parameters TDE MACNO), kind ' t '.

The parameters and the reserved connections TDE MACNO doesn't appear in the list if doesn't call the code of P99. Once the value is corrected You press the key ' S ' return to the under menu list making operational the parameter or the corrected connection ; if after correct the value want go out without change the values wait 10 seconds; if the value is no touched for the exit press again the "S" key (it is operative the same original value). About parameters and connections, the return to the status of rest display is in automatically way after 10 seconds from any kind of visualization.



4.2. Visualization of the internal dimensions (INT)

From INT You enter into the list of under-menu of the internal dimensions pressing ' S '. In the list you are moving with the keys ' + ' or ' - ' till that appearing address of dimensions wanted visualize “dxx” ; pressing ' S ' disappears the address and appear the value of the dimension. From this status You go back to under-menu list, repressing ' S ', and go again to the main menu repressing “S” twice in fast succession; from the menu and from the under-menu. You return automatically to the status of rest after a time of 10 seconds.



4.3. Alarms (ALL)

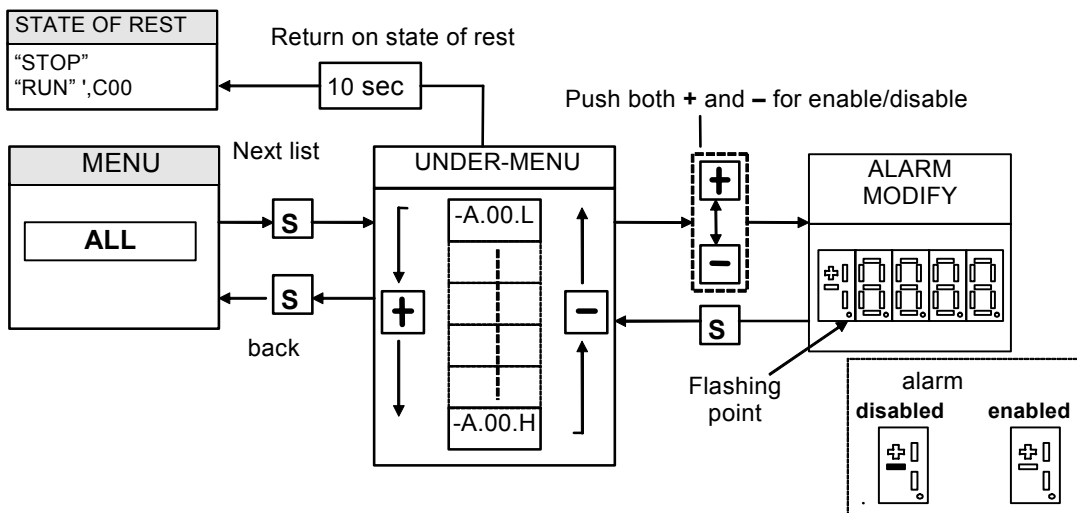
From ALL You enter into of under-menu list of the alarms pressing ' S '.

From the corresponding under-menu with the keys ' + ' and ' - ' move all addresses desired for the alarms; with this, in the box to the right, appears the status of the alarm ' H ' if active, ' L ' if don't.

If the alarm has been disabled ; in this case too with the active status doesn't appear any stop of the regulation, the address of the alarm is preceded by the sign ' - '.

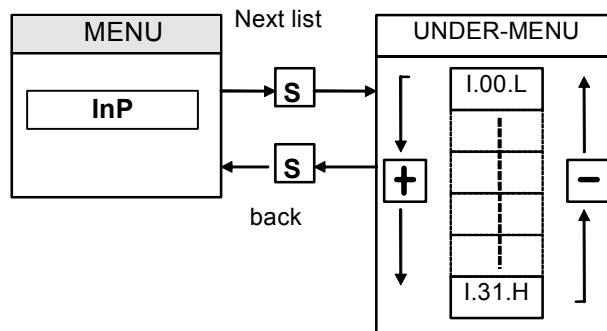
To exclude the event of an alarm You must enter into the menu to modify both the keys ' + ' and ' - ' and when the flashing point appears of the first number You can enable or disable the alarm with the keys ' + ' or ' - ' ; if the alarm is disabled appears the sign the ' - ' to the left of the writing "A.XX.Y".

From the status of modification returns to the list of under-menu and You return operative the select made pressing ' S ', from the menu and from the under-menu You turn automatically to the status of rest after a time closed to 10 seconds.



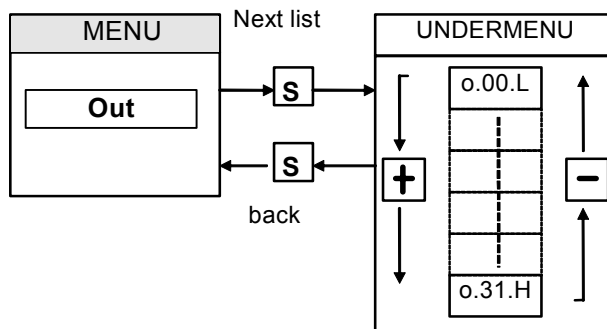
4.4. Visualization of the input and output (INP and OUT)

From the INP or from the OUT You enter into corresponding list of under-menu pressing ' S '.
 From the corresponding list of under-menu with the keys ' + ' and ' - ' move to the address desired for the digital input (I) and the output (O); together to this, in the box, appear the status: “H” if activate, L if not active.
 From this status You returns to the main menu pressing ' S '.



To note the last three digital input are about the power logical input:

POWER LOGICAL INPUT		STATUS(H=ON L=OFF)
I	29 / PTM	H = OK; I = active alarm
I	30 / MAXV	H = OK; I = active alarm
I	31 / MAINS SUPPLY OFF	H = OK; I = active alarm



OPEN DRIVE

OPEN DRIVE

Modbus protocol

Modbus Protocol

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The OPEN drive products line is compatible with the protocol of the serial communication Modbus rtu. At a physical level , the supported standard is the RS485, see the drive installation manual for information about it. Specifications about the Modbus Protocol are available at the Internet address :

www.modicon.com/TECHPUBS/intr7.html

1. Application Configuration

1.1. *Node Configuration*

The drive configuration as Modbus node requires the correct configuration of the following parameters:

Name	Description	Range	Default
P92	Serial identification number	0÷255	1
P93	Serial baud rate	19,2 ; 38,4 ; 57,6	19,2 Kbit/s

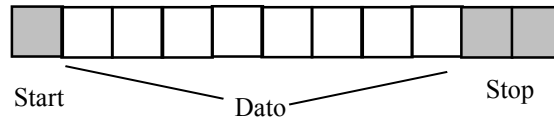
By setting these parameters in real time, they will become instantly active :

Note: the communication mode in broadcast with address = 0 is not managed

2. Managed services

The drive represents the slave in the communication : this means that it is only able to answer to messages received if its address (settable in P92) corresponds with the one indicated in the message itself. If the address is wrong or there is an error of communication in CRC, the drive will not send any answer, as the protocol requires.

Every word transmitted is composed by 11 bit : 1 bit for start, 8 bit for the data and 2 bit for stop. The parity check is not supported.



The Modbus protocol requires a long functions series; our application requires less than these : in the following table you can find the implemented functions and their codification :

Code	Function	Description
01	Read Coil Status	Reading of digital input/output
03	Read Holding Registers	Reading of memorised data
15	Force Multiple Coils	Writing of digital inputs
16	Preset Multiple Registers	Writing of memorised data

Hereinafter you can find the description of the action and of the related address of each function.

2.1. 01 Read Coil Status

This function allows the user to read the status of the digital inputs and outputs.

It is important to underline that the standard management of the digital inputs requires that the RUN enable must be given both via terminal board and via serial line; all the other inputs instead can be commanded by one of the two ways just listed. The default RUN input from the serial line is high while all the others are low: in this way the user who is not using it, can have the total control of digital inputs from the terminal board.

Thanks to Read Coil Status function it is possible to read the status of the digital inputs and related outputs you are interested in, just specifying the correct address written in the following table :

starting address(hex)	Max number of data	Description
0300	32	Digital inputs
0320	32	Digital outputs

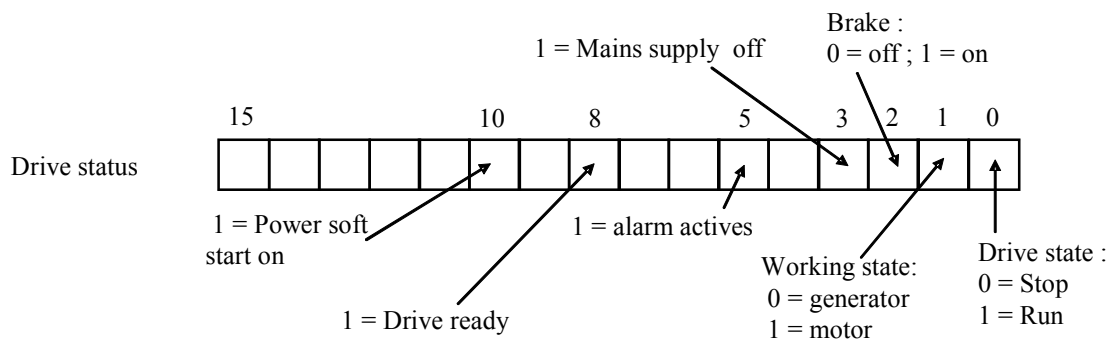
The order number of the inputs and the outputs is the one specified in the related tables (see specific description of the control's core)

2.2. 03 Read Holding Register

This function allows the user to read the values of all the Parameters, Connections, Internal Sizes and some status variables. Writing the correct address you can access these data (see the table under for the address); considering the internal representation you can rightly interpret the read data : as usual it is necessary to see the related tables in the specific description of the core :

starting address (hex)	Max number of data	Description
0000	200	Parameters table
00C8	100	Connections table
012C	100	Application Data table
0380	64	Internal sizes
0200	1	Drive status
0202	1	Drive alarms
0203	1	Alarm enabling

It is not possible to read more than 127 registers at a time due to the memory limits of the buffer. The order number of the parameters, of the connections and of the internal sizes is the one related to the lists contained in the description of the control's core. See the specific documentation for data area application. The status variable is the same for all the implementations; hereinafter you can find the meaning of the most important bit :



referring to alarms and their enabling, the order number for the bit of the word corresponds to the number of the alarm itself. (e.g. A2= external enable corresponding to the bit 2 of drive alarms)

2.3. 15 (OF hex) Force Multiple Coils

This function enables to set the value of digital inputs via serial line. As previously said, the digital inputs via serial line are all parallel to the related digital inputs via terminal board except the RUN enable (where the two inputs are in series)

Starting address	Max data number	Digital inputs
Starting address(hex)	Max data number	Description
0340	32	Digital inputs

2.4. 16 (10 hex) Preset Multiple Registers

This function allows to set the value of the parameters, connections and to enable the alarms even if the corresponding keys are opened.

To correctly set these data it is required the right address (that you can find in the following table) and it is necessary to consider the internal data representation, referring to the specific descriptions of the core. The application area's meaning depends on the present application (see specific documentation):

starting address	Max data number	Description
0000	200	Parameters table
00C8	100	Connections table
012C	100	Applications data table
0203	1	Alarms enabling

If it is written a value not included in the range, the value will be ignored and the previous one will remain valid.

2.5. Exception Responses

The following exception codes in the answer are managed:

Code	Name	Description
01	Not managed function	The drive doesn't manage this Modbus function
02	Wrong data address	The address is not valid
03	Wrong data value	The data number required is too big



OPEN DRIVE

OPEN DRIVE

Canbus

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OPEN DRIVE line products are compatible with CAN open Communication Profile DS301 of CiA rev 4.02. This document describes the mandatory and the optional functions that complete the implementation.

1 Configuration of the application

1.1 Configuration of the node

The drive configuration as CAN node includes the use of the following customer parameters (of conventional use):

Name	Description	Range	Default
P162	ID CAN BUS node	1 ÷ 127	1
C48	Configuration CAN BUS baud rate	0 ÷ 7 0 = 1 Mbit/s 1 = 800 Kbit/s 2 = 500 Kbit/s 3 = 250 Kbit/s 4 = 125 Kbit/s 5 = 50 Kbit/s 6 = 20 Kbit/s 7 = 10 Kbit/s	0 = 1 Mbit/s

These parameters must be rightly configured and saved in the permanent memory of the drive (C63=1). At start up these data are considered and become operating.

1.2 Configuration of the communication objects

The configuration of the communication objects CAN OPEN DS301 can uniquely be done via CAN.

At first switch on, the drive is a non-configured node which satisfies the “pre defined connection set” for the identifiers allocation; for this, the following objects are available:

- rx SDO with COB-ID = 600h + ID CAN node (parameter P162)
- tx SDO with COB-ID = 580h + ID CAN node
- an emergency object with COB-ID = 80h + ID CAN node
- NMT objects (Network Management) : in broadcast (COB-ID=0) for Module Control services and COB-ID = 700h + ID CAN node for Error Control.
- The SYNC object in broadcast with COB-ID = 80h

With the SDO available, the drive can be totally configured as CAN node and only after the communication objects can be saved in the permanent memory using the proper command “store parameters” (1010h)” on the Sub-Index 2.

Also the object “restore default parameters (1011h)” Sub-Index 2 is managed to load all the default communication objects and to save them automatically in the permanent memory (switch off and then on the drive to make objects operating).

2 Managed services

2.1 Service data object (SDO)

SDO are used to access the objects dictionary. In our implementation a maximum of 4 server SDO can be available which can be configured with the following objects:

- 1200h 1st server SDO parameter
- 1201h 2nd server SDO parameter
- 1202h 3rd server SDO parameter
- 1203h 4th server SDO parameter

The transfer mode depends on the length of the data to be transferred : up to 4byte data length, the modality *expedited* is used as it is simple and immediate; for bigger size objects the modality *segmented* and *block* are both supported. See the specific Communication Profile DS301 for having details on the different transmission modes; hereinafter are written only some peculiarities of our implementation:

- a writing access to SDO must indicate the number of significant byte (data set size)
- the writing data by SDO is liable to the same rules (drive state, keys, tolerated range...) seen for the other modalities of parameters modify (serial and keyboard).
- If SDO are structured in more segments, the drive will start writing the data at the indicated address with the first segment, without using a temporary buffer
- A controller is intended to avoid that two SDOs access the same object at the same time.
- With the transmission in block modality, the computation of CRC and the “Protocol Switch Threshold” are not supported.

- It is possible to set the block size of the SDO Block Download service at the address 2000h of the objects dictionary, in the manufacturer specific section.

2.2 Process Data Object (PDO)

PDO are used for the data exchange in real-time in the objects dictionary that supports this function.

2.2.1 Transmit PDO

In our implementation up to a maximum of **4 TPDO** can be configured with the following objects :

- 1800h 1st Transmit PDO Communication parameter
- 1801h 2nd Transmit PDO Communication parameter
- 1802h 3rd Transmit PDO Communication parameter
- 1803h 4th Transmit PDO Communication parameter

the 5 Sub-Index related to every type of TPDO are all managed : it is possible to set the transmission type (see the following table), the inhibit time with 100µs resolution and the period of the event timer with 1ms resolution.

transmission type	PDO transmission
0	Synchronous: data are refreshed and transmitted with every SYNC received.
1-240	Synchronous and cyclical: the number indicates how many SYNC are in between two following transmissions
241-251	----- reserved -----
252	Data are refreshed and sent at the following RTR when the SYNC is received
253	Data are refreshed and sent when the RTR is received (remote transmission request)
254	Event timer : cyclical transmission with a period time settable in ms in the Sub-Index 5
255	Manufacturer specific : it is settable time by time

Note: in the transmission type 255, it is possible to choose on which event the TPDO transmission works. The event choice can be effectuated only during the compiling the software code.

The TPDO mapping can be dynamically effectuated by rightly configuring the following communication objects:

- 1A00h 1st Transmit PDO Mapping parameter
- 1A01h 2nd Transmit PDO Mapping parameter
- 1A02h 3rd Transmit PDO Mapping parameter
- 1A03h 4th Transmit PDO Mapping parameter

the PDO mapping must be done by following these instructions:

1. the number of the mapped objects in Sub-Index 0 must be equal to zero
2. the addresses of all mapped objects must be configured
3. the correct number of mapped objects in the Sub-Index 0 must be indicated

2.2.2 Received PDO

In our implementation a maximum of 4 RPDO can be configured with the following objects:

- 1400h 1st Receive PDO Communication parameter
- 1401h 2nd Receive PDO Communication parameter
- 1402h 3rd Receive PDO Communication parameter
- 1403h 4th Receive PDO Communication parameter

The first 2 Sub-Index related to each RPDO are managed: in this way it is possible to set the transmission type:

transmission type	PDO receiving
0-240	synchronous : when the following SYNC is received, the values received on the RPDO will be activated.
241-253	----- reserved -----
254	Asynchronous : the values received in the RPDO are immediately activated.

The RPDO mapping can be dynamically effectuated by rightly configuring the following communication objects:

- 1600h 1st Receive PDO Mapping parameter
- 1601h 2nd Receive PDO Mapping parameter
- 1602h 3rd Receive PDO Mapping parameter
- 1603h 4th Receive PDO Mapping parameter

RPDO mapping must be executed by following the next directives as well:

3. Set the number of mapped objects in Sub-Index 0 to be equal to zero
4. Configure the addresses of all mapped objects
5. Indicate the correct number of mapped objects in Sub-Index 0

2.3 Emergency Object (EMCY)

The emergency object is transmitted by the drive when a new enabled alarm comes trough or when one or more alarms are reset. The Emergency telegram is made by 8byte as shown in the following table:

Byte	0	1	2	3	4	5	6	7
meaning	Emergency Error Code		Error register	Manufacturer specific alarms LSB –MSB				

In our implementation only two codes of the error code are implemented :

- 00xx = Error Reset or No Error
- 10xx = Generic Error

Speaking of the **Error register** (object 1001h), the following bits are managed corresponding to the following alarms:

Bit	Meaning	Corresponding alarms
0	General error	all
1	Current	A3
2	Voltage	A10 - A11 -A13
3	temperature	A4 - A5 - A6

In Manufacturer specific only the bytes 3 and 4 are assigned which contain the state of the various alarms of the drive. Further 3 bytes for the transmission of possible other user's data are available.

The management of 1003h "pre-defined error field " object memorises the chronology of the alarm events (from start up of the drive) up to a maximum of 32 elements.

At every new alarm event 4 bytes are memorised, 2 are mandatory and correspond to the Error Code; the other 2 are Manufacturer specific and in our specific case correspond to the state of all the drive alarms.

MSB		LSB	
Additional information		Error code	
alarms MSB	alarms LSB	Error code MSB	Error code LSB

2.4 Network Management Objects (NMT)

This function allows the NMT master to check and set the state to every NMT slave.

All the services of Module Control and also the Node Guarding Protocol which uses the COB-ID = 700h + ID CAN node are implemented: this allows the slave to communicate that the bootup ended and the pre-operational modality is active, thus the master can interrogate the different slaves with an RTR.

The Life guarding function is implemented as well: the drive (NMT slave) can be set up by the objects:

100Ch Guard time in ms	} their product yields the Node life time
100Dh Life time factor (multiplier factor)	
note: node life time is internally saturated in the period time of 32767/fpwm sec.	

Life guarding is enabled only if life time Node is different to zero; in this case the check-up starts after having received the first RTR from the NMT master.

The Communication profile DS301 doesn't decide which action it has to start if the time constrain of life guarding hasn't been respected. It's possible to decide how to act, during the firmware compilation step. By default, no action is done.

2.5 Objects dictionary : communication profile area

The following objects of the communication profile are supported:

Index (hex)	Object	Name	Type	Access	Par.
1000	VAR	Device type	UNSIGNED32	Reading	
1001	VAR	Error register	UNSIGNED8	Reading	2.3
1002	VAR	Manufacturer status register	UNSIGNED32	Reading	
1003	ARRAY	Pre-defined error field	UNSIGNED32	Reading	2.3
1005	VAR	COB-ID SYNC	UNSIGNED32	Reading/writing	2.2
1006	VAR	Communication cycle period	UNSIGNED32	Reading/writing	2.2
1008	VAR	Manufacturer device name	Vis-String	constant	
1009	VAR	Manufacturer hardware version	Vis-String	constant	
100A	VAR	Manufacturer software version	Vis-String	constant	
100C	VAR	Guard time	UNSIGNED16	Reading/writing	2.4
100D	VAR	Life time factor	UNSIGNED8	Reading/writing	2.4
1010	ARRAY	Store parameters	UNSIGNED32	Reading/writing	1.2
1011	ARRAY	Restore default parameters	UNSIGNED32	Reading/writing	1.2
1014	VAR	COB-ID EMCY	UNSIGNED32	Reading/writing	2.3
1015	VAR	Inhibit Time EMCY	UNSIGNED16	Reading/writing	2.3
1018	RECORD	Identity Object	Identity (23h)	Reading	
Server SDO Parameter					
1200	RECORD	1 st Server SDO parameter	SDO parameter	Reading/writing	2.1
1201	RECORD	2 nd Server SDO parameter	SDO parameter	Reading/writing	2.1
1202	RECORD	3 rd Server SDO parameter	SDO parameter	Reading/writing	2.1
1203	RECORD	4 th Server SDO parameter	SDO parameter	Reading/writing	2.1
Receive PDO Communication Parameter					
1400	RECORD	1 st receive PDO parameter	PDO CommPar	Reading/writing	2.2.2
1401	RECORD	2 nd receive PDO parameter	PDO CommPar	Reading/writing	2.2.2
1402	RECORD	3 rd receive PDO parameter	PDO CommPar	Reading/writing	2.2.2
1403	RECORD	4 th receive PDO parameter	PDO CommPar	Reading/writing	2.2.2
Receive PDO Mapping Parameter					
1600	RECORD	1 st receive PDO mapping	PDO Mapping	Reading/writing	2.2.2
1601	RECORD	2 nd receive PDO mapping	PDO Mapping	Reading/writing	2.2.2
1602	RECORD	3 rd receive PDO mapping	PDO Mapping	Reading/writing	2.2.2
1603	RECORD	4 th receive PDO mapping	PDO Mapping	Reading/writing	2.2.2
Transmit PDO Mapping Parameter					
1800	RECORD	1 st transmit PDO parameter	PDO CommPar	Reading/writing	2.2.1
1801	RECORD	2 nd receive PDO parameter	PDO CommPar	Reading/writing	2.2.1
1802	RECORD	3 rd receive PDO parameter	PDO CommPar	Reading/writing	2.2.1
1803	RECORD	4 th receive PDO parameter	PDO CommPar	Reading/writing	2.2.1
Transmit PDO Mapping Parameter					
1A00	RECORD	1 st transmit PDO mapping	PDO Mapping	Reading/writing	2.2.1
1A01	RECORD	2 nd transmit PDO mapping	PDO Mapping	Reading/writing	2.2.1
1A02	RECORD	3 rd transmit PDO mapping	PDO Mapping	Reading/writing	2.2.1
1A03	RECORD	4 th transmit PDO mapping	PDO Mapping	Reading/writing	2.2.1

2.6 Objects' dictionary : manufacturer specific profile area

The words reported in bold type can be mapped in PDO.

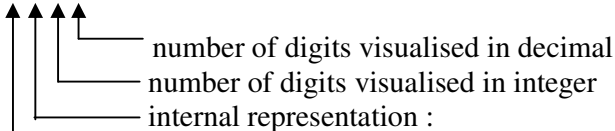
Index (hex)	Object	Type	Name	Description	Access
2000	VAR	INTEGER16	Block size	SDO Block size Block Download	Reading/writing
2001	VAR	DOMAIN	Tab_formati	Formats of the 200 parameters	reading
2002	VAR	DOMAIN	Tab_con_formati	Formats of the 100 connections	Reading
2003	VAR	DOMAIN	Tab_exp_int	Formats of the 64 internal values	reading
2004	VAR	DOMAIN	Tab_exp_osc	Formats of the 64 monitor's sizes	Reading
2005	VAR	DOMAIN	Tab_par_def	Values of the default parameters	Reading
2006	VAR	DOMAIN	Tab_con_def	Values of the default connections	Reading
2007	VAR	INTEGER16	hw_software	Sensor managed by the firmware	Reading
2008	VAR	INTEGER16	hw_sensore	Sensor managed by electronic card	Reading
2009	VAR	INTEGER16	K_zz	Monitor counter	Reading
200A	VAR	INTEGER16	Via_alla_conta	Monitor trigger	Reading
200B	VAR	DOMAIN	Tab_monitor_A	Data saved in the channel A of the monitor	Reading
200C	VAR	DOMAIN	Tab_monitor_B	Data saved in the channel B of the monitor	Reading
200D	ARRAY	INTEGER16	Tab_par [200]	Actual values of the parameters	Reading/writing
200E	ARRAY	INTEGER16	Tab_con [100]	Actual values of the connection	Reading/writing
200F	ARRAY	INTEGER16	Tab_int [64]	Actual values of the internal words	Reading
2010	ARRAY	INTEGER16	Tab_inp_dig [32]	Actual values of the logical input's functions	Reading
2011	ARRAY	INTEGER16	Tab_out_dig [32]	Actual values of the logical output's functions	Reading
2012	ARRAY	INTEGER16	Tab_osc [64]	Actual values of the checked words	Reading
2013	VAR	UNSIGNED16	ingressi	Logical status of the 8 inputs of the terminal board	Reading
2014	VAR	UNSIGNED16	ingressi_hw	Logical status of the 3 inputs from the power	Reading
2015	VAR	UNSIGNED16	uscite_hw	Logical status of the 4 digit outputs	Reading
2016	ARRAY	INTEGER16	Tab_inp_dig_field [32]	Values set by CAN of the output logical function	Reading/writing
2017	VAR	UNSIGNED16	stato	Variable of the drive's status	Reading
2018	VAR	UNSIGNED16	allarmi	Drive alarms' status	Reading
2019	VAR	UNSIGNED16	abilitazione_allarmi	Word for enabling drive's alarms	Reading
201A	VAR	INTEGER16	f_fieldbus	Speed reference in % of n _{MAX} in 16384	Reading/writing
201B	VAR	INTEGER16	limit_fieldbus	torque limit in % di Tnom in 4095	Reading/writing
201C	VAR	INTEGER16	trif_fieldbus	torque reference in % di Tnom in 4095	Reading/writing
201D	VAR	INTEGER16	theta_fieldbus	Speed reference in electr. pulses x T _{pwm}	Reading/writing
201E	ARRAY	INTEGER16	Tab_dati_applicazione [100]	Data Area available for the application	Reading/writing
201F	VAR	UNSIGNED32	Ingressi_standard_wr	Writing standard logical inputs	Reading/writing
2020	VAR	UNSIGNED32	Ingressi_appl_wr	Writing application logical inputs	Reading/writing
2021	VAR	UNSIGNED32	Ingressi_standard_rd	Reading standard inputs	Reading
2022	VAR	UNSIGNED32	Ingressi_appl_rd	Reading application inputs	Reading
2023	VAR	UNSIGNED32	Uscite_logiche_rd	Reading logical outputs	Reading
2024	VAR	UNSIGNED16	word_vuota	Unused Word	Reading/writing
2025	VAR	UNSIGNED32	double_vuota	Unused Double word	Reading/writing
2026	VAR	DOMAIN	Tab_formati_extra	Formats of extra parameters	Reading

2.6.1 Format parameters table (Tab_format 2001h)

This table is made by 800word (200*4) 4 words for each parameter :

1st word : it defines the parameter typology, its internal representation and the number of decimal and integer digits which are shown up on the display. Each nibble has the following meaning:

0x 0 0 0 0 (in hexadecimal)



0	Direct value
1	Percent of the base (100/base)
2	Proportional to the base (1/base)
3	Direct value unsigned

Type of parameter:

0	Not managed
1	free (changeable on-line)
2	Reserved (changeable off-line + key P60)
4	TDE (changeable off-line + key P99)

For example:

0x1231 → free parameter proportional to the base: the real value is = internal representation/base (4th word).

2nd word : it defines the min. value admitted in the internal representation of the parameter

3rd word : it defines the max value admitted in the internal representation of the parameter

4th word : it defines the representation base of the parameter

example 1: (hexadecimal if leaded by '0x...'):

1st word = 0x1131

2nd word = 0000

3rd word = 8190

4th word = 4095

free parameter in percent of the base: the real value is = (internal representation divided by the base)*100

if the current value is 1000 → $(1000/4095)*100 = 24,4\%$
the variation range is included between 0 and 200%

example 2 : (hexadecimal if leaded by '0x...'):

1st word = 0x2231

2nd word = 5

3rd word = 1000

4th word = 10

reserved parameter proportional to the base : the real value is internal representation divided by the base

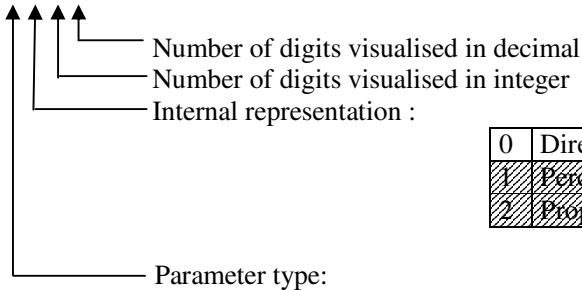
if the current value is 400 → $(400/10) = 40,0\%$
the variation range is included between 0,5 and 100%

2.6.2 Format connections table (tab_with_formats 2002h)

This table is composed by 400 words (100x4), 4words for each connection:

1st word : it defines the type of connection ,its internal representation and the number of integer and decimal digits that will show up on the display. Each nibble has the following meaning:

0x 0 0 0 0 (hexadecimal)



0	Direct value
1	Percent of the base (100/base)
2	Proportional to the base (1/base)

0	Not managed
1	free (changeable on-line)
2	Reserved (change off-line + key P60)
4	TDE (change off-line + key P99)

2nd word : it defines the min admitted value in the internal representation of the connection

3rd word : it defines the max admitted value in the internal representation of the connection

4th word : it defines the base of the representation of the connection (always 1)

the internal representation is always the direct value.

Example (hexadecimal if leaded by '0x...') :

1st word = 0x2020

2nd word = 0 reserved connection : its value is included between 0 and 18

3rd word = 18

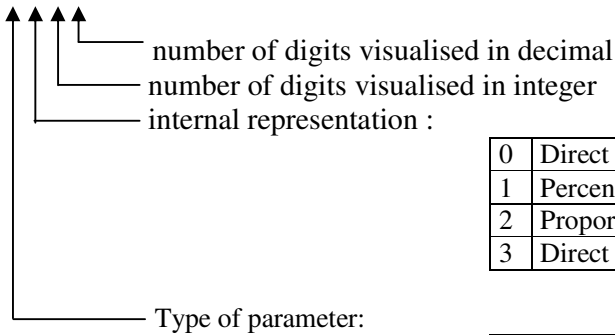
4th word = 1

2.6.3 Format Extra parameters table (Tab_format 2026h)

This table is made by 1000word (200*5) 5 words for each parameter :

1st word : it defines the parameter typology, its internal representation and the number of decimal and integer digits which are shown up on the display. Each nibble has the following meaning:

0x 0 0 0 0 (in hexadecimal)



0	Direct value
1	Percent of the base (100/base)
2	Proportional to the base (1/base)
3	Direct value unsigned

0	Not managed
1	free (changeable on-line)
2	Reserved (changeable off-line + key P60)
4	TDE (changeable off-line + key P99)

For example:

0x1231 → free parameter proportional to the base: the real value is = internal representation/base (4th word).

2nd word : it defines the min. value admitted in the internal representation of the parameter

3rd word : it defines the max value admitted in the internal representation of the parameter

4th word : it defines the representation base of the parameter

5th word : it defines the default value of the parameter

example: (hexadecimal if leaded by '0x...'):

1st word = 0x1131

2nd word = 0000

3rd word = 8190

4th word = 4095

5th word = 4095

free parameter in percent of the base: the real value is = (internal representation divided by the base)*100

if the current value is 1000 → $(1000/4095)*100 = 24,4\%$

the variation range is included between 0 and 200%

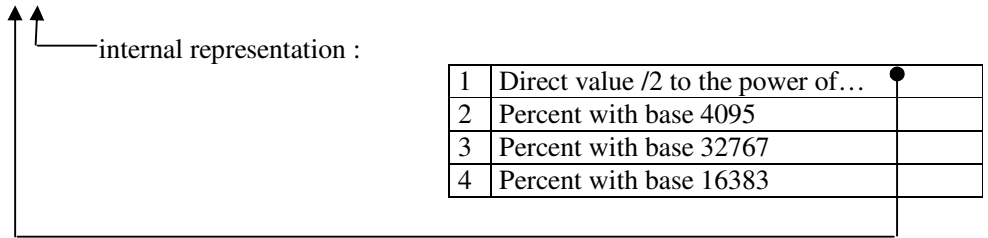
the default value is 100%

2.6.4 Format of internal values table (tab_exp_int 2003h)

This table is composed by 64 words, one word for each internal value :

1st word : it defines the representation of the internal values

0x 0 0 0 0 (hexadecimal)



example 1 (hexadecimal if leaded by '0x...')

0x0002 internal representation of the value : percent of 4095.
 For example if its value is 2040 → $(2040/4095)*100 = 49,8\%$

Example 2 (hexadecimal if leaded by '0x...')

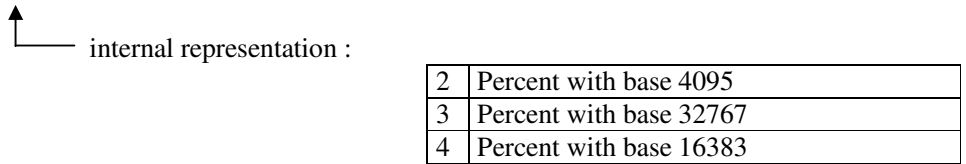
0x0041 internal representation of the size : direct value divided by 2^4
 For example if its value is 120 → $(120/2^4) = 7,5$

2.6.5 Format of monitor values table (tab_exp_osc 2004h)

This table is composed by 64 words, one word for each monitor value.

1st word : it defines the representation of internal values :

0x 0 0 0 0 (hexadecimal)



example 1 (hexadecimal if leaded by '0x...'):

0x0003 internal representation of the internal value: percent of 32767.
 For example if its value is 5000 → $(5000/32767)*100 = 15,2\%$

2.6.6 Management of the speed sensor (hw_software 2007h and hw_sensor 2008h)

The two variables hw_software and hw_sensor can assume the following values :

value	Corresponding sensor
0	--- none ---
1	Incremental encoder
2	Incremental encoder + Hall probes
4	Resolver
8	Sinuisoidal encoder Sin/Cos analog
9	Sinuisoidal encoder Sin/Cos absolute analog
10	Endat

hw_software represents the managed sensor of the version of the drive firmware.

hw_sensor represents the sensor managed by the feedback board mounted in the drive.

2.6.7 Management of the monitor (objects from 2009h to 200Ch +2012h)

These objects are related to the monitor of the drive internal values.

K_zz (2009h) is the internal counter of the 2000 points circular buffer.

Start_count If ≠0 it indicates that the trigger event set with C14 went off

Tab_monitor_A (200Bh) and **Tab_monitor_B (200Ch)** are circular buffer where the internal values selected by C15 and C16 are stored

Moreover parameter P54,P55 and P56 are involved. P54 sets the sample time of the monitor(units = PWM period); P55 sets the post-trigger points; P56 sets the trigger level if this is effectuated on the monitored internal values

See the product documentation for detailing of the monitored internal values

The object **Tab_osc (2012h)** is an array of 64 internal values with the most recent values of all the monitoring variables. In this way the single objects can be mapped as PDOs to keep under control the internal values of the drive.

2.6.8 Input logic functions (objects 2010h, 2013h, 2014h, 2016h, 201Fh, 2020h, 2021h, 2022h)

The management of the input logic functions is totally controlled via CAN.

In the variable **inputs (2013h)** it is possible to read the status of the 8 input available in the terminal-box in the less significant bit. The 8 logic input are configured by the C1-C8 connections, each one checking a particular input logic function.

Standard input logic functions (I00 ÷ I28)

The status of the 32 input logic functions is available in two different dictionary objects:

the array **Tab_inp_dig (2010h)** in which it's possible to read function by function using sub-index (logic state 0 = low ; 32767 = high) and the 32 bit variable **Ingressi_standard_rd (2021h)** in which every bit is related to the state of corresponding function.

Via CAN it's possible to set the status of the input logic functions: writing function by function with the array **Tab_inp_dig_field (2016h)** (0=low, 32767=high) or setting the state of all 32 logic functions writing the 32bit variable **Ingressi_standard_wr (201Fh)**.

The implemented logic provides that:

- The 0 logic input function (drive switch on/off) is given by the logic AND of the different input channels : terminal board, field-bus and serial line
- All the other logic functions can be set high by the logic OR of the different channels.

At start up, Tab_inp_dig_field [0]=high : in this way if this value is never over-written, the drive can be controlled via terminal-board.

Application input logic functions (I29 ÷ I63)

The status of the 32 application input logic functions is available in the 32 bit variable **Ingressi_appl_rd (2022h)** in which every bit is related to the state of corresponding function. Via CAN it's possible to set the status of all application input logic functions writing the 32bit variable **Ingressi_appl_wr (2020h)**.

The implemented logic provides that:

- The 32 application input logic functions can be set via CAN
- If one application input logic function is configured to a connector logic input, the physical state imposes the state of corresponding logic function.

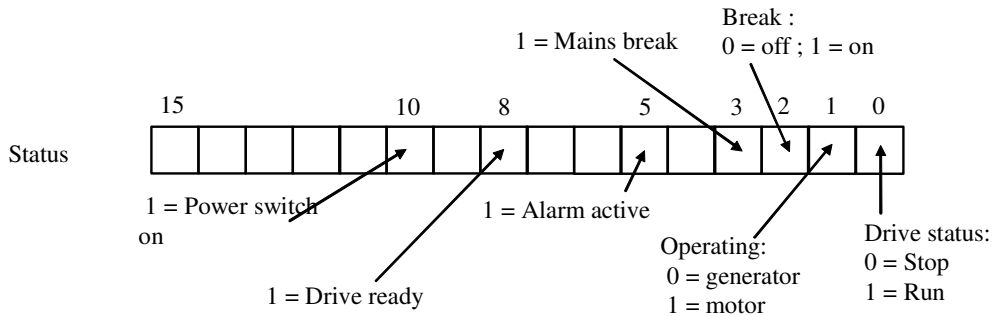
2.6.9 Output logic functions (objects 2011h, 2015h, 2023h)

Via CAN bus ,it is possible the monitoring the state of :

- the status of the 4 logic outputs in the 4 less significant bits of the variable **output (2015h)**
- the status of the 32 logic output functions in the array **Tab_out_dig (2011h)** using the sub-index. Like the inputs logic levels are: 0=low and 32767=high
- the status of all 32 output logic functions in the 32 bit variable **Uscite_logiche_rd (2023h)** in which every bit is related to the corresponding function

2.6.10 Status words (objects 2017h, 2018 and 2019h)

the object **2017h** is available as **status word** of the drive with the following meaning:



The object **2018h** is available as the status of the different **alarms** of the drive bit by bit; for example, the status of A8 alarm is shown by the bit n.8 of the word.

The object **2019h** is the alarm enabling mask. Again the meaning is bit by bit. This variable is available as read only access ; see parameter P163 for read and write access.

2.6.11 Control reference via CAN BUS (objects 201Ah,201Bh,201Ch and 201Dh)

These objects can be used to give: speed-reference, torque-reference, torque-limit to the drive. For doing this it is necessary to enable their management, setting **C52=1**.

f_fieldbus (201A) = speed reference in percent of the max speed set. Base representation is equal to 16384; thus 16384 is equal to 100%.

Theta_fieldbus (201D) = speed reference in electric pulses per period of PWM, considering that there are 65536 pulses per revolution and that the term 'electric' means they must be multiplied by the number of polar pairs of the motor.

Trif_fieldbus (201C) = couple reference in percent of the nominal torque of the motor. Base of Representation = 4095 : thus 4095 is = 100%

Limit_fieldbus (201A) = torque limit in percent of the nominal torque of the motor (it is in alternative to the other existing limits, the most restricted is the one that values). Representation base is 4095 : thus 4095 = 100%

OPEN DRIVE

OPEN DRIVE

Super Visor

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1. INTRODUCTION

This supervision software is a program designed to easy configure and control the OPEN DRIVE drives.

The program uses the PC RS485 serial line to communicate with the drive.

2. MINIMUM SYSTEM REQUIREMENTS

- Developed for Windows 2000, NT, XP, ME, 9X.
- Minimum video resolution: 800x600 (optimal)
- 32 Mbyte RAM

3. SOFTWARE INSTALLATION

- Launch the file “setup.exe” from the CD or from the folder in wich the files have been copied.
- Follow the instructions of the setup program. It will install the supervisor software and the Runtime Engine (Labview 6.1)

During the setup procedure the program will ask you to specify the folder where you desire to install the supervisor. The default floder is:

C:\Supervisor\azionamenti\Open v xx

In this folder are created the support files for the supervisor, and the supervisor itself: “Open v xx.exe”

If the files are compressed, before to launch the setup procedure decompress them using the program pkunzip.

To uninstall the supervisor program double click on the same file “setup.exe” used to install it and follow the instructions.

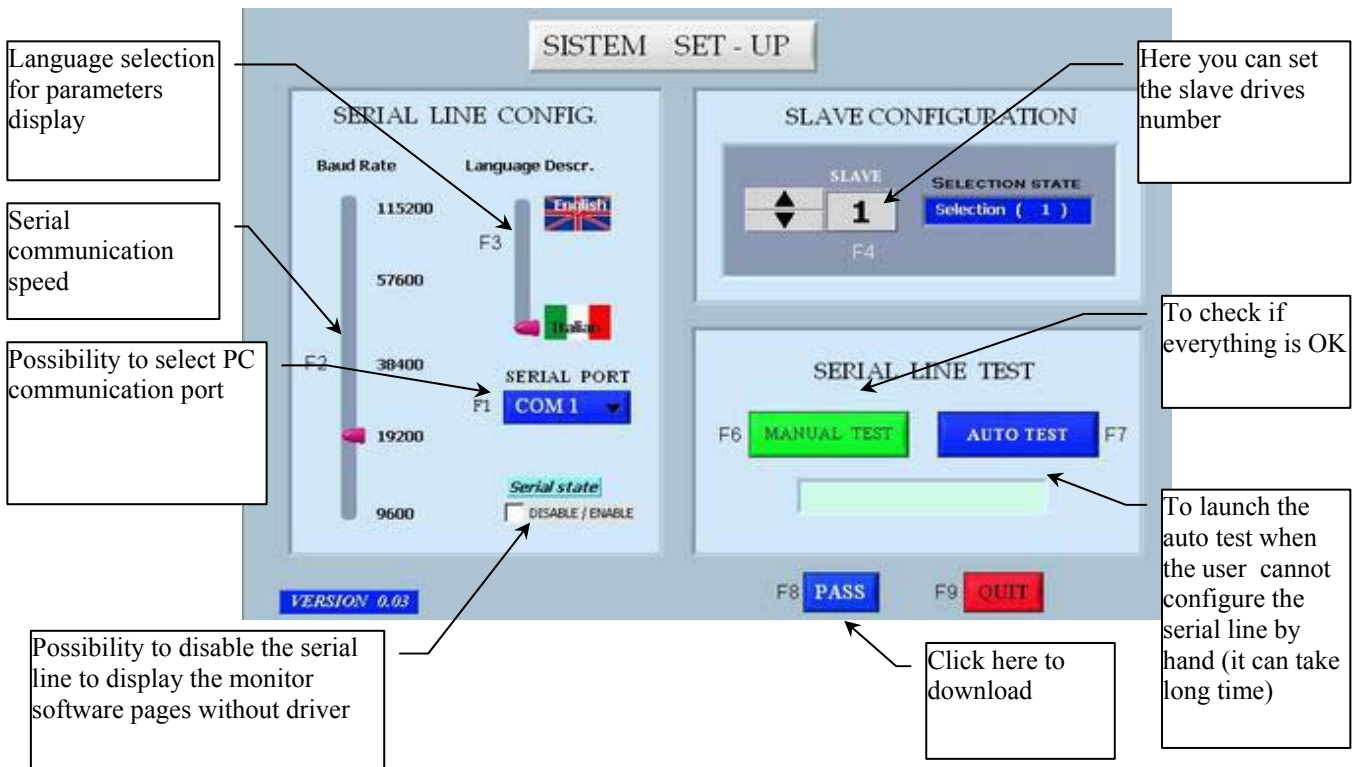
4. CONNECTION WITH THE DRIVE

Two different modes are available to connect the PC to the drive:

- Connect to the RS485 port in the drive. In this case it is needed a RS485/RS232 adapter. the cable type and the pinout depend on the adapter used.

TDEMACNO can provide the RS232/485 adapter with relative cable.

5. GETTING STARTED



The first step to access the program is the setting of the correct communication parameters:

- the slave number set in the supervisor must correspond to the slave number set in the drive (see parameter P92)
- the baudrate set in the supervisor must correspond to the baudrate set in the drive (see P93)
- select the COM port where the communication cable is connected

In the drive the default values are:

- Baudrate: 19200 baud (P93 =19.2)
- N. slave: 1 (P 92 = 1).

The user can select the language that will used in the program.

The second step is to check if the communication is correct:

- manual test: the communication between the PC and the drive is checked with the data set in the screen.
- automatic test: the first 20 slave number, the COM ports and the baudrates are scanned until the correct combination is found. (to abort the test disable the button)

When the communication is correct the message “Communication OK” is displayed, and the user can access the program pressing the “PASS” button.

The download screen is displayed to indicate that data are being downloaded from the drive:

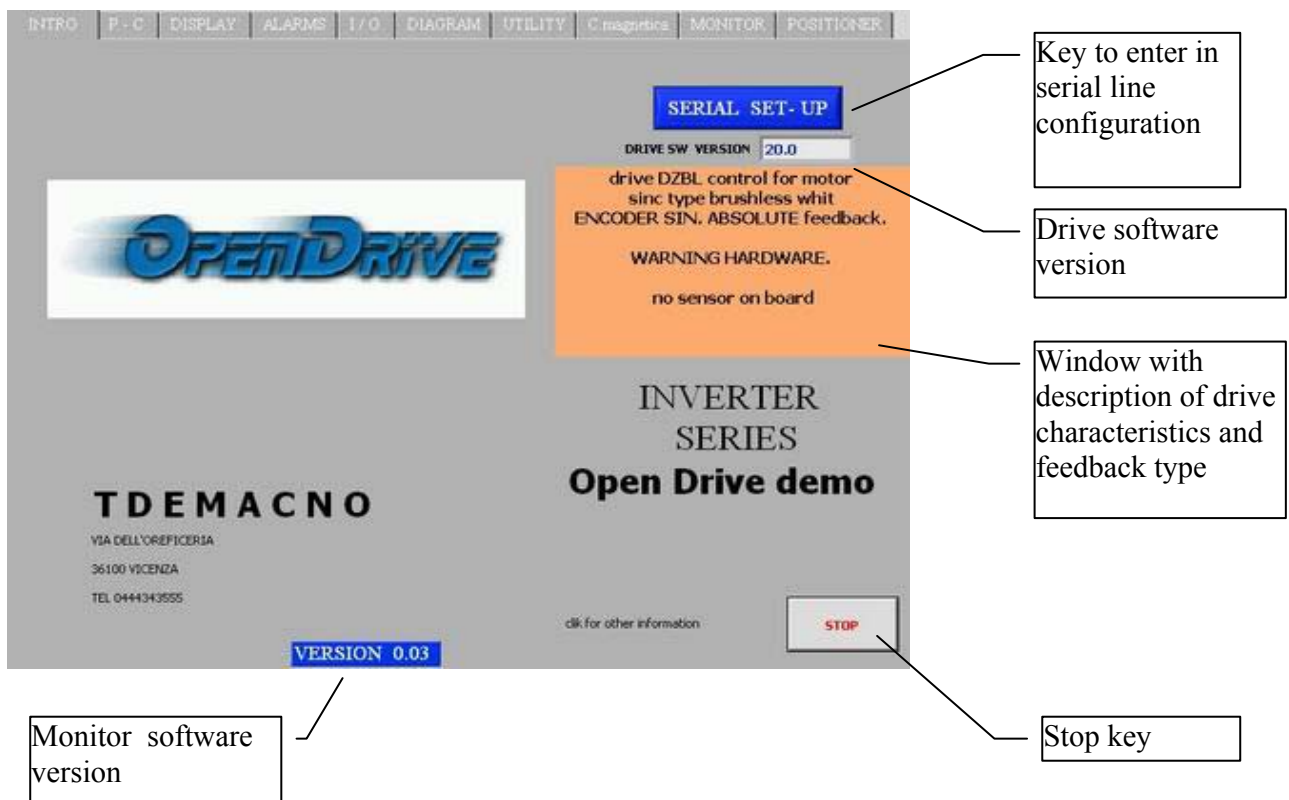
Note: the supervisor program uses the Modbus RTU communication protocol.

The supervisor program can work in “**OFFLINE**” mode, to allow the setting and saving of parameters configurations in the hard disk without having a drive connected to the serial line. To work in “**OFFLINE**” mode check the “Serial state” checkbox, and then press the “PASS” button.

6. PAGES DESCRIPTION

6.1. INTRODUCTION

In the first page you can go back to the serial configuration page or terminate the program pressing “ESC”.



6.2. P,C

In this page the user can access all the parameters “P” of the drive : the table contains the actual value of the parameter in the RAM of the drive, and then the default value and the limits.

To change the value of one parameter, select it in the table and write the new value in the field above the table, then press enter to confirm.

To enable the access to the protected parameters “r”, select the “key” button and set the value equal to 95. The same is to read and set the connections “c”.

To access the direct commands “dcd” press the button below the table, and then select the desired command.

PARAMETERS

DESCRIPTION	VALUE	FLAG	MAX	MIN	DEF.
P.1. Fattore correttivo rif. analogico 1 (AN_INP_1) a 14 bit [%]		On line	400.0	-400.0	100.0
P.2. Offset correttivo rif. analogico 1 (AN_INP_1) a 14 bit [%]		On line	100.0	-100.0	0.0
P.3. Fattore correttivo rif. analogico 2 (AN_INP_2) a 14 bit [%]		On line	400.0	-400.0	100.0
P.4. Offset correttivo rif. analogico 2 (AN_INP_2) a 14 bit [%]		On line	100.0	-100.0	0.0
P.5. Fattore correttivo rif. analogico 3 (AN_INP_3) a 14 bit [%]		On line	400.0	-400.0	100.0
P.6. Offset correttivo rif. analogico 3 (AN_INP_3) a 14 bit [%]		On line	100.0	-100.0	0.0
P.7. Riferimento di velocità in digitale (JOG1) [% nmax]		On line	100.00	-100.00	0.00
P.8. Velocità di partenza motopotenzimetro [% nmax]		On line	100.0	-100.0	2.0
P.9. Velocità di indessaggio [% nmax]		On line	100.00	-100.00	2.00

CONNECTIONS

DESCRIPTION	VALUE	FLAG	MAX	MIN	DEF.
C.0. Visione automatica grandezze interne		On line	63	0	21
C.1. Significato ingresso logico 1		Reserved(r)	28	0	9
C.2. Significato ingresso logico 2		Reserved(r)	28	0	10
C.3. Significato ingresso logico 3		Reserved(r)	28	0	6
C.4. Significato ingresso logico 4		Reserved(r)	28	0	0
C.5. Significato ingresso logico 5		Reserved(r)	28	0	3
C.6. Significato ingresso logico 6		Reserved(r)	28	0	12
C.7. Significato ingresso logico 7		Reserved(r)	28	0	2
C.8. Significato ingresso logico 8		Reserved(r)	28	0	8

6.3. DISPLAY

There are displayed some of the internal variables of the drive. The graph shows the value of the variable versus the time.

The max and min displayable value can be selected with the two controls below the graph. The limits can be increased beyond ± 200 overwriting the value of the controls.

Note: the values are updated very slowly, because of the serial communication time. Thus these values can monitor smooth variations but not fast dynamic changes.

The screenshot shows a software interface with a menu bar at the top containing: INTRO, P-C, DISPLAY, ALARMS, I/O, DIAGRAM, UTILITY, C magnetica, MONITOR, POSITIONER. The main area is titled 'DISPLAY' and features a large blue grid graph on the left. Below the graph are two rotary dials labeled 'Max' and 'Min' with numerical scales. To the right of the graph is a 'Display-RAM' indicator, a numeric display showing '0', and another numeric display showing '0.0'. Below these is a 'Display description' field containing 'd00 Versione software'. At the bottom right is a 'tastierino' keypad simulation. Callouts with arrows point to various elements: 'Graphic of the selected value' points to the graph; 'To chose display or reading through RAM' points to the 'Display-RAM' indicator; 'Selected value' points to the '0' display; 'Numeric value' points to the '0.0' display; 'Value description in displaying status' points to the 'Display description' field; 'Simulation of external keypad' points to the 'tastierino' keypad; and 'BOX for display setting' points to the 'Max' and 'Min' control area.

6.4. ALARMS

In this page is displayed the state of the alarms of the drive “Axx”.

The alarms can be reset pressing the “Alarms reset” button (command C30=1 in the drive keypad).

Some alarms can be disabled; to do this set the key P60=95 and select the undesired alarms, then press “Send”.

See the user manual to read more informations about the alarms and the disabilities.

The screenshot shows the 'ALARMS STATE' screen with a menu on the left, a list of alarms in the center, and control buttons on the right. Annotations explain the interface elements:

- Red ball = active alarm with description**: Points to the first item in the left menu.
- Disabled alarm**: Points to the 'A 15' entry in the center list.
- Keys for alarms disabling**: Points to the 'push' buttons for 'A 11' through 'A 15'.
- Alarm fast reset**: Points to the 'ALARMS RESET F 10' button.
- Key for P60 setting**: Points to the 'KEY' button.

Alarm ID	Status	Action
A 0	Active	push A 0
A 1	Active	push A 1
A 2	Active	push A 2
A 3	Active	push A 3
A 4	Active	push A 4
A 5	Active	push A 5
A 6	Active	push A 6
A 7	Active	push A 7
A 8	Active	push A 8
A 9	Active	push A 9
A 10	Active	push A 10
A 11	Active	push A 11
A 12	Active	push A 12
A 13	Active	push A 13
A 14	Active	push A 14
A 15	Disabled	push A 15

6.5. I / O STATE

This page shows the state of the inputs and the outputs of the drive. Some input and outputs are not used (N.U.).

The function “logic configuration” allows the quick configuration of the logic inputs and outputs (note: the change of the configuration is allowed if P50=95 and the drive is in “stop”). In the popup menu are displayed the available functions.

The screenshot shows the 'I / O STATE' screen with a menu on the left and a central display area. The menu lists 26 items (I00-I26) with status indicators. The central area has 'INPUT' and 'OUTPUT' sections with status indicators and a 'Logic configuration' button. Annotations with arrows point to various elements:

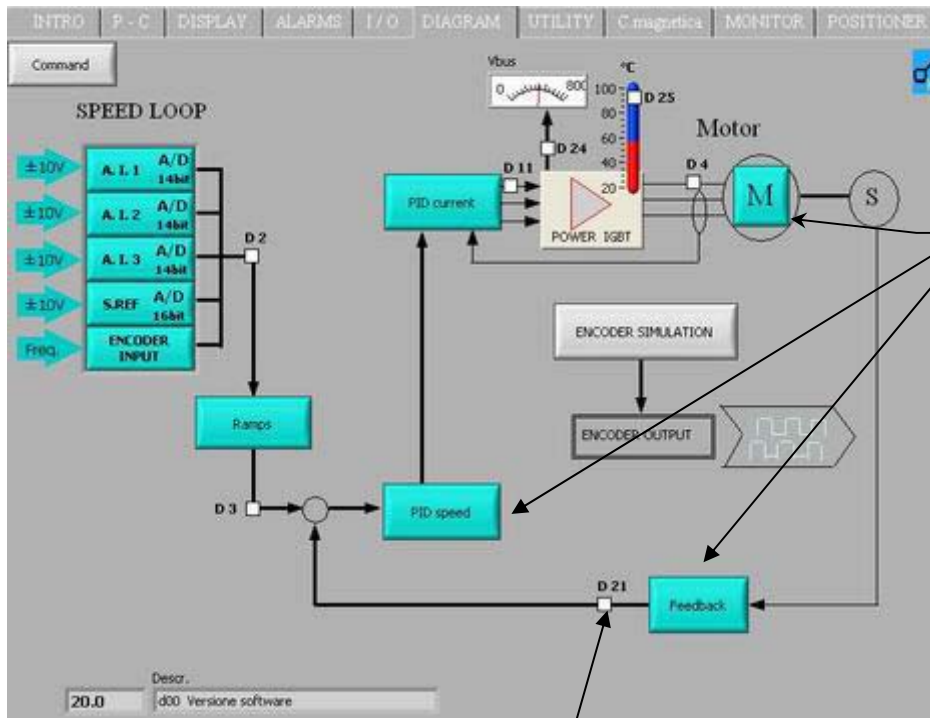
- Possibility to directly configure hardware I/O**: Points to the 'Logic configuration' button.
- To select I/O pages**: Points to the 'INPUT' and 'OUTPUT' status indicators.
- Software input status**: Points to the menu items I00-I26.
- Hardware input status**: Points to the 'Ingresso logico 1-8' list.

6.6. DIAGRAM

This page shows a diagram of the drive-motor system: the user can set quickly the main parameters (press the light buttons????).

If the mouse arrow stops over one of the parameters, a small windows pops up showing its limits and its default value.

To change the value of the parameters, just write the new value and press “enter



Each box is an interactive page where you can modify parameters

To display the selected value with description by clicking the left key of the mouse

6.7. UTILITY

Default data report: creates a report of the default values (parameters P1÷P130 and connections C1÷C80); the format of this file is “html”.

RAM data report: creates a report of the RAM values (parameters P1÷P130 and connections C1÷C80); the format of this file is “html”.

Alarms report: creates a report of alarms A1÷A15; the format of this file is “html”.

Data saving: creates a binary file in which the RAM values (P1÷P130 e C1÷C80) are saved.

Data loading: uploads to the drive the data previously saved in a binary file using the "Data saving" (P1÷P130 e C1÷C80).

Protected parameters and connections are modified on the drive only if P50=95.
If some error occurs, a warning message is displayed to avoid incorrect settings in the drive.

Display data saved: this function displays the contents of a binary file previously saved using the "Data saving" function. The first 140 parameters and 80 connections are displayed (description and value).

The switch selector and the scroll bar can be used to select “parameter-connection” and to quickly access the desired data.

Possibility to generate .html files and to save DEFAULT data, data in RAM and ALLARM status

Possibility to generate .txt files and to save DEFAULT data, data in RAM and ALLARM

Receipts in dat format are not readable by standard editor progr. To check the data use this tool

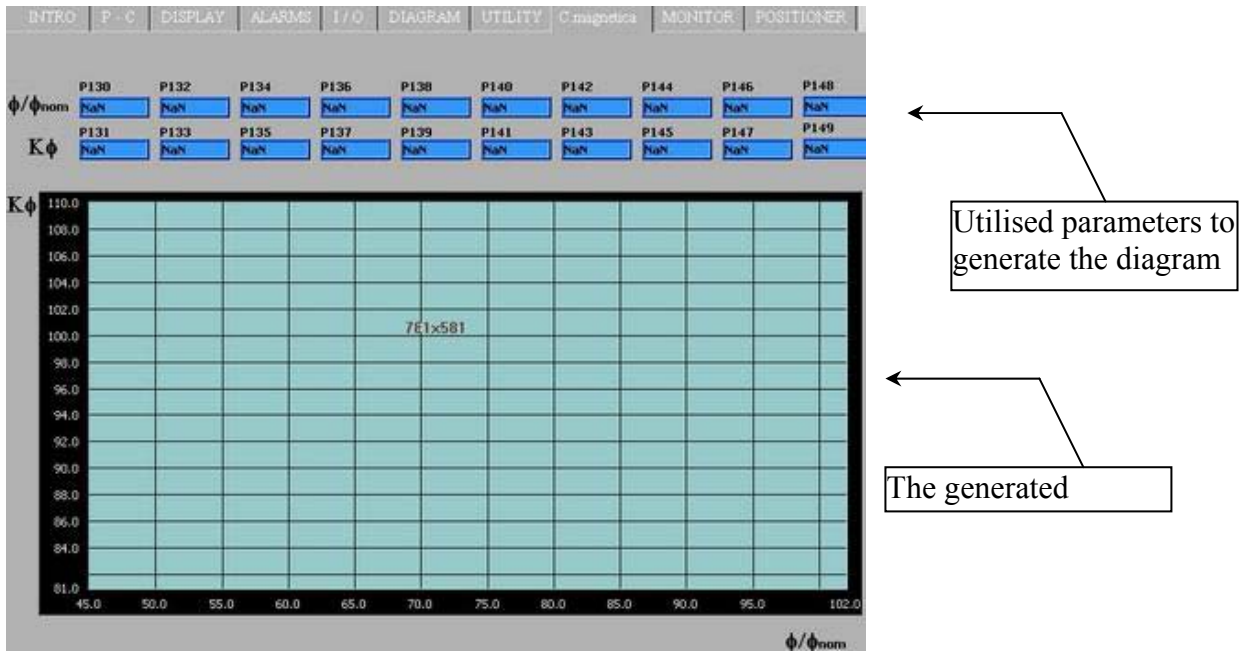
First function allows to generate .dat data to customised receipts. The second one download an existing receipt in the drive and check the compatibility with the drive type

6.8. CHARACTERISTIC

This test has the dual purpose of determine the magnetizing current of the motor and his magnetic characteristic (for version DVET)

Using the parameters P71 , P72 , P73 and P74 it is possible to define a three-section working curve by points (so as to be better able to adjust to the desired characteristics).

Points P72 and P74 define the frequency percentage with reference to the maximum working frequency (P68) while points P71 and P73 define the percentage voltage with reference to the maximum working voltage (P69). (for version DFNT)



6.9. MONITOR

With the “MONITOR” function the user can manage the real-time acquisition of the drive internal variables.

The page is divided into three subpages:

- settings
- acquisition
- analysis and data processing

In the setup subpage can be set the acquisition parameters: the trigger level, the trigger type, the sample time.

Then open the “acquisition” subpage: press the “restart” button and the acquisition begins in the drive, following the settings.

The box near the “restart” button tells the user if the acquisition has already been triggered.

Once triggered, the acquisition keep on until the number of points after trigger is reached (post trigger points). When the value in the box “fine buffer” stops, press te button “Download data”.

Now the data are being downloaded from the drive to the PC (2000 samples per channel).

The user can save the obtained waveshape (SAVE) or can load a previously saved waveshape (LOAD), or can even create a report in “xls” format.

Selectiong the function “Options” the user can hide or unhide the trigger line and the trigger level in the graph. Two vertical and horizontal markers can be enabled to measure the time delta and the amplitude delta of the acquired signals.

There are two different possibilities for the zooming of the graph: window zoom and digital zoom.

In the first case select the desired graph area dragging the mouse arrow.

In the second case write in the fields the desired limit values and the graph will change accordingly.

Acquisition example: we suppose to acquire the waveshape of the current in the U and V phases.

First step, set these two variables on the channel one and two (c15, c16).

Then select the trigger type “level of channel 1”, set the desired level (P56, “trigger level”) to 50%.

Set the “sample time” (P54); remember to multiply this number by 200µsec to obtain the correct time.

Finally set the number of samples to acquire after the trigger (P55).

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